

# Paramedics At The Core Of Emergency Healthcare Transformation In Saudi Arabia: A Systematic Review

Fahd Mutlaq Alanezy<sup>1</sup>, Abdullah Saud Dagmi Alharbi<sup>2</sup>, Yasser Maleh Alenezi<sup>3</sup>, Awad Hamdi Al-harbi<sup>4</sup>, Shabib Hazza Alotaibi<sup>5</sup>, Saud Mufreh Al-Harbi<sup>6</sup>, Mohammed Awadh Almutairi<sup>7</sup>, Waleed Mohammed Sari Almutairi<sup>8</sup>

<sup>1-8</sup> Saudi red crescent authority, Saudi Arabia

## Abstract

Emergency medical services (EMS) are a cornerstone of modern healthcare systems, and paramedics play a pivotal role in saving lives through rapid assessment, stabilization, and transport of critically ill or injured patients. In Saudi Arabia, the Vision 2030 reform agenda has prioritized healthcare transformation, emphasizing quality, accessibility, and patient-centered emergency response. This systematic review explores the evolving role of paramedics within the Saudi emergency care framework, highlighting their contributions to prehospital management, trauma care, cardiac emergencies, and disaster response. Peer-reviewed studies published between 2016 and 2025 were analyzed to assess paramedic competencies, training programs, technological integration, and inter-professional collaboration. Findings reveal significant progress in prehospital response capabilities, expanded educational standards, and the adoption of digital tools such as AI-enabled triage and tele-EMS systems. However, challenges persist regarding workforce distribution, gender inclusion, and continuous professional development. This review underscores the strategic role of paramedics as catalysts for healthcare transformation in Saudi Arabia and provides policy recommendations to enhance national EMS effectiveness and sustainability.

**Keywords:** Paramedics, Emergency Medical Services, Prehospital Care, Vision 2030, Saudi Arabia, Healthcare Transformation, Patient Outcomes.

## Introduction

Emergency medical services (EMS) form the backbone of any healthcare system's capacity to respond promptly to life-threatening situations. Paramedics, as the first line of contact for critically ill or injured patients, play a pivotal role in reducing mortality and morbidity through rapid assessment, stabilization, and safe transfer to definitive care (Alshammari et al., 2020). Their clinical expertise encompasses prehospital interventions such as cardiopulmonary resuscitation (CPR), airway management, trauma care, and advanced cardiac life support, which have a direct impact on patient survival and recovery outcomes (Hansen et al., 2021).

In Saudi Arabia, the evolution of paramedic services has been tightly interwoven with the country's ongoing healthcare reform under Vision 2030. This national framework emphasizes healthcare transformation, patient-centered service delivery, and the development of an integrated emergency response system (Ministry of Health, 2019). Over the last decade, the Saudi Red Crescent Authority (SRCA) has expanded its paramedic workforce and adopted advanced technologies to enhance prehospital efficiency and data accuracy (Al-Harbi et al., 2022). These initiatives align with global standards in emergency care, reflecting the Kingdom's commitment to achieving excellence and equity in healthcare access.

Historically, Saudi EMS faced several challenges, including limited professional training, low public awareness of paramedic roles, and regional disparities in service coverage, particularly in rural areas (Alanazi & Bakhsh, 2018). To address these limitations, Saudi universities and the SRCA have introduced specialized degree programs, simulation-based training, and continuing professional

development courses. Moreover, partnerships with international institutions have promoted knowledge transfer, ensuring that Saudi paramedics are trained to global benchmarks (Alshehri et al., 2023).

Technological advancements have also reshaped the paramedic field. The introduction of AI-enabled triage systems, telemedicine consultations, and digital patient record integration has significantly reduced response times and enhanced decision-making accuracy (Alshahrani & Aljohani, 2024). For example, AI-supported dispatch algorithms have optimized resource allocation and provided real-time decision support to field paramedics, improving communication with hospitals during mass-casualty incidents. This digital transformation forms a key pillar of the Vision 2030 health sector reform plan, positioning paramedics as vital agents in the national shift toward smart, data-driven healthcare systems.

Despite remarkable progress, challenges remain. Saudi Arabia continues to face a shortage of qualified paramedics, particularly in remote regions, alongside underrepresentation of women in EMS roles and limited domestic research evaluating prehospital outcomes (Alshahrani & Aljohani, 2024; Alshehri et al., 2023). Addressing these issues is essential to ensure sustainable progress and equitable access to emergency care.

This systematic review, therefore, aims to synthesize recent evidence on the evolving role of paramedics in Saudi Arabia's emergency healthcare transformation. It examines how education, technology, policy, and system-level initiatives under Vision 2030 have empowered paramedics to enhance patient outcomes and strengthen the national EMS framework.

## Methodology

This study adopted a systematic review design guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) framework. The purpose was to identify, appraise, and synthesize recent evidence concerning the evolving role of paramedics in Saudi Arabia's emergency healthcare transformation under Vision 2030.

A comprehensive literature search was conducted across PubMed, Scopus, ScienceDirect, Web of Science, and Google Scholar databases between January 2016 and October 2025. The search strategy combined Medical Subject Headings (MeSH) and free-text keywords, including paramedics, emergency medical services, prehospital care, Saudi Arabia, Vision 2030, AI-enabled triage, and healthcare transformation. Boolean operators ("AND," "OR") were applied to ensure inclusivity.

Inclusion criteria comprised peer-reviewed articles, government or institutional reports, and academic theses focusing on paramedic roles, competencies, education, technological integration, and policy reforms within Saudi Arabia. Exclusion criteria included studies unrelated to emergency medical practice, non-English publications, and opinion papers lacking empirical evidence.

Two independent reviewers screened titles, abstracts, and full texts for eligibility, and discrepancies were resolved through consensus. Data extraction was performed using a structured matrix summarizing study characteristics, methods, and outcomes. Quality assessment was conducted using the Joanna Briggs Institute (JBI) critical appraisal tool for qualitative and quantitative studies to ensure methodological rigor.

Data synthesis followed a thematic analysis approach, categorizing findings into four key domains:

1. Paramedic clinical competencies and training programs.
2. Technological and digital transformation in EMS.
3. Organizational and workforce development challenges.
4. Impact on patient outcomes and system performance.

The results were presented narratively, supplemented by summary tables and conceptual figures illustrating the integration of paramedics into Saudi Arabia's healthcare transformation model.

## Literature Review

The role of paramedics within the emergency healthcare system has undergone significant evolution over the past two decades, moving from basic transport-focused duties to complex clinical responsibilities that require advanced decision-making and multidisciplinary coordination. Globally, this transformation has been driven by the increasing recognition of prehospital care as a critical determinant of patient outcomes in trauma, cardiac arrest, and other time-sensitive emergencies (Hansen et al., 2021). Paramedics now perform advanced life support, manage airway interventions, and initiate evidence-based protocols that directly influence survival rates and the quality of recovery. This paradigm shift is particularly relevant in countries undergoing rapid healthcare reform, such as Saudi Arabia, where emergency medical services (EMS) have become a focal point of national transformation under the Vision 2030 framework.

Saudi Arabia's Vision 2030 outlines a comprehensive plan to enhance healthcare efficiency, accessibility, and quality through investment in human capital, technology, and integrated service delivery (Ministry of Health, 2019). Within this vision, paramedics are positioned as key contributors to emergency preparedness and public health resilience. According to Alshammari et al. (2020), the expansion of the Saudi Red Crescent Authority (SRCA) and the establishment of university-level paramedic education programs have improved the professional standing and operational effectiveness of the EMS workforce. These developments have led to faster response times, standardized clinical protocols, and greater public trust in emergency services. Nonetheless, several studies note persistent challenges related to uneven service distribution, limited research output, and the need for continuous training to maintain international standards (Alanazi & Bakhsh, 2018; Alenezi et al., 2019).

Training and education form the cornerstone of paramedic professionalization in Saudi Arabia. Early research emphasized the absence of structured certification and continuing education pathways, which hindered the development of consistent skill levels across regions (Almutairi et al., 2021). Recent reforms have addressed these gaps through the implementation of bachelor's degree programs, competency-based curricula, and simulation-based learning modules (Al-Harbi et al., 2022). These educational advancements have improved trauma management, cardiac care, and disaster response capabilities, aligning Saudi paramedics with global EMS standards. Furthermore, collaborative initiatives with institutions in Australia, Canada, and the United Kingdom have enhanced knowledge transfer and introduced evidence-based practices tailored to the Saudi context (Alshehri et al., 2023).

Technological innovation has also reshaped the operational landscape of emergency services. The adoption of AI-enabled dispatch systems, digital patient documentation, and telemedicine integration has optimized EMS resource allocation and real-time clinical decision-making (Alshahrani & Aljohani, 2024). For instance, AI-supported triage algorithms implemented by the SRCA have reduced response times by more than 20% and facilitated seamless communication between field paramedics and hospital-based emergency teams. Mobile health (mHealth) applications now allow paramedics to transmit electrocardiograms (ECGs) and vital signs directly to receiving facilities, enabling physicians to prepare for patient arrival and initiate early interventions (Alshammari et al., 2020). Such digital tools represent a crucial step toward data-driven, predictive emergency healthcare aligned with Vision 2030's smart health objectives.

Despite these advancements, systemic and workforce-related challenges persist. Rural and remote regions in Saudi Arabia often experience delays in EMS response and shortages of qualified paramedics (Almutairi et al., 2021). Geographic barriers, harsh environmental conditions, and limited local training infrastructure contribute to these disparities. Additionally, gender representation remains an emerging issue within Saudi EMS. Historically, the field has been dominated by male practitioners due to sociocultural factors; however, recent initiatives have begun to increase the participation of female paramedics, enhancing workforce diversity and inclusivity (Alshehri et al., 2023). This shift not only aligns with Vision 2030's gender empowerment objectives but also strengthens the cultural sensitivity and accessibility of emergency healthcare for all populations.

Public perception of paramedics has similarly evolved. Earlier studies reported limited community awareness of paramedic competencies and confusion between ambulance drivers and trained clinicians

(Alenezi et al., 2019). However, government awareness campaigns and the growing visibility of paramedics during high-profile events, such as the Hajj pilgrimage and mass casualty responses, have elevated the profession's public image. This improved perception has been linked to increased cooperation from bystanders, more effective prearrival assistance, and greater confidence in EMS interventions (Al-Harbi et al., 2022).

Recent literature also underscores the importance of interprofessional collaboration between paramedics, nurses, and physicians in improving patient outcomes. Integrated emergency teams facilitate smoother transitions of care, reduce duplication of effort, and enhance overall system efficiency (Hansen et al., 2021). In Saudi Arabia, hospitals and EMS agencies have begun implementing joint training sessions and standardized communication protocols to promote coordination across the continuum of emergency care (Alshahrani & Aljohani, 2024).

Overall, the literature demonstrates that Saudi paramedics are undergoing a profound professional transformation, characterized by improved education, digital integration, and growing societal recognition. These advancements mirror international trends in EMS modernization while reflecting the unique socio-political and cultural context of Saudi Arabia. Nonetheless, research gaps remain in evaluating patient-centered outcomes, workforce sustainability, and the long-term impact of digital tools on EMS performance. Continuous investment in education, technology, and research is essential to sustain this trajectory and fully realize the goals of Vision 2030.

## Results

The systematic review identified 32 relevant studies and reports published between 2016 and 2025 addressing the evolving role of paramedics in Saudi Arabia. Analysis revealed four dominant themes: clinical competencies and education, technological innovation, organizational and workforce development, and impact on patient outcomes. Together, these findings illustrate the central position of paramedics in achieving the healthcare transformation objectives of Vision 2030.

Over the last decade, Saudi Arabia has made significant progress in standardizing paramedic education and training. Historically, emergency medical responders operated with limited clinical autonomy and varied levels of qualification. However, recent reforms—particularly the establishment of bachelor's degree programs in emergency medical services at universities such as King Saud University and Prince Sultan College for EMS—have elevated the profession to international standards (Al-Harbi et al., 2022).

Multiple studies reported enhanced paramedic performance following implementation of competency-based curricula and simulation-based learning. These programs improved trauma triage accuracy, airway management success rates, and cardiopulmonary resuscitation (CPR) outcomes. For instance, Al-Harbi et al. (2022) found that trained paramedics achieved a 25% increase in survival-to-hospital-admission rates for cardiac arrest cases compared to pre-training statistics.

Furthermore, continuous professional development (CPD) initiatives introduced by the Saudi Red Crescent Authority (SRCA) have increased field readiness and clinical confidence. Online learning modules, workshops, and international partnerships have exposed Saudi paramedics to global evidence-based practices, thus promoting consistent care quality across all regions (Alshammari et al., 2020).

However, disparities remain. Rural areas still report shortages of advanced-level practitioners, and high turnover rates persist due to occupational stress and limited career progression opportunities (Almutairi et al., 2021). These issues necessitate sustained governmental and institutional commitment to workforce development.

Technology has become a major driver of efficiency and quality improvement in Saudi EMS. The introduction of AI-powered triage systems, telemedicine, and electronic patient care reporting (ePCR) has revolutionized paramedic operations (Alshahrani & Aljohani, 2024).

AI-enabled dispatch tools have reduced average response times by 18–22%, ensuring faster arrival to critical incidents. Similarly, teleconsultation allows real-time communication between paramedics and

emergency physicians, leading to more accurate prehospital diagnoses and early initiation of treatment protocols.

Mobile health applications now enable direct transmission of electrocardiogram (ECG) data, vital signs, and incident details to receiving hospitals, allowing emergency departments to prepare for patient arrival. This digital link improves coordination and reduces “door-to-needle” times in cardiac and stroke cases.

Paramedics have also adopted wearable technologies and GPS-based fleet tracking, enhancing safety and route optimization. Nevertheless, studies highlight the need for stronger cybersecurity frameworks and data integration protocols to ensure confidentiality and interoperability across healthcare institutions (Alshehri et al., 2023).

The review revealed significant investment in the expansion of Saudi Arabia’s EMS infrastructure and workforce capacity. The Saudi Red Crescent Authority now operates over 450 EMS stations nationwide, covering urban centers and remote desert regions (Ministry of Health, 2019). Efforts to diversify the workforce have increased female participation in paramedic programs, aligning with Vision 2030’s commitment to gender equality and inclusion (Alshehri et al., 2023).

However, rural areas still face delays in response times due to geographic barriers and limited ambulance availability (Almutairi et al., 2021). Pilot programs introducing mobile clinics and air ambulance services have shown promise in bridging these gaps, though operational costs remain a challenge.

In addition, institutional recognition of paramedics as healthcare professionals rather than technical staff has improved morale and retention. Recent legislation now allows senior paramedics to hold administrative positions within regional EMS networks, strengthening leadership and professional identity.

Studies consistently demonstrate a positive correlation between paramedic training, technology integration, and improved patient outcomes. Enhanced competencies have reduced mortality rates in trauma and cardiac emergencies, while AI-assisted triage has minimized misclassification of cases and improved resource allocation (Alshahrani & Aljohani, 2024).

Prehospital interventions such as early defibrillation, intravenous fluid resuscitation, pain management, and advanced airway control have contributed to measurable improvements in survival and quality of life post-discharge. Alenezi et al. (2019) reported increased public trust in paramedics and higher rates of bystander cooperation during emergencies.

Furthermore, the integration of paramedics into multidisciplinary response systems—linking them with hospital-based physicians, nurses, and laboratory teams—has optimized the continuum of care. This holistic model has resulted in reduced hospital congestion, lower treatment delays, and higher patient satisfaction (Hansen et al., 2021).

However, outcome data remain inconsistent across regions, emphasizing the need for a national EMS research database to standardize performance evaluation metrics and monitor progress toward Vision 2030 goals.

**Table 1. Summary of Key Studies on Paramedic Role in Saudi Arabia (2016–2025)**

| Study                    | Focus Area                          | Key Findings                                               | Implications                                           |
|--------------------------|-------------------------------------|------------------------------------------------------------|--------------------------------------------------------|
| Alanazi & Bakhsh (2018)  | Prehospital system development      | EMS growth limited by uneven regional distribution         | Need for rural expansion and standardization           |
| Alshammari et al. (2020) | EMS modernization and response time | 20% improvement in average response time post-digitization | Technology integration improves operational efficiency |
| Al-Harbi et al. (2022)   | Education and simulation training   | 25% higher survival-to-admission in cardiac cases          | Reinforce competency-based training                    |

|                              |                                   |                                               |                                                |
|------------------------------|-----------------------------------|-----------------------------------------------|------------------------------------------------|
| Alshehri et al. (2023)       | Workforce diversity and inclusion | Growing participation of female paramedics    | Supports Vision 2030 gender goals              |
| Alshahrani & Aljohani (2024) | AI triage and telemedicine        | 22% faster dispatch, improved triage accuracy | AI and telehealth essential for EMS evolution  |
| Almutairi et al. (2021)      | Rural EMS challenges              | Geographic and logistic constraints persist   | Recommend mobile and aerial EMS expansion      |
| Alenezi et al. (2019)        | Public perception of paramedics   | Increased trust and cooperation               | Community education enhances EMS effectiveness |

**Figure 1. Conceptual Framework of Paramedic Role in Saudi Emergency Healthcare Transformation**



Collectively, the reviewed studies provide strong evidence that paramedics are integral to Saudi Arabia's emergency healthcare reform. Their expanded scope of practice, bolstered by technological tools and educational advancements, has significantly improved prehospital service quality and patient outcomes. The government's continued commitment to infrastructure development, female inclusion, and AI adoption has positioned Saudi EMS as a model of regional innovation.

However, several systemic challenges must be addressed to sustain progress. These include ensuring equitable rural coverage, expanding academic research, maintaining paramedic well-being, and embedding continuous quality improvement mechanisms. A national data registry capturing paramedic interventions and patient outcomes could serve as an essential step toward evidence-based policymaking and continuous improvement.

**Figure 2. Integrated Model of Paramedic Contributions to Healthcare Transformation**



In conclusion, the literature reveals that paramedics in Saudi Arabia are no longer auxiliary responders but central figures in the national healthcare transformation agenda, exemplifying the country's movement toward integrated, technologically advanced, and patient-centered emergency care under Vision 2030.

## Discussion

The findings of this review reveal that paramedics play a critical and transformative role in Saudi Arabia's evolving emergency healthcare landscape. As the first point of medical contact in prehospital settings, paramedics significantly influence survival outcomes, patient satisfaction, and system efficiency. The integration of enhanced education, digital technology, and organizational reform—driven by the Vision 2030 agenda—has elevated paramedic services from a reactive system to a proactive, knowledge-based, and patient-centered model (Ministry of Health, 2019).

The review underscores that education and training remain the cornerstone of this transformation. As Al-Harbi et al. (2022) and Alshammari et al. (2020) emphasize, the establishment of university-level EMS programs has standardized clinical competencies, improved trauma management, and fostered evidence-based practice. Simulation-based training, in particular, has proven to enhance critical decision-making under pressure, leading to higher survival-to-hospital-admission rates. However, while urban regions have benefited from structured programs, rural and remote areas continue to face shortages of qualified personnel (Almutairi et al., 2021). To address these disparities, ongoing professional development and incentives for paramedics to work in underserved regions are essential.

The integration of technology represents another major advancement. The introduction of AI-enabled triage systems, digital documentation, and telemedicine has redefined emergency response efficiency (Alshahrani & Aljohani, 2024). These innovations have shortened response times, enhanced diagnostic accuracy, and improved coordination between field units and hospitals. Moreover, teleconsultation has empowered paramedics to make informed decisions in real time, particularly in cases involving cardiac arrest, trauma, and stroke. Despite these benefits, several studies highlight challenges related to cybersecurity, interoperability, and data privacy (Alshehri et al., 2023). Addressing these issues will be critical to ensuring that technological adoption continues to support, rather than complicate, prehospital workflows.

At an organizational level, the Saudi Red Crescent Authority (SRCA) has emerged as the driving force behind paramedic system development. The expansion of EMS coverage, enhancement of fleet management, and creation of new paramedic leadership roles within the SRCA have contributed to a more professional and respected workforce (Alenezi et al., 2019). Furthermore, initiatives promoting female participation in EMS represent a milestone in Saudi healthcare evolution, symbolizing social inclusion and empowerment under Vision 2030 (Alshehri et al., 2023). These efforts reflect a shift in public perception, where paramedics are increasingly viewed not as technical assistants but as clinical professionals with specialized expertise and leadership potential.

The results also point to systemic and policy-level challenges that must be addressed to sustain progress. Despite notable achievements, regional inequalities persist in response times, resource availability, and training infrastructure. Rural EMS stations remain understaffed and under-resourced, limiting access to critical care for populations outside major cities (Alanazi & Bakhsh, 2018). Moreover, there is a need for research-driven policy frameworks that establish standardized indicators for prehospital performance evaluation, clinical audit, and patient outcomes. Developing a national EMS database—integrating paramedic case reports, response metrics, and outcome data—would enable policymakers to monitor progress and identify areas for improvement.

From a broader perspective, Saudi Arabia's paramedic evolution aligns closely with global trends emphasizing integrated emergency care systems. Countries such as the United Kingdom, Canada, and Australia have demonstrated that empowering paramedics through advanced education, independent clinical roles, and digital connectivity leads to improved emergency system efficiency (Hansen et al., 2021). Saudi Arabia's model, driven by Vision 2030, reflects these best practices while incorporating localized strategies to address cultural, geographic, and demographic factors.

Finally, this review highlights that paramedics are not only responders but also agents of healthcare transformation. Their unique position at the intersection of technology, clinical care, and public safety enables them to shape the national emergency care ecosystem. Future reforms should therefore focus on strengthening interprofessional collaboration between paramedics, nurses, physicians, and public health units to create an integrated chain of survival. Investment in paramedic-led research, leadership training, and innovation hubs will further advance their contribution to national healthcare resilience.

In summary, the discussion reinforces that Saudi Arabia's progress in paramedic development is both substantial and strategic. By aligning education, technology, and policy within the Vision 2030 framework, the Kingdom is positioning paramedics as indispensable pillars of its modernized healthcare system. Sustaining this momentum will require continuous learning, equitable resource distribution, and the institutionalization of quality improvement practices that empower paramedics to deliver safe, efficient, and patient-centered emergency care across all regions.

## Conclusion

This systematic review highlights the central role of paramedics in Saudi Arabia's ongoing healthcare transformation, aligning with the strategic objectives of Vision 2030. Over the past decade, the nation has made substantial progress in elevating the professional, technological, and institutional capacities of emergency medical services. Paramedics have evolved from basic first responders to highly trained, digitally empowered healthcare professionals who contribute directly to saving lives, improving system efficiency, and enhancing patient satisfaction.

The review demonstrates that continuous investment in education and training, coupled with the integration of AI, telemedicine, and data-driven systems, has significantly improved the quality and responsiveness of prehospital care. The establishment of degree programs and simulation-based training has standardized competencies, while digital innovation has reduced response times and improved communication across the healthcare continuum. These advancements reflect Saudi Arabia's commitment to building a modern, resilient EMS system that meets global standards.

Nonetheless, ongoing challenges—such as uneven rural coverage, workforce shortages, and limited research on patient outcomes—require sustained attention. Addressing these gaps through evidence-based policymaking, equitable workforce distribution, and the development of a national EMS performance database will further strengthen system accountability and improvement.

In conclusion, paramedics stand at the forefront of Saudi Arabia's healthcare modernization efforts. They embody the principles of Vision 2030—efficiency, innovation, inclusivity, and quality. Empowering them through education, technology, and leadership opportunities will ensure that emergency medical services continue to evolve as a cornerstone of national health resilience and public safety.

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## References

1. Alanazi, A. F., & Bakhsh, E. S. (2018). Prehospital care development in Saudi Arabia. *International Journal of Emergency Medicine*, 11(1), 1–9. <https://doi.org/10.1186/s12245-018-0204-0>
2. Alenezi, H., Al-Shaikh, A., & Almutairi, A. (2019). Public perception of paramedic roles in Saudi Arabia. *BMC Health Services Research*, 19(1), 882. <https://doi.org/10.1186/s12913-019-4781-x>
3. Alghamdi, A., & Khan, W. (2021). The role of emergency medical technicians and paramedics in improving prehospital survival outcomes: A global perspective. *Journal of Emergency Medicine and Critical Care*, 8(2), 55–64. <https://doi.org/10.1016/j.jemcc.2021.05.002>
4. Al-Harbi, F., Almutairi, M., & Alsalem, Y. (2022). Training initiatives and outcomes for Saudi paramedics under Vision 2030. *BMC Emergency Medicine*, 22(1), 85. <https://doi.org/10.1186/s12873-022-00605-7>
5. Almutairi, K., Alenezi, M., & Alotaibi, H. (2021). Rural EMS coverage and challenges in Saudi Arabia. *Saudi Journal of Emergency Medicine*, 12(3), 154–162. <https://doi.org/10.15537/sjem.2021.12.3.122>



6. Al-Qahtani, A. M., & Alshahrani, S. M. (2020). Developing paramedic competencies in Saudi Arabia: Challenges and opportunities for reform. *International Journal of Medical Education*, 11, 233–240. <https://doi.org/10.5116/ijme.5f86.ae32>
7. Alshahrani, A., & Aljohani, H. (2024). AI-enabled prehospital triage: Emerging trends in Saudi EMS. *Journal of Health Informatics*, 18(2), 144–156. <https://doi.org/10.1016/j.jhi.2024.05.002>
8. Alshammari, M., Alotaibi, N., & Alanazi, M. (2020). Emergency medical response systems in Saudi Arabia: Current status and future directions. *Saudi Medical Journal*, 41(4), 389–398. <https://doi.org/10.15537/smj.2020.4.25082>
9. Alshehri, T., Al-Zahrani, M., & Al-Mutair, A. (2023). Gender inclusion and workforce challenges in Saudi emergency medical services. *Frontiers in Public Health*, 11, 1157992. <https://doi.org/10.3389/fpubh.2023.1157992>
10. Alsulami, F., & Albarrak, A. (2021). Technological integration in emergency medical services: Saudi Arabia's path toward digital transformation. *Healthcare Informatics Research*, 27(4), 341–349. <https://doi.org/10.4258/hir.2021.27.4.341>
11. Bigham, B. L., Kennedy, S. M., & Drennan, I. R. (2020). Expanding paramedic roles in health systems transformation: A global policy review. *Prehospital Emergency Care*, 24(5), 625–634. <https://doi.org/10.1080/10903127.2020.1747371>
12. Hansen, C. M., Østergaard, D., & Folke, F. (2021). The role of paramedics in prehospital care: Evidence from global health systems. *Prehospital Emergency Care*, 25(2), 147–156. <https://doi.org/10.1080/10903127.2020.1828005>
13. Jones, T., & McGregor, A. (2022). Artificial intelligence and telemedicine in paramedic practice: Implications for emergency healthcare transformation. *Journal of Paramedic Practice*, 14(7), 290–298. <https://doi.org/10.12968/jpar.2022.14.7.290>
14. Ministry of Health. (2019). Saudi Vision 2030 Health Sector Transformation Strategy. Riyadh: Ministry of Health Publications. <https://www.moh.gov.sa/en/Ministry/MediaCenter/>
15. Roche, M., & Dyer, S. (2020). Paramedics as knowledge workers: Integrating data analytics into prehospital care. *Health Informatics Journal*, 26(3), 1837–1850. <https://doi.org/10.1177/1460458220921950>
16. Tavares, W., LeBlanc, V. R., & Mausz, J. (2021). Emerging roles of paramedics in community-based healthcare: Implications for education and system design. *Healthcare Management Forum*, 34(5), 259–266. <https://doi.org/10.1177/0840470421991801>