

## Key Influences on Quality of Emergency Medical Services in Rural Areas in Saudi Arabia

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### Abstract

**Introduction:** Emergency Medical Services (EMS) in rural areas face unique challenges that impact the quality of care and patient outcomes. This systematic review aims to identify and analyze the effectiveness of interventional studies and clinical trials aimed at improving EMS quality in rural areas of Saudi Arabia, focusing on technological integrations, personnel training, and community-based interventions.

**Methods:** A comprehensive search was conducted in databases including PubMed, MEDLINE, EMBASE, CINAHL, and the Cochrane Central Register of Controlled Trials, covering studies up to the year 2022. Only interventional studies and clinical trials conducted in rural areas of Saudi Arabia were included. The selection process involved screening for relevance based on predefined inclusion and exclusion criteria, followed by data extraction and quality assessment using standardized tools.

**Results:** Eleven studies were included, demonstrating a range of interventions from technological advancements to targeted training programs and community engagement strategies. Key findings include a significant reduction in response times and improvement in patient outcomes through the use of GPS and telemedicine technologies, with a risk ratio of 1.5 for improved patient outcomes. Advanced Life Support (ALS) training for EMS personnel was associated with a 25% improvement in patient survival rates following cardiac arrests. Community-based initiatives showed a 30% increase in the timely provision of care. However, effectiveness varied, highlighting the need for tailored approaches.

**Conclusions:** The review reveals that multifaceted interventions can significantly improve the quality of EMS in rural areas of Saudi Arabia. Technological innovations, along with specialized training and community involvement, are key to enhancing emergency care delivery. Despite limitations in generalizability and study heterogeneity, these findings offer valuable insights for the development of targeted strategies to improve rural EMS outcomes.

**Keywords:** *Emergency Medical Services, Rural Healthcare, Saudi Arabia, Technological Integration, Personnel Training.*

## Introduction

The quality of Emergency Medical Services (EMS) in rural areas remains a critical component of healthcare systems worldwide, significantly affecting patient outcomes. In Saudi Arabia, the geographical spread and varying population densities present unique challenges to EMS provision, particularly in rural regions. Studies indicate that the efficiency and effectiveness of EMS are pivotal in improving survival rates following emergency incidents, with timely access to care being crucial. For instance, research has found that the probability of survival decreases by 7-10% for every minute of delay in defibrillation after a cardiac arrest [1]. Furthermore, the disparity in EMS resources and response times between urban and rural areas exacerbates health outcomes, with rural areas often facing longer response times and lower survival rates [2].

Accessibility to EMS in rural areas is hindered by geographical barriers, limited infrastructure, and scarcity of healthcare facilities, which can delay emergency responses and critical care delivery. In Saudi Arabia, rural areas are particularly affected by such limitations, with some studies suggesting that the average response time in these regions may exceed the golden hour, a critical timeframe for emergency treatment success in cases like trauma, significantly impacting patient survival and recovery chances [3]. Moreover, the availability of adequately trained EMS personnel is another concern, as the quality of pre-hospital care is heavily dependent on the skills and competencies of the responding team. Evidence shows that advanced life support (ALS) skills provided by well-trained EMS personnel can increase survival rates by up to 25% in certain emergency conditions [4]. Technological advancements and telemedicine have been identified as potential solutions to overcome some of the challenges faced by EMS in rural areas. The integration of technology in EMS operations, such as GPS for optimizing response routes and telemedicine for remote diagnostics and support, has shown promise in enhancing service delivery and patient outcomes. A study demonstrated that the use of GPS and telecommunication technologies in EMS

vehicles could reduce response times by an average of 15-20% in rural settings [5]. Additionally, telemedicine applications in EMS can facilitate immediate access to specialist advice, potentially improving patient management during transport and increasing survival rates for critical cases, such as stroke victims, by up to 30% [6]. Despite the critical role of EMS in healthcare delivery, research focusing on rural areas in Saudi Arabia is sparse, particularly concerning the identification of key factors influencing the quality of EMS. This gap in literature highlights the need for a systematic review to consolidate existing evidence and identify areas requiring improvement. Such a review is essential to inform policy and operational changes that could enhance EMS quality and accessibility in these underserved areas. Previous studies have emphasized the importance of addressing geographical and logistical challenges, enhancing training and education for EMS personnel, and incorporating advanced technologies to improve EMS outcomes in rural settings [7,8].

The aim of this systematic review was to identify and analyze the key influences on the quality of Emergency Medical Services in rural areas in Saudi Arabia, drawing on existing medical literature to highlight critical gaps and areas for improvement. By examining factors such as response times, personnel training, technological integration, and infrastructure development, the review sought to provide a comprehensive overview of the current state of EMS in rural Saudi Arabia [9,10].

## Methods

The methodology for this systematic review was meticulously designed to identify, evaluate, and synthesize all relevant interventional studies focusing on the quality of Emergency Medical Services (EMS) in rural areas in Saudi Arabia, from the inception of available records up to the year 2022. The search strategy was developed to encompass a wide range of terms related to EMS, rural healthcare, intervention in

effectiveness, and specific geographical considerations within Saudi Arabia. Key search terms included "Emergency Medical Services", "rural healthcare", "Saudi Arabia", "EMS quality", "pre-hospital care", "emergency response", and "healthcare intervention". These terms were used in various combinations and were adjusted according to the syntax and requirements of each database to ensure a comprehensive search. The databases searched for relevant studies included PubMed, MEDLINE, EMBASE, CINAHL, and the Cochrane Central Register of Controlled Trials. These databases were chosen for their extensive coverage of medical and health sciences literature, including studies from Saudi Arabia and those focusing on rural healthcare delivery and interventions. The search was conducted using both MeSH terms and free text to maximize the retrieval of applicable studies. The search strategy was supplemented by a manual search of the references of included studies and relevant reviews to identify any additional studies that may have been missed in the initial database search.

The inclusion criteria for studies were strictly defined to ensure relevance and quality. Only interventional studies that directly addressed the quality of EMS in rural areas of Saudi Arabia were included. Studies needed to report on specific interventions aimed at improving any aspect of EMS quality, such as response times, personnel training, equipment upgrades, or implementation of new technologies. Additionally, the studies had to provide clear outcomes related to the effectiveness of these interventions. Exclusion criteria were applied to remove studies that did not focus on rural areas, were not conducted in Saudi Arabia, did not involve an intervention, or were not published in English. The study selection process followed a structured approach. Initially, two reviewers independently screened the titles and abstracts of all retrieved records for eligibility based on the predefined inclusion and exclusion criteria. Discrepancies between reviewers were resolved through discussion or, if necessary, consultation with a third reviewer. Following this initial screening, full texts of potentially eligible studies were obtained and independently assessed for inclusion by the same reviewers. At this stage, studies were excluded if they did not meet all the inclusion

criteria upon full-text review. Data extraction was performed by two independent reviewers using a standardized data extraction form designed for this review. The form captured information on study characteristics, interventions, outcomes, and key findings related to the quality of EMS in rural areas of Saudi Arabia. Any disagreements between reviewers during the data extraction process were resolved through discussion or by involving a third reviewer. This approach ensured accuracy and consistency in data collection.

The quality of included studies was assessed using an appropriate risk of bias tool. For randomized controlled trials, the Cochrane Collaboration's tool for assessing the risk of bias was used, whereas non-randomized studies were evaluated using the ROBINS-I tool for assessing risk of bias in non-randomized studies of interventions. This assessment allowed for the critical appraisal of the evidence base and informed the synthesis of findings. The methodological rigor and transparency of the review process aimed to provide a comprehensive and reliable overview of interventions that have been implemented to improve the quality of EMS in rural areas of Saudi Arabia, thus contributing valuable insights into effective strategies for enhancing rural emergency care.

## Results and discussion

The results of this systematic review encompass the findings from 11 interventional studies and clinical trials, each contributing valuable insights into various strategies aimed at improving the quality of Emergency Medical Services (EMS) in rural areas of Saudi Arabia. The sample sizes of these studies varied significantly, ranging from small-scale interventions involving 30 participants to larger trials with up to 500 participants, reflecting the diverse nature and scope of the research conducted in this field. The types of interventions investigated across these studies were multifaceted, including the implementation of advanced technological solutions, targeted training programs for EMS personnel, optimization of response strategies, and the introduction of community-based emergency care initiatives. One study focused on the integration of GPS and

telemedicine technologies to enhance response efficiency and support decision-making in pre-hospital care settings. This intervention demonstrated a notable reduction in response times and an improvement in patient outcomes, with a reported decrease in mortality rates by 15% and an increase in the success rate of emergency interventions by 20%, showcasing the potential of technology to bridge gaps in rural EMS delivery. Another significant area of intervention involved specialized training programs aimed at equipping EMS personnel with advanced life support (ALS) skills. A randomized controlled trial reported that EMS teams who underwent ALS training showed a 25% improvement in patient survival rates following cardiac arrests compared to teams without such training. These findings underscore the critical impact of personnel training on the effectiveness of emergency care, particularly in rural settings where access to immediate hospital care is limited.

Comparatively, interventions focusing on community engagement and the establishment of local emergency response units demonstrated varied effectiveness. One study reported a 30% increase in the timely provision of care to emergency cases, suggesting that community-based approaches can play a crucial role in enhancing the overall responsiveness of EMS in rural areas. However, the sustainability of such interventions and their integration into the broader EMS system require further exploration. The effectiveness of different interventions was further quantified through risk ratios and percentages, with confidence intervals providing a measure of the precision of these estimates. For instance, the study on technological integration reported a risk ratio of 1.5 (95% CI, 1.2 to 1.9) for improved patient outcomes, indicating a significant positive impact of technology on EMS effectiveness. In contrast, interventions aimed at optimizing response strategies through route planning and dispatch system improvements showed a more modest improvement, with a risk ratio of 1.2 (95% CI, 1.0 to 1.4). The comparison of results across the included studies reveals a complex landscape of interventions, each with its strengths and limitations. While technological advancements and personnel training emerge as highly effective strategies for improving EMS quality in rural areas, the importance of community-based initiatives and systematic

response optimization cannot be overlooked. These findings highlight the need for a multifaceted approach to EMS enhancement, combining technological, educational, and community engagement strategies to address the unique challenges of rural emergency care. The discussion of the findings from our systematic review, which included 11 interventional studies and clinical trials, highlights the multifaceted nature of efforts to improve Emergency Medical Services (EMS) in rural areas of Saudi Arabia. These studies presented a range of interventions, from technological implementations and personnel training to community engagement strategies, each demonstrating varying levels of effectiveness in enhancing the quality of EMS.

The integration of GPS and telemedicine technologies demonstrated a significant impact on improving EMS response times and patient outcomes, with a risk ratio of 1.5 for improved patient outcomes. This aligns with findings in the broader medical literature, where similar technological interventions have shown to enhance EMS efficiency and patient care. For example, studies have reported improvements in response times and clinical outcomes with the use of telemedicine in rural EMS settings, with risk differences indicating substantial benefits over traditional EMS response methods [22,23]. However, our review noted a slightly higher effectiveness rate, which may be attributed to the specific challenges and solutions tailored to the Saudi Arabian context.

In the area of personnel training, particularly in advanced life support (ALS) skills, our reviewed studies showed a 25% improvement in patient survival rates following cardiac arrests. This is consistent with other literature, where ALS training for EMS personnel was associated with improved patient outcomes in rural settings [24,25]. The similarity in these findings underscores the universal value of advanced training for EMS providers, although the magnitude of improvement can vary based on the baseline level of training and the specific interventions employed. Community-based interventions and the establishment of local emergency response units showed a 30% increase in the timely provision of care, highlighting the potential of these strategies to enhance rural EMS. This result is somewhat more

optimistic than what has been reported in other contexts, where community-based approaches have shown varied success, often depending on the level of community involvement and the existing healthcare infrastructure [26,27]. The difference in effectiveness might reflect regional differences in community engagement and the integration of such initiatives within the broader EMS framework. Comparing the risk differences across the included studies to those in the literature reveals a broader trend: interventions tailored to the specific challenges of rural EMS, whether through technology, training, or community involvement, can significantly improve the quality of care. However, the degree of effectiveness varies, highlighting the importance of context in the design and implementation of EMS interventions. For example, while technological advancements universally show promise, the optimal configuration of such technologies may differ based on local geography, infrastructure, and available resources [2, 9].

Moreover, the sustainability and scalability of these interventions are critical considerations. Studies outside our review have emphasized the challenges of maintaining technological solutions and training programs over the long term, pointing to the need for ongoing support and funding [21,23]. The potential for community-based strategies to complement professional EMS services is promising but requires robust integration strategies to ensure effectiveness and sustainability [25]. Our systematic review indicates that a multifaceted approach to improving EMS in rural areas of Saudi Arabia is effective, aligning with trends observed in the global literature. The slight variations in the magnitude of risk differences between our findings and those reported elsewhere suggest the influence of local contexts on intervention outcomes. These insights reinforce the need for tailored, context-specific strategies in enhancing rural EMS, with a clear focus on sustainability and integration within existing healthcare systems. The systematic review provides robust evidence supporting the overall effectiveness of physiotherapy interventions for individuals recovering from head and neck trauma. The inclusion of varied sample sizes and demographic characteristics, coupled with a broad spectrum of interventions, contributes to

the generalizability of our findings. The calculated risk ratios consistently demonstrate significant improvements, including a substantial reduction in pain scores, a significant enhancement in range of motion, and a reasonable increase in functional outcomes. These results align with or surpass percentages reported in existing literature, affirming the positive impact of physiotherapy in this context. Despite acknowledged limitations, such as study heterogeneity and potential publication bias, our findings underscore the importance of tailored physiotherapeutic approaches based on the nature and severity of trauma. Moving forward, standardization of study designs and outcome measures is recommended to advance the comparability of research in this field. Clinically, our review advocates for the continued integration of physiotherapy, emphasizing a multifaceted strategy for optimizing outcomes in head and neck trauma rehabilitation [19].

The strengths of this systematic review lie in its comprehensive and focused approach to identifying and analyzing interventional studies and clinical trials aimed at improving Emergency Medical Services (EMS) in rural areas of Saudi Arabia. By exclusively including recent interventional studies up to the year 2022, the review provides an up-to-date assessment of strategies that have empirical support for their effectiveness in enhancing the quality of EMS. The diversity of interventions examined, from technological innovations and personnel training to community-based initiatives, allows for a broad understanding of potential improvements within the EMS framework. Furthermore, the rigorous methodology employed in selecting and evaluating studies ensures that the findings are reliable and reflective of the current state of knowledge in the field. However, the review is not without its limitations [17]. The restriction to interventional studies and clinical trials conducted solely in Saudi Arabia may limit the generalizability of the findings to other rural contexts with different geographical, cultural, and infrastructural challenges. Additionally, the variability in study designs, interventions, and outcome measures across the included studies introduces heterogeneity that complicates the direct comparison of effectiveness between different strategies. This heterogeneity reflects the complex nature of EMS

improvement efforts but also poses challenges in synthesizing and interpreting the results. Lastly, the reliance on published literature may introduce publication bias, as studies with positive outcomes are more likely to be published than those with negative or inconclusive results.

## Conclusions

This systematic review highlights the effectiveness of various interventions in improving Emergency Medical Services in rural areas of Saudi Arabia, with technological integrations showing a risk ratio of 1.5 for improved patient outcomes and ALS training for EMS personnel resulting in a 25% improvement in patient survival rates following cardiac arrests. Community-based interventions also demonstrated a 30% increase in the timely provision of care. These findings suggest that a multifaceted approach, combining technological advancements, specialized training, and community engagement, can significantly enhance the quality of EMS in rural settings.

## Conflict of interests

The authors declared no conflict of interests.

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**Table (1): Summary of studies targeted improvement of EMS in Saudi Arabia**

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
[11]	120	Rural EMS providers	GPS and telemedicine	RD: 0.15, 95% CI [0.10, 0.20]	Significant reduction in response times and improvement in patient outcomes
[12]	250	Rural communities	Community-based training	RD: 0.20, 95% CI [0.15, 0.25]	Enhanced community response capabilities and patient survival rates
[13]	45	EMS personnel	ALS training program	RD: 0.25, 95% CI [0.18, 0.32]	Improved patient survival rates following cardiac arrests
[14]	500	Rural residents	Public access defibrillation	RD: 0.10, 95% CI [0.05, 0.15]	Increased bystander intervention rates and survival following cardiac arrests
[15]	300	Hospital-based EMS teams	Mobile app for EMS alert	RD: 0.12, 95% CI [0.07, 0.17]	Enhanced early notification and response to emergency incidents
[16]	150	Community responders	Telehealth for remote assistance	RD: 0.18, 95% CI [0.13, 0.23]	Improved management of emergency cases through remote assistance
[17]	80	EMS dispatchers	Dispatch system optimization	RD: 0.14, 95% CI [0.09, 0.19]	Increased efficiency in emergency dispatch and response



Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
[18]	200	Rural health workers	Emergency response training	RD: 0.22, 95% CI [0.17, 0.27]	Improved emergency preparedness and response in rural health workers
[19]	60	Volunteer first responders	First aid community workshops	RD: 0.30, 95% CI [0.25, 0.35]	Increased community engagement and capability to provide initial emergency care
[20]	400	Rural EMS units	Technology-enhanced EMS vehicles	RD: 0.16, 95% CI [0.11, 0.21]	Enhanced EMS response efficiency and patient care through technological integration
[21]	350	Emergency care practitioners	Integrated care pathways	RD: 0.28, 95% CI [0.23, 0.33]	Improved coordination and outcomes in emergency care through integrated pathways

