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The Impact of Prehospital Emergency Care on Improving Patient Clinical Outcomes: A Systematic Review

أثر الرعاية الإسعافية قبل الوصول إلى المستشفى في تحسين النتائج السريرية للمرضى :مراجعة منهجية

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Abstract:

Background: Prehospital emergency care plays a crucial role in reducing preventable mortality, minimizing complications, and improving patient outcomes through early assessment, timely interventions, and rapid transportation to healthcare facilities. However, the effectiveness of prehospital interventions varies across emergency conditions and healthcare settings.

Objective: To systematically evaluate the impact of prehospital emergency care on patient clinical outcomes, particularly survival, mortality, neurological recovery, and functional improvement.

Methods: A structured review of published evidence was undertaken, focusing on prehospital emergency interventions and their associations with patient clinical outcomes. Evidence was examined across major emergency conditions, including cardiac arrest, acute cardiovascular emergencies, stroke, and traumatic injuries. Findings were narratively synthesized according to intervention type, reported outcomes, and methodological limitations.

Results: The reviewed evidence suggested that prehospital emergency care was associated with improved clinical outcomes, particularly when timely interventions were supported by trained emergency personnel and effective hospital coordination. Advanced prehospital cardiac care was associated with improved survival and neurological outcomes, while early electrocardiographic assessment and hospital notification were linked to reduced treatment delays and lower mortality in acute cardiovascular emergencies. Prehospital stroke management improved treatment efficiency, although benefits regarding long-term functional recovery and mortality were less consistent. Early hemorrhage control in trauma patients was also associated with improved survival. However, methodological limitations and heterogeneity reduced the certainty of several findings.

Conclusion: Prehospital emergency care is an essential component of effective emergency healthcare delivery and may contribute to improved patient survival and clinical recovery. Strengthening emergency response systems, professional training, evidence-based interventions, and coordination with receiving hospitals may further improve patient outcomes. Additional high-quality studies are needed to establish the effectiveness of specific interventions and their long-term clinical benefits.

Keywords: Prehospital Emergency Care; Emergency Medical Services; Patient Clinical Outcomes; Survival; Mortality; Emergency Interventions; Systematic Review.

الملخص:

الخلفية :تؤدي الرعاية الإسعافية قبل الوصول إلى المستشفى دورًا محوريًا في الحد من الوفيات التي يمكن الوقاية منها، وتقليل المضاعفات، وتحسين النتائج الصحية للمرضى، وذلك من خلال التقييم المبكر، والتدخلات العلاجية في الوقت المناسب، والنقل السريع إلى المؤسسات الصحية .ومع ذلك، تختلف فعالية التدخلات الإسعافية السابقة للوصول إلى المستشفى باختلاف الحالات الطارئة وبيئات الرعاية الصحية.

الهدف :التقييم المنهجي لأثر الرعاية الإسعافية قبل الوصول إلى المستشفى في النتائج السريرية للمرضى، ولا سيما معدلات البقاء على قيد الحياة، والوفيات، والتعافي العصبي، والتحسن الوظيفي.

المنهجية :أُجريت مراجعة منظمة للأدلة المنشورة، مع التركيز على التدخلات الإسعافية السابقة للوصول إلى المستشفى وعلاقتها بالنتائج السريرية للمرضى .وشمل استعراض الأدلة مجموعة من الحالات الطارئة الرئيسة، بما في ذلك توقف القلب، وحالات الطوارئ القلبية الوعائية الحادة، والسكتة الدماغية، والإصابات الرضحية .وصُنّفت النتائج ووُلّفت سرديًا وفقًا لنوع التدخل، والنتائج المبلغ عنها، والقيود المنهجية للدراسات.

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النتائج :أشارت الأدلة التي شملتها المراجعة إلى ارتباط الرعاية الإسعافية قبل الوصول إلى المستشفى بتحسن النتائج السريرية، ولا سيما عندما تكون التدخلات في الوقت المناسب مدعومة بكوادر إسعافية مدرّبة وتنسيق فعّال مع المستشفيات .وارتبطت الرعاية القلبية الإسعافية المتقدمة بتحسن معدلات البقاء على قيد الحياة والنتائج العصبية، في حين ارتبط التقييم المبكر باستخدام تخطيط كهربية القلب وإخطار المستشفى مسبقًا بتقليل التأخير في تقديم العلاج وخفض معدلات الوفيات في حالات الطوارئ القلبية الوعائية الحادة .كما أسهم تدبير حالات السكتة الدماغية قبل الوصول إلى المستشفى في تحسين كفاءة تقديم العلاج، إلا أن الفوائد المتعلقة بالتعافي الوظيفي طويل الأمد والوفيات كانت أقل اتساقًا .كذلك، ارتبطت السيطرة المبكرة على النزيف لدى مرضى الإصابات الرضحية بتحسن معدلات البقاء على قيد الحياة .ومع ذلك، حدّت القيود المنهجية والتباين بين الدراسات من درجة اليقين في عدد من النتائج.

الخلاصة :تُعد الرعاية الإسعافية قبل الوصول إلى المستشفى عنصرًا أساسيًا في تقديم خدمات الرعاية الصحية الطارئة بفعالية، وقد تسهم في تحسين معدلات بقاء المرضى على قيد الحياة وتعافيهم السريري .وقد يؤدي تعزيز أنظمة الاستجابة للطوارئ، والتدريب المهني، وتطبيق التدخلات المستندة إلى الأدلة، والتنسيق مع المستشفيات المستقبلة للمرضى، إلى مزيد من التحسن في النتائج الصحية .وهناك حاجة إلى دراسات إضافية عالية الجودة لتحديد مدى فعالية التدخلات المحددة وفوائدها السريرية طويلة الأمد.

الكلمات المفتاحية :الرعاية الإسعافية قبل الوصول إلى المستشفى؛ خدمات الطوارئ الطبية؛ النتائج السريرية للمرضى؛ البقاء على قيد الحياة؛ الوفيات؛ التدخلات الإسعافية؛ مراجعة منهجية.

1. Introduction

Prehospital emergency care is a fundamental component of modern healthcare systems, providing immediate medical assessment, stabilization, and treatment to patients experiencing acute illnesses or traumatic injuries before their arrival at healthcare facilities. Emergency Medical Services (EMS) play a critical role in reducing preventable mortality, minimizing complications, and improving clinical outcomes through timely interventions and appropriate patient transportation. According to the World Health Organization (WHO), strengthening prehospital emergency care is essential for improving healthcare accessibility, reducing disability, and ensuring effective management of life-threatening conditions, including cardiac arrest, stroke, traumatic injuries, respiratory emergencies, and other acute medical conditions [1].

The effectiveness of prehospital emergency care depends on several interconnected factors, including emergency response time, the qualifications and competencies of healthcare providers, availability of medical equipment, adherence to evidence-based clinical protocols, and coordination between emergency responders and receiving hospitals. Early recognition of critical conditions, rapid clinical decision-making, cardiopulmonary resuscitation (CPR), airway management, hemorrhage control, and appropriate stabilization during transportation are important components of prehospital management. These interventions aim to prevent physiological deterioration, facilitate timely definitive treatment, and improve patient survival and recovery. However, the effectiveness of individual interventions may vary according to the patient's clinical condition, illness severity, available resources, and characteristics of the EMS system [2].

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Previous research has demonstrated associations between organized prehospital emergency care and improved outcomes in selected emergency conditions. Boulton et al. (2025) reported that prehospital critical care teams were associated with improved survival and favorable neurological outcomes among patients experiencing out-of-hospital cardiac arrest, although the certainty of the evidence was limited [3]. Similarly, Oostema et al. (2024) found that adherence to recommended prehospital stroke care measures was associated with faster diagnostic evaluation, shorter treatment intervals, and increased likelihood of discharge home [4]. Research on acute ischemic stroke has also highlighted the importance of early recognition, appropriate triage, and rapid transportation to specialized healthcare facilities. Nevertheless, improvements in prehospital processes do not consistently translate into statistically significant improvements in long-term functional outcomes or mortality [5].

Despite advances in emergency medicine, significant challenges continue to affect the quality and accessibility of prehospital services worldwide. These challenges include delayed emergency responses, shortages of adequately trained healthcare professionals, limited availability of advanced medical equipment, geographical disparities, and inadequate coordination between prehospital and hospital-based services. Such limitations are particularly evident in low- and middle-income countries, where emergency care systems may be fragmented or insufficiently developed. Bhattarai et al. (2023) identified important gaps in prehospital infrastructure, workforce capacity, transportation, and coordination across low- and middle-income settings, highlighting the need for systematic improvements in emergency medical service delivery [6].

Although numerous studies have investigated specific prehospital interventions and emergency conditions, the available evidence varies considerably in study design, patient populations, clinical practices, healthcare settings, and measured outcomes. Furthermore, differences in EMS organization, provider qualifications, intervention timing, and resource availability complicate comparisons between studies. While some investigations report improvements in survival, neurological recovery, and functional independence, others primarily demonstrate improvements in operational indicators, such as response time and time to definitive treatment. Consequently, a comprehensive synthesis is needed to distinguish improvements in healthcare processes from clinically meaningful benefits and to identify the interventions most consistently associated with better patient outcomes.

Therefore, this systematic review aims to evaluate and synthesize the available evidence regarding the impact of prehospital emergency care on patient clinical outcomes. Specifically, it examines the relationship between prehospital interventions, emergency response efficiency, quality of care, and patient outcomes, including survival, mortality, complications, neurological recovery, and functional status. Furthermore, the review seeks to identify factors influencing the effectiveness of prehospital emergency care, highlight existing

evidence gaps, and provide evidence-based recommendations to support improvements in emergency medical services and patient care.

2. Research Objectives and questions

2.1. General Objective

To systematically evaluate the impact of prehospital emergency care on improving clinical outcomes among patients experiencing acute medical emergencies and traumatic injuries.

2.2. Specific Objectives

1. To assess the association between prehospital emergency care interventions and patient survival, mortality, and clinical recovery.
2. To evaluate the influence of emergency medical services response time, early clinical assessment, and timely interventions on patient outcomes.
3. To examine the effectiveness of prehospital emergency care in managing life-threatening conditions, including cardiac arrest, acute coronary syndromes, stroke, and traumatic injuries.
4. To identify healthcare system-related and operational factors that influence the effectiveness of prehospital emergency care.
5. To synthesize the available evidence and identify research gaps to support improvements in prehospital emergency medical services.

2.3. Research Questions

1. How does prehospital emergency care influence survival rates, mortality, and other clinical outcomes among patients experiencing medical or traumatic emergencies?
2. Which prehospital emergency interventions are most consistently associated with improved patient outcomes?
3. How do emergency response time, healthcare provider competency, and coordination between prehospital and hospital services affect clinical outcomes?
4. What challenges and limitations influence the effectiveness of prehospital emergency care across different healthcare settings?

3. Literature Review

3.1. Overview of Prehospital Emergency Care

Prehospital emergency care represents the initial phase of emergency medical management and serves as an essential connection between the community and hospital-based healthcare services. It encompasses emergency dispatch, rapid patient assessment, early recognition of life-threatening conditions, immediate medical interventions, stabilization, and transportation to an appropriate healthcare facility. The primary objective of prehospital emergency care is to minimize delays in treatment, prevent clinical deterioration, and improve patient survival and recovery.

The effectiveness of prehospital emergency care depends on the integration of clinical skills, operational efficiency, medical resources, and communication systems. Well-organized emergency medical services facilitate timely access to appropriate treatment and support continuity of care throughout the emergency management process. The World Health Organization emphasizes that effective prehospital systems require trained personnel, standardized clinical protocols, appropriate equipment, operational coordination, and effective referral mechanisms [1].

3.2. Prehospital Emergency Care and Patient Survival

Patient survival is one of the most important indicators used to evaluate the effectiveness of emergency medical services. Early recognition of critical conditions and timely initiation of appropriate interventions may reduce the risk of preventable death, particularly among patients experiencing cardiac arrest, severe traumatic injuries, or acute cardiovascular emergencies.

Boulton et al. (2025) conducted a systematic review investigating the impact of prehospital critical care teams on outcomes among patients experiencing out-of-hospital cardiac arrest. The review included 17 studies involving approximately 1.19 million patients and identified associations between prehospital critical care team involvement and improved survival and neurological outcomes in adult non-traumatic cardiac arrest. However, the overall certainty of evidence was limited, and most included studies were observational [3].

These findings suggest that enhanced prehospital clinical capabilities may contribute to improved survival in selected patient populations. Nevertheless, variations in emergency medical service organization, provider qualifications, intervention availability, and patient characteristics should be considered when interpreting these associations.

3.3. The Role of Emergency Response Time

Emergency response time is a widely used performance indicator in prehospital emergency care. It generally refers to the interval between the receipt of an emergency request and the arrival of emergency medical personnel at the scene. Shorter response intervals may support earlier assessment and treatment, particularly in time-sensitive conditions such as cardiac arrest, acute myocardial infarction, and severe trauma.

However, response time alone does not fully represent the effectiveness of prehospital emergency care. Other important intervals include dispatch processing time, on-scene time, transportation time, and the interval between first medical contact and definitive hospital treatment.

The relationship between time and clinical outcomes may also vary according to the underlying emergency condition. Consequently, response time should be evaluated alongside treatment appropriateness, clinical intervention timing, patient characteristics, and the quality of subsequent hospital care.

3.4. Prehospital Management of Acute Cardiovascular Emergencies

Acute cardiovascular emergencies, particularly ST-elevation myocardial infarction (STEMI) and cardiac arrest, require rapid assessment and coordinated treatment. Prehospital interventions may include cardiac monitoring, electrocardiographic assessment, cardiopulmonary resuscitation, defibrillation when indicated, and early communication with receiving hospitals.

Moxham et al. (2024) conducted a systematic review and meta-analysis examining prehospital digital electrocardiogram transmission in patients with STEMI. The review included 17 observational studies involving 4,306 patients. Prehospital ECG transmission was associated with reduced delays to coronary reperfusion and lower mortality compared with care without prehospital ECG transmission. However, substantial heterogeneity was observed in treatment-time outcomes [7].

These findings highlight the potential contribution of early diagnosis and coordinated hospital notification to improved cardiovascular emergency care. Nevertheless, the clinical effectiveness of such interventions depends on the availability of appropriate receiving facilities and efficient pathways for definitive treatment.

3.5. Prehospital Emergency Care in Acute Stroke

Acute stroke represents another time-sensitive medical emergency in which early identification and rapid access to specialized treatment are essential. Prehospital management focuses on recognizing possible stroke

symptoms, assessing neurological abnormalities, identifying the time of symptom onset or last known well, evaluating blood glucose, and notifying the receiving hospital.

Oostema et al. (2024) examined associations between prehospital stroke quality measures and subsequent hospital evaluation and treatment. Their study included 5,707 EMS-transported stroke cases and demonstrated that adherence to selected prehospital quality measures was associated with faster diagnostic imaging, shorter treatment intervals, and greater likelihood of discharge home [4].

These findings indicate that structured prehospital stroke assessment and effective coordination with receiving hospitals may improve care efficiency and selected patient outcomes. However, further research is required to establish the extent to which individual prehospital interventions independently improve long-term neurological function and survival.

3.6. Prehospital Management of Traumatic Injuries

Traumatic injuries contribute substantially to preventable mortality and disability worldwide. Early prehospital trauma management aims to identify life-threatening injuries, control external bleeding, support airway and breathing functions, prevent further deterioration, and facilitate rapid transportation to appropriate trauma facilities.

Prehospital hemorrhage control is particularly important in patients with severe external bleeding. A systematic review and meta-analysis published in 2024 examined tourniquet use for civilian vascular extremity trauma. The analysis included seven studies involving 4,095 patients and found an association between prehospital tourniquet use and reduced mortality. However, the certainty of the available evidence was rated very low [8].

These findings suggest that selected prehospital trauma interventions may improve clinical outcomes when appropriately applied. Nevertheless, further high-quality comparative research is needed to clarify their effectiveness across different trauma populations and healthcare systems.

3.7. Challenges Affecting Prehospital Emergency Care

Despite improvements in emergency medical technology and clinical protocols, several challenges continue to limit the effectiveness of prehospital emergency care. These include delays in emergency dispatch, insufficient numbers of trained personnel, geographical barriers, inadequate medical equipment, limited access to specialized hospitals, and poor communication between emergency responders and healthcare facilities.

Bhattarai et al. (2023) reviewed prehospital emergency care in low- and middle-income countries and identified substantial gaps in emergency medical service infrastructure, workforce development, transportation, and organizational coordination [6].

Such limitations may contribute to delayed treatment and unequal access to emergency care. Strengthening emergency response systems, implementing standardized clinical protocols, improving workforce training, and enhancing communication between prehospital and hospital services are therefore important priorities for healthcare improvement.

3.8. Research Gap

Although previous studies have examined the effectiveness of particular prehospital interventions, much of the available evidence is focused on specific emergency conditions, such as cardiac arrest, acute coronary syndromes, stroke, or traumatic injuries.

Furthermore, considerable variation exists in the types of interventions evaluated, study designs, patient characteristics, healthcare settings, and clinical outcome measures. Some studies focus primarily on process indicators, including response time and treatment delays, whereas others assess survival, mortality, neurological recovery, and functional outcomes.

Consequently, a broader synthesis of the evidence is needed to evaluate how different components of prehospital emergency care influence clinically meaningful patient outcomes across emergency conditions. This systematic review aims to address that need by critically examining the available comparative evidence, identifying consistent patterns in clinical outcomes, and exploring factors that may influence the effectiveness of prehospital emergency care.

4. Methodology

4.1. Study Design

This systematic review evaluated the impact of prehospital emergency care on patient clinical outcomes. The review was structured according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines.

4.2. Search Strategy

A comprehensive literature search was conducted across five electronic databases: PubMed/MEDLINE, Scopus, Web of Science, Embase, and the Cochrane Library. The search covered studies published up to [insert verified final search date]. Keywords included "prehospital emergency care," "emergency medical services," "prehospital interventions," "patient outcomes," "survival," and "mortality." Boolean operators (AND/OR) were used to identify relevant studies.

4.3. Eligibility Criteria

Studies were included if they investigated prehospital emergency interventions and reported clinical outcomes, including survival, mortality, neurological recovery, or functional improvement. Eligible designs included randomized controlled trials, cohort studies, case-control studies, and comparative observational studies. Studies focusing exclusively on hospital-based care, case reports, editorials, narrative reviews, and publications without relevant clinical outcomes were excluded.

4.4. Study Selection and Data Extraction

Retrieved records were screened according to predefined eligibility criteria. Duplicate records were removed, followed by title, abstract, and full-text screening. Two independent reviewers assessed study eligibility and resolved disagreements through discussion. Relevant data were extracted, including author, publication year, country, study design, sample size, intervention type, and reported clinical outcomes.

4.5. Quality Assessment

The methodological quality and risk of bias of included studies were assessed using appropriate tools, including Cochrane RoB 2 for randomized trials and ROBINS-I or Joanna Briggs Institute (JBI) appraisal tools for applicable non-randomized studies. The assessment considered selection bias, confounding, outcome measurement, and reporting bias.

4.6. Data Synthesis and Analysis

A narrative synthesis was conducted to summarize the findings according to intervention type, emergency condition, and clinical outcomes. Differences in study designs, populations, and outcome measures were considered when interpreting the evidence. The suitability of quantitative pooling was evaluated based on clinical and methodological comparability. The certainty of evidence was assessed using the GRADE approach.

4.7. Ethical Considerations

The review was based on previously published studies and did not involve direct patient participation or collection of identifiable personal data. Therefore, individual informed consent was not required.

5. Results

5.1. Overview of Study Findings

The reviewed literature demonstrated that prehospital emergency care was associated with improvements in several important patient clinical outcomes, particularly survival, mortality reduction, neurological recovery, and timely access to definitive treatment. However, the magnitude and consistency of these benefits varied according to the emergency condition, intervention type, and organization of emergency medical services.

The evidence suggested that effective prehospital care depended not only on rapid emergency response but also on the early delivery of appropriate clinical interventions, professional competency, and coordination between emergency responders and receiving hospitals.

5.2. Impact on Survival and Mortality

The findings indicated that advanced prehospital emergency care was associated with improved survival among critically ill patients, particularly those experiencing out-of-hospital cardiac arrest. Boulton et al. (2025) [3] reported improved survival and favorable neurological outcomes among patients receiving specialized prehospital critical care compared with conventional advanced life support.

Similarly, Lavery et al. (2025) [2] demonstrated that physician-led interprofessional prehospital teams were associated with higher survival rates and lower mortality among critically ill or injured patients compared with paramedic-only care.

These findings suggest that specialized clinical expertise, appropriate advanced interventions, and effective emergency decision-making may contribute to better survival outcomes. Nevertheless, the predominance of observational evidence limits definitive conclusions regarding causality.

5.3. Impact on Cardiovascular Emergency Outcomes

The evidence highlighted the importance of early cardiovascular assessment and coordinated emergency treatment. Moxham et al. (2024) [7] found that prehospital electrocardiogram transmission among patients

with ST-elevation myocardial infarction was associated with shorter intervals to coronary reperfusion and reduced mortality.

These findings suggest that early diagnosis, immediate communication with specialized cardiac centers, and timely activation of definitive treatment pathways may improve cardiovascular emergency outcomes. The benefits appear to reflect the combined effectiveness of prehospital intervention and coordinated hospital response.

5.4. Impact on Stroke Outcomes

The findings concerning prehospital stroke management demonstrated improvements in treatment efficiency, although benefits in long-term clinical outcomes were less consistent.

Oostema et al. (2024) [4] found that adherence to prehospital stroke quality measures was associated with faster diagnostic evaluation, shorter treatment intervals, and greater likelihood of discharge home.

Similarly, Chowdhury et al. (2021) [5] reported that optimizing prehospital stroke workflows reduced several treatment delays and improved access to reperfusion therapy. However, these improvements were not accompanied by statistically significant reductions in mortality or improvements in functional outcomes at 90 days.

Collectively, these findings indicate that organized prehospital stroke care improves treatment efficiency, while its direct contribution to long-term survival and neurological recovery requires further investigation.

5.5. Impact on Trauma-Related Clinical Outcomes

The reviewed evidence suggested that selected prehospital trauma interventions were associated with improved survival, particularly among patients experiencing severe external hemorrhage.

Ko et al. (2024) [8] reported an association between prehospital tourniquet application and reduced mortality among patients with traumatic extremity vascular injuries. The study also found no statistically significant increase in major complications such as amputation or compartment syndrome.

These findings support the potential clinical value of early hemorrhage control as part of comprehensive prehospital trauma management. However, the very low certainty of the available evidence limits the strength of conclusions regarding the effectiveness and safety of these interventions.

5.6. Influence of Emergency Medical Service Organization

The findings indicated that the effectiveness of prehospital emergency care was influenced by organizational and healthcare system factors, including provider training, availability of medical resources, emergency transportation, and communication between healthcare services.

Bhattarai et al. (2023) [6] identified substantial limitations in prehospital emergency care systems in low- and middle-income countries, including fragmented service delivery, inadequate infrastructure, insufficiently trained personnel, and poor coordination.

These findings suggest that strengthening emergency medical service organization and improving access to appropriately equipped and trained emergency teams may enhance the delivery of timely care. However, the extent to which individual system improvements translate into better clinical outcomes remains dependent on the supporting evidence.

5.7. Risk of Bias and Evidence Limitations

The reviewed evidence was predominantly observational, with important limitations related to potential confounding, patient selection, variation in clinical interventions, and differences between emergency medical service systems.

Boulton et al. (2025) [3] identified methodological limitations in the underlying studies and rated the certainty of evidence for major adult cardiac arrest outcomes as low. Similarly, Ko et al. (2024) [8] reported very low certainty of evidence across the evaluated trauma outcomes.

Considerable heterogeneity was also reported in some studies assessing treatment delays, limiting the generalizability of pooled estimates.

Therefore, although the overall findings were generally favorable toward selected prehospital interventions, these limitations indicate that the observed associations should not be interpreted as definitive evidence of causation.

5.8. Overall Synthesis of Results

Overall, the findings suggest that prehospital emergency care plays an important role in improving patient clinical outcomes, especially when timely interventions are integrated with trained emergency personnel and coordinated hospital services.

The most consistent evidence of clinical benefit was observed in specialized cardiac arrest management, prehospital cardiovascular assessment, and selected trauma interventions. In stroke care, improvements were more consistently demonstrated in treatment efficiency than in long-term functional outcomes or mortality.

Taken together, the reviewed studies indicate that improving prehospital emergency care requires a comprehensive approach involving early recognition, appropriate clinical interventions, professional competency, and effective coordination across the emergency care pathway. Nevertheless, further high-quality comparative research is needed to establish the independent effects of individual prehospital interventions and determine their long-term clinical benefits.

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