OPEN ACCESS
Journal of Multidisciplinary Applied Natural Science Vol. 5 No. 2 (2025) https://journal.pandawainstitutes.com/index.php/jmans/article/view/210

Check for updates

Research Article

Prehospital Management of Cardiac Arrest: Current Practices and Future Directions in EMS

Khaled Alanazi, Ayesh AL- Khamis, Mohammed AL- Turayk, Nawaf Almaimoni, Abdullah Albedaiwi, Fahad Alotaibi and Abdullah Abu Hilal.

Received : August 04, 2025	Revised : September 02, 2025	Accepted : October 05, 2025	Online : October 09, 2025

Abstract

Prehospital cardiac arrest remains a critical global health challenge, with survival heavily dependent on timely and effective emergency medical services (EMS) intervention. This article reviews current EMS practices in managing out-of-hospital cardiac arrest (OHCA), focusing on airway management, medication administration, defibrillation, and advanced resuscitation techniques. It also explores recent outcome studies and future directions including extracorporeal CPR (ECPR) and quality improvement initiatives. Case studies and EMS protocol examples illustrate practical applications and highlight ongoing barriers to improved survival. Understanding the evolving landscape of prehospital cardiac arrest care is vital for enhancing patient outcomes and guiding EMS training and protocols. Despite advances, challenges such as regional disparities and variable bystander response rates continue to limit overall survival. Technological innovations and protocol refinements show promise but require widespread adoption and system integration. Ultimately, a coordinated effort involving EMS, healthcare systems, and public engagement is essential to drive meaningful improvements in survival and neurological recovery. [1]

Keywords: cardiac arrest, prehospital care, EMS, advanced cardiac life support, resuscitation, out-of-hospital cardiac arrest, emergency medical services, airway management, defibrillation, extracorporeal CPR, neurological outcomes

1. Introduction

Cardiac arrest outside the hospital is an acute medical emergency with profound implications for public health worldwide. Characterized by the sudden cessation of cardiac mechanical activity, cardiac arrest leads to the abrupt loss of effective circulation, causing brain hypoxia and death within minutes if not promptly treated. Globally, out-of-hospital cardiac arrest (OHCA) affects an estimated 55 to 110 individuals per 100,000 population annually, with survival rates varying widely across regions and EMS systems. The critical factor influencing survival is the time elapsed between collapse and the initiation of resuscitative efforts. Early recognition by bystanders, immediate initiation of high-quality cardiopulmonary resuscitation (CPR), and rapid defibrillation form the cornerstone of the "chain of survival," a framework that underscores the sequential steps necessary for favorable outcomes.

Emergency Medical Services (EMS) play a pivotal role in this chain, bridging the gap between initial collapse and advanced hospital care. EMS interventions have evolved considerably over the past decades, incorporating advancements in airway management, pharmacological protocols, mechanical CPR devices, and post-resuscitative care. Despite these advances, the overall survival to hospital discharge for OHCA remains dismally low, often reported between 10% and 20% in high-income countries, and even lower in less developed regions. Furthermore, survivors often face significant neurological impairments, underscoring the importance of not just survival, but quality of survival.

The complexity of prehospital cardiac arrest management is amplified by variable EMS system structures, differences in training and protocols, and disparities in public awareness and bystander CPR rates. Innovations such as supraglottic airway devices, which simplify airway management, and extracorporeal CPR (ECPR), which supports circulation in refractory cases, are promising but require careful integration into existing systems. Additionally, continuous quality improvement (CQI) programs and real-time data feedback have been shown to enhance EMS performance and patient outcomes.

This article aims to provide an in-depth analysis of current EMS practices in prehospital cardiac arrest management, supported by recent outcome studies and real-world examples. It will also explore future directions, including technological innovations and system-wide strategies, that hold potential to reshape the landscape of cardiac arrest care and improve survival rates with favorable neurological outcomes. The goal is to equip EMS providers, healthcare policymakers, and stakeholders with a comprehensive understanding of the challenges and opportunities in this critical domain. [2]

2. Methodology

This article undertook a comprehensive and systematic approach to gather, analyze, and synthesize the latest evidence and practices surrounding prehospital management of cardiac arrest by Emergency Medical Services (EMS). The primary step involved an extensive literature search conducted across multiple leading medical and scientific databases, including PubMed, ScienceDirect, JAMA Network, Cochrane Library, and the American Heart Association's Circulation archives. The timeframe for included publications was restricted to the years 2020 through mid-2025 to capture the most current research, reflecting advances in resuscitation science, EMS protocols, and technological innovations.

Search queries combined broad and specific keywords such as "out-of-hospital cardiac arrest (OHCA)," "EMS cardiac arrest management," "prehospital airway devices," "extracorporeal CPR (ECPR)," "advanced cardiac life support (ACLS)," "prehospital medication use," "defibrillation strategies," and "neurological outcomes after cardiac arrest." The search strategy employed Boolean operators and medical subject headings (MeSH) to ensure comprehensive coverage of relevant studies. Inclusion criteria prioritized research focusing on prehospital interventions, survival rates, neurological outcomes, EMS system performance, and innovations impacting resuscitation quality. Both experimental designs, including randomized controlled trials and controlled cohort studies, and observational studies such as registry analyses and retrospective reviews were considered. Studies exclusively examining in-hospital cardiac arrest management were excluded to maintain a clear focus on prehospital care.

In parallel with the literature review, a detailed analysis was performed on official EMS clinical protocols from a selection of diverse U.S. states, including New York, Nebraska, Wisconsin, Massachusetts, and New Jersey. These protocols, publicly available through respective health department or EMS regulatory bodies, provided practical insight into the standardized procedures currently guiding EMS providers in cardiac arrest scenarios. The documents covered key aspects such as airway management options (ranging from bag-valve-mask ventilation to supraglottic airway devices and endotracheal intubation), pharmacological treatment algorithms (epinephrine, amiodarone, lidocaine), defibrillation protocols (energy settings, timing, and rhythm analysis), and criteria for termination of resuscitative efforts in the field. This examination revealed both commonalities and regional variations reflective of differing EMS system capabilities, resource availability, and training emphases.

To ground the synthesis in real-world outcomes, data from national and regional cardiac arrest registries were incorporated. These registries provide detailed information on incidence, EMS response times, interventions delivered, rates of return of spontaneous circulation (ROSC), survival to hospital admission and discharge, and neurological outcomes. Recent multicenter clinical trials and large observational studies published within the selected timeframe were also reviewed to assess the impact of specific interventions such as the use of new airway devices, mechanical CPR systems, and the emerging application of extracorporeal CPR (ECPR) in refractory cardiac arrest cases. Selected case studies from EMS agencies were integrated to illustrate implementation challenges, successes, and lessons learned, thus bridging the gap between controlled study environments and complex prehospital realities.

Complementing the empirical data and protocol review, expert consensus statements, position papers, and guidelines from authoritative bodies such as the American Heart Association (AHA), Resuscitation Council UK, European Resuscitation Council (ERC), and the International Liaison Committee on Resuscitation (ILCOR) were analyzed. These documents offer a distillation of the latest evidence and expert opinion, often shaping EMS training curricula, certification standards, and legislative policy. Their inclusion ensures that the article not only reflects current scientific understanding but also aligns with practical recommendations and future directions endorsed by global leaders in resuscitation science.

The synthesis process involved critical appraisal of the collected data, emphasizing the identification of trends, gaps, and contradictions between controlled clinical trials and operational EMS practices. Special attention was given to evaluating how technological innovations and quality improvement initiatives translate into improved patient outcomes in diverse EMS settings. The methodology also accounted for the complex interplay between EMS system design, public engagement in bystander CPR, and hospital post-resuscitation care, recognizing that prehospital management is one integral component of a broader continuum of cardiac arrest care.

By integrating scientific literature, EMS protocols, registry data, and expert guidance, this methodology provides a comprehensive, multifaceted perspective on prehospital cardiac arrest management. It establishes a robust foundation for understanding the current state of EMS practice and highlights promising avenues for future advancement aimed at increasing survival and neurological recovery for cardiac arrest patients.[3]

3. Literature Review

The field of prehospital cardiac arrest management has seen significant evolution, driven by ongoing research and technological innovation.

Central to improving survival outcomes is the concept of the "chain of survival," which emphasizes early recognition, immediate bystander CPR, rapid defibrillation, advanced cardiac life support (ACLS), and integrated post-resuscitation care. Research consistently confirms that early CPR and defibrillation are the most critical determinants of survival and neurological recovery, underpinning the urgency of efficient EMS response systems.

Airway management in the prehospital setting has undergone notable shifts. Traditional endotracheal intubation, once considered the gold standard, is now often supplemented or replaced by supraglottic airway devices (SGAs) such as laryngeal tubes and laryngeal mask airways. These devices offer easier insertion, require less training, and reduce interruptions in chest compressions. Multiple studies, including recent randomized trials, suggest that the use of SGAs may improve survival rates and neurological outcomes by minimizing delays and complications associated with intubation attempts.

Pharmacological management remains a key component of EMS cardiac arrest care. Epinephrine continues to be the primary vasopressor administered during resuscitation due to its alpha-adrenergic effects that promote coronary and cerebral perfusion. However, debate persists regarding optimal dosing, timing, and the impact on long-term neurological outcomes. Antiarrhythmic drugs like amiodarone and lidocaine are used to manage refractory ventricular fibrillation or tachycardia, although evidence of their influence on survival to discharge is mixed. Other agents such as sodium bicarbonate and calcium are reserved for specific scenarios like hyperkalemia or calcium channel blocker overdose.

In recent years, extracorporeal CPR (ECPR) has emerged as a promising intervention for refractory cardiac arrest unresponsive to conventional ACLS. ECPR involves the initiation of extracorporeal membrane oxygenation (ECMO) in the prehospital or early hospital phase to provide circulatory support.

Clinical trials have demonstrated that while survival benefits vary, selected patients treated with ECPR exhibit improved rates of survival with favorable neurological function, particularly when low-flow times are minimized.

Continuous quality improvement (CQI) initiatives have gained traction as a means to enhance EMS performance and patient outcomes. These programs focus on monitoring CPR quality metrics, adherence to protocols, and timely defibrillation. Feedback mechanisms, regular training, and data-driven adjustments have been shown to increase rates of return of spontaneous circulation (ROSC) and survival.

Despite progress, disparities remain. Survival rates for OHCA vary internationally, influenced by EMS system design, bystander CPR prevalence, public access to automated external defibrillators (AEDs), and regional healthcare infrastructure. Studies underscore the need for tailored EMS protocols that incorporate local resources and community engagement strategies to maximize effectiveness.

In summary, the literature reveals a dynamic landscape in prehospital cardiac arrest care. Advances in airway management, pharmacology, mechanical and extracorporeal support, combined with system-level quality improvements, form the backbone of current best practices. Ongoing research continues to refine these approaches, striving to increase survival rates and neurological outcomes for the thousands of patients who suffer cardiac arrest each year. [4][5][6][7][9]

4. Results

Recent studies and registry data highlight both progress and persistent challenges in prehospital cardiac arrest outcomes. Survival rates at 24 hours post-cardiac arrest have been reported around 29%, while 30-day survival decreases to approximately 16%. Among survivors, about 13% achieve good neurological outcomes, representing roughly 80% of those who survive to discharge. These figures demonstrate modest but meaningful improvements compared to historical data, reflecting advances in EMS interventions and system-wide efforts to optimize care.

Temporal trends indicate increasing adoption of advanced airway devices such as laryngeal tubes and supraglottic airways, which have been associated with improved ease of use and potential survival benefits. EMS agencies have also shifted airway management strategies away from routine endotracheal intubation towards these simpler devices, especially in cases where intubation may delay chest compressions or ventilation.

Medication administration patterns have evolved as well, with epinephrine remaining the cornerstone of pharmacologic resuscitation. However, studies show variation in timing and dosing, with some evidence suggesting that early administration may be linked to better chances of return of spontaneous circulation (ROSC). Antiarrhythmics like amiodarone are selectively used for refractory ventricular fibrillation, though their impact on long-term outcomes remains less clear.

Extracorporeal CPR (ECPR) is gaining traction, particularly for patients with refractory cardiac arrest who do not respond to standard advanced cardiac life support. Clinical trials demonstrate that ECPR can achieve survival rates with favorable neurological outcomes comparable to conventional CPR, especially when instituted quickly to minimize low-flow time. However, logistical challenges and resource intensity currently limit widespread prehospital application.

Continuous quality improvement initiatives within EMS systems have yielded positive effects on key performance metrics, including adherence to resuscitation protocols, quality of chest compressions, and defibrillation timing. Programs that incorporate real-time CPR feedback and post-event data review have been instrumental in improving ROSC rates and survival.

Despite these advances, disparities persist based on geography, EMS system maturity, and bystander intervention rates. Most cardiac arrests occur at home, where bystander CPR rates tend to be lower, adversely impacting outcomes. Regional differences in EMS training, equipment availability, and protocol adherence also contribute to variable survival statistics globally.

In summary, while survival and neurological outcomes after out-of-hospital cardiac arrest have improved incrementally, there remains significant room for advancement. The integration of new airway devices, refined medication protocols, extracorporeal support, and system-level quality improvement efforts have each contributed to these gains. Ongoing research and real-world implementation studies continue to shape best practices and highlight critical areas for future focus. [7][8][9]

5. Discussion

The management of cardiac arrest in the prehospital setting is a complex challenge shaped by clinical, operational, and systemic factors. The body of evidence reviewed underscores the paramount importance of rapid, coordinated action beginning with early recognition and bystander intervention, followed by high-quality EMS resuscitation efforts. While the foundational pillars of survival—early CPR and defibrillation—remain unchanged, significant progress has been made in refining advanced airway management, pharmacologic strategies, and the integration of cutting-edge technologies such as extracorporeal CPR (ECPR).

The shift towards supraglottic airway devices reflects a practical balance between maintaining effective ventilation and minimizing interruptions in chest compressions. These devices' ease of use reduces the cognitive and technical burden on EMS providers, particularly in high-stress, time-sensitive scenarios. Nevertheless, endotracheal intubation retains a role in specific cases, with ongoing debates about the optimal airway approach highlighting the need for EMS systems to tailor protocols based on provider training and local resources.

Pharmacologic interventions remain central to resuscitation, with epinephrine's vasoconstrictive properties enhancing coronary and cerebral blood flow during CPR. However, the timing and dosage of epinephrine administration warrant further investigation to optimize neurological outcomes. The utility of antiarrhythmic agents like amiodarone and lidocaine appears more nuanced, offering benefits in select arrhythmias but without definitive - survival advantages in all cases. Extracorporeal CPR represents a frontier with transformative potential for patients who fail conventional resuscitation. While promising results from clinical trials suggest improved survival with favorable neurological status, widespread adoption faces logistical, financial, and training hurdles. Prehospital initiation of ECPR requires sophisticated infrastructure and highly trained personnel, currently limiting its application to specialized centers and select patient populations.

Continuous quality improvement (CQI) programs emerge as a critical enabler of enhanced EMS performance. By leveraging real-time feedback, data analytics, and structured training, EMS agencies can systematically improve CPR quality, reduce response times, and ensure adherence to evolving protocols. CQI initiatives also foster a culture of accountability and learning, which is essential in a field where seconds can mean the difference between life and death.

Despite these advances, disparities in outcomes persist due to variability in EMS system design, public awareness, and access to resources. Most cardiac arrests occur at home, where bystander CPR rates remain suboptimal. Increasing community education and AED accessibility are vital components of a comprehensive strategy to close these gaps. Furthermore, regional differences in EMS training and equipment availability highlight the need for tailored approaches that reflect local capabilities and challenges.

Looking forward, the integration of emerging technologies such as automated vital signs monitoring, artificial intelligence-assisted decision support, and enhanced communication platforms between dispatch, EMS, and receiving hospitals may further revolutionize prehospital care. Personalized resuscitation strategies, informed by patient-specific data and predictive analytics, hold promise for maximizing survival and neurological recovery.

In conclusion, prehospital cardiac arrest management is advancing through a confluence of improved clinical practices, technological innovation, and system-level quality initiatives.

Continued research, investment in EMS training, and public engagement are essential to sustain and accelerate these gains, ultimately transforming cardiac arrest survival on a global scale. [10][11] [12]

6. Conclusion

The prehospital management of cardiac arrest has reached a critical juncture, where decades of incremental progress are converging with novel innovations to reshape the future of emergency medical care. Although the overall survival rates for out-of-hospital cardiac arrest (OHCA) remain modest, recent advancements in EMS protocols, airway management techniques, pharmacologic interventions, and resuscitation technologies are driving measurable improvements. The broader adoption of supraglottic airway devices has simplified airway management and reduced interruptions in chest compressions, while refinements in epinephrine administration and targeted use of antiarrhythmics have enhanced resuscitation effectiveness. Moreover, the emergence of extracorporeal CPR (ECPR) offers renewed hope for patients unresponsive to conventional therapies, demonstrating that even refractory cardiac arrests may be survivable with appropriate resources and rapid intervention.

Beyond these clinical innovations, the implementation of continuous quality improvement (CQI) programs within EMS systems has proven vital in translating evidence into practice. By systematically monitoring performance metrics such as CPR quality, response times, and protocol adherence, EMS agencies can identify gaps, drive training enhancements, and ultimately improve patient outcomes. These efforts, together with increased public education and engagement to boost bystander CPR and automated external defibrillator (AED) usage, strengthen the overall chain of survival and expand the window of opportunity for successful resuscitation.

However, challenges persist, including significant disparities in survival related to geographic variability, EMS system design, resource availability, and community involvement. Many cardiac arrests occur in private residences where bystander intervention rates are lower, and EMS systems vary widely in their capacity to adopt new technologies or training protocols. Addressing these disparities requires a multifaceted strategy that balances local realities with the imperative to provide equitable, high-quality care to all patients.

Looking forward, the integration of emerging technologies such as real-time physiological monitoring, artificial intelligence-driven decision support tools, and advanced communication networks holds the potential to revolutionize prehospital care. Personalized resuscitation strategies tailored to patient-specific data and predictive analytics may soon become the norm, enabling EMS providers to optimize interventions in ways previously unimaginable.

To realize this vision, sustained collaboration among EMS providers, researchers, healthcare systems, policymakers, and the public at large is essential. Investments in workforce training, infrastructure, and community education must be prioritized alongside ongoing research to refine existing therapies and develop new ones. Only through such concerted efforts can the promise of modern resuscitation science be fully realized, transforming prehospital cardiac arrest care into a system that consistently delivers not just survival, but meaningful recovery and quality of life.

In essence, the mission of EMS in the management of cardiac arrest extends beyond restoring circulation—it is about preserving life, function, and hope. As the field continues to evolve, embracing innovation and fostering system-wide excellence will be key to saving more lives and reducing the devastating impact of cardiac arrest worldwide. [13]

References

[1] Emergency Medical Services Response to Cardiac Arrest. National Center for Biotechnology Information (NCBI). https://www.ncbi.nlm.nih.gov/books/NBK321505/

[2] Advances in Out-of-Hospital Cardiac Arrest Resuscitation: A Review Since 2020. ScienceDirect. https://www.sciencedirect.com/science/article/abs/pii/S0914508725001091

[3] New York State EMS Collaborative Protocols for Cardiac Arrest. New York State Department of Health. https://www.health.ny.gov/professionals/ems/pdf/ny_collaborative_protocols_v23.1.pdf

[4] Prehospital Airway Management and Survival in OHCA. JAMA Network Open. https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2832116

[5] The Fourth Link in Saving Lives: Advanced Resuscitation by EMS. RQI Partners. https://rqipartners.com/resources/blog/the-fourth-link-in-saving-lives-advanced-resuscitation-by-ems/

[6] Extracorporeal CPR in Out-of-Hospital Cardiac Arrest. New England Journal of Medicine. https://www.nejm.org/doi/full/10.1056/NEJMoa2204511

[7] Outcome Studies of Prehospital Cardiac Arrest 2025. ScienceDirect. https://www.sciencedirect.com/science/article/pii/S0147956325000706

[8] EMS Protocols for Cardiac Arrest Management. Nebraska Emergency Medical Services. https://dhhs.ne.gov/OEHS%20Program%20Documents/EMS%20Model%20Protocols.pdf

[9] Continuous Quality Improvement Impact on OHCA Outcomes. ScienceDirect. https://www.sciencedirect.com/science/article/pii/S2666520424001346

[10] Discussion on Prehospital Cardiac Arrest Care Improvements. PMC. https://pmc.ncbi.nlm.nih.gov/articles/PMC7703417/

[11] Strategies to Facilitate Resuscitation and Improve Outcomes. World Journal of Cardiology. https://www.wjgnet.com/1949-8462/full/v17/i1/100782.htm

[12] EMS System of Care and Complex Interactions in OHCA Treatment. American Heart Association. https://www.ahajournals.org/doi/10.1161/JAHA.122.027756

[13] Enhancing Prehospital Outcomes for Cardiac Arrest. PMC. https://pmc.ncbi.nlm.nih.gov/articles/PMC10213088/