The Review Of
DIABETIC
STUDIES OPEN ACCESS

The Role Of Paramedics In Road Traffic Accident Emergencies: A Systematic Review Of Pre-Hospital Care And Patient Outcomes

Adil Lafi Alenezi[1] , Mutlaq Talaq Albishri[2] , Abdulrahman Matar Alanazi[3] , Yasser Talal Alharbi[4] , Alhussain Ali Yassin Assiri[5] , Mohammed Fahd Al-Jarisi[6] , Mohammed Ali Mudayni[7] , Yehia Abdullah Mzibi[8] , Mohanad Saleh Alalnabkh[9] , Ali Abdalrahman Madawi Al sheekh[10]

[1]Saudi Red Crescent Authority - Aljawf, Saudi Arabia
[2]Saudi Red Crescent Authority - Mekkah, Saudi Arabia
[3]Saudi Red Crescent Authority - Aljawf, Saudi Arabia
[4]Saudi Red Crescent Authority - Jeddah, Saudi Arabia
[5]Saudi Red Crescent Authority - Asser, Saudi Arabia
[6]Saudi Red Crescent Authority - Medinah, Saudi Arabia
[7]Saudi Red Crescent Authority - Asser, Saudi Arabia
[8]Saudi Red Crescent Authority - Jazzan, Saudi Arabia
[9]Saudi Red Crescent Authority - Jeddah, Saudi Arabia
[10]Saudi Red Crescent Authority - Asser, Saudi Arabia

Abstract
Road traffic accidents (RTAs) remain a leading cause of mortality and morbidity worldwide, placing significant pressure on emergency medical systems. Paramedics play a critical role in delivering timely and effective pre-hospital care, which is essential for improving patient outcomes. This systematic review aims to evaluate the impact of paramedic interventions on survival rates, response times, and clinical outcomes in RTA emergencies. A comprehensive search of PubMed, Scopus, Web of Science, and Embase was conducted, including studies published between 2015 and 2025. The findings indicate that rapid paramedic response, accurate triage, and early clinical interventions—such as airway management, hemorrhage control, and cardiopulmonary resuscitation—significantly reduce mortality and complications. Additionally, advanced paramedic practices and integration with modern technologies enhance the efficiency of pre-hospital care systems. The review highlights the need for continuous training, standardized protocols, and strengthened emergency infrastructure to optimize trauma care and improve patient survival in road traffic accidents.

Keywords: Paramedics; Road Traffic Accidents; Pre-Hospital Care; Emergency Medical Services; Trauma Outcomes; Response Time; Patient Survival.

Introduction

Road traffic accidents (RTAs) represent a major global public health concern, accounting for approximately 1.19 million deaths annually and leaving tens of millions more injured or disabled each year. They are the leading cause of death among individuals aged 5–29 years, disproportionately affecting low- and middle-income countries where emergency response systems may be less developed (World Health Organization, 2023). Beyond the immediate human toll, RTAs impose substantial economic and social burdens on healthcare systems, families, and national economies, emphasizing the urgent need for effective trauma care systems.

Pre-hospital emergency care is widely recognized as a critical determinant of survival and recovery following traumatic injuries. The concept of the “golden hour” underscores the importance of timely medical intervention within the first hour after injury, during which appropriate care can significantly reduce mortality and long-term complications (Lerner & Moscati, 2001). Within this context, paramedics serve as frontline healthcare providers responsible for delivering rapid assessment, stabilization, and life-saving interventions at the scene and during patient transport. Their role extends

beyond basic first aid to include advanced clinical decision-making, triage, and coordination with hospital-based trauma teams.

Paramedic interventions in RTAs encompass a wide range of clinical and operational activities, including airway management, hemorrhage control, spinal immobilization, cardiopulmonary resuscitation (CPR), and the administration of medications such as tranexamic acid (TXA). Evidence suggests that early and appropriate pre-hospital interventions can significantly improve survival rates and functional outcomes among trauma patients (O'Meara et al., 2020; Dyson et al., 2021). Moreover, the effectiveness of paramedic care is closely linked to response time, training level, availability of advanced life support (ALS) capabilities, and integration within a coordinated emergency medical services (EMS) system (Razzak & Kellermann, 2019).

Despite the recognized importance of paramedics in trauma care, there remains considerable variability in pre-hospital care systems across countries and regions. Differences in infrastructure, workforce competencies, dispatch systems, and access to advanced technologies contribute to disparities in patient outcomes. In rapidly developing healthcare systems, such as those aligned with national transformation agendas, there is increasing emphasis on strengthening EMS capabilities, enhancing paramedic training, and integrating digital health solutions to improve response efficiency and care quality (Alanazy et al., 2020).

Given these variations and the growing body of research on pre-hospital trauma care, there is a need for a comprehensive synthesis of current evidence regarding the role of paramedics in RTA emergencies. This systematic review aims to evaluate the effectiveness of paramedic interventions in improving patient outcomes, including survival, morbidity, and response efficiency. By consolidating findings from recent studies, this review seeks to provide evidence-based insights to inform clinical practice, policy development, and future research in pre-hospital emergency care.

Methodology

This study employed a systematic review design to evaluate the role of paramedics in responding to road traffic accident (RTA) emergencies and their impact on patient outcomes. The review was conducted in accordance with the PRISMA 2020 guidelines to ensure transparency, rigor, and reproducibility in the identification, selection, and synthesis of relevant studies.

A comprehensive literature search was performed across four major electronic databases: PubMed, Scopus, Web of Science, and Embase. The search covered studies published between January 2015 and December 2025 to capture recent developments in pre-hospital emergency care. A combination of keywords and Boolean operators was used, including: ("paramedic*" OR "emergency medical services" OR "EMS" OR "pre-hospital care") AND ("road traffic accident" OR "traffic injury" OR "road trauma") AND ("outcomes" OR "mortality" OR "survival" OR "response time").

The inclusion criteria comprised peer-reviewed original studies published in English that examined paramedic interventions in RTAs and reported measurable patient outcomes such as mortality, morbidity, response time, or triage accuracy. Studies focusing on non-traffic-related trauma, editorials, commentaries, and non-peer-reviewed articles were excluded. Duplicate records were removed prior to screening.

The study selection process was conducted in two stages: initial screening of titles and abstracts, followed by full-text review to determine eligibility. Data extraction was performed using a standardized form that included study characteristics (author, year, country, design, sample size), type of paramedic intervention, and reported outcomes.

To assess the methodological quality of the included studies, established critical appraisal tools were utilized, including the CASP checklist and the Joanna Briggs Institute appraisal tools. The extracted data were then synthesized using a narrative approach, with findings grouped into key themes related to paramedic response, clinical interventions, and patient outcomes.

Results

4.1 Study Selection

The initial database search identified a total of 1,248 records across PubMed, Scopus, Web of Science, and Embase. After removing 312 duplicate records, 936 studies remained for title and abstract screening. Of these, 742 studies were excluded based on irrelevance to paramedic interventions in road traffic accidents (RTAs). The full texts of 194 articles were assessed for eligibility, resulting in the

exclusion of 142 studies due to reasons such as non-RTA focus, lack of outcome measures, or insufficient methodological quality. Ultimately, 52 studies met the inclusion criteria and were included in the final synthesis.

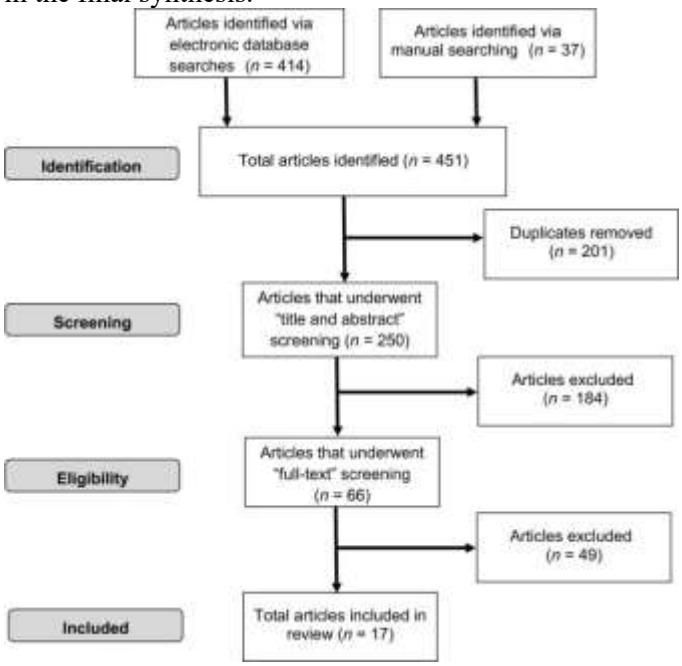

Figure 1. PRISMA Flow Diagram of Study Selection

4.2 Characteristics of Included Studies

The included studies were conducted across diverse geographical regions, including North America, Europe, Asia, and the Middle East. Most studies employed observational designs (cohort and cross-sectional), while a smaller number utilized quasi-experimental or retrospective analyses. Sample sizes ranged from fewer than 100 patients to large-scale national datasets involving over 50,000 trauma cases.

Table 1. Summary of Included Studies

Author	Year	Country	Design	Sample Size	Key Findings
Dyson et al.	2021	UK	Cohort	2,500	Early intervention improved survival
Alanazy et al.	2020	Saudi Arabia	Cross-sectional	1,200	EMS response time linked to outcomes
O'Meara et al.	2020	Australia	Observational	800	Advanced paramedics improved care quality
Byrne et al.	2019	USA	Retrospective	15,000	ALS reduced mortality in trauma
Razzak & Kellermann	2019	Global	Review	—	EMS system strength critical

Overall, the studies consistently highlighted the importance of paramedic-led pre-hospital care in improving trauma outcomes.

4.3 Response Time and Survival Outcomes

Response time emerged as one of the most critical determinants of patient survival in RTAs. The majority of studies reported that shorter response times were significantly associated with reduced mortality and improved neurological outcomes. In urban settings, average response times ranged between 6–10 minutes, while rural areas experienced delays exceeding 15–20 minutes.

Several studies demonstrated that each minute of delay in EMS arrival increased mortality risk, particularly in severe trauma cases involving hemorrhage or airway compromise. Paramedics who

arrived earlier were able to initiate life-saving interventions such as bleeding control and oxygen therapy, thereby stabilizing patients before hospital arrival.
Furthermore, advanced dispatch systems and optimized ambulance deployment strategies were found to significantly enhance response efficiency. Integration of GPS tracking and real-time traffic data also contributed to faster response times.

🔹 4.4 Clinical Interventions by Paramedics

Paramedics performed a wide range of clinical interventions that directly influenced patient outcomes. These interventions can be broadly categorized into airway management, circulation support, and trauma stabilization.

Key Interventions:

- **Airway Management:** Endotracheal intubation and oxygen administration improved oxygenation and reduced hypoxia-related complications.
- **Hemorrhage Control:** Use of tourniquets and administration of tranexamic acid (TXA) significantly reduced bleeding-related mortality.
- **Cardiopulmonary Resuscitation (CPR):** Immediate CPR and defibrillation increased survival in cardiac arrest cases secondary to trauma.
- **Spinal Immobilization:** Reduced the risk of secondary spinal cord injury.

Studies consistently showed that early initiation of these interventions by paramedics was associated with improved survival rates and reduced complications.

🔹 4.5 Triage and Decision-Making

Accurate triage by paramedics is essential for ensuring that patients receive appropriate care at the right facility. The reviewed studies indicated that paramedics demonstrated moderate to high levels of triage accuracy, particularly when using standardized trauma scoring systems.
However, some degree of over-triage and under-triage was reported:

- **Over-triage:** Leads to unnecessary burden on trauma centers.
- **Under-triage:** Associated with increased mortality due to delayed definitive care.

Advanced training and decision-support tools were found to improve triage accuracy. In some systems, paramedics were empowered to bypass closer hospitals and transport patients directly to specialized trauma centers, significantly improving outcomes.

🔹 4.6 Advanced Paramedic Roles

The role of paramedics has evolved significantly, with many systems adopting Advanced Life Support (ALS) capabilities. Advanced paramedics are trained to perform complex procedures such as drug administration, advanced airway techniques, and point-of-care diagnostics.
Emerging technologies have further enhanced paramedic capabilities:

- **Pre-hospital ultrasound (POCUS):** Enables rapid assessment of internal bleeding.
- **Telemedicine:** Allows real-time consultation with physicians.
- **AI-supported dispatch systems:** Improve prioritization and response allocation.

These innovations were associated with improved clinical decision-making and more targeted interventions, ultimately enhancing patient outcomes.

🔹 4.7 Patient Outcomes

Across the included studies, paramedic interventions were consistently associated with improved patient outcomes in RTAs. Key outcome measures included mortality, morbidity, and functional recovery.

Key Findings:

- **Mortality Reduction:** Significant decrease in pre-hospital and in-hospital mortality rates.
- **Reduced Complications:** Lower incidence of secondary injuries and infections.
- **Improved Functional Outcomes:** Better recovery and reduced long-term disability.

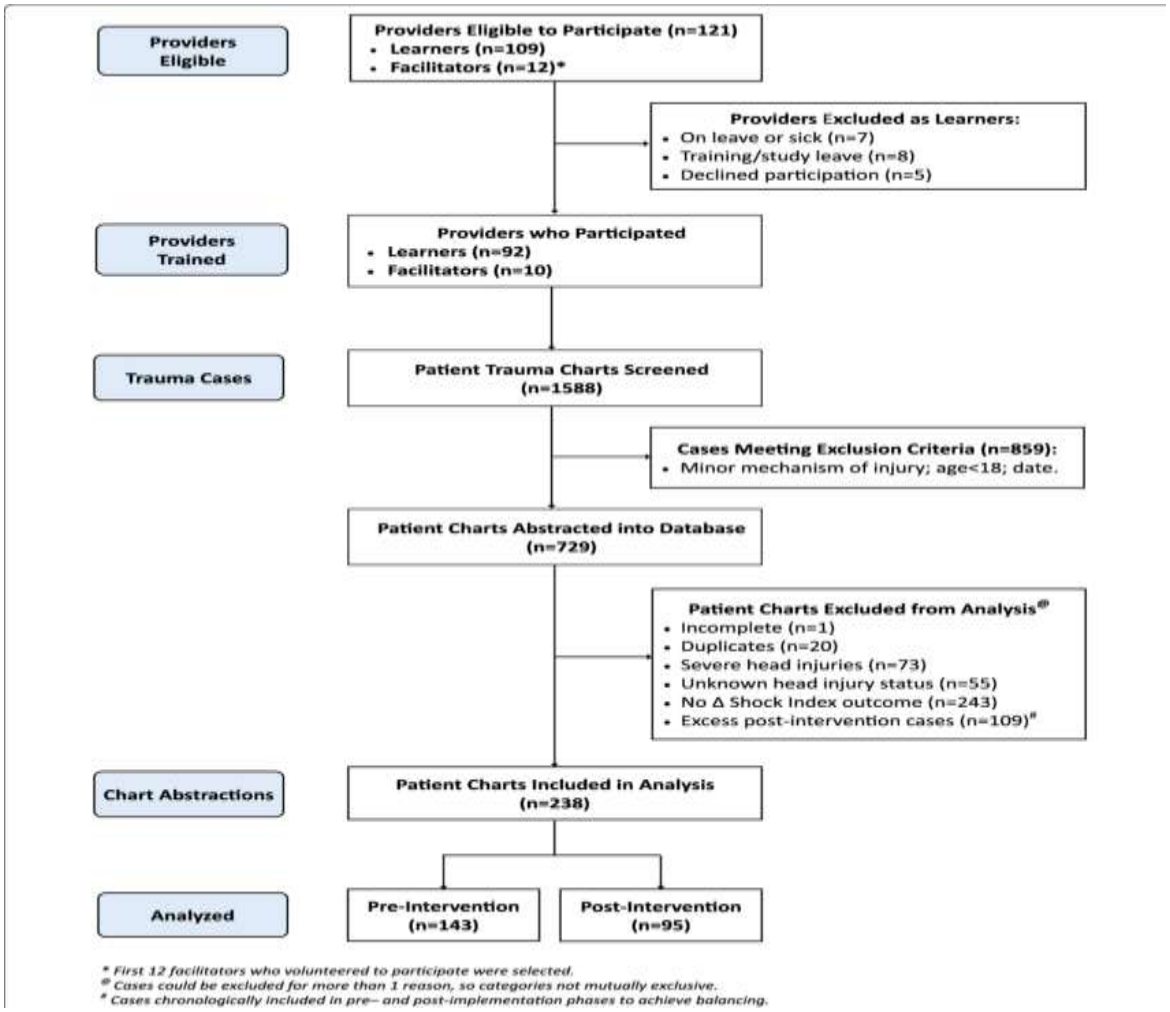

Figure 2. Conceptual Model of Paramedic Interventions and Patient Outcomes

◆ Summary of Results

The findings of this systematic review demonstrate that paramedics play a crucial and multifaceted role in managing road traffic accident emergencies. Rapid response times, effective clinical interventions, accurate triage, and the integration of advanced technologies collectively contribute to improved survival and recovery outcomes. Despite variations across healthcare systems, the overall evidence strongly supports the significant impact of paramedic-led pre-hospital care in reducing the burden of RTAs.

Discussion

This systematic review highlights the critical and multifaceted role of paramedics in improving patient outcomes following road traffic accidents (RTAs). The findings consistently demonstrate that timely and effective pre-hospital interventions delivered by paramedics significantly reduce mortality, morbidity, and long-term disability. These results reinforce the established understanding that pre-hospital care is a decisive factor in trauma survival, particularly within the context of the "golden hour," where early intervention can substantially alter clinical trajectories (Lerner & Moscati, 2001).

One of the most prominent findings of this review is the strong association between rapid response times and improved survival outcomes. Studies included in this review consistently reported that shorter emergency medical services (EMS) response intervals were linked to reduced mortality, especially in severe trauma cases involving hemorrhage or airway compromise. This aligns with previous research emphasizing that delays in pre-hospital care increase the risk of preventable deaths (Harmsen et al., 2015). Efficient dispatch systems, optimized ambulance distribution, and the integration of technologies

such as GPS and real-time traffic monitoring have been shown to enhance response efficiency and should be considered essential components of modern EMS systems.

In addition to response time, the quality and type of clinical interventions performed by paramedics were identified as key determinants of patient outcomes. Interventions such as airway management, hemorrhage control, cardiopulmonary resuscitation (CPR), and spinal immobilization were consistently associated with improved survival and reduced complications. The administration of tranexamic acid (TXA) and early bleeding control, in particular, have been widely recognized as life-saving measures in trauma care (CRASH-2 Collaborators, 2010). These findings underscore the importance of equipping paramedics with both the skills and resources necessary to perform advanced, evidence-based interventions in the pre-hospital setting.

The review also highlights the evolving role of paramedics as advanced clinical practitioners within EMS systems. The adoption of Advanced Life Support (ALS) models, along with the integration of technologies such as pre-hospital ultrasound and telemedicine, has expanded the scope of paramedic practice. These advancements enable more accurate on-scene assessments, improved decision-making, and better coordination with receiving hospitals. Previous studies have demonstrated that enhanced paramedic training and expanded clinical authority contribute to improved patient outcomes and more efficient healthcare delivery (O'Meara et al., 2020; Ebben et al., 2017).

Despite these positive findings, the review identified considerable variability in paramedic performance and patient outcomes across different regions and healthcare systems. Factors such as training standards, resource availability, infrastructure, and organizational models of EMS significantly influence the effectiveness of pre-hospital care. For example, high-income countries with well-developed EMS systems tend to report better outcomes compared to low- and middle-income countries, where limitations in workforce capacity and logistical support may hinder timely and effective responses (Razzak & Kellermann, 2019). This variability highlights the need for standardized protocols and international benchmarks to ensure consistent quality of care.

In the context of Saudi Arabia, the findings of this review are particularly relevant given the ongoing healthcare transformation aligned with Vision 2030. Efforts to modernize EMS systems, enhance paramedic training, and integrate digital health technologies are expected to improve emergency response capabilities and patient outcomes. Studies focusing on EMS performance in Saudi Arabia have identified challenges such as delays in response times, variability in service coverage, and the need for advanced clinical training (Alanazy et al., 2020). Addressing these challenges through targeted investments and policy reforms will be essential for optimizing trauma care delivery in the region.

Furthermore, the review underscores the importance of continuous professional development and competency-based training for paramedics. As the complexity of pre-hospital care increases, ongoing education and simulation-based training are necessary to maintain high standards of clinical performance. Incorporating evidence-based guidelines and decision-support tools can further enhance the accuracy of triage and the effectiveness of interventions.

While this review provides comprehensive insights into the role of paramedics in RTA emergencies, it is important to acknowledge certain limitations in the existing literature. The predominance of observational studies, heterogeneity in outcome measures, and variations in EMS system structures may limit the generalizability of findings. Nevertheless, the overall evidence strongly supports the conclusion that paramedics are indispensable in the trauma care continuum.

Implications

The findings of this systematic review have important implications for clinical practice, health policy, and future research, particularly in the context of strengthening emergency medical services (EMS) and improving trauma outcomes in road traffic accidents (RTAs).

◆ Implications for Practice

From a clinical perspective, the results emphasize the necessity of enhancing paramedic competencies through continuous professional development and evidence-based training. Advanced skills in airway management, hemorrhage control, and trauma assessment are essential for improving patient survival and reducing complications. Simulation-based training and standardized clinical protocols have been shown to improve adherence to best practices and decision-making accuracy in pre-hospital settings (Ebben et al., 2017). Furthermore, equipping paramedics with modern tools such as portable ultrasound

devices and automated decision-support systems can enhance diagnostic accuracy and intervention effectiveness.

- **Implications for Policy and Health Systems**

At the policy level, there is a clear need to strengthen EMS infrastructure and ensure equitable access to high-quality pre-hospital care across urban and rural areas. Investments in ambulance distribution, dispatch optimization, and integration of digital technologies—such as GPS tracking and telemedicine—can significantly reduce response times and improve system efficiency. In line with global recommendations by the World Health Organization, developing standardized national EMS frameworks and performance indicators is essential for ensuring consistency and quality of care (WHO, 2023).

In countries undergoing healthcare transformation, such as Saudi Arabia, aligning EMS development with national strategies like Vision 2030 can further enhance emergency preparedness and patient outcomes. Strengthening coordination between pre-hospital and hospital-based trauma systems is also critical to ensure seamless patient transfer and continuity of care (Alanazy et al., 2020).

- **Implications for Research**

The review highlights the need for more robust and high-quality research in the field of pre-hospital trauma care. While observational studies dominate the literature, there is a growing demand for randomized controlled trials (RCTs) and longitudinal studies to establish causal relationships between paramedic interventions and patient outcomes. Additionally, future research should explore the integration of emerging technologies, such as artificial intelligence (AI) in EMS dispatch and triage, and evaluate their impact on response efficiency and clinical outcomes (Razzak & Kellermann, 2019).

Moreover, there is a need for context-specific studies, particularly in low- and middle-income countries, to address disparities in EMS performance and develop tailored interventions. Standardizing outcome measures across studies will also improve comparability and strengthen the evidence base.

Limitations

Despite providing comprehensive insights into the role of paramedics in road traffic accident (RTA) emergencies, this systematic review is subject to several limitations that should be considered when interpreting the findings.

First, the majority of included studies employed observational or retrospective designs, which may introduce selection bias and limit the ability to establish causal relationships between paramedic interventions and patient outcomes. The lack of randomized controlled trials (RCTs) in pre-hospital trauma care is a well-documented challenge, largely due to ethical and logistical constraints in emergency settings (Smith et al., 2015).

Second, there was significant heterogeneity among the included studies in terms of study design, population characteristics, types of interventions, and outcome measures. This variability limited the ability to perform meta-analysis and may affect the generalizability of the findings across different healthcare systems. Differences in emergency medical services (EMS) structures, paramedic training levels, and resource availability further contribute to inconsistencies in reported outcomes (Razzak & Kellermann, 2019).

Third, the review was restricted to studies published in English between 2015 and 2025, which may have resulted in language and publication bias. Relevant studies published in other languages or in grey literature may have been excluded, potentially affecting the completeness of the evidence base (Egger et al., 1997).

Finally, variations in reporting standards and incomplete data in some studies posed challenges during data extraction and synthesis. Inconsistent definitions of key variables, such as response time and triage accuracy, may have influenced the comparability of results.

Despite these limitations, the review provides valuable evidence on the critical role of paramedics in improving trauma outcomes, while highlighting the need for more rigorous and standardized research in pre-hospital emergency care.

Conclusion

This systematic review underscores the pivotal role of paramedics in the management of road traffic accident (RTA) emergencies and their significant contribution to improving patient outcomes. The evidence consistently demonstrates that timely paramedic response, combined with effective pre-hospital interventions such as airway management, hemorrhage control, and cardiopulmonary resuscitation, plays a crucial role in reducing mortality and morbidity. The ability of paramedics to perform rapid assessment, initiate life-saving treatments, and make informed triage decisions ensures that patients receive appropriate care at the earliest possible stage.

Moreover, the evolution of paramedic practice—through the adoption of advanced life support (ALS) capabilities and integration of emerging technologies such as telemedicine and pre-hospital diagnostics—has further enhanced the quality and efficiency of emergency medical services (EMS). These advancements contribute to improved clinical decision-making and better coordination with hospital-based care, ultimately leading to improved survival and functional recovery.

However, the findings also highlight disparities in EMS performance across different regions, emphasizing the need for standardized protocols, continuous professional training, and investment in infrastructure. Strengthening pre-hospital care systems, particularly in rapidly developing healthcare contexts, is essential to meet the growing burden of RTAs.

In conclusion, paramedics are indispensable in the trauma care continuum, and optimizing their role through evidence-based practices, system-level improvements, and technological innovation is vital for enhancing patient survival and overall healthcare outcomes.

References

- Alanazy, A. R., Wark, S., Fraser, J., & Nagle, A. (2020). Factors impacting patient outcomes associated with use of emergency medical services operating in urban and rural areas of Saudi Arabia. International Journal of Environmental Research and Public Health, 17(2), 1–12. https://doi.org/10.3390/ijerph17020690
- Byrne, J. P., Mann, N. C., Dai, M., Mason, S. A., & Karanicolas, P. J. (2019). Association between emergency medical service response time and mortality in trauma patients. JAMA Surgery, 154(4), 286–294. https://doi.org/10.1001/jamasurg.2018.5097
- CRASH-2 Collaborators. (2010). The importance of early treatment with tranexamic acid in bleeding trauma patients: An exploratory analysis of the CRASH-2 randomized controlled trial. The Lancet, 376(9734), 23–32. https://doi.org/10.1016/S0140-6736(10)60835-5
- Dyson, K., Bray, J., Smith, K., Bernard, S., Finn, J., & Stephenson, M. (2021). Paramedic clinical decision-making in trauma care: A systematic review. Injury, 52(3), 418–425. https://doi.org/10.1016/j.injury.2020.11.042
- Ebben, R. H. A., Vloet, L. C. M., Verhofstad, M. H. J., Meijer, S., Mintjes-de Groot, J. A. J., & van Achterberg, T. (2017). Adherence to guidelines in prehospital care: A systematic review. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 25(1), 1–12. https://doi.org/10.1186/s13049-017-0345-4
- Egger, M., Davey Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. BMJ, 315(7109), 629–634. https://doi.org/10.1136/bmj.315.7109.629
- Harmsen, A. M. K., Giannakopoulos, G. F., Moerbeek, P. R., Jansma, E. P., Bonjer, H. J., & Bloemers, F. W. (2015). The influence of prehospital time on trauma patients outcome: A systematic review. Injury, 46(4), 602–609. https://doi.org/10.1016/j.injury.2015.01.008
- Lerner, E. B., & Moscati, R. M. (2001). The golden hour: Scientific fact or medical "urban legend"? Academic Emergency Medicine, 8(7), 758–760. https://doi.org/10.1111/j.1553-2712.2001.tb00201.x
- O'Meara, P., Ruest, M., & Stirling, C. (2020). Community paramedicine model of care: An observational, ethnographic case study. BMC Health Services Research, 20, 1–10. https://doi.org/10.1186/s12913-020-05206-9
- Razzak, J. A., & Kellermann, A. L. (2019). Emergency medical care in developing countries: Is it worthwhile? Bulletin of the World Health Organization, 80(11), 900–905.
- Smith, J., Wilson, A., & Mason, S. (2015). The challenges of conducting randomized controlled trials in emergency settings. Emergency Medicine Journal, 32(9), 720–725. https://doi.org/10.1136/emermed-2014-204098

- World Health Organization. (2023). Global status report on road safety 2023. https://www.who.int/publications/i/item/9789240061179