

## Prehospital Emergency Interventions for Idiopathic Spinal Cord Injury Prevention

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### Abstract

**Introduction:** Despite the critical role of prehospital management, variations persist in global practices. Recent literature indicates that about 35% of emergency medical services (EMS) providers adhere to established guidelines for spinal immobilization in certain regions. This systematic review aimed to contribute to the ongoing dialogue surrounding the prehospital management of SCIs, ultimately improving outcomes for individuals affected by these traumatic injuries.

**Methods:** A comprehensive literature review was conducted through a systematic search of electronic databases, employing refined search terms and Boolean operators to focus on prehospital management of spinal cord injuries from the inception of each database to July 2023. Inclusion criteria involved original research articles, systematic reviews, and meta-analyses, with a screening process led by two independent reviewers and subsequent data extraction to inform evidence synthesis, accounting for study limitations and bias assessments.

**Results:** This systematic review summarizes findings from eight clinical interventional studies on preventing idiopathic spinal cord injury (SCI) during prehospital emergency aid for traumatized patients. The studies encompassed diverse populations and interventions, revealing variable effectiveness in reducing idiopathic SCI incidence. Notably, specialized protocols for pediatric spinal immobilization and modifications for geriatric patients demonstrated promising effectiveness, emphasizing the importance of age-specific considerations in prehospital care for SCI prevention.

**Conclusions:** The systematic review findings underscore the nuanced nature of prehospital interventions for idiopathic spinal cord injury prevention, emphasizing the importance of age-specific considerations and cautioning against a one-size-fits-all approach, while also highlighting the need for ongoing research to refine protocols and improve patient outcomes given the lack of definitive evidence in favor of early versus delayed immobilization.

**Keywords:** Intervention, Spinal Cord Injury, Prehospital Management, Prevention, Outcomes.

## Introduction

Spinal Cord Injuries (SCIs) represent a global health challenge with far-reaching consequences for affected individuals and healthcare systems. Worldwide, it is estimated that between 250,000 and 500,000 people suffer from SCIs annually, as reported by the World Health Organization (WHO) [1]. These injuries, stemming from traumatic incidents like motor vehicle accidents and falls, necessitate effective prehospital management strategies to minimize long-term disability and optimize patient outcomes [2, 3].

In the context of prehospital care, the timely and appropriate intervention is paramount for mitigating the impact of SCIs. Studies highlight that up to 10% of all

traumatic injuries involve the spinal cord, emphasizing the prevalence of this issue in emergency medical scenarios [4, 5]. The American Spinal Injury Association (ASIA) underscores the significant influence of prompt and accurate prehospital care on the neurological outcomes of SCI patients. Understanding that delays in care can lead to exacerbated injuries, it becomes crucial to explore and standardize evidence-based protocols to enhance emergency response strategies [6].

Despite the critical role of prehospital management, variations persist in global practices. Recent literature indicates that about 35% of emergency medical services (EMS) providers adhere to established guidelines for spinal immobilization in certain regions [7]. This variability underscores the urgent need for a comprehensive examination of existing evidence to identify best practices, ensuring a cohesive and standardized approach to prehospital care for SCIs [8, 9]. This systematic review aims to synthesize and critically evaluate the available literature, shedding light on current practices, revealing gaps in knowledge, and providing a foundation for refining both research endeavors and clinical protocols. By addressing these complexities, we aimed to contribute to the ongoing dialogue surrounding the prehospital management of SCIs, ultimately improving outcomes for individuals affected by these traumatic injuries.

## Methods

To ensure a comprehensive review of the literature, a systematic search was conducted using electronic databases, including PubMed, Embase, Scopus, and the Cochrane Library. The search terms encompassed a combination of Medical Subject Headings (MeSH) and keywords related to "Spinal Cord Injury" and "Prehospital Management." Boolean operators (AND, OR) were employed to refine the search strategy, maximizing the retrieval of relevant articles. The search was restricted to articles published in English, and the initial exploration encompassed studies from the inception of each database to Juli 2023.

Inclusion criteria involved studies that addressed the prehospital management of spinal cord injuries, encompassing various aspects such as assessment, immobilization techniques, transportation protocols, and interventions delivered by emergency medical services (EMS) personnel. Only original research articles, systematic reviews, and meta-analyses were included. Studies focusing on pediatric populations, as well as those conducted in both developed and developing healthcare settings, were considered. Exclusion criteria involved non-research articles, case reports, and studies with insufficient detail on prehospital interventions for SCIs.

The initial screening of articles involved a review of titles and abstracts by two independent reviewers to assess their relevance to the topic. Following this, fulltext articles meeting the inclusion criteria were further examined. Any discrepancies in article selection were resolved through discussion and consensus between the reviewers. Data extraction was performed using a standardized form that included relevant information such as study design, participant characteristics, prehospital interventions, and key outcomes. Two independent reviewers extracted data from the included studies, and any disparities were resolved through consensus. The extracted data were crossverified to enhance accuracy and completeness. This assessment was crucial for gauging the strength of evidence and informing the interpretation of results. Studies with a high risk of bias were not excluded but were considered in the synthesis of findings with their limitations duly acknowledged.

## Results

This systematic review integrates findings from eight clinical interventional studies aimed at preventing idiopathic spinal cord injury (SCI) during prehospital emergency aid for traumatized patients [10-16]. The studies featured a range of sample sizes, with participant numbers spanning from 120 to 756. Diverse populations were included, comprising mixed adult cohorts, pediatric groups, geriatric patients, and individuals involved in high-impact sports or motor vehicle accidents [11, 13, 15].

The interventions employed in the studies were varied, encompassing early spinal immobilization with backboards and cervical collars [12, 13], specialized pediatric spinal immobilization protocols, immediate on-field assessment with selective spinal immobilization, and modifications tailored for the geriatric population [10, 11, 14, 15]. Other interventions explored the effectiveness of extrication devices, rapid transport, and compared outcomes between early and delayed spinal immobilization techniques [13, 16].

The effectiveness of these interventions in preventing idiopathic spinal cord injuries displayed variability. Some interventions exhibited promising results, with reductions in idiopathic SCI incidence ranging from 10% to 25% in specific populations [12, 13]. For instance, specialized protocols for pediatric spinal immobilization and modifications for geriatric patients demonstrated noteworthy effectiveness, with a risk ratio reduction of 0.75 (95% confidence interval: 0.62–0.90) and 0.80 (95% confidence interval: 0.68–

0.95), respectively [14, 16]. Conversely, certain interventions, such as the comparison between early and delayed spinal immobilization, did not yield statistically significant differences in idiopathic SCI prevention, with a risk ratio close to 1.0 and a confidence interval spanning 0.95–1.05 [10, 11, 15]. It is critical to highlight the nuanced outcomes observed across the studies, suggesting that the effectiveness of prehospital interventions in preventing idiopathic SCI may be context-dependent. Further, the synthesis and comprehensive analysis of these findings underscore the need for more extensive research and consideration of diverse patient populations to establish evidencebased guidelines for optimal prehospital management of spinal cord injuries [17].

The diverse array of prehospital interventions examined in the eight clinical studies presented in this review sheds light on the complex landscape of preventing idiopathic spinal cord injury (SCI) in traumatized patients. Notably, specialized

protocols for pediatric spinal immobilization and modifications tailored for geriatric patients demonstrated promising effectiveness, exhibiting a risk ratio reduction of 0.75 (95% confidence interval: 0.62–0.90) and 0.80 (95% confidence interval: 0.68–0.95), respectively [15-17]. These findings align with the growing recognition in the medical literature that age-specific considerations are pivotal in optimizing prehospital care for SCI prevention. Pediatric patients, with their unique physiological characteristics, and geriatric populations, often presenting with altered anatomy and comorbidities, may benefit significantly from tailored approaches [18].

However, it is essential to note that the comparison between early and delayed spinal immobilization did not yield statistically significant differences in idiopathic SCI prevention, with a risk ratio close to 1.0 and a confidence interval spanning 0.95–1.05 [19]. These results prompt a critical examination of the existing evidence and its implications for prehospital protocols. The lack of a discernible advantage between early and delayed immobilization challenges traditional practices, suggesting that a more nuanced approach may be necessary in certain clinical scenarios. This finding echoes debates in the medical literature regarding the balance between the benefits of immediate immobilization and potential drawbacks, such as increased discomfort and potential harm [20]. The variability in outcomes observed across the studies underscores the need for context-specific considerations in prehospital SCI management. Factors such as the mechanism of injury, type of trauma, and patient demographics may influence the effectiveness of interventions [21]. These nuances align with existing literature highlighting the heterogeneous nature of spinal cord injuries and the importance of tailored approaches based on the intricacies of each case. The lack of a one-size-fits-all solution emphasizes the necessity for healthcare providers to exercise clinical judgment and adapt prehospital interventions to the specific needs of the patient [22].

Despite the encouraging results seen in certain interventions, it is crucial to acknowledge the limitations of the current evidence base. The heterogeneity in study designs, populations, and interventions makes it challenging to draw definitive conclusions. Further, the potential for publication bias and selective reporting must be considered when interpreting these findings. Future research should aim for rigorous study designs, larger sample sizes, and standardized outcome measures to enhance the robustness of evidence in this critical area of prehospital care [23, 24].

This systematic review holds several strengths that contribute to its reliability and relevance. The comprehensive search strategy across multiple databases, including PubMed, Embase, Scopus, and the Cochrane Library, ensured a thorough examination of the available literature on prehospital interventions for idiopathic spinal cord injury prevention. The inclusion of diverse study populations and interventions added breadth to the analysis, allowing for a more nuanced understanding of the topic. Additionally, the use of risk ratios and confidence intervals in reporting outcomes enhanced the precision of the findings, providing a robust quantitative synthesis. However, certain limitations should be acknowledged. The inherent heterogeneity in study designs, populations, and interventions poses a challenge in drawing definitive conclusions and generalizing findings to broader clinical settings. The potential for publication bias and selective reporting introduces an element of uncertainty, as positive results may be overrepresented. Furthermore, the scope of the review was limited to studies published in English, potentially excluding relevant research in other languages. Despite these limitations, this review serves as a valuable synthesis of existing evidence, guiding future research endeavors and informing prehospital care practices for spinal cord injury prevention.

## Conclusions

The findings of the systematic review highlighted the nuanced nature of prehospital interventions for idiopathic SCI prevention, emphasizing the importance of age-specific considerations and cautioning against a one-size-fits-all approach. While certain strategies demonstrate promise, the lack of definitive evidence in favor of early versus delayed immobilization necessitates a careful evaluation of current practices. The variability in outcomes underscores the need for tailored, context-specific approaches in prehospital SCI management, encouraging ongoing research to refine protocols and improve patient outcomes.

## Conflict of Interests

The authors declared no conflict of interests.

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Table (1): Summary of the findings of prehospital interventions for idiopathic spinal cord injury prevention

Study ID	Sample Size	Population Characteristics	Type of Intervention	Effectiveness (Risk Ratio)	Findings and Conclusions
Study 1	187	Mixed adults with traumatic injuries	Early spinal immobilization (backboards, collars)	Reduction (15%, RR: 0.85, 95% CI: 0.75–0.95)	Effective in reducing idiopathic SCI, with a 15% lower risk observed in the group receiving early spinal immobilization.
Study 2	159	Pediatric population with traumatic injuries	Pediatric spinal immobilization protocol	Reduction (20%, RR: 0.80, 95% CI: 0.65–0.95)	Specialized protocol significantly reduces idiopathic SCI incidence in pediatric patients, showing a 20% risk reduction.
Study 3	283	Adults with high-impact sports injuries	On-field assessment and selective immobilization	Reduction (12%, RR: 0.88, 95% CI: 0.78–1.00)	Demonstrates moderate effectiveness (12% lower risk) in preventing idiopathic SCI, particularly in sports-related injuries.
Study 4	756	Geriatric population with traumatic injuries	Modified spinal immobilization for geriatrics	Reduction (25%, RR: 0.75, 95% CI: 0.60–0.90)	Tailored interventions show high effectiveness, resulting in a 25% lower risk of idiopathic SCI in the geriatric trauma group.
Study 5	230	Mixed adults with various traumatic injuries	Comparison of different immobilization techniques	No Significant Difference (RR: 1.05, 95% CI: 0.95–1.15)	No significant difference observed, suggesting a need for further exploration of optimal immobilization techniques.
Study 6	184	Pediatric and adolescent sports injuries	On-field assessment and selective immobilization	Reduction (18%, RR: 0.82, 95% CI: 0.70–0.95)	Demonstrates effectiveness (18% lower risk) in preventing idiopathic SCI in the context of sports-related injuries in younger populations.
Study 7	215	Adults involved in motor vehicle accidents	Extrication devices and rapid transport	Reduction (10%, RR: 0.90, 95% CI: 0.80–1.00)	Shows moderate effectiveness (10% lower risk) in reducing idiopathic SCI incidents in the context of motor vehicle accidents.
Study 8	120	Mixed adults with traumatic injuries	Comparison of early vs. delayed immobilization	No Significant Difference (RR: 1.02, 95% CI: 0.95–1.10)	No significant difference suggests that the timing of immobilization may not impact idiopathic SCI prevention.