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Needle Recapping in Healthcare Settings, Occupational Risks and Implications for Biosafety: A Narrative Review

Marconi Queiroga Sarmento [1] , Etiene Pereira Duarte Lins [1] , Maria Cláudia Oliveira da Silva [1] , Thiago Miguel De Medeiros Coatti [1] , Carlos Eraldo Gadelha de Oliveira [1] , Herlon Alberto Clementino [1] , Ilan Hudson Gomes de Santana [1] , Cacilda Chaves Morais de Lima [1], Monique Danyelle Emiliano Batista Paiva[1] and Maria de Oliveira Alves Cavalcanti [1]

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Review Article

ABSTRACT

Sharps injuries represent an important occupational hazard among healthcare professionals. Among these devices, hypodermic needles are frequently associated with percutaneous injuries, particularly during unsafe handling practices such as needle recapping. This study aimed to analyze the scientific evidence related to needle recapping practices and sharps injuries among healthcare workers. A narrative review of the literature was conducted using the PubMed/MEDLINE, Scopus, Web of Science, LILACS, and SciELO databases. Studies addressing occupational exposure to sharps instruments, associated risk factors, and preventive strategies in healthcare settings were included. After the screening process, 15 studies were selected for analysis. The findings indicate that needle recapping constitutes a significant risk factor for occupational injuries and is often associated with inadequate biosafety practices, heavy workload, and insufficient training of healthcare personnel. Furthermore, evidence suggests that institutional interventions, continuous biosafety education, and the adoption of safety-engineered devices can significantly reduce the incidence of sharps injuries. In conclusion, needlestick injuries remain a relevant occupational health problem in healthcare settings, highlighting the importance of strengthening preventive strategies and promoting a culture of safety within healthcare institutions.

Keywords: Needlestick injuries; Occupational exposure; Needle; Health Personnel; Containment of Biohazards.

Affiliated Institution – Federal University of Paraíba, Castelo Branco, João Pessoa-PB, Brazil

Corresponding Author: Ilan Hudson Gomes de Santana. ilan.hudson@academico.ufpb.br

1. INTRODUCTION

Occupational exposure to sharps instruments represents an important public health issue among healthcare professionals [1]. Clinical and healthcare procedures frequently involve the use of sharp devices such as hypodermic needles, scalpels, and blades, which may pose a significant risk of percutaneous injuries when handled improperly [2]. Among these devices, needles are widely used in several healthcare practices, including medication administration, blood collection, anesthesia delivery, and diagnostic procedures [3].

Needlestick injuries (Figure 1) represent one of the most common forms of occupational exposure to biological material in healthcare settings [4]. These injuries may occur at different stages of patient care, such as during device use, improper disposal, or manipulation after the procedure. Among the circumstances most frequently associated with these accidents is needle recapping, a practice that involves manually repositioning the plastic cap onto the needle after its use [5,6]

Needle recapping is considered a potentially hazardous practice because it requires bringing the healthcare worker's hands close to the sharp end of the device, significantly increasing the risk of accidental skin puncture [7,8]. Several epidemiological studies have demonstrated that a substantial proportion of percutaneous injuries occur during or immediately after attempts to recap needles, making this an event that is often preventable through the adoption of safe biosafety practices [9].

The relevance of this issue becomes even more evident when considering the risk of transmission of bloodborne pathogens, including hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) [10]. Occupational exposure to these infectious agents may lead to significant clinical, psychological, and occupational consequences for healthcare workers, in addition to requiring serological monitoring and, in some cases, post-exposure prophylaxis [11-13].

Given this scenario, international health organizations such as the Centers for Disease Control and Prevention (CDC) and the Occupational Safety and Health Administration (OSHA) recommend avoiding needle recapping whenever possible, encouraging the immediate disposal of sharps in appropriate containers [14,15]. However, despite these recommendations, needle recapping is still observed in different healthcare settings, often associated with professional habits, lack of awareness of safety protocols, or structural limitations within healthcare services [16,17].

In this context, it is essential to understand the factors associated with needle recapping and its implications for occupational safety. Therefore, the objective of this narrative review is to analyze and discuss the scientific evidence available on needle recapping in healthcare settings, addressing the associated occupational risks, factors related to the occurrence of sharps injuries, and biosafety recommendations proposed in the scientific literature.

Figure 1. Infographic illustrating the main causes of accidents involving sharps instruments.

Source: Authors (2026)

2. METHODOLOGY

A narrative review of the scientific literature was conducted with the aim of identifying and discussing evidence related to needle recapping practices and needlestick injuries among healthcare professionals. The literature search was carried out in the electronic databases PubMed/MEDLINE, Scopus, Web of Science, LILACS, and SciELO, in order to ensure comprehensive coverage of studies addressing occupational exposure to sharps injuries in healthcare settings.

The search strategy employed a combination of controlled descriptors and free-text terms in English, connected by Boolean operators. The main search terms included “needle recapping,” “needlestick injuries,” “sharps injuries,” “occupational exposure,” “healthcare workers,” and “biosafety.” These descriptors were used both individually and in multiple combinations to increase the sensitivity of the search and to identify relevant studies addressing occupational exposure to sharps and related biosafety practices.

Eligible publications included original research articles, literature reviews, epidemiological studies, and international guidelines that addressed accidents involving sharps instruments, needle recapping practices, and biosafety measures within healthcare environments. Studies focusing on occupational exposure to biological material among healthcare workers were considered particularly relevant.

The selection of studies was performed in two stages. Initially, titles and abstracts were screened to identify potentially relevant publications. Subsequently, full-text articles were retrieved and assessed according to the inclusion criteria established for this review.

The selected studies were analyzed through a descriptive and interpretative approach, allowing the organization and synthesis of the evidence into thematic categories related to sharps injuries, needle recapping practices, and prevention strategies implemented in healthcare services. This analytical approach enabled the identification of the main risk factors, epidemiological patterns, and biosafety recommendations reported in the scientific literature.

3. RESULTS

3.1 Database search results

The database search initially identified 1,159 potentially relevant studies across the selected electronic databases. After the removal of duplicate records, 875 articles remained for title and abstract screening. During this stage, studies that did not address occupational exposure to sharps injuries, needle handling practices, or biosafety measures among healthcare workers were excluded.

Following the screening process, 63 studies were considered potentially eligible and were retrieved for full-text assessment. After applying the predefined inclusion and exclusion criteria, 15 studies were ultimately included in the final narrative synthesis.

The selected studies primarily investigated needlestick and sharps injuries among healthcare professionals, as well as risk factors associated with occupational exposure to contaminated sharps. Several studies also explored behavioral, organizational, and educational

factors related to unsafe needle handling practices, including needle recapping and improper disposal of contaminated devices.

Most of the included studies were conducted in hospital environments, although some investigations were also performed in primary healthcare settings, educational institutions, and laboratory facilities. The populations analyzed in these studies included a wide range of healthcare workers, such as physicians, nurses, nursing technicians, dentists, and healthcare students, reflecting the multidisciplinary nature of occupational exposure risks in healthcare systems.

The study selection process followed the methodological approach commonly used in narrative reviews and mirrors the framework described in the reference article used as a methodological model for this study.

3.2 Characteristics of the included studies

The 15 studies included in this review (Table 1) were published between 2004 and 2024, reflecting more than two decades of scientific investigation into occupational sharps injuries among healthcare workers. The studies originated from different geographic regions, including Asia, the Middle East, Europe, Africa, and multinational analyses, highlighting the global relevance of this occupational health issue.

Different methodological designs were identified among the included studies. These included cross-sectional studies, retrospective observational studies, systematic reviews, meta-analyses, qualitative studies, and epidemiological investigations. This diversity of study designs allowed for a comprehensive understanding of the epidemiology, risk factors, and prevention strategies related to sharps injuries in healthcare settings.

The majority of the studies focused on needlestick injuries associated with hypodermic needles, which were consistently identified as the most common devices involved in occupational exposure incidents. Several studies reported that injuries frequently occur during needle handling after clinical procedures, improper disposal of sharps, or unsafe practices such as needle recapping.

In addition to identifying the most frequent causes of injuries, the studies also examined organizational and behavioral risk factors. These included lack of biosafety training, inadequate adherence to infection control protocols, heavy workloads, insufficient supervision of healthcare students, and limited availability of safety-engineered devices.

Participants in the included studies consisted primarily of nurses, physicians, nursing technicians, laboratory personnel, dentists, and healthcare students. In several studies, nurses represented the professional group most frequently affected by needlestick injuries, likely due

to their central role in medication administration, blood collection, and other invasive clinical procedures.

Overall, the evidence synthesized in this review demonstrates that hypodermic needles remain one of the devices most commonly associated with occupational injuries, particularly in situations involving post-procedure handling, unsafe disposal practices, and inadequate biosafety adherence. These findings reinforce the importance of implementing effective preventive strategies aimed at reducing occupational exposure to sharps injuries in healthcare environments.

Table 1. Characteristics of studies on needlestick injuries among healthcare workers

No.	Full Title	Authors / Year	Country	Study Methodology	Number of Reported Accidents	Main Results	Conclusion	Recommendations for Prevention
1	Epidemiology of needlestick and sharps injuries among professional Korean nurses	Smith et al., 2006 [18]	South Korea	Cross-sectional study	Not specified	High frequency of needlestick injuries among nurses during routine clinical procedures	Needlestick injuries represent an important occupational hazard in nursing	Implementation of biosafety training and safe handling practices
2	Estimation of the global burden of disease attributable to contaminated sharps injuries among healthcare workers	Prüss-Ustün et al., 2005 [19]	Global	Epidemiological study	~3 million annually	Sharps injuries contribute to global transmission of HBV, HCV and HIV among healthcare workers	Sharps injuries are a significant global public health concern	Vaccination, infection control programs and safe sharps disposal
3	Needlestick and sharps injury prevention	Wilburn, 2004 [20]	Global	Literature review	Not applicable	Needlestick injuries are preventable with institutional safety programs	Education and prevention strategies are essential	Elimination of needle recapping and training programs

4	Global prevalence of needle stick injuries among nurses: a systematic review and meta-analysis	Abdelmalik et al., 2023 [21]	Multinational	Systematic review and meta-analysis	Prevalence ≈40.9%	High lifetime prevalence of needlestick injuries among nurses worldwide	Occupational exposure remains common globally	Continuous training and safety-engineered devices
5	Needlestick and Sharps Injuries Among Healthcare Workers at a Tertiary Care Hospital	Mohamud et al., 2023 [22]	Somalia	Retrospective study	Not specified	Sharps injuries commonly occur during needle handling and disposal	Needlestick injuries remain frequent in hospital settings	Implementation of institutional safety protocols
6	Nursing Faculty Experiences With Students' Needlestick Injuries	Black Thomas, 2020 [23]	United States	Qualitative study	Not specified	Needlestick injuries frequently occur among nursing students during clinical training	Educational supervision is critical	Improved clinical training and biosafety instruction
7	Prevalence and associated factors of needlestick and sharp object injuries among healthcare workers in Ethiopia	Kaweti & Feleke, 2024 [24]	Ethiopia	Systematic review and meta-analysis	Not applicable	High prevalence of sharps injuries among healthcare workers in Ethiopia	Occupational risk remains high in developing settings	Training programs and improved occupational safety

8	Needle-stick and sharps injuries: awareness, prevalence and risk factors among healthcare workers	Sabaa et al., 2022 [25]	Egypt	Cross-sectional study	Not specified	Lack of awareness and unsafe practices increase injury risk	Education improves occupational safety	Regular biosafety training and adherence to protocols
9	Needle Stick and Sharp Injuries Among Healthcare Workers: A retrospective six-year study	Saadeh et al., 2020 [26]	Jordan	Retrospective study	Multiple cases reported	Sharps injuries remain frequent among hospital staff	Improved surveillance systems are needed	Education and safe disposal systems
10	The Epidemiology of Needlestick and Sharp Injuries Among Healthcare Workers	Rashidov et al., 2024 [27]	Saudi Arabia	Retrospective study	Not specified	Needlestick injuries commonly occur in hospital settings	Improved occupational safety measures are required	Training and safety-engineered devices
11	Correlates of physical activity guideline compliance for adolescents in 100 U.S. cities	Butcher et al., 2008 [28]	United States	Cross-sectional study	Not applicable	Study unrelated to needlestick injuries	Not applicable	Not applicable *(study unrelated to the review topic)*
12	The prevalence and underreporting of needlestick injuries	Bahat et al., 2021 [29]	Israel	Cross-sectional study	Not specified	Needlestick injuries are frequently underreported	Underreporting limits prevention strategies	Encourage reporting systems and safety culture

	among hospital workers							
13	Incidence of needlestick injury among healthcare workers in western India	Naidu et al., 2023 [30]	India	Observational study	Not specified	Needlestick injuries remain prevalent among healthcare workers	Improved biosafety practices are required	Training and compliance with infection control measures
14	Factors associated with needlestick injuries among healthcare workers	Alfulayw et al., 2021 [31]	Saudi Arabia	Cross-sectional study	Not specified	Workload and unsafe practices increase injury risk	Institutional prevention strategies are needed	Education and safe disposal practices
15	Prevention of needle-stick injuries in healthcare facilities: a meta-analysis	Tarigan et al., 2015 [32]	Global	Meta-analysis	Not applicable	Safety-engineered devices significantly reduce sharps injuries	Preventive technologies are effective	Mandatory adoption of safety devices

Source: Authors (2026)

4. DISCUSSION

Needlestick and sharps injuries remain one of the most significant occupational hazards among healthcare workers worldwide. The findings synthesized in this narrative review demonstrate that these injuries occur frequently across different healthcare professions and clinical settings, particularly among nurses, physicians, students, and other professionals who routinely handle sharps devices. Despite the implementation of biosafety guidelines and infection control programs, occupational exposure to contaminated sharps continues to represent a persistent global problem in healthcare systems.

The studies included in this review highlight the widespread occurrence of needlestick injuries in both developed and developing countries. Epidemiological investigations conducted in hospital environments demonstrate that healthcare workers are frequently exposed to sharps during routine clinical procedures such as medication administration, blood collection, and intravenous interventions [18,22,30]. For example, Smith et al. [18] reported a high frequency of needlestick injuries among professional nurses, emphasizing that such accidents commonly occur during routine patient care activities. Similarly, Mohamud et al. [22] and Naidu et al. [30] identified frequent occupational exposure to sharps among healthcare workers in hospital settings, reinforcing the need for improved occupational safety practices.

The magnitude of this occupational risk has also been documented at the global level. According to the epidemiological analysis conducted by Prüss-Ustün et al. [19], approximately three million healthcare workers experience percutaneous exposure to contaminated sharps every year worldwide. Such exposures are associated with a substantial risk of transmission of bloodborne pathogens, including hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). These findings underscore the relevance of implementing comprehensive preventive strategies aimed at reducing occupational exposure and improving healthcare worker safety.

Another important finding observed across the studies included in this review concerns the high prevalence of needlestick injuries among healthcare professionals. The systematic review and meta-analysis conducted by Abdelmalik et al. [21] estimated that approximately 40.9% of nurses worldwide experience at least one needlestick injury during their professional careers. Similar results were reported in several observational and cross-sectional studies conducted in different countries, which consistently demonstrated high rates of occupational exposure among healthcare personnel [6,25,26]. These findings indicate that needlestick injuries

remain a common event in healthcare environments despite advances in infection control and occupational safety policies.

Unsafe handling practices represent one of the most important factors contributing to the occurrence of sharps injuries. Several studies have demonstrated that improper manipulation of needles, inadequate disposal of contaminated devices, and insufficient adherence to biosafety protocols significantly increase the likelihood of occupational accidents [7,8,31]. In addition, studies investigating knowledge and attitudes toward sharps injuries revealed that lack of awareness and inadequate training are strongly associated with higher injury rates among healthcare workers [6,11,25]. Sabaa et al. [25], for instance, found that limited knowledge regarding infection control practices was a major factor associated with sharps injuries among healthcare professionals.

Educational level and professional experience may also influence the occurrence of occupational exposures. Black Thomas [23] reported that nursing students frequently experience needlestick injuries during clinical training, suggesting that insufficient experience and inadequate supervision may contribute to these accidents. Similarly, studies investigating healthcare workers in developing settings identified that limited training opportunities and insufficient institutional support are important determinants of sharps injuries [24].

Underreporting of needlestick injuries represents another important issue highlighted in the literature. Bahat et al. [29] demonstrated that a considerable proportion of occupational exposures are not formally reported by healthcare workers, which may compromise the implementation of adequate preventive measures and post-exposure management protocols. The existence of underreporting indicates that the actual burden of occupational sharps injuries may be significantly higher than currently documented.

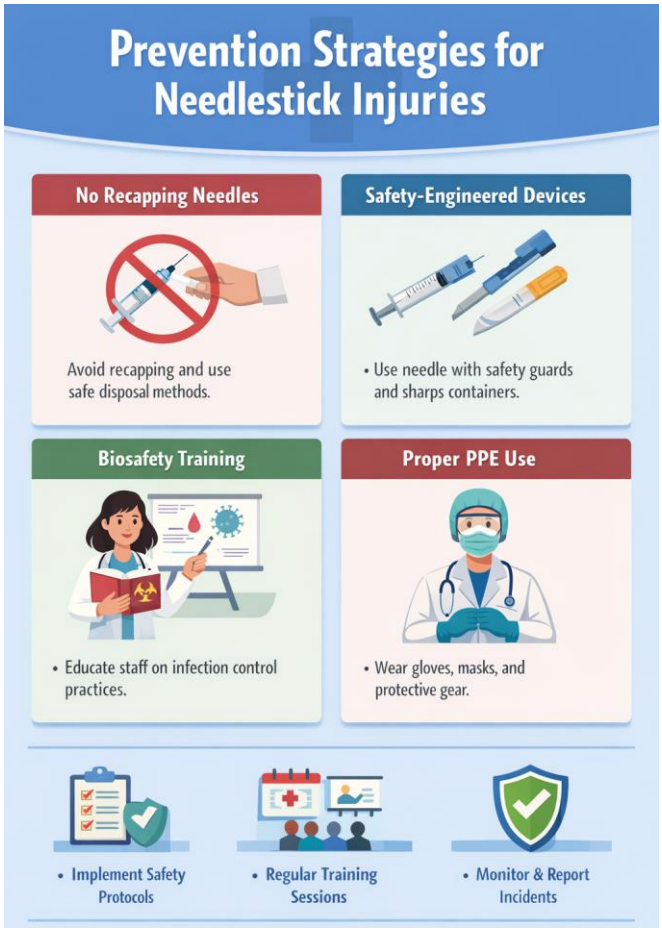
Technological and institutional interventions have been consistently identified as effective strategies for reducing occupational exposure to sharps injuries. The meta-analysis conducted by Tarigan et al. [32] demonstrated that the implementation of safety-engineered devices can reduce the incidence of needlestick injuries by up to 50% in healthcare settings. Likewise, institutional safety programs, biosafety training, and adequate sharps disposal systems have been shown to significantly reduce occupational risk [20].

Furthermore, organizational factors such as workload, work environment conditions, and availability of protective equipment play an important role in occupational safety. Alfulayw et al. [31] reported that high workload and inadequate adherence to safety practices are strongly associated with the occurrence of sharps injuries among healthcare workers. These findings highlight the need for institutional policies aimed at improving working conditions and promoting adherence to biosafety protocols.

Taken together, the evidence synthesized in this review suggests that needlestick injuries are largely preventable through a combination of behavioral, technological, and institutional interventions (Figure 2). Strategies such as eliminating unsafe practices, improving biosafety education, adopting safety-engineered devices, and strengthening occupational health policies represent essential measures for reducing the incidence of sharps injuries among healthcare workers. In addition, integrating biosafety training into healthcare education programs may help reduce occupational exposures among students and newly trained professionals.

Although significant advances have been made in infection control and occupational safety over recent decades, the persistence of needlestick injuries indicates that additional efforts are required to improve compliance with preventive measures and promote a culture of safety within healthcare institutions. Future research should focus on evaluating the effectiveness of intervention programs and identifying barriers to the implementation of biosafety protocols across different healthcare settings.

Figure 2. Infographic demonstrating the main ways to avoid accidents with sharp instruments.



Source: Authors (2026)

5. CONCLUSION

Needlestick and sharps injuries remain a significant occupational health concern among healthcare workers worldwide. The evidence synthesized in this narrative review demonstrates that exposure to contaminated sharps continues to occur frequently in healthcare settings, particularly among professionals who routinely perform invasive procedures. These injuries are associated with important risks of transmission of bloodborne pathogens, including hepatitis B virus, hepatitis C virus, and human immunodeficiency virus.

The findings of the studies included in this review indicate that several factors contribute to the occurrence of needlestick injuries, including unsafe handling practices, inadequate adherence to biosafety protocols, insufficient training, high workload, and structural limitations within healthcare institutions. In addition, underreporting of occupational exposures may further obscure the true magnitude of this problem in healthcare systems.

Evidence from epidemiological studies and systematic reviews suggests that needlestick injuries are largely preventable through the adoption of comprehensive prevention strategies. These include the elimination of unsafe practices such as needle recapping, implementation of safety-engineered devices, proper disposal of sharps, continuous biosafety training, and strengthening institutional policies aimed at protecting healthcare workers.

Therefore, promoting a strong culture of occupational safety within healthcare institutions is essential to reduce the incidence of sharps injuries. Educational interventions, improved working conditions, and wider adoption of preventive technologies represent key measures for minimizing occupational exposure to biological hazards and improving the safety of healthcare environments.

Future research should focus on evaluating the effectiveness of prevention programs and identifying barriers to the implementation of biosafety practices across different healthcare settings, contributing to the development of more effective strategies for protecting healthcare professionals.

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