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Review

Effectiveness of chain of survival for out-of-hospital-cardiac-arrest (OHCA) in resource limited countries: A systematic review

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Abstract

Aim: Given the critical disparities in survival for out-of-hospital-cardiac-arrest (OHCA) in resource limited countries and the lack of context-specific evidence to guide resuscitation practices, we aimed to systematically evaluate the effectiveness of the chain of survival components including bystander response, emergency medical services (EMS) response, advanced life support, and post-resuscitation care on outcomes such as return of spontaneous circulation, survival to admission, survival to hospital discharge, and neurological outcomes in these settings.

Methods: This systematic review, following PRISMA guidelines, included observational and interventional studies on OHCA management from low, lower-middle, and upper-middle-income countries, published in English (2004–2023). PubMed, Embase, CINAHL, and Cochrane Library were searched using predefined terms. Two reviewers independently screened studies, extracted data using the Utstein template, and resolved conflicts with a third reviewer. Data included pre-hospital, patient, and post-resuscitation care factors, as well as short and long-term outcomes. Descriptive analysis and narrative synthesis were conducted, with return of spontaneous circulation (ROSC) rates compared across income groups using *t*-tests.

Results: Sixteen (16) eligible studies were included. No study was found from low-income countries. ROSC rates ranged from 0.7% to 44%, survival to discharge from 0.6% to 14.1%, and good neurological outcomes (CPC 1–2) from 0.6% to 53.8%. While upper-middle-income countries showed slightly higher ROSC rates, differences were not statistically significant. Risk of bias was moderate to high due to selection bias, inadequate confounding control, and inconsistent reporting. These findings emphasize the need for standardized reporting and further research to improve outcomes in resource limited countries.

Conclusion: This review highlights low survival rates for OHCA in resource limited countries, with significant variability and gaps in evidence. Strengthening EMS systems, adopting context-specific strategies, and standardizing reporting are critical to improving outcomes.

Keywords: Out-of-Hospital-Cardiac-Arrest (OHCA), Chain of Survival, Resource Limited Countries

Introduction

Early cardiopulmonary resuscitation (CPR) and defibrillation can double or triple survival rates in out-of-hospital-cardiac-arrest (OHCA), yet these interventions remain underutilized in low and lower-middle-income countries (LMICs).[1–6] Furthermore, the mortality rates from cardiovascular diseases, including OHCA, are increasing in low and lower-middle-income countries, largely due to limited access to emergency care and essential medications.[7–10] The chain of survival, an operational framework for managing cardiac arrest, comprises steps like early recognition, activation of emergency medical services (EMS), CPR and defibrillation, advanced life support, and post-resuscitation care. The Utstein template provides a standardized system for reporting key indicators such as EMS response times and bystander CPR, yet significant global variations in OHCA outcomes persist, with survival rates ranging from less than 1% in Asia to 8–10% in the United States.[11–14] These disparities stem from differences in resources, EMS infrastructure, community awareness and data systems.[15–17] The International Liaison Committee on

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Resuscitation (ILCOR) has called for strategies tailored to resource-limited settings, emphasizing context-specific instructional methods and the development of CPR standards. While prior work has described clinical outcomes and challenges, gaps remain in evaluating the feasibility and implementation of the chain of survival in these settings.[18,19]

This review addresses these gaps by systematically analyzing the effectiveness of the chain of survival components, including bystander response, EMS response, advanced life support, and post-resuscitation care, on key OHCA outcomes such as return of spontaneous circulation (ROSC) and survival to discharge in resource limited countries. The findings aim to guide policymakers and healthcare providers in optimizing system design and improving OHCA outcomes in these regions.

Methods

The review received an ethical approval from the Ethical Review Committee of the Aga Khan University, Karachi, Pakistan (ERC Reference Number: 2022-7355-21842), and follows the Preferred Reported Items for Systematic Review and Meta-Analysis (PRISMA) guidelines to ensure methodological rigor and transparency in reporting. (Please refer to the PRISMA checklist in the supplement).

Eligibility criteria

The eligibility criteria for this systematic review were clearly defined to ensure a focused and comprehensive selection of studies. Studies conducted in low-income, lower-middle-income, and upper-middle-income countries were eligible for inclusion, with a focus on both observational studies examining the characteristics and outcomes of OHCA patients and interventional studies evaluating management strategies for these patients. Human studies involving adult patients (≥18 years) with OHCA were eligible. Studies published in English with full-text availability were considered to facilitate a comprehensive analysis. This restriction was due to limited resources for translating non-English articles.

Exclusion criteria were applied to refine the selection process. Studies from high income countries were excluded to maintain relevance to resource limited countries. Studies involving manikins or simulations were excluded, to ensure the focus remained on human populations and real-world outcomes. Furthermore, after the initial data extraction, studies focusing on traumatic OHCA, as well as cases of drowning or electrocution, were excluded to reduce complexity and ensure the focus remained on non-traumatic OHCA scenarios. This decision was made because the management of traumatic OHCA often involves surgical and trauma-specific interventions, which differ significantly from medical care. Including these cases would introduce additional heterogeneity and complicate the analysis of the chain of survival components, which are primarily designed for non-traumatic cardiac arrest scenarios. These criteria were designed to capture relevant evidence while maintaining a clear and manageable scope for the review.

Information sources & search strategy

The search strategy was developed by authors (NB & ZF) in collaboration with the university librarian experienced in systematic reviews. The initial draft of the search strategy was designed to identify studies addressing the chain of survival components in OHCA within resource limited countries. To ensure accuracy and comprehensiveness, the strategy was reviewed by a second information specialist. (Please see Supplement 1).

The search was conducted from January 01, 2004, till December 31, 2023. We limited our search to studies published from January 2004 onwards because the Utstein guidelines for standardized reporting of OHCA were updated in 2004. The Utstein reporting template provides a globally accepted framework for reporting OHCA outcomes, ensuring consistency and comparability across studies.[11] By restricting the timeframe, we aimed to include studies that adhered to these updated guidelines and provided standardized, high-quality data. The search was carried out by the author (NB) with the help of the university librarian. PubMed, Embase, CINAHL and Cochrane Library were used as primary databases for the electronic search. The key search terms that we used were: out-of-hospital-cardiac-arrest/OHCA, sudden cardiac arrest/SCA, sudden cardiac death/SCD, chain of survival, outcomes/survival, effectiveness/efficacy and low income/lower-middle-income/upper-middle-income countries. We used the population (adult patients with OHCA), concept (chain of survival) and context (low, lower-middle and upper-middle income countries) framework to determine the eligibility criteria.

We also used the Population, Intervention, Comparison, Outcomes, Setting & Timeframe (PICOST) to bring more clarity in our search for eligible studies. The PICOST for the review was defined as follows:

Population: Adult (>18 years of age) patients with OHCA from low, lower-middle and upper-middle-income countries.

Intervention: Components of the chain of survival, including bystander response (e.g., CPR, defibrillation), EMS system factors (e.g., response time, dispatcher-assisted CPR), advanced life support (e.g., pre-hospital intubation, defibrillation, medications), and post-resuscitation care (e.g., PCI, therapeutic hypothermia).

Comparison: Not applicable as no control group was included in this review.

Outcomes: The primary and secondary outcomes for this review were defined using the standardized Utstein reporting template for OHCA.[11] Primary outcomes were short-term measures such as return of spontaneous circulation (ROSC), survival to admission, survival to discharge or 30-day-survival, and neurological outcomes (using CPC scores) at discharge. Secondary outcomes included long-term survival and neurological outcomes measured after discharge (e.g., 6-month or 12-month follow-up).

Setting: Resource limited countries, defined as low, lower-middle, and upper-middle-income countries based on World Bank classifications.[20]

Timeframe: Studies published between January 2004 and December 2023, aligning with the adoption of updated Utstein reporting guidelines.

Selection process

Two review authors (NB & AR) independently examined the titles and abstracts to remove duplicate and non-eligible studies. Full texts of potentially eligible studies were retrieved. (NB & AR) independently reviewed full text articles for inclusion, and recorded reasons for exclusion. Disagreements between review authors were resolved by discussion and in consultation with the third review author (ZF). To include resource limited countries, we utilised the World Bank categorization of countries as per their economic status. The World Bank classifies countries as Low-Income countries (<1085$), Low-Middle-Income-Countries (1086-4255), Upper-Middle-Income-Countries (4256$–13,205$) & High-Income-Countries- (>13,205$) according to the Gross National Income (GNI) per capita.[20] For every study in the review we applied the World Bank's economic category for the particular country in which the study was conducted (Table 1). Where data was incomplete or unclear, we corresponded with the investigators for clarification and additional details.

Data extraction

We used the Utstein guidelines for OHCA for standardised reporting and definitions of terms.[11] Two authors (NB & AR) independently conducted data extraction using a piloted data collection form to ensure consistency. Key variables including study design, pre-hospital system factors (EMS response times), patient and event related factors (age, gender, comorbidities, location of arrest, witnessed arrest, bystander response in terms of CPR & defibrillation, initial rhythm), dispatcher related factors (time to recognize cardiac arrest and commencement of CPR instructions), OHCA processes (pre-hospital intubations, defibrillation, medications), post-resuscitation care (angiography, PCI, therapeutic hypothermia), short-term outcomes (ROSC, survival to admission, survival to hospital discharge & neurological outcomes at hospital discharge) and long-term outcomes (survival and neurological outcomes after a certain time frame) were captured. Conflicts were resolved by consensus. Where conflicts could not be resolved, a third reviewer (ZF) acted as an arbitrator.

An Excel spreadsheet was used to extract relevant data. The results of each study including the chain of survival interventions and their outcomes as per the Utstein template were presented in Tables 2 and 3. As we also included studies from upper-middle-income countries, which may have better infrastructure and resources to manage OHCA patients, we compared the mean difference in ROSC between lower-middle and upper-middle-income countries through student *t*-test using a statistical computing software R, (version 4.3.2). We reported P values to determine statistical significance, with $P < 0.05$ considered significant.

Meta-analysis was initially considered for this systematic review but deemed unfeasible due to significant heterogeneity among the included studies. To provide clarity, we calculated measures of consistency using the I2 statistic, which quantifies the percentage of variation across studies that is due to heterogeneity rather than chance. The overall heterogeneity across all studies is 100%, reflecting substantial differences in the studies' results (Please see Supplement 2). Key sources of variability included differences in study design, with all studies being observational but employing varied methodologies (e.g., retrospective versus prospective cohorts), complicating statistical pooling. The studies also differed in healthcare contexts, spanning upper-middle- and lower-middle-income countries, which introduced marked disparities in EMS quality, public CPR training, and hospital resources, factors that could confound the chain of survival's effectiveness. While ROSC was a commonly reported outcome, variations in definitions, timing, and measurement methods, alongside inconsistent reporting of other survival metrics (e.g., discharge or neurological outcomes), further limited comparability. Additionally, a high risk of bias across key domains, particularly in random sequence generation and other biases, suggested methodological inconsistencies that could undermine pooled results. To handle this heterogeneity, we employed subgroup analyses based on the economic classification of countries (upper-middle-income vs. lower-middle-income) and narrative synthesis to interpret findings systematically.

Given these findings, we refrained from pooling data using meta-analytic methods, as it would likely yield misleading conclusions. Instead, a narrative approach allowed us to explore patterns, gaps, and trends in the data while acknowledging the limitations imposed by heterogeneity.

Table 1 – Number of studies as per regions of the world.

Region	Number of Studies	Countries
Asia	06	Taiwan (03), Vietnam (01), China (01), Thailand (01)
South Asia	03	Pakistan (02), India (01)
Middle East	03	Lebanon (02), Iran (01)
Africa	01	Tunisia (01)
Europe	03	Turkey (03)
Total	16	

Risk of bias assessment

The risk of bias in the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklists, which are tailored for different study designs, including cross-sectional, cohort, and case-control studies. These tools were selected due to their ability to evaluate key domains of bias relevant to observational studies, such as selection bias, confounding control, measurement reliability, missing data bias, and context-specific bias. Each domain was assessed based on predefined criteria provided in the JBI checklists.

The assessment process was conducted by two independent reviewers (NB & AR) who evaluated each study against the checklist items corresponding to its design. Disagreements between the reviewers were resolved through discussion, and if consensus could not be reached, a third reviewer (ZF) was consulted. The reviewers worked independently to minimize subjective influence and ensure unbiased evaluations of the included studies.

Results

During the initial search 4802 abstracts were identified out of which 39 articles were selected for retrieval of full texts (Fig. 1). The search identified sixteen (16) eligible studies from five different regions of the world including Asia, South Asia, Middle East, Africa and Europe.[21–36] There were no studies from the low-income countries. Eight studies were from lower-middle-income countries (Lebanon: 02, Pakistan: 02, Vietnam: 01, Iran: 01, Tunis: 01 & India: 01)[21–28] and eight studies were from upper-middle-income countries (Turkey: 03, Taiwan: 03, Thailand: 01 & China: 01)[29–36] (Table 1).

The number of patients reported were from 129[29] to 132,262.[36] Only four studies had a sample size of greater than 1000.[22,34–36] The study design of all the studies was observational (retrospective or prospective). Among the variables, only one study reported all variables according to the Utstein template for OHCA patients,[36] whereas 10 studies reported the EMS system related factors with

Table 2 – Summary of findings.

Country	Publication Author & Year	Socioeconomic Status	Core System	Core Dispatcher	Core Patient	Core OHCA Process	Core Post-Resuscitation Processes	Core Outcome	Notes
Asia									
Taiwan	Wang, Chih-Hung et al., 2019	Upper-middle	No	No	Yes	No	No	Yes	
Taiwan	Yen- Nien Lin et al., 2017	Upper-middle	Yes	No	Yes	No	No	Yes	Number of cardiac arrests attended and system description were not reported in core system factors. Only response times were reported in core OHCA process. Neurological outcomes on discharge were not reported in core outcomes.
Taiwan	Chan-Wei, Kuo et al., 2014	Upper-middle	Yes	Yes	Yes	Yes	No	Yes	
Vietnam	Do, N Son et al., 2021	Lower-middle	No	Yes	Yes	Yes	Yes	Yes	Core System mentioned system description only
China	Zheng Jiaqi et al., 2023	Upper-middle	Yes	Yes	Yes	Yes	Yes	Yes	
Thailand	Wachiranun S et al., 2022	Upper-middle	Yes	No	Yes	Yes	No	Yes	
Middle East									
Lebanon	El Sayed et al., 2017	Lower-middle	No	No	Yes	No	No	Yes	Core OHCA processes mentioned response times only.
Lebanon	El Sayed et al., 2014	Lower-middle	No	No	Yes	No	No	yes	Core OHCA processes mentioned response times only. Core outcomes reported 30 day survival or survival to discharge
Iran	Elham Navab et al., 2et al., 2019	Lower-middle	No	No	Yes	No	No	Yes	Only response times were mentioned in core OHCA process. Neurological outcomes were reported in core outcomes.
South Asia									
Pakistan	Moosajee et al., 2018	Lower-middle	No	No	Yes	No	No	Yes	
Pakistan	Mawani et al., 2016	Lower-middle	Yes	No	Yes	No	Yes	Yes	Core system mentioned the total population served and system description. Core OHCA processes only mentioned defibrillation times.
India	Srinivas Ramaka et al., 2020	Lower-middle	No	No	Yes	Yes	No	Yes	Only response times mentioned in core OHCA process.
Europe									
Turkey	KG Balci et al., 2017	Upper-middle	No	No	Yes	Yes	Yes	Yes	Arrest location, bystander response and first monitor rhythm not mentioned in Core Patient Factors. In Core OHCA Process defibrillation times, TTM and medications given were not mentioned.
Turkey	Ibrahim, C et al., 2016	Upper-middle	No	No	Yes	No	No	Yes	Witnessed arrest, arrest location and bystander response were not mentioned in core patient factors.

Table 2 (continued)

Country	Publication Author & Year	Socioeconomic Status	Core System	Core Dispatcher	Core Patient	Core OHCA Process	Core Post-Resuscitation Processes	Core Outcome	Notes
Turkey	Bulent Erdur et al., 2008	Upper-middle	Yes	No	Yes	Yes	No	Yes	OHCA process did not mention defibrillation times and TTM. Neurological outcomes were not mentioned in Core outcomes.
Africa									
Tunis	Zelfani, Saida et al., 2019	Lower-middle	No	No	Yes	No	No	Yes	Only response times mentioned in core OHCA process.

variations in terms of population served, number of cardiac arrests attended, number of resuscitations attempted, response times, and system description.[21–25,27,29–31,35] All studies reported patient related factors like age and gender, and most of the studies reported comorbidities whereas there was variation in reporting certain event related factors like location of arrest, witnessed arrest, bystander response and initial rhythm. Few studies reported OHCA processes including pre-hospital airway control, medications and defibrillation by EMS but there was variation in reporting (Table 2). Fifteen (15) studies reported short-term clinical outcomes including return of spontaneous circulation (ROSC), survival to admission or survival to discharge within 30 days but only 02 studies reported long term outcome that is survival and neurological outcome after 06,09 and 12 months (Table 3).[30,36]

The mean age of the patients ranged between 54.4 ± 21.8 Years[35] and 70.1 ± 29.2 Years.[33] The EMS response times varied between 06 (04–09) minutes[22] to 50 (40–90) minutes[28] whereas the bystander response rate was reported from 2.3%[23] to 22.3%.[21] The ROSC rates were reported from 0.7%[24] to 44%.[32] The survival to admission was reported from 1.6%[23] to 24.2%[21] whereas the survival to hospital discharge or 30-day survival varied from 0.6%[23] to 14.1%.[21]

Neurological outcomes on discharge were reported in 08 studies.[21,24–26,31,32,35,36] Good neurological outcome (CPC 1–2) ranged from 0.6%[36] to 53.8%.[24] We also noticed that although there was a significant reduction in number of patients who were discharged alive from the hospital after achieving ROSC, but the proportion of favourable neurological outcomes (CPC 1–2) were reasonably hight at discharge.[21,24–26,31,35,36]

Table 2 highlights significant reporting gaps in core Utstein elements, particularly in system and dispatcher-related factors. Only three studies described dispatcher interventions,[21,34,36] and post-resuscitation processes were reported in just four studies.[21,23,29,36] These omissions are critical, as they likely reflect inadequacies in EMS infrastructure and dispatcher-assisted CPR programs in resource-limited countries. The limited reporting of these components makes it challenging to evaluate their role in survival outcomes. These gaps emphasize the need for robust EMS and dispatcher systems to strengthen the chain of survival.

While Table 3 summarizes ROSC, short term and long term survival along with neurological outcomes, the variability in denominators (e.g., total number of cardiac arrests or patients receiving CPR) and inclusion criteria across studies limits direct comparability. This heterogeneity reflects differences in study design, sample sizes, and data collection methods, which are inherent challenges in resource limited countries. Nonetheless, the table provides valuable insights into survival outcomes and highlights the need for standardized reporting using Utstein templates.

Comparison between upper-middle & lower-middle income countries

We compared ROSC rates between upper-middle-income countries (UMICs) and lower-middle-income countries (LMICs). On average, UMICs achieved slightly higher ROSC rates (Mean: 23.44% ± 16.42%) compared to LMICs (Mean: 13.36% ± 8.72%). However, this difference was not statistically significant ($P = 0.18$), suggesting that while there is a trend toward better outcomes in UMICs, the variation may not be conclusive.

In terms of distribution, ROSC rates in UMICs demonstrated greater variability, as indicated by a wider interquartile range (IQR)

Table 3 – Summary of findings.

Country	Publication Author & Year	Socioeconomic Status	Study Design	Sample Size	Outcome 1: ROSC	Outcome 2: Survival to Admission & Survival to Discharge	Outcome 3: Long Term Outcome (Survival/neurological outcome at 6 months, 12 months)
Asia							
Taiwan	Wang, Chih-Hung et al., 2019	Upper-middle	Prospective	Out of 936 patients, 412 with sustainable ROSC were included	44%	22.8% of those with sustainable ROSC survived to hospital discharge with favorable neurological outcomes	Not reported
Taiwan	Yen- Nien Lin et al., 2017	Upper-middle	Prospective	1629	Pre-hospital ROSC: 2.1%, Survival at 2 h: 17.3%, Survival at 24 h: 11.5%	Survival to hospital discharge: 3.9%	Not reported
Taiwan	Chan-Wei, Kuo et al., 2014	Upper-middle	Retrospective	712	7.8%	Survival to Admission: 16.3% Survival to Discharge: 1.4%	Not reported
Vietnam	Do,N Son et al., 2021	Lower-middle	Prospective	590	Pre-hospital ROSC: 19% ROSC in ED: 24.7%	Survival to Hospital Admission 24.2%. Survival to Hospital Discharge within 30 days 14.1%. CPC 1 & 2: 5.6%	Not reported
China	Zheng Jiaqi et al., 2023	Upper-middle	Prospective	38,227	Pre-hospital ROSC: 3.4% ROSC at ED: 1.7%	Survival to discharge or 30 days: 1·2%. 0·8% survived with favorable neurological outcomes	Survival at 06 months: 0·8%. 0·7% survived with favorable neurological outcomes. Survival at 12 months: 0·7% 0·6% survived with favorable neurological outcomes
Thailand	Wachiranun S et al., 2022	Upper-middle	Retrospective	1240	40.3%	Survival at 30 days: 3.4%. CPC 1–2: 04 patients, CPC 3–4: 02 patients, 36 patients were unknown	Not measured
Middle East							
Lebanon	El Sayed et al., 2017	Lower-middle	Retrospective	271	Pre-hospital ROSC: 0.7%	15.9% survival to admission. 4.8% survival to discharge; CPC 1–2 in 53.8%	Not reported
Lebanon	El Sayed et al., 2014	Lower-middle	Retrospective	214	19%	5.5% survival to hospital discharge; CPC 1–2 in 45.4%	Not reported
Iran	Elham Navab et al., 2019	Lower-middle	Retrospective	3214	8.49%	Survival to Hospital Discharge: 3.92%	Not reported
South Asia							
Pakistan	Moosajee et al., 2018	Lower-middle	Retrospective	468	21%	Survival to hospital discharge: 4%	Not reported
Pakistan	Mawani et al., 2016	Lower-middle	Prospective Cohort	310	2.6%	Survival to ED discharge: 1.6%. Survival to hospital discharge 0.6%	Survival after 02 months of discharge: 0%
India	Srinivas Ramaka et al., 2020	Lower-middle	Prospective	814	No survivors	No survivors	No survivors

Table 3 (continued)

Country	Publication Author & Year	Socioeconomic Status	Study Design	Sample Size	Outcome 1: ROSC	Outcome 2: Survival to Admission & Survival to Discharge	Outcome 3: Long Term Outcome (Survival/neurological outcome at 6 months, 12 months)
Europe							
Turkey	KG Balci et al., 2et al., 2017	Upper-middle	Retrospective	129	22.4%	Survival to Hospital Discharge: 5.4%	Not reported
Turkey	Ibrahim, C et al., 2016	Upper-middle	–	233	30.9%	Survival to Discharge: 11.1%	Not reported
Turkey	Bulent Erdur et al., 2008	Upper-middle	Prospective	222	38.3%	Survival to Discharge: 11.2%	Survival at 09 months: 9.4%
Africa							
Tunis	Zelfani, Saida et al., 2019	Lower-middle	Prospective	228	Pre-hospital ROSC: 17%	Survival to ED Admission: 7.89%	Not reported

of 8.5–37.8%, which may reflect disparities in healthcare resources, emergency response infrastructure, and patient demographics across these settings. Conversely, ROSC rates in LMICs were more consistent, with a narrower IQR of 12.0–21.5%, likely due to uniformly constrained resources and similar healthcare capacities.

Risk of bias and methodological limitations

The assessment revealed moderate to high risk of bias across most domains. Selection bias was prevalent, as many studies relied on convenience samples from specific EMS or hospital registries, limiting generalizability. Confounding control was generally inadequate, with most studies lacking adjustments for critical factors such as age, comorbidities, and EMS response times, which could affect the validity of associations observed between interventions and outcomes. Measurement reliability varied, with some studies following standardized Utstein reporting guidelines but others showing inconsistencies in definitions and timing for key outcomes like ROSC and survival to discharge. Missing data was another common limitation, particularly in retrospective studies relying on registry data, leading to moderate to high attrition bias. Lastly, context-specific bias was observed due to the wide variability in EMS infrastructure and healthcare resources across settings, impacting the applicability of findings across low-resource environments.

In summary, the JBI assessment highlighted substantial bias risks across the studies, particularly in selection and confounding. These limitations underscore the challenges of evaluating the effectiveness of the chain of survival in low-resource settings and suggest that findings should be interpreted with caution. Future research could benefit from prospective designs, standardized outcome measures, and more rigorous control of confounding factors to strengthen the validity of findings in this field (Fig. 2).

Discussion

Key findings

In this review, we systematically examined the effectiveness of the chain of survival by analyzing the outcomes of patients with out-of-hospital-cardiac-arrest (OHCA) reported in studies from resource limited countries. Data from nine low-middle-income countries (LMICs) and seven upper-middle-income countries (UMICs) were included. However, no studies from low-income countries were identified, likely due to a lack of resuscitation science researchers and insufficient resources to conduct and publish studies in these settings.

Heterogeneity in data

The review revealed significant heterogeneity in data, ranging from core system factors to OHCA processes and survival outcomes. This variability is likely due to the absence of uniform data collection and management systems in these countries, leading to gaps in key indicators such as dispatcher-related factors, core system factors, core OHCA processes, and core outcomes.

The Utstein outcome variables, which include return of spontaneous circulation (ROSC), survival to admission, survival to discharge or 30-day survival, and neurological outcomes, were inconsistently reported. Although fewer studies included neurological outcomes, those that did showed that a reasonable proportion of patients who survived to discharge had favorable neurological outcomes, characterized by a CPC score between 1 and 2.

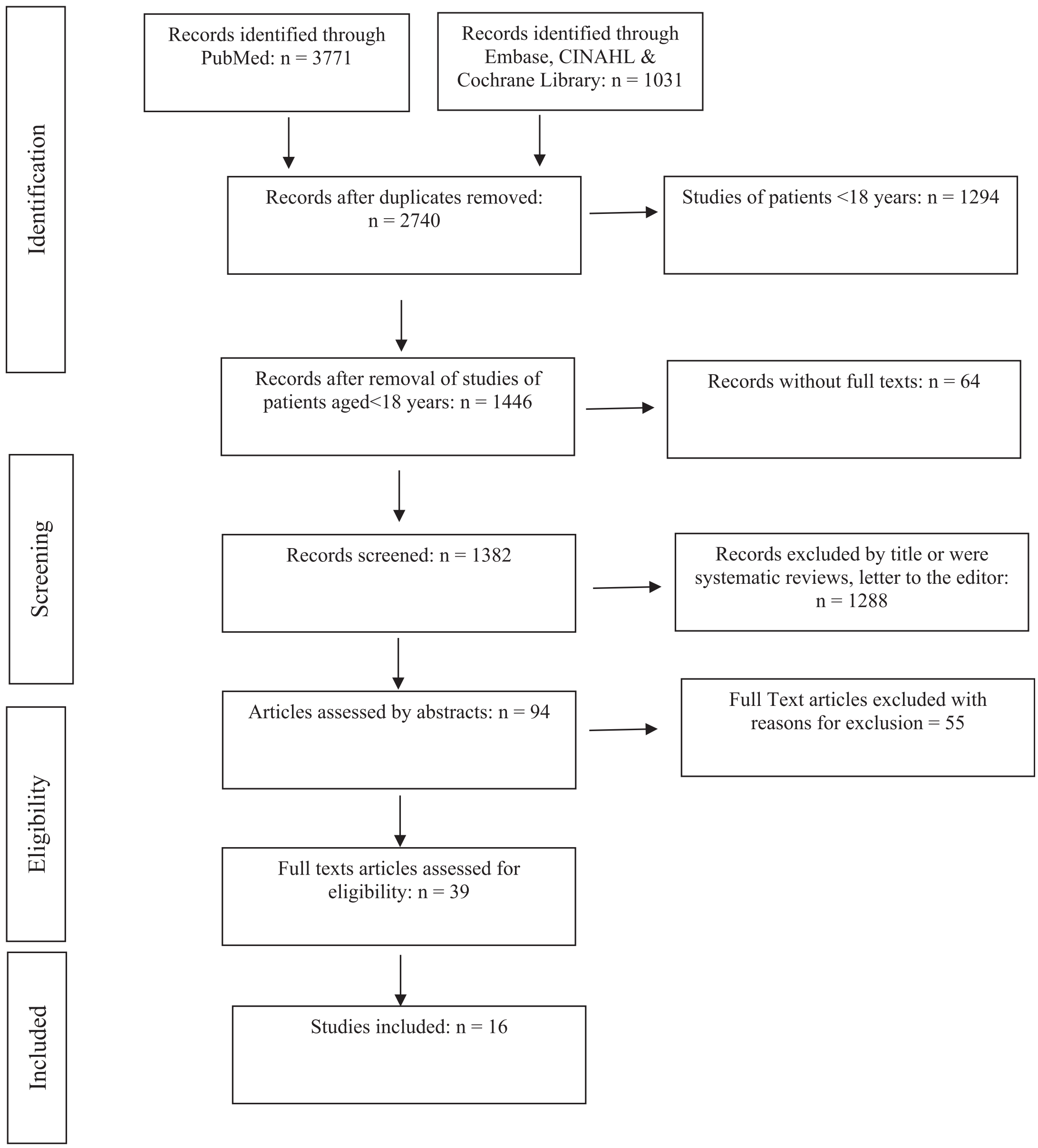

Fig. 1 – Flow diagram for selection of studies.

Linking chain of survival components to outcomes

Table 2 highlights critical reporting gaps in the chain of survival components, particularly in dispatcher interventions, EMS systems, and post-resuscitation care. These gaps align with the variability in outcomes seen in Table 3. For instance, studies from upper-middle-income countries (UMICs) with better EMS infrastructure reported higher ROSC rates and survival outcomes compared to studies from lower-middle-income countries (LMICs). In LMICs, dispatcher systems were rarely described, contributing to low bystander CPR rates and delayed responses.

By identifying how missing chain components impact survival outcomes, this review underscores the need for targeted interventions. Strengthening dispatcher-assisted CPR programs, improving EMS response times, and investing in post-resuscitation care can bridge these gaps and enhance OHCA outcomes in resource-limited countries. Linking specific chain components to patient outcomes, as illustrated in Tables 2 and 3, provides actionable insights for policymakers to prioritize resource allocation and system improvements.

Comparison to existing literature

Compared to the scoping review by Schnaubelt et al., which provided an overview of OHCA challenges in low-resource settings,[19] our study offers a more focused analysis of the chain of survival components. While the scoping review identified barriers and gaps, it did not specifically assess the feasibility and applicability of the chain of survival in these settings. Our review advances this by systematically linking chain components to patient outcomes, providing actionable recommendations to address gaps in implementation.

Importance of data registries

It is crucial to measure key indicators to identify and address gaps in the management of OHCA patients. Establishing cardiac arrest reg-

	Selection Bias	Confounding Control	Measurement Reliability	Missing Data Bias	Context Specific Bias
Erdur et aL	M	L	M	H	H
Ibrahim et al	H	M	M	M	H
Balci et al	M	L	H	M	M
Chan Wei Kuo et al	M	M	M	H	H
Wang, Chih-Hung et al	H	L	M	M	H
Yen-Nien Lin et al	M	L	H	M	M
Mawani et al	M	M	M	H	H
Moosajee et al	H	L	M	M	H
Zheng Jiaqi et al	M	M	H	M	M
Navab Elham et al	M	L	M	H	H
El Sayed 2014	H	M	H	M	H
El Sayed 2017	H	M	M	M	H
Zelfani et al	M	M	H	M	H
Son N Do et al	H	L	M	H	M
Wachiranun S et al. et al	M	M	H	M	H
Srinivas Ramaka et al	H	L	M	M	H

**L: Low Risk of Bias M: Moderate Risk of Bias H: High Risk of Bias*

Fig. 2 – Risk of bias assessment using JBI checklist.

istries that collect and manage data in a standardized format is essential. Such registries enable subject experts and policymakers to design evidence-based interventions that improve survival and long-term outcomes. Countries with established data registries tend to achieve better outcomes, as they can systematically identify and address deficiencies through robust data collection and management practices.

The implementation of technology-based solutions, such as cloud computing, offers significant potential to ease data collection and integration into a single database. Cloud-based systems allow for real-time data entry, remote access, and centralized storage, which are particularly advantageous in resource-limited settings. By leveraging such technologies, cardiac arrest registries can become more accessible and cost-effective, enabling researchers and policymakers to systematically collect and analyze data. These systems can also facilitate standardized reporting through automated templates, reduce data loss, and enhance the comparability of outcomes across regions. Additionally, cloud computing supports interoperability, allowing integration with existing healthcare infrastructure to further streamline data management and reporting.

However, developing data registries in resource-limited countries is both resource-intensive and costly. Strategic planning is needed to create cost-effective data management systems tailored to the needs of these populations. These systems can also help assess the feasibility of implementing the chain of survival, given that the standard of care in high-income countries is often inaccessible in resource-limited settings.[19,37,38]

Barriers to implementation

Most studies contributing to the scientific evidence on OHCA originate from high-income countries, making it challenging for LMICs to implement these practices within their healthcare systems. The chain of survival must be tailored to the specific needs and resources of resource limited countries. This requires the involvement of regional experts in developing guidelines, focusing on essential elements of the chain, and empowering stakeholders, such as EMS providers and dispatchers. For example, training EMS providers in basic life support (BLS), initiating telephone CPR programs for dispatchers, ensuring access to defibrillators, and establishing referral mechanisms to hospitals capable of advanced cardiac care are critical steps. These measures can strengthen the chain of survival in resource limited countries and improve patient outcomes.

Factors influencing ROSC outcomes between UMICs & LMICS

The variability in ROSC rates between UMICs and LMICs underscores the influence of multiple factors impacting outcomes in different healthcare contexts. Studies from UMICs report slightly higher ROSC rates, potentially attributable to better-resourced EMS systems, advanced pre-hospital care infrastructure, shorter response times, and higher rates of bystander CPR. In contrast, LMICs face challenges such as delayed EMS response, limited availability of defibrillators, lower public awareness of CPR, and underdeveloped dispatcher-assisted CPR programs.[39] Moreover, disparities in hospital resources, such as access to post-resuscitation care, including PCI and therapeutic hypothermia, further widen the gap. These findings highlight the need for targeted interventions to address these gaps and optimize ROSC outcomes in resource-limited settings.

Policy and system design implications

To enhance the chain of survival and improve OHCA outcomes, several policy implications can be considered. Expanding community-level training programs to increase bystander CPR rates is essential for boosting immediate response during cardiac arrests. Developing robust EMS infrastructure, including the availability of defibrillators and dispatcher-assisted CPR, is another critical step. Furthermore, investing in hospital capabilities for advanced post-resuscitation care, such as percutaneous coronary intervention (PCI) and therapeutic hypothermia, can significantly improve survival to discharge.

Outcome data, such as ROSC rates, should guide data-driven policy decisions to prioritize investments in chain components that yield the greatest survival benefits. Policymakers can adopt a structured framework to address gaps in the chain of survival. This framework involves four key steps: (1) Assess missing chain components using regional data, (2) Plan resource allocation to address critical gaps, such as EMS training, (3) Implement tailored interventions based on local needs, such as telephone CPR in resource limited countries, and (4) Evaluate improvements by using survival outcomes, such as those presented in Table 3, as benchmarks.

Role of local governments

Local governments play a pivotal role in overcoming these barriers by making strategic investments to strengthen the chain of survival. Prioritizing resources and implementing tailored solutions can lead to significant improvements in the outcomes of OHCA patients in resource-limited settings.

Limitations

We were not able to find any relevant studies from low-income-countries. In addition, to avoid heterogeneity we excluded certain studies like those with trauma and drowning which may have resulted in missing data. Future studies may include these cohorts to provide a more comprehensive picture. Moreover, the studies included in our review may represent well-resourced settings within low-middle-income and upper-middle-income countries, which might not accurately reflect the broader population. Conducting and publishing research is resource-intensive, and it is possible that these studies represent higher-resource environments within these countries. Additionally, our search was conducted up to December 2023, and no further updates were performed. This may limit the inclusion of the most recent evidence, highlighting the need for updated searches in future reviews.

Furthermore, the scoping review by Schnaubelt et al. included additional databases beyond those used in our study, likely capturing studies that did not appear in our search results.[19] These methodological differences may have inadvertently excluded studies covered in Schnaubelt et al.'s review. Future research should adopt a broader range of databases and more comprehensive search strategies to ensure the inclusion of all relevant studies.

Finally, we acknowledge that this systematic review was not registered in the PROSPERO database. While PROSPERO registration is considered a standard for ensuring transparency and reducing the risk of duplication in systematic reviews, our study was not registered due to the retrospective nature of the planning phase. Including PROSPERO registration in future systematic reviews is recommended to align with best practices for transparency and to provide stakeholders with a clear protocol for reference.

Conclusion

This systematic review highlights significant variability in the implementation and outcomes of the chain of survival for out-of-hospital-cardiac-arrest (OHCA) in low-resource settings, with limited evidence from low-income countries. While survival rates and neurological outcomes remain low compared to high-income countries, the findings underscore the importance of context-specific strategies, improved EMS systems, and standardized reporting to enhance OHCA outcomes. Future research should focus on addressing resource gaps and tailoring interventions to the unique challenges of these regions.

Declaration Statement for the Use of Generative AI

During the preparation of this work the author(s) used ChatGPT to improve language and correct grammatical mistakes in order to improve the readability. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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CRediT authorship contribution statement

Mirza Noor Ali Baig: Writing – original draft, Methodology, Data curation, Conceptualization. **Zafar Fatmi:** Writing – review & editing, Supervision. **Nadeem Ullah Khan:** Writing – review & editing. **Uzma Rahim Khan:** Writing – review & editing. **Ahmed Raheem:** Formal analysis, Data curation. **Junaid Abdul Razzak:** Writing – review & editing, Supervision.

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.

Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.resplu.2025.100874.

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