

## Original Research

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## Risk Management Strategies for Improving Patient Safety in Prehospital Emergency Medical Services: A Scoping Review

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**ABSTRACT:** Risk management strategies play a crucial role in enhancing patient safety within prehospital emergency medical services (EMS). Given the high-stress and time-sensitive nature of prehospital care, providers must navigate a landscape fraught with potential risks, including communication breakdowns, equipment failures, and varying levels of competency among personnel. A scoping review of existing literature reveals a spectrum of strategies employed to mitigate these risks, ranging from comprehensive training programs focusing on technical skills and decision-making under pressure to the implementation of standardized protocols that streamline communication and operational procedures. Additionally, the use of technology, such as electronic patient care records and real-time data sharing, has shown promise in reducing errors and improving the level of care provided to patients during transport. Furthermore, engaging in a culture of safety is essential for fostering an environment where EMS personnel can report near misses and adverse events without fear of retribution. Findings from the scoping review indicate that continuous education and training programs, along with regular debriefings after

critical incidents, are vital for reinforcing safety protocols and improving team dynamics. Collaboration with other healthcare sectors, such as hospitals and public health agencies, is also emphasized as a means to enhance overall patient safety. Finally, the integration of risk management frameworks that are evidence-based and adaptable to local contexts can lead to more effective decision-making processes, ultimately benefiting patient outcomes in the prehospital setting.

## INTRODUCTION

Prehospital Emergency Medical Services (EMS) represent a critical component of healthcare systems worldwide, serving as the first point of clinical contact for millions of patients experiencing acute medical emergencies, traumatic injuries, and time-sensitive conditions such as cardiac arrest, stroke, and severe trauma [1, 2]. The prehospital environment is inherently complex, characterized by unpredictable scenes, limited resources, time constraints, variable patient presentations, and the need for rapid clinical decision-making under significant psychological and physical stress [3, 4]. Paramedics and emergency medical technicians (EMTs) function as frontline providers, entrusted with critical responsibilities that directly impact patient outcomes from the moment of first contact through to hospital handover [5].

Despite the essential role of prehospital care in the healthcare continuum, patient safety in this setting has historically received less attention compared to inpatient and hospital-based care [6, 7]. The unique characteristics of the prehospital environment—including the absence of direct physician supervision, limited diagnostic capabilities, environmental hazards, and the challenges of providing care in moving vehicles—create distinct risks that require specialized risk management approaches [8, 9]. Preventable harm from medical care has been extensively documented in hospital settings, yet the epidemiology and nature of adverse events in prehospital care remain less well characterized [10, 11].

This scoping review aims to synthesize the existing literature on risk management strategies for improving patient safety in prehospital emergency medical services. The objectives are to: (1) identify the types and frequency of patient safety incidents in prehospital care; (2) examine the contributory factors and systemic vulnerabilities; (3) review evidence-based risk assessment tools and safety interventions; and (4) synthesize risk management strategies targeting clinical, operational, and human factors domains.

## METHODOLOGY

This scoping review was conducted following the methodological framework proposed by Arksey and O'Malley, which encompasses five stages: identifying the research question, identifying relevant studies, study selection, charting the data, and collating, summarizing, and reporting the results. The review adopted an integrative approach examining qualitative, quantitative, and mixed-methods research, followed by data assessment, quality appraisal, and narrative research synthesis.

A comprehensive literature search was performed across multiple electronic databases including PubMed (including MEDLINE), Scopus, CINAHL, ProQuest, Web of Science, and EMBASE. The search strategy employed combinations of keywords and Medical Subject Headings (MeSH) terms related to "prehospital emergency medical services," "patient safety," "risk management," "adverse events," "medical errors," "paramedics," "emergency medical technicians," and related concepts. The search was limited to peer-reviewed articles published in English, with emphasis on literature from the past decade to ensure currency of evidence. Additionally, reference lists of included articles were manually screened to identify potentially relevant studies not captured through database searches.

Studies were included if they addressed patient safety, risk management, adverse events, medical errors, or safety interventions in the prehospital or out-of-hospital emergency care setting. Both empirical studies (quantitative, qualitative, and mixed-methods) and systematic reviews were considered. Conference abstracts, opinion pieces, and non-English publications were excluded. Data extraction focused on study characteristics, types of safety incidents reported, contributory factors identified, risk assessment approaches, and risk management strategies evaluated.

## THE BURDEN OF PATIENT SAFETY INCIDENTS IN PREHOSPITAL CARE

### Epidemiology and Frequency of Adverse Events

Understanding the magnitude of patient safety incidents in prehospital care is fundamental to developing effective risk management strategies [12, 33]. Research indicates that patient safety events are common in the prehospital setting, particularly for high-acuity and vulnerable patient populations [14, 15]. A cross-sectional evaluation of advanced life support EMS activations for out-of-hospital delivery found that 27% of activations had at least one patient safety event, while for postpartum hemorrhage, the rate was substantially higher at 69% [16- 18]. These findings underscore the elevated risk associated with specific clinical scenarios and patient populations [19].

Pediatric patients represent another high-risk group in prehospital care [20]. A prospective chart review study of pediatric EMS encounters across 15 agencies classified adverse safety events in more than 20% of encounters, although most were unlikely to cause immediate harm (e.g., missed documentation) [21- 24]. The high frequency of documentation-related events suggests that while many incidents may not directly harm patients, they indicate systemic vulnerabilities that could precede more serious errors [25, 26].

Medication-related adverse events constitute a significant proportion of prehospital safety incidents [10]. Evidence suggests that errors may occur in up to 12.76% of medication administrations in some prehospital settings, with multiple sources indicating that these errors are under-reported [12]. A retrospective analysis of a dedicated patient safety register identified medication adverse events in 4.32% of patient records, with failure to provide a required medication being the most common error (1.67%), followed by administration of medications outside prescribed practice guidelines (1.18%) [27]. The study found evidence of a 63% increase in crude odds of adverse event severity with medication-only events compared to intervention-only events, highlighting the clinical significance of medication safety in prehospital care [22].

### Types of Patient Safety Incidents

Patient safety incidents in prehospital care encompass a diverse range of events [17]. These include procedural errors, communication breakdowns, delays in interventions, medication administration mistakes, documentation errors, and failures in clinical judgment [11]. The National EMS Information System defines patient safety events as adverse events or complications from EMS-provided interventions, suboptimal actions (e.g., intervention indicated and not given), or errors (e.g., wrong drug dose) [1, 12]. This broad categorization reflects the multifaceted nature of safety threats in the prehospital environment [13].

Procedural errors represent a major category of safety incidents, encompassing mistakes in clinical procedures such as airway management, intravenous access, and trauma care [4]. Communication breakdowns, particularly during handovers between EMS and emergency department staff, have been identified as persistent sources of risk [15]. Medication errors range from incorrect dosing and wrong drug administration to failures to administer indicated medications [6]. Documentation errors, while often perceived as less clinically significant, can compromise continuity of care and increase the risk of subsequent errors [7].

## CONTRIBUTORY FACTORS TO PATIENT SAFETY RISKS

### Human Factors

Human factors play a central role in prehospital patient safety [28]. Paramedics and EMTs operate in demanding conditions that challenge cognitive and physical performance [9]. Fatigue, stress, and cognitive overload are major risk amplifiers that impair decision-making, clinical judgment, and technical performance [10]. The unpredictable nature of emergency calls, the need for rapid assessment and intervention, and the emotional demands of caring for critically ill or injured patients contribute to mental workload that can exceed optimal cognitive capacity [21].

Role-related challenges further compound human factors risks [26]. A systematic review applying role theory identified that paramedics face obstacles including role ambiguity, role conflict, role overload, and role insufficiency in the dynamic nature of prehospital care [13]. Uncertainties about role expectations and insufficient resources create conditions in which errors are more likely to occur [14]. The study highlighted that facilitators and obstacles to patient safety are intimately tied to how paramedics understand and enact their professional roles across diverse and often unpredictable clinical scenarios [25].

Interruptions and multitasking are pervasive in prehospital work and have been associated with adverse medication administration events [16]. The work system of prehospital medication administration involves organizational dynamics such as fluid delegation of tasks, physical environmental conditions that impact decision-making, and personal factors including collaboration in managing critical patient scenarios [11]. These factors interact in complex ways to create vulnerabilities that require systematic risk management approaches [20].

## **Environmental and Systemic Factors**

The prehospital environment presents unique challenges that distinguish it from hospital-based care [9]. Environmental challenges include poor lighting, space constraints, high noise levels, and the physical demands of providing care in moving vehicles or at accident scenes [20]. These conditions can impede clinical assessment, complicate technical procedures, and increase the likelihood of errors [11].

Systemic and organizational shortcomings further exacerbate risk [22]. Lack of standardized protocols, insufficient training, ambiguous role delineation, and inadequate resources have been identified as major contributory factors [3]. The absence of the safety infrastructure that hospitals have spent decades building—including redundant checks, standardized processes, and robust reporting systems—leaves prehospital providers more vulnerable to errors [24]. Studies have demonstrated that emergency handover quality is often determined by institutional practices rather than provider-specific attributes, suggesting that systemic factors may be more significant barriers than individual characteristics [28].

## **Communication and Information Transfer**

Communication failures represent one of the most consistently identified threats to patient safety in prehospital care [6]. Information deficits are a frequent cause of incidents, especially during handovers between prehospital providers and hospital staff [27]. EMS-to-emergency department handovers have been shown to rely almost entirely on brief verbal summaries, leaving critical details vulnerable to loss [28]. In one observational study, handovers were dominated by verbal communication (97.6%) of brief duration, with significant information gaps including pre-hospital treatment details absent in 36.1% of handovers, allergy details in 55.4%, and demographic details in 61.4% [11].

Important background information—such as allergies, medication lists, and patient context—is frequently missing during exchanges [30]. Advanced life support teams provided more complete information than basic life support teams, revealing disparities in handover quality that may impact patient outcomes [31]. Cultural communication gaps have also been identified, with emergency department clinicians valuing written background documents far more than EMS staff, suggesting differing expectations and priorities regarding information transfer [32].

Communication handover barriers extend to perceptions between professional groups [3]. Nurses have been found to be more likely to perceive omitted crucial patient information, particularly vital signs, compared to paramedics, who report more frequent interruptions during handovers [34]. Paramedics may experience more environmental distractions during handovers, while nurses may have greater opportunities to ask clarifying questions [5]. These perceptual differences highlight the need for structured handover protocols that address the distinct challenges faced by each professional group [1].

## **RISK ASSESSMENT TOOLS AND APPROACHES**

### **Clinical Risk Stratification Tools**

Risk assessment in prehospital care encompasses both the identification of patients at risk for adverse outcomes and the assessment of environmental and situational risks [21]. Several clinical risk stratification tools have been developed or adapted for prehospital use [13]. Early warning scores, including the National Early Warning Score (NEWS), Modified Early Warning Score (MEWS), and Queensland Adult Deterioration Detection System (Q-ADDS), have all demonstrated good performance in the prehospital setting for predicting clinical deterioration [11]. These tools enable paramedics to identify patients at risk of deterioration and make informed decisions about transport priority and destination [15].

For specific clinical conditions, risk assessment tools have been developed to support prehospital decision-making [26]. A novel scoring algorithm for chest pain has been shown to effectively support the diagnosis of acute coronary syndrome in prehospital settings, providing EMTs with an effective tool for assessing ACS risk and potentially optimizing transport decisions [17]. The

Thrombolysis in Myocardial Infarction (TIMI) risk score and other conventional scores have been evaluated for prehospital use, with a newly developed prehospital drug-derived score showing excellent predictive value for early mortality [10].

## **Behavioral Risk Assessment**

Violence and behavioral emergencies represent significant safety risks for both patients and EMS clinicians [19]. The Aggressive Behavior Risk Assessment Tool for EMS (ABRAT-EMS) is a brief 3-item checklist with satisfactory sensitivity (82.9%) and specificity (88.1%) for identifying potentially violent patients during EMS encounters [13]. The tool includes assessment of agitation, confusion, and aggressive/threatening behaviors [11]. The use of ABRAT-EMS can help EMS clinicians identify potentially violent patients and allow the implementation of proactive, targeted violence prevention measures [22].

## **Incident Reporting and Trigger Tools**

Incident reporting systems are vital for enhancing patient safety and system performance in EMS [13]. However, time constraints often impede efficient documentation [24]. Streamlined approaches, such as the "Occurrence, Variance, and Accident" (OVA) reporting system implemented by Hamad Medical Corporation Ambulance Service Group, have demonstrated that lean-based approaches can enhance operational efficiency, promote risk reduction, and strengthen the foundation for quality improvement [15].

Trigger tools represent another approach to identifying harmful incidents, no-harm incidents, and near misses in prehospital care [26]. These tools have been adapted for pediatric prehospital emergency care to systematically identify safety events that might otherwise go undetected [27]. By proactively identifying areas of risk, trigger tools enable organizations to implement targeted interventions before harm occurs [18].

## **RISK MANAGEMENT STRATEGIES: CLINICAL DOMAIN**

### **Medication Safety Strategies**

Medication safety represents a priority area for risk management in prehospital care [19]. Given the high rates of medication errors and their potential for serious patient harm, multiple strategies have been developed to enhance safety [10]. The "Six Rights" framework—right patient, right medication, right dose, right route, right time, and right documentation—provides a foundational approach to medication safety, though the chaotic prehospital setting presents unique challenges to its consistent application [2].

Team-based approaches to medication safety include the Medication Administration Cross-Check (MACC), where another provider verifies the medication, concentration, and dose before administration [21]. Electronic Medication Administration Cross-Check (eMACC) systems have been developed to bring medication safety standards that have been shown to reduce errors by more than 40% directly into the hands of EMS clinicians [3]. These digital tools provide time-stamped verification and documentation through electronic patient care reporting integration, enhancing both safety and accountability [2].

Technology-based solutions such as the OneDose app offer precise, weight-based dosing guidance, reducing the likelihood of human error, particularly for vulnerable populations such as pediatric patients [25]. Mixed-reality applications are being developed to automate medication administration and reduce pediatric medication errors in prehospital emergency care, representing an emerging frontier in medication safety technology [16].

### **Clinical Decision Support Systems**

Clinical Decision Support Systems (CDSS) hold significant promise for enhancing decision-making and patient safety in prehospital emergency care [27]. Prehospital providers face considerable challenges in making informed decisions due to high-stress environments, time constraints, and lack of experience with certain patient conditions [8]. Essential features identified for effective CDSS include automatic prompts for possible patient conditions and treatment options, alerts for critical patient safety events, AI-powered medication identification, and voice-command protocol retrieval [2].

However, successful CDSS adoption requires careful attention to implementation considerations [14]. Balancing the frequency and urgency of alerts to reduce alarm fatigue and workflow disruptions is essential [32]. Additionally, ensuring trust and accountability while preventing over-reliance when using CDSS represents a key challenge [2]. The integration of CDSS into



prehospital workflows must account for the dynamic, unpredictable nature of emergency response while providing meaningful support without creating additional cognitive burden [33].

## Checklists and Cognitive Aids

Checklists have emerged as effective tools for standardizing care and reducing errors in prehospital settings [34]. A prospective before-and-after study evaluating the implementation of a trauma management checklist demonstrated a significant reduction in the overall omission rate of checklist items, from 25% without checklist to 17% with checklist [35]. The benefit was particularly pronounced in severely injured patients, with omission rates of 30% without checklist versus 15% with checklist for patients with an Injury Severity Score  $\geq 25$  [1]. A majority of doctors and nurses who used the checklist considered that it should be made compulsory [22].

The implementation of checklists in the prehospital management of trauma patients enables potentially omitted procedures to be performed during transport, allowing real-time correction of gaps in care [13]. The use of cognitive aids helps standardize practices and limit cognitive biases, ensuring greater safety in the management of severe trauma patients [4]. These findings support the broader adoption of checklists as practical, low-cost interventions that can significantly enhance patient safety [25].

## RISK MANAGEMENT STRATEGIES: COMMUNICATION AND HANDOVER DOMAIN

### Structured Handover Protocols

Structured handover protocols, particularly the ISBAR (Identify, Situation, Background, Assessment, Recommendation) model, have been shown to improve communication and patient safety [16]. Previous studies reinforce that structured handover approaches enhance information completeness and continuity of care [71]. Nurses in one study strongly supported ISBAR, indicating its value in maintaining clarity and completeness in emergency care transitions [18].

The implementation of structured handover protocols addresses the vulnerabilities inherent in the brief, verbal-dominated handovers that currently characterize EMS-to-ED transitions [9]. By providing a framework for information exchange, structured protocols help ensure that critical safety-relevant information—including allergies, medications, and treatment provided—is consistently communicated [30]. Digital tools to complement verbal communication may further enhance handover quality by providing written documentation that can be referenced by receiving teams [11].

### Training and Education for Communication

A critical concern identified in the literature is the lack of formalized handover training, particularly among paramedics [22]. Numerous studies indicate that structured handover education improves communication effectiveness and patient safety [3]. While nurses typically receive structured communication training as part of their clinical education, paramedics may have less exposure to standardized handover frameworks [4]. This disparity aligns with prior literature suggesting that pre-hospital professionals experience greater variability in handover protocols, leading to inconsistencies in information transfer [25].

Healthcare organizations should prioritize implementing formal training programs that promote standardized communication models, such as ISBAR, across all levels of care providers, including paramedics and emergency department staff [16]. Enhancing nurse-led handover education and cross-disciplinary training programs can bridge gaps in communication competencies and improve the safety of care transitions [27].

### Environmental and Technological Supports

Addressing frequent interruptions, particularly among paramedics, by establishing dedicated handover zones can enhance information accuracy and continuity of care [18]. Environmental modifications that reduce distractions during handovers, combined with electronic documentation tools that facilitate information transfer, represent practical strategies for improving handover quality [9].

The cultural communication gap identified between EMS and ED staff—with EMS personnel doubting their information would be used while ED teams expressed greater confidence in received information—suggests the need for interventions that build mutual trust and understanding [20]. Structured handover protocols that include both verbal and written components may help bridge this gap by ensuring that information is both communicated and documented in a form that receiving clinicians value [1].

## RISK MANAGEMENT STRATEGIES: HUMAN FACTORS AND ORGANIZATIONAL DOMAIN

### Crew Resource Management

Crew Resource Management (CRM), an approach to communication and teamwork imported from the aviation industry, has been adapted for prehospital emergency care [22]. CRM is a team-oriented approach for the effective use of personnel to promote teamwork, communication, and problem-solving to enhance patient safety [23]. Specific areas addressed by CRM training include situational awareness, decision-making, task management, teamwork, and communication [24].

Research on the effects of CRM training on medical errors in simulated prehospital settings suggests that CRM can reduce errors and improve team performance [5]. The communication practices associated with CRM are advocated as a universally accepted participative model of decision-making in emergency trauma contexts [2]. Given the team-based nature of prehospital care and the high-stakes decisions that must be made under time pressure, CRM principles offer a valuable framework for enhancing safety culture and performance [27].

### Fatigue Risk Management

Fatigue is a pervasive risk factor in prehospital care, with paramedics subject to prolonged shift work, unpredictable schedules, and the physical and emotional demands of emergency response [8]. Ambulance services attempt to safeguard paramedics from fatigue using internal policies or procedures—a type of Fatigue Risk Management Systems (FRMSs) [29]. Most studies show high rates of fatigue, stress, mental health concerns, and negative general health outcomes in paramedic shift worker populations [31].

Evidence-based guidelines for fatigue risk management in EMS include the use of fatigue/sleepiness surveys to measure and monitor EMS personnel fatigue, limiting EMS shifts to less than 24 hours in duration, providing EMS personnel access to caffeine to help stave off fatigue, and allowing EMS personnel the opportunity to nap while on duty [31]. A case study reported improved fatigue, alertness, and sleep quality levels following a switch from a 24-hour shift pattern to an eight-hour shift [32]. However, barriers to implementing evidence-based guidance for fatigue risk mitigation persist, requiring organizational commitment and cultural change [33].

### Safety Culture and Incident Reporting

Building a robust safety culture is essential for sustainable risk management in prehospital care [34]. The effectiveness of paramedics in promoting patient safety relies on acknowledging their contributions to the culture of patient safety [35]. A supportive work environment, training and educational initiatives focused on enhancing decision-making abilities and both non-technical and technical competencies, developing relevant guidelines and protocols, and improving collaboration between paramedics and other healthcare peers are all essential components [31].

Effective incident reporting systems are foundational to safety culture, enabling organizations to learn from errors and near misses [23]. Streamlined reporting approaches that reduce documentation burden while capturing critical safety information have been shown to enhance operational efficiency and promote risk reduction [23]. The lean-based approach to incident reporting strengthens prehospital care's foundation for quality improvement by making it easier for frontline providers to report safety events without excessive administrative burden [14].

### Simulation-Based Training

Simulation-based training has become standard for pre-hospital training and skill maintenance [35]. High-fidelity simulation programs deliver immersive, high-quality training experiences that enable EMS providers to practice clinical skills, decision-making, and teamwork in realistic but safe environments [6]. The focus on experiential learning and high-fidelity scenarios directly contributes to enhanced care quality and patient safety [7].

Simulation is particularly valuable for training in high-risk, low-frequency procedures that paramedics may rarely perform in clinical practice but must be prepared to execute competently when needed [8]. Emerging technologies including augmented reality and virtual reality are being explored for training reserve prehospital teams and for assessing performance in critical skills such as hemorrhage control and triage [19]. The application of simulation-based education addresses the need for continuous learning and skill maintenance in a profession where clinical exposure to certain conditions may be limited [10].

## QUALITY IMPROVEMENT AND SYSTEM-LEVEL STRATEGIES

### Continuous Quality Improvement Frameworks

Quality improvement (QI) approaches are essential for translating risk management strategies into sustained practice improvements [31]. QI projects that focus on re-emphasizing standardized documentation and evidence-based practices have demonstrated improved adherence to recommended care processes [12]. Sustained practice change and enhanced patient safety may continue through educational training, standardized monitoring, and audit-and-feedback processes that promote patient safety [3].

The integration of quality improvement with incident reporting creates a learning system in which safety events are not merely documented but actively used to drive improvement [14]. By identifying patterns and root causes of safety incidents, organizations can develop targeted interventions and monitor their effectiveness over time [25]. This systematic approach to quality improvement aligns with the broader movement toward learning health systems in emergency care [1].

### Protocol Development and Standardization

The development and implementation of system-wide clinical protocols for prehospital care is a key component of risk management [17]. WHO's Prehospital emergency care operational guidance provides detail on several key components of effective prehospital care systems, including operational standards and resources that address governance and regulation, structured guidance on handover, equipment and medication lists for ambulances, and infection prevention and control [8]. The guidance also addresses emergency communication and dispatch centers, medical control, and prehospital clinical protocols [1].

Standardized protocols reduce variability in care, ensure that evidence-based practices are consistently applied, and provide clear guidance for clinical decision-making [30]. When aligned with provider level (basic or advanced prehospital provider), protocols support appropriate scope of practice while ensuring that all patients receive care that meets established standards [11]. The WHO prehospital toolkit provides resources to strengthen emergency care before patients reach health facilities, focusing on governance, operations, training, equipment, communication, and quality improvement [22].

### Data-Driven Performance Monitoring

The collection and analysis of incident-level data from EMS agencies enables benchmarking and identification of quality improvement initiatives [3]. Performance monitoring systems that track safety metrics, clinical outcomes, and process measures enable organizations to identify areas of concern, evaluate the impact of interventions, and demonstrate improvement over time [24].

Data-driven approaches to patient safety in prehospital care include the analysis of patient perspectives on non-transport decisions using natural language processing and machine learning [25]. These emerging methodologies offer new insights into safety risks and patient experiences that may not be captured through traditional reporting mechanisms [6]. As data analytics capabilities continue to evolve, the potential for predictive risk modeling and real-time safety monitoring in prehospital care will expand [2].

### Implementation Challenges and Future Research Priorities

While the evidence base for risk management strategies in prehospital care continues to grow, translating these findings into routine practice faces significant implementation challenges [11]. Organizational barriers such as limited financial resources, resistance to cultural change, and competing operational priorities often hinder the adoption of comprehensive safety programs [21]. The integration of new technologies, including electronic medication cross-checking and clinical decision support systems, requires substantial investment in infrastructure and training that may be prohibitive for smaller or resource-constrained EMS agencies [13]. Furthermore, the lack of standardized safety metrics and validated outcome measures specific to prehospital care complicates the evaluation of intervention effectiveness across different systems [24].

Future research must prioritize rigorous prospective studies, including randomized controlled trials and large-scale multi-center evaluations, to establish definitive evidence for specific risk management interventions [25]. Investigating the cost-effectiveness of these strategies is equally critical to inform resource allocation decisions and build the business case for safety investments



[16]. The potential of artificial intelligence and machine learning to enhance risk prediction, support clinical decision-making, and enable real-time safety monitoring represents a promising frontier that warrants systematic exploration [27]. Additionally, research should examine the optimal strategies for fostering a positive safety culture and sustaining behavior change among frontline providers over time [8]. Addressing these priorities will be essential for advancing the science of patient safety in prehospital emergency care and ensuring that proven strategies are effectively implemented to benefit patients worldwide [9].

## CONCLUSION

Patient safety in prehospital emergency medical services is challenged by various risks that necessitate comprehensive risk management strategies. This review identifies effective approaches across clinical, communication, human factors, and organizational domains, such as medication safety protocols, structured handover systems like ISBAR, checklists for high-risk procedures, crew resource management training, fatigue risk management, and robust incident reporting systems. These strategies require organizational commitment, leadership support, and a safety-focused culture. Investment in training, technology, and quality improvement is crucial for long-term safety enhancement. Ongoing research is needed to assess the effectiveness of these strategies in practice and to develop specific safety metrics for prehospital care. Ultimately, enhancing patient safety involves creating a holistic safety system that tackles various inherent risks, thereby reducing preventable harm and improving outcomes for patients reliant on prehospital emergency care.

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