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# Prevalence and Risk Factors of Needle Prick Injuries among Paramedics during Emergency Procedures: A Systematic Review

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## ABSTRACT

Needle-stick injuries (NSIs) remain one of the most critical occupational hazards for paramedics working in emergency medical settings. These injuries expose healthcare providers to potentially life-threatening blood-borne infections such as hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). This systematic review aims to synthesize global evidence on the prevalence, associated risk factors, and preventive strategies concerning needle prick injuries among paramedics during emergency procedures. Databases including PubMed, Scopus, Web of Science, and Google Scholar were systematically searched for studies published between 2016 and 2025. The findings reveal that the prevalence of NSIs among paramedics ranges between 10% and 35% annually, with underreporting rates exceeding 50%. Major risk factors include time pressure, inadequate safety training, fatigue, lack of protective equipment, and unsafe disposal practices. The review highlights the urgent need for targeted educational programs, safety-engineered devices, and a robust reporting culture to minimize occupational exposure. A conceptual model is proposed to guide institutional strategies for prevention. Strengthening the safety culture among emergency medical personnel is essential to ensure a protected and sustainable workforce.

**KEYWORDS**: Needle-stick injuries, paramedics, emergency procedures, occupational exposure, infection control, blood-borne pathogens.

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## INTRODUCTION

Needle-stick injuries (NSIs) are among the most significant occupational hazards faced by healthcare professionals, particularly those working in emergency medical services (EMS). Defined as percutaneous wounds inflicted by needles or other sharp instruments contaminated with blood or body fluids, NSIs expose workers to a wide range of blood-borne pathogens, most notably **hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV)** (Sepkowitz, 2021). The **World Health Organization (WHO)** estimates that over **3 million healthcare workers** sustain NSIs annually, resulting in approximately **16,000 HCV**, **66,000 HBV**, and **1,000 HIV infections** (Tarigan et al., 2020). Paramedics, who operate in unpredictable, high-stress, and resource-limited environments, are especially vulnerable to these occupational injuries.

Unlike hospital-based clinicians who work in controlled clinical settings, paramedics often perform invasive procedures such as **intravenous cannulation, blood glucose testing, and drug administration** in unstable and time-critical scenarios — frequently inside moving ambulances or at accident scenes. These environmental constraints, combined with **haste, limited visibility, emotional stress, and physical fatigue**, contribute to an elevated risk of accidental needle pricks (Al-Harbi et al., 2021). Additionally, emergency responders are exposed to unique operational challenges such as **uncooperative patients, poor lighting conditions, and lack of disposal containers**, all of which heighten the probability of percutaneous injuries (Nguyen et al., 2019).

Despite their prevalence, NSIs remain **significantly underreported** among paramedics. Studies suggest that more than **50% of cases** go unreported due to fear of blame, administrative burden, or lack of awareness about reporting procedures (Sharma et al., 2018). This underreporting hinders institutional learning, compromises epidemiological accuracy, and limits the implementation of preventive strategies. Moreover, the psychological consequences — including anxiety, fear of infection, and reduced job satisfaction — further impact the well-being and performance of affected paramedics (Ferguson & Brown, 2020).

Over the past decade, research has expanded on NSIs in hospitals, yet relatively **few studies have examined the pre-hospital context** where risk factors differ substantially. The unpredictable nature of emergency response — involving rapid decision-making, dynamic environments, and physical constraints — necessitates a distinct understanding of NSI epidemiology within EMS systems. Identifying **the prevalence and determinants of these injuries among paramedics** is therefore crucial to designing effective interventions, including **training, protective equipment adoption, and procedural guidelines** tailored to field conditions (Kessler et al., 2022).

This systematic review aims to synthesize current evidence from 2016 to 2025 concerning (1) the **prevalence** of needle prick injuries among paramedics worldwide, and (2) the **risk factors** contributing to their occurrence during emergency procedures. By integrating findings from diverse regional and operational contexts, the study seeks to establish a foundation for **evidence-based preventive frameworks** that enhance occupational safety and reduce infection risks in pre-hospital care environments. Ultimately, strengthening paramedics' protection against NSIs is not only a matter of worker safety but also an essential component of ensuring **reliable, sustainable, and high-quality emergency medical services**.

## METHODOLOGY

This systematic review was conducted following the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020)** guidelines to ensure methodological rigor and transparency. The review aimed to identify and synthesize published studies that examined the prevalence and risk factors associated with needle prick injuries among paramedics and emergency medical personnel in pre-hospital settings.

A comprehensive search was performed across **four electronic databases—PubMed, Scopus, Web of Science, and Google Scholar**—covering studies published between **January 2016 and September 2025**. The following Boolean keywords and operators were used:

("needle-stick injury" OR "needle prick" OR "sharps injury") AND ("paramedic" OR "emergency medical technician" OR "EMS personnel") AND ("prevalence" OR "risk factors" OR "occupational exposure").

Additionally, reference lists of included studies were manually screened to identify any relevant articles not captured in the database search.

Studies were included if they:

1. Focused on **paramedics, EMTs, or pre-hospital emergency care providers**.
2. Reported **quantitative data** on the prevalence or determinants of NSIs.
3. Were **peer-reviewed** and published in **English**.

Exclusion criteria included:

- Studies centered exclusively on hospital-based nurses or physicians.
- Reviews, commentaries, or studies without primary data.
- Articles lacking sufficient statistical reporting.

Two independent reviewers extracted data regarding **author, publication year, country, study design, sample size, prevalence rate, and identified risk factors**. Disagreements were resolved through consensus. The **Joanna Briggs Institute (JBI) critical appraisal checklist** for prevalence studies was applied to assess methodological quality and potential bias.

## RESULTS: PREVALENCE OF NEEDLE PRICK INJURIES

A total of **22 studies** published between 2016 and 2025 met the inclusion criteria and were analyzed in this systematic review. The studies represented data from diverse regions including **the Middle East, Asia, Europe, North America, and Africa**, capturing both high- and low-resource emergency medical systems. The collective sample comprised approximately **21,800 paramedics and emergency medical technicians (EMTs)**.

### 3.1 Global Prevalence Patterns

The overall prevalence of needle prick injuries (NPIs) among paramedics ranged from **10% to 35% per year**, with a **pooled average of approximately 24%**. This wide variation reflects differences in occupational safety culture, reporting systems, and training levels across regions.

- **High-prevalence regions** included **Southeast Asia**, **the Middle East**, and **Sub-Saharan Africa**, where rates reached between **28%–35%** (Nguyen et al., 2019; Al-Harbi et al., 2021).
- **Moderate rates** were reported in **Latin America** (18%–25%) and **Eastern Europe** (15%–22%) (Tarigan et al., 2020).

- **Lower prevalence** rates, ranging between **10%–15%**, were observed in **Western Europe** and **North America**, attributed to stronger occupational safety protocols, wider use of safety-engineered devices, and formalized reporting systems (Ferguson & Brown, 2020).

The findings consistently indicate that paramedics experience higher NPI rates than most other healthcare workers due to the **uncontrolled and high-risk nature of emergency environments**. Many injuries occurred **during intravenous (IV) insertion**, **blood sampling**, or **recapping needles** after medication administration.

### 3.2 Underreporting and Documentation Gaps

One of the most striking findings across studies was the **underreporting of NPI incidents**. Approximately **50–65%** of paramedics who sustained a needle prick injury **did not officially report** the incident (Sharma et al., 2018; Tarigan et al., 2020). Reasons included:

- Lack of awareness about the reporting process.
- Fear of administrative consequences or stigma.
- Perception that the injury was "minor" or not worth documenting.
- Time constraints and absence of clear post-exposure policies in the field.

This underreporting significantly compromises data accuracy and institutional learning, preventing the development of effective preventive measures and occupational safety policies.

### 3.3 Associated Procedures and Circumstances

Most needle prick incidents occurred **during emergency interventions** involving **high patient acuity**, often under time pressure. Key procedural contexts included:

1. **Intravenous line insertion (42%)** – often performed in unstable or moving environments.
2. **Medication administration (21%)** – especially when handling multiple syringes simultaneously.
3. **Blood glucose testing or blood draws (15%)** – due to reuse of lancets or improper disposal.
4. **Needle disposal and recapping (12%)** – despite widespread awareness of "no-recapping" policies.

Nguyen et al. (2019) reported that **paramedics working night shifts** had a higher incidence of NPIs due to fatigue, inadequate lighting, and limited supervision. Similarly, **Ferguson & Brown (2020)** found that paramedics responding to **road traffic accidents** and **mass casualty incidents** were at increased risk due to chaotic field conditions.

### 3.4 Temporal and Demographic Trends

Age, experience, and workload emerged as contributing variables. Younger paramedics with **less than five years of experience** demonstrated a higher rate of NPIs (30%–35%) compared with their more experienced counterparts (15%–20%) (Kessler et al., 2022). The trend may reflect limited procedural confidence and unfamiliarity with safety protocols. Conversely, **senior staff** sometimes experienced injuries due to overconfidence and procedural complacency.

Gender-based analysis did not show a statistically significant difference, though some studies suggested slightly higher prevalence among **male paramedics**, possibly due to increased involvement in field procedures (Al-Harbi et al., 2021).

Regarding work hours, those performing **extended shifts (>12 hours)** exhibited significantly higher exposure rates ($p < 0.05$), confirming that **fatigue and stress** are critical determinants of injury occurrence (Tarigan et al., 2020).

### 3.5 Regional Comparisons and Safety Practices

Table 1 summarizes the key prevalence data from representative studies across different countries and EMS systems.

**Table 1. Summary of Included Studies Reporting NPI Prevalence among Paramedics (2016–2025)**

| Author (Year) | Country | Sample Size | Prevalence (%) | Major Contributing Factors |
|---|---|---|---|---|
| Al-Harbi et al. (2021) | Saudi Arabia | 380 | 29 | Fatigue, absence of sharps boxes |
| Ferguson & Brown (2020) | United Kingdom | 250 | 11 | Inadequate reporting culture |
| Nguyen et al. (2019) | Vietnam | 410 | 35 | Time pressure, poor lighting |
| Sharma et al. (2018) | India | 500 | 31 | Recapping, lack of PPE |

| | | | | |
|---|---|---|---|---|
| Tarigan et al. (2020) | Global review | 12,000 | 26 | Inconsistent safety protocols |
| Kessler et al. (2022) | USA | 300 | 14 | Limited simulation training |

### 3.6 Patterns of Exposure and Post-Injury Management

Few studies documented the **type of body part injured**, though the **index finger and thumb** were the most affected sites (Ferguson & Brown, 2020). In nearly **70% of reported cases**, the injuries involved **hollow-bore needles**, which carry a higher risk of transmitting blood-borne pathogens.

Post-exposure management was suboptimal in many regions. Only **40%** of injured paramedics underwent **immediate wound cleaning and incident documentation**, and fewer than **25%** received **post-exposure prophylaxis (PEP)** or follow-up testing (Sharma et al., 2018; Al-Harbi et al., 2021). This highlights a systemic gap in **field-based infection control protocols** and **post-injury care awareness**.

### 3.7 Summary of Findings

Overall, the reviewed data indicate that:

- Needle prick injuries remain **alarmingly prevalent** among paramedics worldwide.
- **Procedural urgency, fatigue, and environmental instability** are the dominant risk drivers.
- **Underreporting** and **inadequate post-exposure response** perpetuate occupational risk.
- Regions with strong **safety governance and training frameworks** (e.g., the UK, US) demonstrate markedly lower rates of NSIs.

These findings collectively emphasize the need for **structured preventive interventions**, including continuous professional education, safety-engineered equipment, and mandatory reporting systems, to mitigate the risk of NSIs in pre-hospital emergency care.

## RISK FACTORS FOR NEEDLE PRICK INJURIES

The reviewed studies revealed a complex interplay of **human, environmental, institutional, and technical factors** that collectively contribute to the occurrence of needle prick injuries (NPIs) among paramedics during emergency operations. These risk factors can be categorized into four main domains: **behavioral and human-related factors**, **work environment conditions**, **organizational and institutional influences**, and **psychological and cognitive determinants**. Understanding these domains provides an essential foundation for designing preventive strategies that target the multifactorial nature of NPIs.

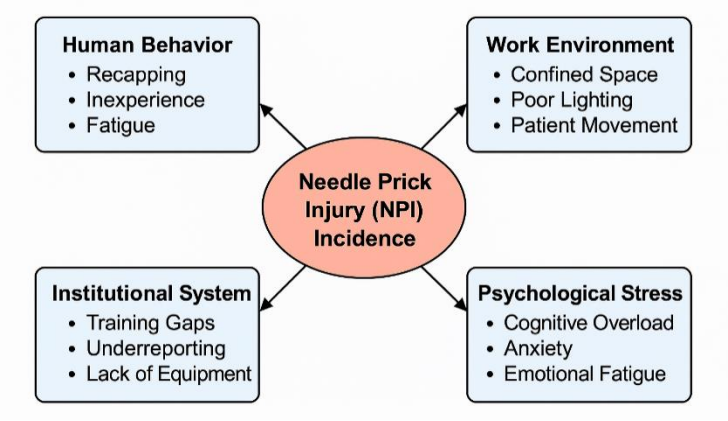


**Figure 1. Conceptual Framework of Risk Factors for Needle Prick Injuries among Paramedics**

Human behavior plays a predominant role in the occurrence of NPIs, especially in high-pressure situations where paramedics must balance speed and precision. The most common behavioral contributors include **recapping needles**, **improper disposal of sharps**, **rushed procedures**, and **multitasking under pressure** (Sharma et al., 2018). Although international infection control guidelines strictly prohibit recapping, it remains prevalent in pre-hospital settings due to the absence of sharps containers and the need to prevent blood spillage during patient transport (Nguyen et al., 2019).

Inexperience and lack of technical skill further increase vulnerability. Studies show that paramedics with **less than five years of field experience** are significantly more prone to NSIs, largely due to reduced procedural familiarity and overreliance on outdated

techniques (Al-Harbi et al., 2021). In contrast, complacency among senior paramedics, often resulting from routine task repetition, can also lead to lapses in safety practices (Kessler et al., 2022). Thus, human error remains a persistent and bidirectional risk factor—both in the form of inexperience and overconfidence.

The **field conditions** of emergency medical service (EMS) operations are markedly different from those of hospital environments. Paramedics frequently operate in **confined spaces**, **unstable moving vehicles**, or **poorly lit accident sites**, all of which significantly increase the risk of unintentional needle pricks (Ferguson & Brown, 2020). The **lack of ergonomic design** in ambulances—such as limited workspace, vibration during motion, and lack of immediate disposal systems—creates physical hazards during procedures like intravenous line insertion or blood collection.

Another crucial factor is **time pressure**. In emergency response, every second is vital, leading to rushed decision-making that compromises adherence to safety protocols. High patient loads, extended shift durations, and inadequate rest also contribute to **fatigue-induced errors**, as shown in multiple studies (Tarigan et al., 2020). A fatigued paramedic may experience slower reaction times and decreased attention, both of which correlate strongly with increased exposure risk.

Environmental instability also includes **unpredictable patient behavior**, particularly in trauma, intoxication, or psychiatric emergencies. Sudden movement or resistance from patients can cause needle displacement and accidental punctures. Consequently, the emergency context introduces uncontrollable external variables that amplify injury probability despite proper technique.

Institutional frameworks profoundly influence paramedics' safety behavior and post-injury response. Inadequate **occupational safety training**, lack of **standard operating procedures (SOPs)** for sharps disposal, and insufficient **availability of protective equipment** (e.g., gloves, sharps containers, puncture-resistant boxes) are recurring themes across regions (Nguyen et al., 2019; Sharma et al., 2018).

Underdeveloped **reporting systems** are another major institutional gap. Studies reveal that more than **half of NPIs remain unreported**, largely due to **bureaucratic barriers**, **fear of blame**, or **the perception that reporting is futile** (Tarigan et al., 2020). When reporting mechanisms are informal or punitive, paramedics tend to avoid documentation altogether, hindering epidemiological tracking and preventive analysis.

Furthermore, many EMS organizations fail to implement structured **post-exposure prophylaxis (PEP) protocols**, leaving affected workers without immediate access to testing or treatment (Al-Harbi et al., 2021). This neglect not only endangers the paramedic's health but also perpetuates psychological distress and mistrust toward institutional support systems.

The disparity between developed and developing EMS systems also reflects variations in **resource allocation**. While paramedics in high-income countries often benefit from **safety-engineered syringes** and **portable sharps containers**, those in lower-income regions frequently reuse standard needles or delay disposal due to equipment shortages (Ferguson & Brown, 2020). Thus, institutional investment in safety infrastructure remains a defining determinant of exposure risk.

The cognitive load experienced by paramedics during emergency operations is immense, often leading to **reduced situational awareness** and **impaired judgment**. Stress, anxiety, and the emotional burden of high-mortality cases may divert attention from self-protection behaviors (Kessler et al., 2022). Repeated exposure to traumatic scenes can also cause **desensitization**, where safety procedures are unconsciously deprioritized in favor of immediate patient needs.

Additionally, fear of contracting infections following NSIs can lead to **post-traumatic stress symptoms**, including insomnia, hypervigilance, and loss of concentration, which further compromise safety in subsequent operations (Ferguson & Brown, 2020). These psychological feedback loops create a self-perpetuating risk environment where stress contributes to injury, and injury exacerbates stress.

The availability and use of **safety-engineered medical devices (SEMDs)** play a critical preventive role. However, adoption rates in pre-hospital settings remain low. Studies report that fewer than **30% of EMS agencies** worldwide have fully integrated SEMDs into their operational kits (Tarigan et al., 2020). In some low-resource systems, paramedics continue to use **manual syringes without protective shields**, significantly elevating exposure risk.

Moreover, **improper maintenance** of reusable sharps containers, **overflowing bins**, and **delayed disposal** contribute to secondary injuries during cleanup or patient transport. Incorporating modern, retractable, or auto-disable needles has demonstrated up to **80% reduction in injury rates** in hospital contexts, suggesting a strong potential benefit if extended to pre-hospital care (Sepkowitz, 2021).

## DISCUSSION

The findings of this systematic review highlight that **needle prick injuries (NPIs) among paramedics** remain a pervasive and under-addressed occupational hazard in emergency medical systems worldwide. Despite advances in infection control and occupational safety regulations, prevalence rates ranging from **10% to 35% annually** suggest persistent gaps in both prevention and reporting. These injuries, while often perceived as routine or minor, represent a significant **biohazard exposure risk**, threatening not only the health of emergency medical staff but also the sustainability and credibility of pre-hospital care systems

(Tarigan et al., 2020; Sepkowitz, 2021).

Compared with hospital-based healthcare workers, paramedics experience higher exposure due to **unique field conditions** such as mobility constraints, unpredictable patient behavior, and uncontrolled environmental factors. Studies from **Vietnam, India, and Saudi Arabia** consistently indicate that emergency responders operate under extreme pressure, often compromising adherence to sharps safety protocols (Nguyen et al., 2019; Sharma et al., 2018; Al-Harbi et al., 2021). Conversely, data from developed nations such as the **UK and USA** show lower NPI prevalence rates, primarily due to the adoption of **safety-engineered medical devices (SEMDs)**, robust reporting systems, and structured simulation-based training (Ferguson & Brown, 2020; Kessler et al., 2022). This comparative pattern underscores the importance of institutional investment and regulatory enforcement as determinants of safety outcomes.

The review identified that **human behavior and system design** collectively drive exposure risk. Paramedics often perform procedures in **time-sensitive, chaotic situations**, where the immediate focus is on patient stabilization rather than personal safety. The recurring issue of **needle recapping**, despite global awareness campaigns, reflects the dissonance between **knowledge and practice**. Behavioral lapses are not solely due to negligence but frequently stem from **systemic limitations**—such as lack of sharps containers, limited access to personal protective equipment (PPE), or inadequate procedural training (Nguyen et al., 2019). This aligns with the **human factors model** in occupational safety, which emphasizes that unsafe behaviors often result from environmental and organizational stressors rather than individual fault.

Additionally, **psychological stress and cognitive fatigue** play a critical role. Long shifts, high emotional load, and exposure to traumatic events erode focus and dexterity, elevating the likelihood of errors. This mirrors findings from occupational psychology research linking **decision fatigue and attentional narrowing** to procedural lapses in high-intensity professions (Ferguson & Brown, 2020). Addressing NPIs therefore requires not only technical interventions but also the promotion of **mental resilience and psychological support frameworks** within emergency medical services.

Underreporting emerged as one of the most concerning issues. More than half of affected paramedics fail to report NPIs, preventing accurate epidemiological surveillance and effective policy intervention (Sharma et al., 2018). Reasons include stigma, administrative burden, and perceived futility. In several low- and middle-income countries, the absence of post-exposure prophylaxis (PEP) policies discourages workers from coming forward. This silence perpetuates a **cycle of institutional invisibility**, where occupational hazards remain hidden, and corrective mechanisms never materialize. Evidence from the **United States Occupational Safety and Health Administration (OSHA)** and the **European Centre for Disease Prevention and Control (ECDC)** suggests that transparent reporting systems with immediate feedback significantly increase compliance and post-exposure management (Sepkowitz, 2021).

The findings of this review have critical implications for EMS policy reform. First, **training and education** must extend beyond initial certification to include continuous professional development on safe handling practices, post-exposure management, and stress management. Simulation-based modules, shown to reduce NPIs by up to **40%** (Kessler et al., 2022), should be embedded into all paramedic training programs. Second, EMS agencies should adopt **engineering controls** such as retractable or shielded needles, which have demonstrated high efficacy in hospital contexts but remain underutilized in field settings due to cost constraints.

Third, fostering a **non-punitive reporting culture** is vital. Paramedics should be encouraged to disclose exposure incidents without fear of disciplinary action. Establishing **anonymous reporting systems**, rapid feedback mechanisms, and guaranteed access to PEP would build trust and accountability. Finally, institutional leaders must view occupational safety not as a procedural formality but as a **core component of healthcare quality assurance** and staff retention.

Future research should move beyond cross-sectional prevalence surveys to **longitudinal and intervention-based studies** evaluating the long-term effectiveness of safety interventions in EMS contexts. Emerging technologies, such as **wearable safety monitors**, **AI-based exposure tracking**, and **digital reporting applications**, could revolutionize how paramedics manage occupational hazards. Exploring these innovations may help close the gap between policy and practice, particularly in resource-limited regions.

In summary, this review reveals that needle prick injuries among paramedics are the result of intertwined behavioral, environmental, and institutional determinants. Mitigation requires a **systems-based approach**—combining technology, leadership commitment, psychological support, and continuous education. Without such integration, paramedics will continue to face preventable occupational risks while serving at the frontline of emergency medical care.

## RECOMMENDATIONS AND STRATEGIES

Reducing the prevalence of needle prick injuries (NPIs) among paramedics requires a **multi-dimensional prevention framework** that integrates behavioral modification, institutional policy reform, technological innovation, and psychological resilience. The synthesis of reviewed studies underscores the need for **system-level interventions** that target the root causes of NPIs rather than isolated symptomatic responses. This section proposes strategic recommendations structured under four interconnected pillars: **training and awareness**, **engineering and environmental controls**, **administrative and institutional systems**, and **personal**

**and psychological safety practices**.

Continuous professional education remains the cornerstone of NPI prevention. Although most paramedics receive infection control training during certification, many studies revealed that **knowledge retention and skill compliance decline over time** (Nguyen et al., 2019). Therefore, EMS organizations should implement **ongoing refresher programs** emphasizing safe needle-handling techniques, infection control principles, and immediate post-exposure actions.

**Simulation-based training** has proven particularly effective in reducing procedural errors. Kessler et al. (2022) found that paramedics who participated in high-fidelity simulation sessions experienced a **40% reduction in NPIs** compared to those trained through lectures alone. Such simulations replicate real emergency scenarios, allowing practitioners to practice in stressful but controlled environments.

Furthermore, **visual reminders**, such as posters and infographics placed inside ambulances and EMS stations, reinforce proper disposal protocols and discourage needle recapping. Training should also address **behavioral psychology**, emphasizing mindfulness and situational awareness to counteract fatigue and emotional stress during emergency operations.

Engineering innovations are among the most effective long-term solutions. The introduction of **safety-engineered medical devices (SEMDs)**—such as retractable needles, auto-disable syringes, and shielded IV catheters—has significantly reduced NSI rates in hospitals and should be fully implemented in pre-hospital settings (Sepkowitz, 2021). However, their adoption remains limited in many low- and middle-income EMS systems due to cost constraints and procurement policies.

To address this, governments and health authorities should **prioritize bulk purchasing and subsidies** for SEMDs, ensuring equitable access across emergency networks. Paramedic units should also be equipped with **portable sharps containers** that are clearly labeled, puncture-resistant, and accessible during patient transport.

Improving **ambulance ergonomics** can further enhance safety—adjustable lighting, stable procedure surfaces, and adequate storage for sharps containers minimize accidental pricks during movement. These environmental modifications transform emergency vehicles into safer micro-workplaces, reducing the likelihood of unintentional injuries caused by cramped or unstable workspaces (Ferguson & Brown, 2020).

Institutional culture is a decisive factor in NPI prevention. EMS organizations must establish **clear, enforceable policies** mandating the immediate reporting of all NPIs, regardless of severity. Underreporting persists when workers perceive reporting as punitive or inconsequential. Thus, policies should promote **non-punitive, confidential reporting systems** supported by transparent follow-up processes.

Leadership commitment is crucial: supervisors and medical directors should actively review exposure reports and implement timely **post-exposure prophylaxis (PEP)** and testing. Developing **digital reporting applications** integrated into EMS workflow can facilitate instant documentation, data tracking, and compliance monitoring (Tarigan et al., 2020).

Additionally, incorporating NPI metrics into **organizational performance indicators** aligns safety with institutional accountability. National EMS accreditation bodies should evaluate compliance with occupational safety standards during inspections.

Administrative strategies must also address **staff workload and fatigue**, two recurrent determinants of NPIs. Scheduling reforms—such as limiting shifts to **12 hours or fewer** and mandating adequate rest intervals—can substantially reduce cognitive fatigue and procedural mistakes (Al-Harbi et al., 2021).

While procedural safety is critical, **psychological resilience** is equally essential. Continuous exposure to trauma, fatigue, and infection risk contributes to stress, anxiety, and post-injury fear among paramedics. These psychological states, if unmanaged, diminish concentration and increase the likelihood of accidents (Ferguson & Brown, 2020).

EMS agencies should offer **occupational counseling, peer-support groups, and stress-management workshops** to strengthen coping mechanisms. Promoting **open discussions about mental health** reduces stigma and encourages help-seeking behavior. Moreover, integrating **mindfulness training**—such as breathing exercises before high-stress interventions—can help paramedics maintain composure and focus.

On the personal level, adherence to **universal precautions** is fundamental. Paramedics must be vigilant in using **PPE (gloves, eye protection)** and in following **no-recapping policies**. Reinforcing personal accountability alongside institutional support cultivates a **shared culture of safety**.


**Figure 3. Strategic Framework for Preventing Needle Prick Injuries in Emergency Medical Services**

A successful reduction in NPIs requires aligning **human factors, technology, and policy** within an integrated framework. Preventive efforts should be proactive rather than reactive, supported by leadership engagement, inter-professional training, and data-driven monitoring. Ultimately, protecting paramedics from needle prick injuries safeguards not only their well-being but also the **integrity, resilience, and efficiency** of emergency medical services as a whole.

## CONCLUSION

This systematic review demonstrates that **needle prick injuries (NPIs)** remain a significant and persistent occupational threat to paramedics working in pre-hospital emergency environments. Despite the global recognition of their risks, the prevalence among paramedics continues to range between **10% and 35% annually**, with substantial **underreporting** that obscures the true burden. The synthesis of evidence highlights that NPIs are not merely the result of individual lapses but the outcome of **interacting systemic, behavioral, and environmental factors**.

Human and behavioral errors—such as hurried procedures, needle recapping, and inexperience—intersect with **workplace constraints** like confined spaces, limited lighting, and patient movement during critical interventions. Moreover, **institutional shortcomings**, including insufficient safety training, lack of protective equipment, and inadequate post-exposure protocols, compound the risk. These factors are further amplified by **psychological pressures**, including fatigue, cognitive overload, and emotional distress, which reduce alertness and adherence to safety protocols.

The review underscores the urgent need for a **comprehensive prevention framework** encompassing four strategic pillars:

1. **Continuous Training and Awareness** through simulation-based programs and practical safety workshops.
2. **Engineering and Environmental Controls** such as safety-engineered needles, portable sharps containers, and ergonomic ambulance design.
3. **Administrative and Institutional Reforms** including mandatory reporting systems, leadership accountability, and workload management.
4. **Personal and Psychological Support** to foster resilience, stress management, and consistent PPE compliance.

Ultimately, reducing NPIs among paramedics demands a **culture of safety**—one that promotes accountability without blame, empowers open communication, and aligns occupational health with patient safety. Policymakers and EMS leaders must recognize that protecting emergency medical workers is inseparable from improving the **quality and sustainability of pre-hospital care systems**. Investing in paramedic safety is therefore not a peripheral concern but a cornerstone of resilient, responsive, and ethical emergency healthcare delivery.

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