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PREVALENCE OF RISK FACTORS ASSOCIATED WITH NEEDLESTICK AND SHARP INJURIES AMONG NURSES IN HOSPITAL SETTING: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

In hospital environments, health care workers (HCWs) are frequently and inevitably exposed to biological hazards. This type of risk typically arises from accidental needlestick and sharps injuries, or muco-cutaneous contact with biological fluids (BBF) or materials. A systematic literature review conducted in the leading scientific literature databases, PubMed/MedLine, was conducted. Following identification, screening and inclusion processes, 16 articles were selected. The articles analyzed set out to investigate the impact of accidental needlestick and sharps injuries on the selected population by describing the characteristics of the clinical practices adopted. In general, HCWs who did not have adequate infection prevention training were 3.36 times more likely to be exposed to BBF than those who had adequate training. This study found that the risk of exposure was significantly associated with factors such as students' gender, age, frequency of night shift, frequency of injections, lack of safety training, knowledge of safety management policies, and lack of Protective Personal Equipment use. To reduce injuries, prevention efforts must focus on safety devices, the work environment, and increased training on prevention and procedures. Training needs to begin with undergraduate nursing students in order to practice what they learn in face-to-face courses and clinical training.

1. Introduction

In hospital environments, healthcare workers (HCWs) are inevitably exposed to chemical, physical and biological hazards that pose a real threat to the health of all professionals involved. [1]

Exposure to biological agents is the most common occupational risk for all HCWs involved in the care and treatment of patients, and nurses are the most exposed and affected category because of their specific duties. Students belonging to the various health professions degree programs who perform clinical internships in hospital facilities should also be considered at-risk categories. [1]

In the hospital environment, biohazard is intrinsically related to the activity of the HCW and thus by direct contact with the sick, possible carriers of infectious diseases. The possible routes by which penetration of pathogenic microorganisms can be realized include the muco-cutaneous route, the airway, the blood route and the oral route.

Typically, however, biological exposures result from accidental needles tick injuries, sharps injuries, and muco-cutaneous contact with biological fluids or materials. Since blood-borne occupational infectious diseases occur primarily in health care workers as a result of injuries, it is necessary, therefore, to reduce the likelihood and frequency with which these occur. [2]

Safety in hospital setting is a value that cannot be overlooked. A structural or technological variable on which not only the health but the very physical safety of patients and employees depends.

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It therefore turns out to be of fundamental importance to carry out a risk assessment, understood as the set of all those operations, cognitive and operational, that must be implemented to arrive at an estimate of the risk of exposure to the factors of danger to the safety and health of the staff in relation to the performance of the work.[3]

Workers are, in particular, obliged to report immediately to their supervisor or manager (or, in the absence of the latter, to a suitable company contact person) any malfunctions or deficiencies in the safety equipment and/or devices provided, as well as any dangerous situation of which they become aware.[4]

The Italian Legislation mandates the protection of health in the workplace already beginning with Article 32 of the Constitution. In addition, the Consolidated Occupational Safety and Health Act (Legislative Decree No. 81 of April 9, 2008) deals extensively with the aforementioned issue in Title X-Xbis, as reflected in Article 278, which states that "In activities for which the assessment shows biological risks to the health of workers, the employer shall provide workers, based on available knowledge, with information and instructions". [5] Of all needlestick injuries (NSIs) among HCWs about 74% involve nurses. In fact, in the United States, nearly 11% of nurses have specifically suffered at least one needlestick injury (NSI) while, more generally, about 64% of nurses have suffered at least one injury during their careers. [6]

As for Europe, however, an estimated 1 million needlestick injuries occur each year. [7]

The Italian Study of Occupational Risks of HIV and Other Bloodborne Pathogens (SIROH) collected epidemiological data that could make a significant contribution to prevention. That study found the presence of two prevalent modes of exposure: mucosal, which accounts for 25% of the total exposure, and dermal exposure, which accounts for the majority of injuries amounting to about 75% of the total exposure. Of the above exposures, about 63% were attributable to hollow needle sticks, 33% to sharp objects (such as suture needles or lancets) and the remaining 4% due to other devices. Regarding source patients, of the 70,810 percutaneous exposures recorded by SIROH between 1994 and 2011, the study found that 47% of cases were negative for hepatitis C, hepatitis B, and human immunodeficiency virus, 18% of sources were untested, 15% were of unknown origin, and 20% were positive for at least one of the three pathogens tested. [8]

A number of studies have confirmed that nurses are a high-risk group of sharps injuries in the hospital. [9]

American surveys have found that 60–90% of NSI are caused by nursing staff. More than 20 blood-borne diseases can be transmitted through NSI . [10,11,12]

Due to unfamiliar skills and lack of clinical experience and corresponding occupational protection knowledge, interns are more vulnerable to the danger of occupational infection than in-service nurses.[13,14]

In order to explore the NSI protection knowledge of nursing students, we conducted this systematic literature review, to analyze the incidence of NSI, and develop the safety awareness for nursing students.

Furthermore, with this study, we want to identify the risk factors that are the main cause of NSI in order to prevent them.

2. Material and methods

An SLR was carried out on determinants associated with needlestick and sharp injuries among nurses, considering the following key terms used in combination:

- Accidents;
- Prevention and control;
- Diseases;
- Causes;
- Needlestick (NSI) injuries, related infections and causes;
- Nursing, Nurses, and Nursing students;
- Health care work;
- Blood and body fluids exposures.

Using the above keywords, the following nine search strings were formulated: (("Prevention AND Control AND Needlestick Injuries – String n.1" , "Nursing AND Needlestick injuries - String n.2" , "Health care work AND Needlestick injuries - String n.3", Blood AND Body fluids exposures AND Healthcare works safety AND Prevention - String n.4", "Nursing students AND Needlestick injuries - String n.5", "Nurses AND Needlestick-related infections - String n.6", "Needlestick Injuries AND Causes - String n.7" , "Needlestick Injuries Causes AND Nursing - String n.8", "Needlestick-Prevention Devices AND Nurse - String n.9")).

The PubMed/MEDLINE online databases were considered and a manual search was performed based on the references of the articles retrieved. Original articles published from January 2018 to December 2022 were collected.

Exclusion criteria applied during title and abstract screening were: articles published in a language different from English, Italian, or French, studies other than original articles (e.g., review).

Other exclusion criteria were applied during full text analysis: assessing incidence in settings other than hospital; do not take into consideration accidents among patients but only among healthcare personnel.

At least two reviewers screened each title and abstract to select studies for full-text review. Studies that either seemed appropriate for inclusion, or those that could not clearly be excluded on title and abstract alone were carried forward for further evaluation. Two authors then independently assessed each remaining full-text article to determine eligibility for inclusion in the study. In case of any incongruity, the two investigators came to an agreement after further analysis and discussion.

Table 1 describes the search strings and, for each, the resulting and selected articles at the end of screening process.

Search strings	Resulting articles	Selected items after screening
String No. 1	16	3
String No. 2	5	2
String No. 3	7	2
String No. 4	18	7
String No. 5	26	4
String No. 6	1	1
String No.7	6	1
String No. 8	39	6
String No.9	1	1
Overall	119	27

Table 1. Resulting and selected items after screening for each search string

The initial search on the "PubMed" search database, following the input of the previously mentioned filters, identified a total of 119 publications. Following the screening stage, by reading the title and abstract, 26 articles were selected.

In the second phase of the study, the resulting 26 articles were analyzed by full-text reading. Therefore, the total articles included in the study at the end of the procedure were 16.

Figure 1 describes the steps taken in the systematic review conducted.

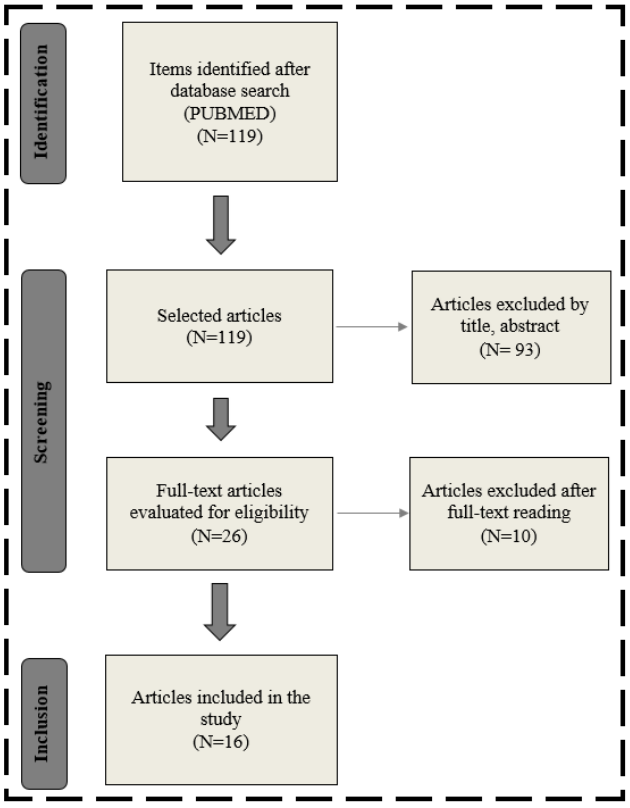

Figure 1. Steps of Systematic literature review (SLR) process conducted

3. Results

The main type of studies found among the selected articles were cross-sectional studies analzing prevalence of NSI. The studies homogeneously investigated the different purposes: impact, knowledge and the characteristics of clinical practices.

Among all the publications viewed during the research phase, 16 articles were considered, grouped and revised according to: type of study, frequency measure investigated and purpose (Tables 2, 3 and 4).

STUDY TYPE.	No. items
Trasversal	9
Longitudinal retrospective	5
Longitudinal prospective	2
Overall	16

Table 2. Stratification of selected articles by study type.

FREQUENCY MEASUREMENT	No. items
Prevalence of NSI or other	9
Incidence of NSI or other	7
Overall	16

Table 3. Stratification of selected items by frequency measure.

PURPOSE OF THE STUDY	No. items
Studies investigating the impact	4
Studies investigating knowledge	6
Studies investigating the characteristics of clinical practices	6
Overall	16

Table 4. Stratification of selected articles by study purpose.

Moreover, in table 5 all the 16 articles included in this systematic review were classified for publication year, country where study was conducted and number of subject recruited. (Table 5).

Title and Ref	Authors	Publication Year	Country	Subject Recruited
Needlestick and Sharps Injuries Among Nursing Students in Nanjing, China. (20)	Zhang X et al	2018	China	442
A multicentre study on needle stick injuries among students of nursing schools. (28)	Veronesi L et al	2018	Italy - Albania	2,742
Underreporting of Bloodborne Pathogen Exposures in Nursing Students. (22)	Black Thomas LM	2020	USA (Virginia)	4,140
Nursing students: A vulnerable health-care worker for NSI in teaching hospitals. (24)	Hada V et al	2018	India (Rajasthan)	N. A.
OSHA Bloodborne Pathogen Standards. (31)	Denault D et al	2022	USA	N. A.
Needle-stick and sharps injuries: awareness, prevalence and risk factors of a global problem in healthcare workers in Egypt. (18)	Sabaa MA et al	2022	Egypt	662
Trend analysis and factors associated with biological injuries among health care workers in Southern Italy. (19)	Cofini V et al	2018	Italy (Southern Italy)	5,671
Factors contributing to needle stick injuries among new registered nurses at a hospital in Trinidad. (29)	Kwanzaa CS et al	2020	Trinidad	120
Occupational exposure to HIV among nurses at a major tertiary hospital: Reporting and utilization of post-exposure prophylaxis; A cross-sectional study in the Western Cape, South Africa. (32)	Kabotho KT et al	2020	South Africa (Western Cape)	160
Assessment of adherence behaviors for the self-reporting of occupational exposure to blood and body fluids among registered nurses: A cross-sectional study. (27)	Yi Y et al	2018	China	548
Interventions to prevent needle stick injuries among health care workers. (21)	Van der Molen HF et al	2012	Olanda	796
Blood and body fluids exposure of healthcare workers in a university hospital of Palermo, Italy: a fourteen years long surveillance. (23)	Maida CM et al	2020	Italy (Sicily)	899
Occupational Exposure to Blood and Body Fluids among HCWs in Northwest Ethiopia: A Cross-Sectional Study. (25)	Abere G et al	2020	Northwest Ethiopia	286
Incidence of sharp and needle-stick injuries and mucocutaneous blood exposure among healthcare workers. (26)	Rapisarda V et al	2019	Italy (Southern Italy)	3,250
Education and devices to prevent blood and body fluid exposures. (30)	Cheetham S et al	2020	Australia (Perth)	2,223
Needlestick prevention devices: data from hospital surveillance in Piedmont, Italy-comprehensive analysis on needlestick injuries between healthcare workers after the introduction of safety devices	Ottino MC et al	2019	Italy (Piedmont)	N.A.

Table 5. Articles included in the SLR at the end of the Identification process.

Based on the data collected in this SLR, it can be seen that needle and/or sharps injuries are the most common occupational injuries reported by healthcare workers, with an incidence of 41%.

Analysis of the frequency of percutaneous exposures that occurred between 1994 and 2013 stratified by occupational category and job description shows that nurses were the most involved category, accounting for 54.8% of exposures, followed by interns and surgeons, both at 10.4%; ancillary staff/OTA/OSS are 7.5%, physicians (non-surgeons) 6.6%, laboratory technicians 2.4%, midwives 1.2%, cleaners 1.1%, with other unspecified figures 5.6% for remaining.[15]

Among all healthcare workers, nurses were found to be the category with the highest rate of percutaneous injuries.

Although sharps injuries can occur anywhere in a health care facility, most (40%) occur in hospital wards, particularly medical wards, intensive care units and operating rooms; 8% occur in emergency departments.[16]

An Italian study showed that 12% of all exposures to biological agents involved trainees, specifically, nursing students and medical and surgical students. The same study, with regard to nursing students, found that 10.29% of them had at least one incidental exposure to blood or other biological material during training. Blood was the main biological material involved in exposure (83.72%), mainly through skin contact (84.16%).

Finally, among the study's recruits, 53% said they had been injured at least once during their careers, and of these, 5.72% said they had not reported the event; 46% said they had performed a risky procedure (needle re-capping); and 95.45% said they had been informed about how to use PPE properly.[17]

Therefore, the articles analyzed set out to investigate the impact this case history has on the selected population by describing the characteristics of the clinical practices employed. In fact, one study states that the most frequently encountered work practice causing injury was specimen collection (16.4%), followed by injections (15.5%) and sharps disposal (14.6%).

In addition, the study carried out enabled us to understand the characteristics of the health care personnel who mainly suffer incidents of this kind.

The prevalence of NSI was significantly higher in females than males (69.3% vs. 19.7%, $p < 0.001$). Needlestick and sharps injuries disproportionately affected younger students, with more than 80% of injuries among students aged 20 years or younger. The highest prevalence rates of NSIs among nursing students were found among those who worked night shifts three or more times a week (88,2%), who performed 10 or more injections each week (77.1%), who lacked safety training (78.4%), who were not aware of needle stick and sharps safety policies (70.5%), and who did not wear PPE when exposed to needles and sharps (78.7%). (Figure 2).

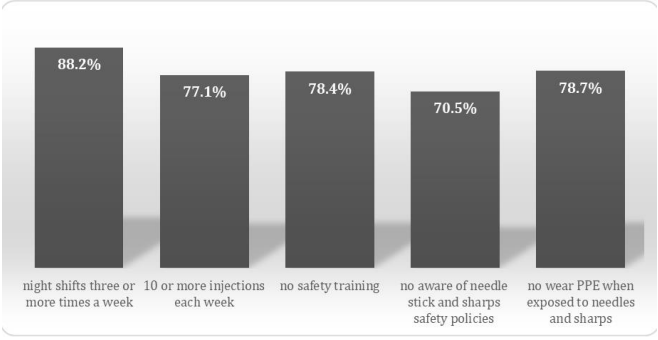

Figure 2. Prevalence of main risk factors in NSI observed in the SLR.

The incidence of NSIs was significantly higher in nurses who had worked in the hospital wards (27.3%; $p<0.001$) and intensive care unit (14.1%; $p < 0.01$) and in physicians who had worked in the Emergency Room (ER) (41.5%; $p < 0.001$) and operating room (OP) (16.4%; $p < 0.05$). (Figure 3). Syringes (30%; $p < 0.001$) and cannulas (16.4%; $p < 0.001$) were the most frequently encountered sources of injuries in nurses.[18,19]

Reasons for non-reporting of NSIs by injured nursing students included ignorance about how to properly report NSI incidents (17.7%), being particularly overworked at the time of the incident (10.5%), and, finally, concern that reporting the injury to the infection control department would incur criticism or recalls (3.8%). In contrast, the most common reason for reporting INS was the need for preventive injection and monitoring (10.1%), followed by required examinations (8.9%) and wound treatment (4.6%).[20,21]

Of those who reported percutaneous exposure to BBP, 92.5% experienced only 1 exposure. It also shows that almost half of the reported exposures occurred during the second quartile of the student's nursing education. This remarkable incidence of exposure in the second quartile is more than double the injury rate of any other quartile of respondents' education. Specifically, 58% of injuries are found to have occurred during intramuscular or subcutaneous injection and 31% during intravenous cannulation.[22]

Practitioners wearing at least one piece of personal protective equipment (PPE) at the time of the incident averaged 81.2%, slightly higher among students (87.3%) than other practitioners (resident physicians=83.0%, nurses=80.1%, hospital physicians=78.0%, others=56.0%).

The PPE most commonly used by health care workers are lab coats or uniforms (72.6%), gloves (70.2%), shoe covers (23.0%), respiratory filters (20.4%), headgear (19.3%) and goggles or face shields (18.8%).[23]

The work practice most frequently found to cause injuries was identified in the collection of samples (16.4%), followed by injections (15.5%) and disposal of sharps (14.6%), but also above all during needle removal procedure, in the morning shift.

Lack of infection prevention training was associated with a high likelihood of experiencing BBF exposure. Healthcare workers who lacked adequate infection prevention training were 3.36 times more likely to be exposed to BBF than those who had adequate training.[24,25]

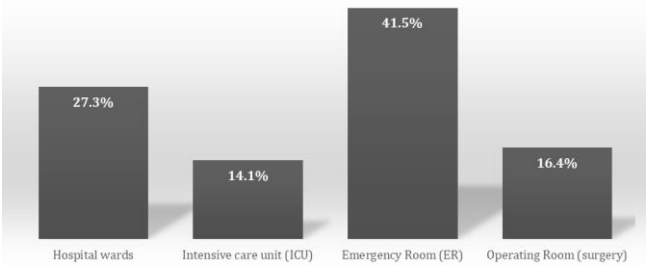

Figure 3. Incidence of NSI according to hospital setting

No differences emerged by work shifts (e.g., night shift), operating unit, and type of injury.[26]

Overall, more than one-third (34.5%) of nurses never completed an exposure report even though they were at high risk of exposure to blood-borne pathogens.[27]

Finally, another article reported how not all student trainees (49.8%) received specific lessons on the knowledge and use of medical devices with safety mechanisms even though this appears to have occurred at different percentages for different devices.[28]

4. Discussion

The systematic review conducted shows that nursing staff, probably because of their daily contact with patients and the tasks to which they are assigned, and students are the most commonly affected groups.

The groups with the highest rates of PPE use and the highest simultaneous use of PPE appear to be medical and surgical students and medical residents, perhaps because they are more aware of the risk of BBF exposures to which they are susceptible during their training.

The level of protective awareness of health care workers is also shown to be inadequate with regard to vaccination (69.5%) or training (54%), held in much higher regard by the medical component than by the nursing component[18], although the results also showed that most newly trained nurses appear to be aware of the institution's policies and procedures regarding standard precautions and safe handling of NSIs. This is of particular importance since sources have indicated that nurses with sufficient knowledge, skills, and advanced techniques for handling needles and sharps may be at lower risk for occupational injuries caused by NSIs.[29]

In general, the data suggest that preventive efforts, such as thorough and effective training in prevention and proper procedures, should be focused on the devices and settings where injuries most commonly occur. Despite the introduction of these measures, however, particularly in facilities exposed to overcrowding where due to overburdening personal protection may not be perceived as a priority, these types of accidents remain a frequent and important occupational risk.[23]

This study also found that the risk of INS due to invasive treatments and nursing procedures is significantly associated with factors such as gender, age, frequency of night shift, frequency of injections, lack of safety training, knowledge of safety management policies, and lack of PPE use.

There is evidence of a significant gender difference (the female/male rate being 1.8) and that among staff aged 20 years or younger, about 80% of NSIs occur. A Chinese study suggested among nursing students with three or more night shifts per week an almost six times greater likelihood of experiencing NSIs than those who did not work night shifts.[20]

However, the risk of NSI is associated not only with skill but also with risks inherent in the procedures, such as the type of needles and glass used or whether patients' blood or body fluid is involved. Despite the high awareness of safe injection policy, the practice of safe injection was reported among our injury-exposed workers at a rate of 67.5%, while the practice of hooding needles after use constituted a very low percentage.[30]

Finally, lack of infection prevention training was a risk factor for occupational exposure to blood and body fluids[25], and lack of availability/shortage of personal protective equipment was significantly associated with occupational exposure to blood and body fluids as supported by the study conducted in Ethiopia.

Council Directive 2010/32/EU of May 10, 2010, which implements the framework agreement, concluded by HOSPEEM and EPSU, on the prevention of sharps injuries in the hospital and healthcare sector, demonstrates how, through the drafting of infection prevention guidelines, standard precautions, vaccinations, post-exposure prophylaxis, and the adoption of safety needles, a health policy aimed at the management and control of biohazard has been undertaken.[31]

Failure to comply with post-exposure protocols, often justified with statements such as "I was not aware of the procedure," "I was discouraged," "I did not think it was necessary" [28], underscores the need for every health care facility to have a clear and shared grievance procedure and an efficient injury reporting system as timely reporting of the injury would provide important information to provide appropriate care and prevent future injuries.

Inadequate reporting of exposures to occupational health services and poor PEP completion rates were also found. This seems to be due to various factors such as forgetting the incident due to workload pressure and time constraints, underestimation of risk, reluctance to admit a lack regarding knowledge of handling certain tools, and fear of positive serological test results.[26]

Results of one study reveal in half of the participants inadequate knowledge of HIV PEP and underestimation of risk with thoughts such as, "not worrying about exposure is just a blood splatter".[32]

In addition, delays in the evaluation and treatment of percutaneous injuries due to lack of timely access to triage create a gap in the ability to provide timely post-exposure care to exposed personnel and potentially expose them to a higher risk of seroconversion when exposed to high-risk BBP.[22] The key to reducing infection rates through occupational exposure to bloodborne pathogens among health care workers is, therefore, to have students achieve a high level of self-awareness about the risk of exposure to blood/body fluids and encourage them to practice safe work behaviors and report any exposure incidents even on their own initiative.

Finally, the costs of needlestick injuries should include direct costs related to the initial and follow-up treatment of exposed health care workers, estimated to range from $71 to nearly $5,000, depending on the treatment provided.[27]

The above regarding underestimation indicates that employers should focus on designing a sharps injury prevention program based on their workplace. Such a program should consist of a set of procedures aimed at preventing exposure incidents and implementing SEP as soon as possible. One study confirmed the importance of training a dedicated team responsible for this task. This team should include occupational safety and health experts who should provide follow-up to injured health workers and ensure the implementation of PEP and psychology experts for the necessary psychological support to employees, especially immediately after exposure.

5. Conclusions

This systematic literature review showed that due to close contact with patients, the most exposed category of HCWs to NSI, appears to be nurses and nurse trainees. However, only the latter have a higher awareness of exposure.

Prevention efforts to reduce injuries should focus on safety devices, work environment and organization, and increased training regarding prevention and procedures. Training must begin with nursing degree students in order to put into practice what they learn in face-to-face courses and clinical training. It is, in fact, proven that good training in needle and sharps injury prevention for nurses can significantly reduce the risk of injury.

Injury reports are used to provide data needed for appropriate care and future injury prevention.

It is noted that little consideration is given to injuries caused by sharps and contact with potentially infectious biological fluids; in addition, post-exposure protocols are rarely considered by both providers and students. The most likely reasons for not reporting an event include underestimating the risk and forgetting about the event.

The use of newly designed safety devices is considered one of the most important strategies to prevent needlestick and sharps injuries. A sharps injury prevention program should be designed by a dedicated team. The plan should include a program to prevent exposure injuries and implement post-exposure prophylaxis (PEP) as early as possible. Also crucial are training sessions for company employees to gain knowledge about biohazards, proper use of personal protective equipment (PPE), and appropriate behaviors to deal with injury and contamination risks.

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