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REVIEW ARTICLE:

Occupational Exposure to Blood and Body Fluids, Biosafety Practices, and Post-Exposure Prophylaxis Utilization among Emergency Nurses: A Systematic Review

Tracy Khaling[1], Bhawna Verma[2], Daisy Thomas[3]

ABSTRACT

Background: Emergency nurses are routinely exposed to blood and body fluids due to the high-intensity, unpredictable nature of emergency care, placing them at increased risk of blood-borne infections such as HIV, hepatitis B, and hepatitis C. Despite established biosafety guidelines and post-exposure prophylaxis (PEP) protocols, occupational exposure and inadequate preventive practices remain significant concerns globally. **Objective:** This systematic review aimed to synthesize existing evidence on the prevalence of occupational exposure to blood and body fluids, adherence to biosafety practices, and utilization of post-exposure prophylaxis among emergency nurses. **Methods:** A comprehensive literature search was conducted across PubMed/MEDLINE, Scopus, CINAHL, Web of Science, and Google Scholar for studies published in English between January 2000 and December 2024. Eligible studies included quantitative, qualitative, and mixed-methods research focusing on emergency nurses. Study selection followed PRISMA guidelines. Data were extracted using a standardized form, and methodological quality was assessed using appropriate critical appraisal tools. Due to heterogeneity among studies, a narrative synthesis approach was adopted. **Results:** Thirty-five studies met the inclusion criteria. The prevalence of occupational exposure among emergency nurses ranged from approximately 30% to over 80% across studies, with needle stick and sharps injuries being the most common exposure types. Adherence to biosafety practices varied widely, with consistent glove use but suboptimal compliance with other personal protective equipment and safe sharps handling. Reporting of exposure incidents and utilization of PEP were generally low, with delayed initiation and incomplete adherence frequently reported. Key barriers included high workload, insufficient training, limited access to protective equipment, and lack of institutional support. **Conclusion:** Occupational exposure to blood and body fluids remains a substantial risk for emergency nurses. Strengthening biosafety practices, improving reporting systems, and ensuring timely access to PEP are essential to enhance occupational safety and protect this vulnerable workforce.

Keywords: Occupational exposure; Blood and body fluids; Emergency nurses; Biosafety practices; Standard precautions; Needle stick injuries; post-exposure prophylaxis (PEP); Infection prevention; Occupational health; Blood-borne infections

Authour(s) Details:

1. Senior Nursing Officer, MSCN, BSCN, RNRM, Department of Critical Care Nursing, Vardhman Mahavir Medical College and Safdarjung Hospital, Ansari Nagar, New Delhi, India, **Email:**khalingtracy@gmail.com, 9654830277
2. Nursing Officer, PhD Nursing Scholar, MSCN, BSCN, RNRM, Department of Paediatrics, Vardhman Mahavir Medical College and Safdarjung Hospital, Ansari Nagar, New Delhi, India, **Email:**bhuriabhawna@gmail.com, 8802005551, ORCID iD- 0009-0007-8856-4087
3. Vice- Principal (Acting), Rajkumari Amrit Kaur, College of Nursing, Lajpat Nagar, New Delhi, India, **Email:**principal-rakcon@gov.in, 9811043881

Corresponding Address: Bhawna Verma, Nursing Officer, PhD Nursing Scholar, MSCN, BSCN, RNRM, Department of Paediatrics, Vardhman Mahavir Medical College and Safdarjung Hospital, Ansari Nagar, New Delhi, India, Email:bhuriabhawna@gmail.com

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Introduction

Occupational health encompasses a comprehensive approach aimed at protecting and promoting the physical, mental, and social well-being of individuals in the workplace.[1] The World Health Organization (WHO) defines occupational health as an area of public health that seeks to "promote and maintain the highest degree of physical, mental and social well-being of workers in all occupations." Within healthcare settings, where professionals are exposed to complex and unpredictable work environments, the maintenance of occupational health assumes critical importance.[2]

Among healthcare professionals, nurses particularly those working in emergency departments face unique and heightened occupational risks. Emergency nurses function as an integral component of healthcare delivery, providing immediate and life-saving care under intense time pressure, heavy workload, and emotionally charged circumstances.[3] In the course of their duties, they are frequently exposed to a wide range of occupational hazards, which may be broadly categorized into biological, chemical, physical, and psychosocial hazards. Of these, biological hazards especially exposure to blood and body fluids pose a significant threat to their health and safety.[4]

The Occupational Safety and Health Administration (OSHA) defines occupational exposure as "reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties."[5]

Nurses are particularly vulnerable to exposure to blood-borne pathogens such as Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and Hepatitis C Virus (HCV), primarily through needlestick injuries, sharps injuries, and splashes involving blood or body fluids.[6] These infections are of particular concern because infected individuals may remain asymptomatic for prolonged periods before clinical or laboratory manifestations become evident, increasing the risk of unrecognized transmission.

In response to the growing risk of occupational exposure, the Centers for Disease Control and Prevention (CDC) introduced the concept of universal precautions in 1985, later formalized in 1987.[7] These precautions mandate that blood and certain body fluids of all patients be treated as potentially infectious, irrespective of known infection status. Universal precautions emphasize the use of personal protective equipment (PPE) such as gloves, masks, gowns, and eye protection, along with safe handling and disposal of sharps, to minimize occupational exposure among healthcare workers.[8]

Biosafety represents a fundamental component of infection prevention and occupational health. It is defined as the discipline concerned with the safe handling, containment, and disposal of infectious microorganisms and hazardous biological materials in clinical, diagnostic, teaching, and research settings.[9] Adherence to biosafety precautions such as appropriate PPE use, hand hygiene, safe sharps management, and environmental controls is essential to reducing exposure to blood and body fluids and preventing transmission of blood-borne infections within healthcare facilities.[10]

Despite established guidelines, exposure to blood and body fluids remains common in hospital settings. The World Health Organization estimates that among approximately 35 million healthcare workers worldwide, nearly three million experience percutaneous exposure to blood-borne pathogens annually.[11] Of these exposures, two million involve HBV, 0.9 million involve HCV, and approximately 170,000 involve HIV, resulting in thousands of new infections each year.[12] Needlestick injuries alone account for a substantial proportion of occupationally acquired infections, contributing significantly to hepatitis B, hepatitis C, and HIV transmission among healthcare workers.

Post-exposure prophylaxis (PEP) serves as a critical secondary prevention strategy following occupational exposure to blood and body fluids. According to the National AIDS Control Organization (NACO), PEP refers to the comprehensive management provided to minimize the risk of infection following potential exposure to blood-borne pathogens, including HIV, HBV, and HCV. HIV PEP involves the prompt initiation of antiretroviral therapy, ideally within 72 hours of exposure, and requires strict adherence to the full treatment regimen to achieve optimal effectiveness.[13] Although PEP has been shown to significantly reduce the risk of infection, it does not offer complete protection and remains underutilized in many healthcare settings.

Evidence from multiple studies highlights substantial gaps in reporting occupational exposures, adherence to biosafety precautions, and utilization of PEP among healthcare workers.[14] Studies conducted in India and other low- and middle-income countries reveal high rates of needlestick injuries among nurses, with underreporting of incidents and low uptake of PEP despite clear indications.[6] Emergency nurses, owing to their frequent involvement in intravenous procedures, resuscitation, and trauma care, are particularly vulnerable to such exposures. Factors such as increased workload, emergency situations, inadequate access to protective equipment, and insufficient training have been consistently identified as barriers to safe practice.[15]

Global and regional data further underscore the magnitude of the problem. Meta-analyses report a pooled global prevalence of occupational exposure to blood and body fluids of more than 50% among healthcare workers during their careers.[16] The WHO estimates that over one-third of hepatitis B infections among healthcare workers are attributable to occupational exposure, despite the availability of effective vaccination. In many regions, hepatitis B immunization coverage among healthcare workers remains unacceptably low, further increasing vulnerability.[17]

The persistent risk of blood-borne infections and the psychological burden associated with fear of infection have reinforced the importance of strengthening occupational exposure prevention strategies in healthcare settings. Emergency departments, in particular, require focused attention due to their high-risk nature. While numerous primary studies have explored occupational exposure, biosafety practices, and PEP utilization among healthcare workers, the evidence remains fragmented, and findings vary across settings and populations. A systematic synthesis focusing specifically on emergency nurses is therefore essential.

Accordingly, this systematic review aims to comprehensively synthesize existing evidence on occupational exposure to blood and body fluids, biosafety practices, and utilization of post-exposure prophylaxis among emergency nurses. By consolidating global findings, this review seeks to identify patterns, gaps, and challenges in current practice and to inform policymakers, healthcare administrators, and nursing educators in developing targeted interventions. Ultimately, improving occupational safety measures and strengthening biosafety and post-exposure management strategies are critical to fostering a safer working environment for emergency nurses and enhancing the quality of emergency healthcare delivery.

Research Question

What is the prevalence of occupational exposure to blood and body fluids, the level of adherence to biosafety practices, and the extent of post-exposure prophylaxis utilization among emergency nurses?

Eligibility Criteria: Studies were considered eligible for inclusion in this systematic review if they met the following criteria:

1. ***Population*:** Registered nurses or nursing personnel providing care in emergency departments, emergency units, or emergency care settings. Studies involving mixed populations of healthcare workers were included if data specific to nurses or emergency settings were separately extractable.
2. ***Exposure*:** Occupational exposure to blood and body fluids, including needlestick injuries, sharps injuries, mucocutaneous exposure, or contact with non-intact skin occurring during clinical practice.
3. ***Intervention / Practice*:** Biosafety practices such as adherence to standard precautions use of personal protective equipment (PPE), hand hygiene, safe handling and disposal of sharps, infection prevention training, and institutional safety protocols.
4. ***Comparators*:** Comparisons between:
    - Emergency nurses with adequate versus inadequate biosafety practices
    - Nurses who utilized post-exposure prophylaxis versus those who did not
    - Different healthcare settings (e.g., tertiary vs secondary care, public vs private institutions)
    - Variations in training, experience, or availability of protective resources
5. ***Outcomes*:**
   Primary Outcomes-
    - Prevalence and types of occupational exposure to blood and body fluids
    - Level of compliance with biosafety precautions
    - Utilization, timeliness, and completion of post-exposure prophylaxis

Secondary Outcomes

- Reporting behavior following exposure
- Factors associated with occupational exposure
- Barriers and facilitators to biosafety adherence and PEP utilization
- Incidence of seroconversion following occupational exposure, where available

6. ***Study Design*:** Cross-sectional studies, cohort studies, case-control studies, qualitative studies, mixed-method studies, and systematic or narrative reviews published in peer-reviewed journals.
7. ***Language and Time Frame*:** Studies published in English between January 2000 and December 2024 were included.

Information Sources

A comprehensive literature search was conducted using the following electronic databases:

- PubMed/MEDLINE
- Scopus
- CINAHL
- Web of Science
- Google Scholar

In addition, reference lists of relevant articles were manually searched to identify additional eligible studies.

Search Strategy: The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords related to occupational exposure, emergency nursing, biosafety practices, and post-exposure prophylaxis. Key search terms included:

- *"Occupational exposure"*
- *"Blood and body fluids"*
- *"Needlestick injury"*
- *"Biosafety" OR "standard precautions"*
- *"Post-exposure prophylaxis" OR "PEP"*
- *"Emergency nurses" OR "emergency department nursing"*

Boolean operators (AND, OR) were used to combine terms appropriately. The search strategy was adapted for each database.

Study Selection

All retrieved records were exported to reference management software, and duplicates were removed. Titles and abstracts were independently screened for relevance. Full-text articles of potentially eligible studies were then assessed against the inclusion and exclusion criteria. Discrepancies during study selection were resolved through discussion and consensus.

Data Extraction: Data were extracted using a standardized data extraction form. Extracted information included:

- Author(s) and year of publication
- Country and study setting
- Study design and sample size
- Characteristics of emergency nurses
- Type and frequency of occupational exposure
- Biosafety practices assessed
- Post-exposure prophylaxis utilization

- Key findings and conclusions

Quality Assessment: The methodological quality of included studies was assessed using appropriate appraisal tools based on study design:

- Joanna Briggs Institute (JBI) Critical Appraisal Checklists for cross-sectional and observational studies
- CASP tools for qualitative studies

Each study was categorized as having low, moderate, or high risk of bias.

Data Synthesis: Due to heterogeneity in study designs, outcome measures, and reporting methods, a narrative synthesis approach was adopted. Findings were summarized thematically under the domains of occupational exposure, biosafety practices, and post-exposure prophylaxis utilization. Where feasible, results were compared across regions and healthcare settings.

Ethical Considerations: As this study was a systematic review of previously published literature, ethical approval was not required. All included studies had obtained ethical clearance from their respective institutions.

Reporting Standards: This systematic review was conducted and reported in accordance with the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines**.

Data Synthesis and Analysis: Given the heterogeneity observed across included studies in terms of study design, sample size, healthcare settings, outcome definitions, and measurement tools, a narrative synthesis approach was adopted rather than a meta-analysis. Quantitative pooling was not feasible due to variability in exposure definitions, biosafety assessment tools, and reporting of post-exposure prophylaxis outcomes.

The findings were synthesized thematically under three key outcome domains:

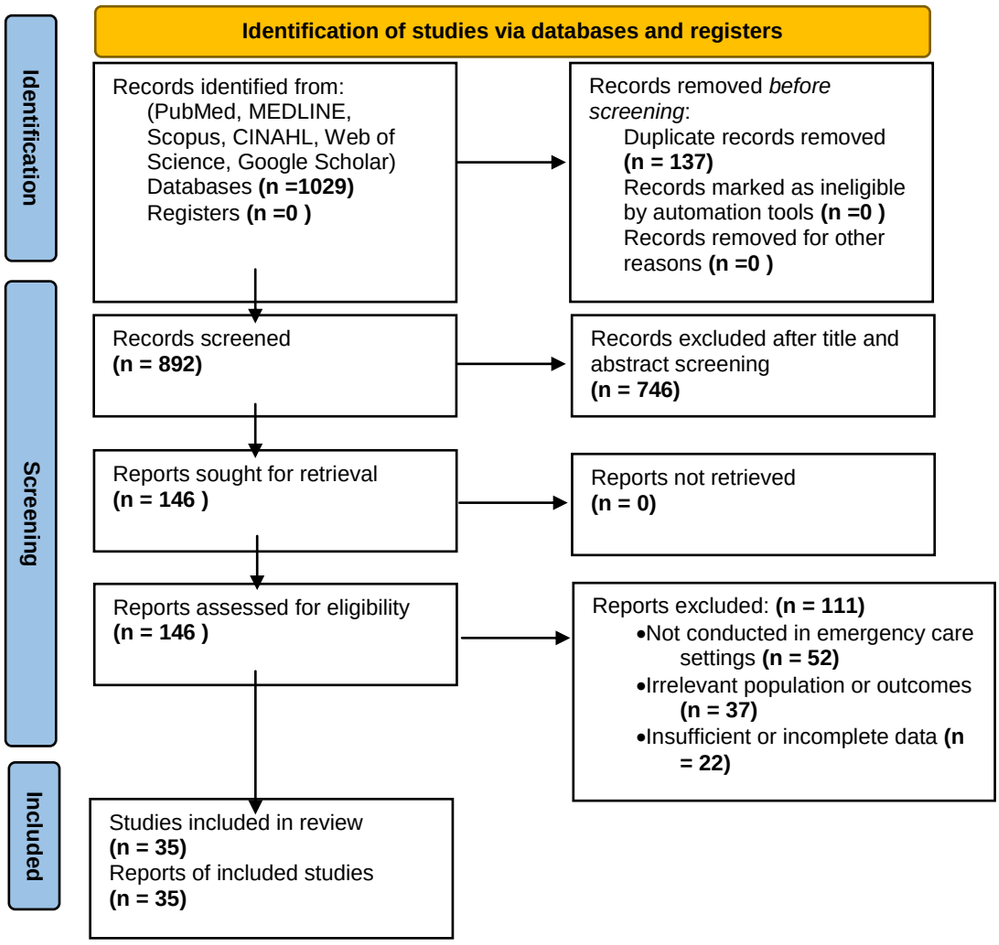
1. **Occupational exposure to blood and body fluids among emergency nurses**
2. **Biosafety practices and adherence to standard precautions**
3. **Utilization of post-exposure prophylaxis following occupational exposure**

Within each domain, results were compared across geographic regions, healthcare settings, and study designs to identify consistent trends, risk factors, and gaps in evidence. Factors influencing exposure risk, biosafety compliance, and PEP utilization were narratively integrated to provide a comprehensive understanding of occupational safety challenges faced by emergency nurses.

Results

Study Selection: The database search identified 1,029 records from electronic databases including PubMed, MEDLINE, Scopus, CINAHL, Web of Science, and Google Scholar. After removal of duplicate records (n = 137), 892 records were screened based on titles and abstracts. Of these, 746 records were excluded due to irrelevance to emergency nursing, non-nursing populations, or lack of occupational exposure outcomes.A total of 146 full-text articles were assessed for eligibility. Following detailed evaluation, 111 studies were excluded for the following reasons: not conducted in emergency care settings (n = 52), irrelevant population or outcomes (n = 37), and insufficient or incomplete data (n = 22). Ultimately, 35 studies met the inclusion criteria and were included in the qualitative synthesis of this systematic review **(Figure 1)**.

Figure 1. PRISMA 2020 flow diagram showing the selection process of studies included in the systematic review on occupational exposure to blood and body fluids, biosafety practices, and post-exposure prophylaxis utilization among emergency nurses.



Study Characteristics: The included studies were published between 2000 and 2024 and represented a wide geographical distribution, including Asia, Africa, Europe, and North America. The majority of studies employed a cross-sectional design, followed by cohort studies and qualitative investigations. Sample sizes ranged from fewer than 100 participants to more than 1,500 emergency nurses.

Most studies were conducted in tertiary care hospitals, particularly within emergency departments, trauma units, and intensive emergency care settings. Data collection methods primarily included structured self-administered questionnaires, interviews, and institutional exposure records.

Main Findings

Occupational Exposure to Blood and Body Fluids: Across the included studies, occupational exposure to blood and body fluids among emergency nurses was consistently reported as high. Lifetime exposure prevalence ranged from approximately 30% to over 80%, while exposure within the previous year ranged from 20% to 60%. Needlestick injuries were the most frequently reported exposure type, followed by sharps injuries and mucocutaneous splashes involving blood or body fluids.[14,16,18–20]

Commonly identified risk factors included high workload, emergency procedures, inadequate staffing, recapping of needles, improper sharps disposal, fatigue, and lack of safety-engineered devices.

Biosafety Practices among Emergency Nurses: Adherence to biosafety and standard precautions varied substantially across studies. While glove use during procedures involving blood contact was generally reported as moderate to high, compliance with other protective measures such as masks, gowns, and eye protection was frequently suboptimal, particularly during emergency situations.

Several studies identified insufficient training, limited availability of personal protective equipment, and poor institutional infection control support as major barriers to consistent biosafety practice. Emergency workload and time constraints were repeatedly cited as contributing factors to non-compliance.[20–23]

Utilization of Post-Exposure Prophylaxis: Utilization of post-exposure prophylaxis following occupational exposure was found to be inadequate across most included studies. Reporting rates following exposure ranged from 40% to 70%, while PEP initiation rates among eligible nurses ranged from 20% to 60%. Completion of the full PEP regimen was often lower, with several studies reporting significant drop-out due to side effects, lack of follow-up, or perceived low risk.

Key barriers to PEP utilization included lack of awareness of PEP protocols, delayed reporting, fear of stigma, concerns about drug side effects, and absence of clear institutional guidelines.[24–26]

Discussion

This systematic review synthesized evidence on occupational exposure to blood and body fluids, biosafety practices, and post-exposure prophylaxis (PEP) utilization among nurses providing emergency care. Emergency nurses operate in high-risk environments characterized by unpredictable patient behavior, high workload, and frequent invasive procedures, making them particularly vulnerable to occupational hazards. The findings of the present study, when examined alongside existing literature, provide important insights into the magnitude of exposure, preventive practices, and gaps in post-exposure management.

Occupational Exposure to Blood and Body Fluids among Emergency Nurses: The present study revealed that 13% of nurses providing emergency care experienced occupational exposure to blood and body fluids in the preceding 12 months. Although this prevalence appears lower compared to some international studies, repeated exposure was common, with 41% experiencing exposure once, 37% twice, and 18% more than three times. This indicates that while overall prevalence may vary, emergency nurses remain repeatedly exposed during routine clinical practice. The predominance of exposure to blood (75%) highlights the persistent risk of blood-borne pathogen transmission in emergency settings.[19,20,27,28]

Most exposures in the present study involved mucous membrane or non-intact skin contact with small volumes (85%), followed by large-volume exposures (15%). Unexpected patient movement (41%) and handling of used needles (26%) were identified as leading causes, underscoring the influence of emergency-related factors such as sudden patient reactions and procedural urgency. Importantly, only 41% of exposed nurses reported the incident to hospital authorities, indicating substantial underreporting.[29,30]

These findings are consistent with the study by Singru and Banerjee (2008), who reported occupational exposure in 32.75% of healthcare workers, with needle-stick injuries accounting for over 92% of exposures.[28] Similarly, Mponela et al. (2015) reported an exceptionally high exposure prevalence (87.1%) among emergency nurses, with needle-stick injuries being the most frequent mode of exposure and a higher tendency among male nurses to report incidents. Compared to these studies, the lower prevalence observed in the present study may reflect differences in institutional safety policies, reporting mechanisms, or underreporting due to fear, stigma, or perceived low risk.[31]

Biosafety Practices among Nurses Providing Emergency Care: With respect to biosafety practices, the present study found that the majority of nurses (84%) demonstrated an average level of biosafety practice, while only 11% exhibited good practice and 5% showed poor practice. These findings indicate partial compliance with standard precautions, suggesting that while basic protective measures may be practiced, consistent and comprehensive adherence remains inadequate.

Supporting evidence from Camila Pinno et al. (2021) demonstrated similar patterns, where glove use was relatively high, yet utilization of other protective equipment such as masks, goggles, and aprons was considerably lower.[32] Likewise, Amoran et al. (2013) reported that although a majority of healthcare workers were aware of universal precautions, significant gaps existed in recognizing vaccination, PEP, and surveillance as integral components of infection control. Inadequate hand hygiene practices and limited availability of sharps disposal systems further compounded the risk.[33]

The predominance of average rather than good biosafety practice in the present study reflects systemic barriers such as time constraints, emergency workload, insufficient training, and limited access to protective equipment. These findings emphasize that knowledge alone does not ensure safe practice; continuous training, monitoring, and institutional support are essential to improve compliance in emergency care environments.

Utilization of Post-Exposure Prophylaxis: The utilization of post-exposure prophylaxis following occupational exposure was found to be suboptimal in the present study. Although 41% of nurses reported exposure incidents to hospital authorities, a majority (59%) did not report, thereby missing opportunities for timely PEP initiation. Underreporting remains a critical challenge, potentially driven by fear of stigma, lack of awareness, perceived low risk, or concerns regarding medication side effects.

These findings align with Singru et al. (2008), who reported that only 50% of exposed healthcare workers reported incidents and merely 21.31% received HIV PEP, despite indications in nearly half of exposure cases.[28] Similarly, Sheth et al. (2016) highlighted delayed initiation and poor uptake of PEP, with only 35.9% of eligible exposures receiving PEP within two hours.[27] Although no sero-conversion was reported in these studies, delayed or absent PEP significantly increases the risk of infection and psychological distress among healthcare workers.

The evidence underscores the need for robust institutional PEP protocols, immediate access to prophylactic medications, clear reporting pathways, and counseling services to encourage timely reporting and adherence. Regular training on PEP guidelines and reassurance regarding confidentiality and support may improve utilization rates among emergency nurses.

Implications for Practice and Policy: The findings of this systematic review demonstrate that occupational exposure to blood and body fluids remains a significant concern among emergency nurses, despite the availability of preventive strategies. Average compliance with biosafety precautions and underutilization of PEP highlight critical gaps in occupational health practices. Strengthening infection control programs, ensuring availability of personal protective equipment, promoting hepatitis B immunization, and establishing non-punitive reporting systems are essential to mitigate occupational risks.

Conclusion and Recommendations

Occupational exposure to blood and body fluids remains a significant concern among nurses providing emergency care. Emergency nurses face high-risk situations involving invasive procedures, unpredictable patient behavior, and heavy workloads, which contribute to repeated exposure. Despite awareness of standard precautions, adherence to biosafety measures is often only average and reporting of exposure incidents is suboptimal. Utilization of post-exposure prophylaxis (PEP) is inadequate due to delayed reporting, limited awareness, fear of stigma, and lack of institutional support, increasing the risk of preventable infections such as HIV, hepatitis B, and hepatitis C.

To address these challenges, targeted interventions are essential. Regular training on standard precautions, safe sharps handling, and infection control should be implemented, alongside continuous monitoring of compliance. Institutions must ensure the availability of personal protective equipment, safety-engineered devices, and sharps disposal systems. Clear, non-punitive reporting mechanisms and immediate access to PEP must be established, with counseling to encourage adherence. Mandatory hepatitis B vaccination and active infection control committees can further enhance occupational safety. Future research should focus on longitudinal and interventional studies to evaluate the effectiveness of these measures in emergency care settings. Implementing these strategies is crucial to safeguard nurses' health, reduce occupational risk, and improve overall patient care outcomes.

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