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The Investigation Into the Impact of Using SafePad on the Incidence Rate of Needlestick Injuries Among Iranian Nurses: A Pre- and Post-Test Study

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ABSTRACT

Background: This study aimed to determine the prevalence of needlestick injuries (NSIs) during the 6 months before and after the implementation of SafePad among nurses.

Methods: Initially, 369 nurses and practical nurses participated, but after applying exclusion criteria, the final sample included 323 participants. The McNemar test, using SPSS version 21, was employed to compare the incidence of NSIs before and after the intervention.

Results: Among the 323 participants, 63 individuals (19.5%) reported experiencing needlestick injuries in the 6 months preceding the intervention. Following the implementation of SafePad, this number decreased to 21 (6.5%), representing a 66.6% reduction in the incidence of NSIs, which was statistically significant ($p < 0.001$). The most common contributing factors were high workload, carelessness, and patient movement.

Conclusion: The findings demonstrate that the implementation of SafePad effectively reduced needlestick injuries among nurses, serving as an important preventive strategy to enhance occupational safety and protect nurses from infections.

1 | Introduction

Ensuring the health and safety of healthcare workers is paramount to the quality of patient care and the overall efficacy of healthcare systems [1]. Among the myriad occupational hazards faced by healthcare personnel, needlestick injuries (NSIs) stand out as a critical concern [2]. NSIs occur when sharp objects, such as needles, inadvertently pierce the skin, posing a significant risk of transmitting infectious pathogens, particularly if the object is contaminated with patient blood or bodily fluids [3–5].

Globally, an estimated 3 million healthcare workers are exposed to bloodborne pathogens annually, with a staggering 90% of these incidents transpiring in developing nations. Within Iran, studies have underscored a troublingly high prevalence of NSIs among healthcare professionals, with reported rates reaching 44% among nurses and 42.5% among other healthcare workers. Alarmingly, the majority of these incidents go unreported, exacerbating the challenge of addressing this occupational hazard effectively [6–8]. And a meta-analysis conducted by Halimi et al. in 2024, which included 15 studies, found that the pooled

prevalence of needle-stick injuries among Iranian nurses was 46% [9].

The heightened risk of bloodborne infections among healthcare workers is indisputable, with exposure to pathogens such as Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and Human Immunodeficiency Virus (HIV) posing grave threats to occupational health. Notably, the majority of occupational exposures occur via subcutaneous routes, amplifying the risk of pathogen transmission compared to mucocutaneous contacts [10–12]. The repercussions of NSIs extend far beyond immediate health concerns, encompassing a broad spectrum of economic, clinical, and psychological burdens. The economic toll of NSIs, both direct and indirect, is particularly burdensome in resource-constrained settings like Iran, where the costs associated with infections can escalate rapidly, surpassing the one-million-dollar mark for a single serious bloodborne infection [13–15].

The economic burden of NSIs is substantial in all countries, particularly in resource-limited settings like Iran, where infections such as HCV, HBV, and HIV pose significant risks. A single serious bloodborne infection can incur costs exceeding 1 million dollars, covering medications, follow-ups, laboratory tests, clinical evaluations, lost wages, and disability-related expenses [13–15].

Preventive measures against NSIs are essential, considering factors such as fatigue, sleepiness at work, young age, lack of experience, rotating shifts, work hours exceeding 40 per week, non-participation in training sessions, needle recapping, and failure to use safety devices. Each of these factors contributes to NSI occurrences, underscoring the importance of addressing predominant risk factors [16–19].

Mitigating the risk of NSIs requires a multifaceted approach, addressing factors such as fatigue, inadequate training, and suboptimal safety practices in healthcare settings. While the implementation of safety-engineered devices (SEDs) has demonstrated efficacy in reducing subcutaneous injuries, a substantial proportion of NSIs still occur during routine patient care activities, highlighting the need for innovative solutions to enhance workplace safety [20, 21].

The use of SEDs reduces the risk of percutaneous injuries among healthcare workers. However, studies indicate that half of all such injuries occur in patient rooms, with nurses accounting for 78% of reported cases [21, 22]. A study conducted in Japan found that safety-engineered butterfly needles and intravenous catheters, designed to prevent needlestick injuries, incorporate both automatic and manual needle shielding mechanisms. In active mechanisms, manual activation is required, whereas passive mechanisms activate automatically. Despite these safety features, most needlestick injuries involving these devices still occur in patient rooms during their use [23]. Additionally, a study by Kakolarimi et al. in hospitals in Tehran revealed that the highest incidence of needlestick injuries occurs during the disposal of needle tips [24].

Considering the significance of the issue and the prevalence of sharp object hazards in hospitals, especially in countries lacking affordable safety-engineered devices, the research team aimed to compare NSI incidence rates before and after implementing a low-cost SafePad device designed for sharp object disposal. This device was patented by the corresponding author of this study on September 18, 2016, under patent number 89917.

2 | Methods

The present study is a semi-experimental and non-randomized research that aims to determine the impact of using SafePad on preventing needlestick injuries. For reporting this study, TREND Statement checklist (the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement) is used [25].

2.1 | Objectives

2.1.1 | Main Objective

To determine the impact of using the SafePad device on the incidence rate of needlestick injuries among healthcare personnel working at Imam Hossein Hospital, affiliated with Shahid Beheshti University of Medical Sciences in Tehran, Iran.

2.1.2 | Specific Objectives

1. To determine the prevalence of needlestick injuries during the 6 months prior to the implementation of the SafePad.
2. To determine the prevalence of needlestick injuries during the 6 months following the implementation of the SafePad.
3. To compare the prevalence of needlestick injuries across different hospital wards before and after the implementation of the SafePad.
4. To compare the prevalence of needlestick injuries by type of sharp instrument before and after the implementation of the SafePad.
5. To compare the prevalence of needlestick injuries by occupational category before and after the implementation of the SafePad.
6. To examine the association between the prevalence of needlestick injuries and demographic variables.

2.2 | Participants

Imam Hossein Hospital, under the supervision of Shahid Beheshti University of Medical Sciences, served as the study environment. The study covered 16 departments within this hospital, including internal medicine, general surgery, pediatrics, emergency, gastroenterology, neurology, infectious diseases, obstetrics and gynecology, orthopedics, endoscopy, ICU, CCU, POST CCU, neurosurgery, maxillofacial, and oncology that 22, 23, 8, 76, 10, 11, 11, 17, 9, 5, 73, 15, 10, 13, 4, and 16 nurses respectively were selected from each ward who had the inclusion criteria.

2.3 | Eligibility/Selection Criteria

The study population consisted of nurses and caregivers employed at Imam Hossein Hospital. The inclusion criteria for

participants were nurses and caregivers with a minimum of 6 months of work experience at the hospital. Nurses and caregivers consented to participate in this study.

The exclusion criteria included individuals who had less than 6 months' work experience as nurses and caregivers at the hospital, individuals who did not consent to participate in this study, and nurses and caregivers who were transferred to a department or another hospital where the SafePad was not used during a 6-month period.

2.4 | Method of Recruitment

The sampling method in this study was convenience sampling after reviewing the study entry requirements.

2.5 | Interventions

The SafePad (Figure 1) is a low-cost and convenient tool. It consists of a cube made of plexiglass, containing a sponge with a density of 40 kg/m^3. The underside of the cube has double-sided adhesive, allowing nurses to place it inside a receiver or tray and carry it to the patient's bedside. With this compact tool, the healthcare staff can easily dispose of various sharp instruments such as Angio catheters, different types of needles, syringes, suture needles, bistouries, and more immediately after use. Once the sponge is filled with needles, it can be removed from the cube using forceps and placed in a sharps container. The SafePad is much easier to use than a traditional sharps container and takes up less space. This device was patented by the corresponding author of this study on September 18, 2016, under patent number 89917 at the Iran Intellectual Property Centre.

2.6 | Intervention Procedure

Prior to the intervention, data on the history of needlestick injuries among participants during the previous 6 months were collected through the Infection Control and Environmental Health Units of the hospital. Nurses and nursing assistants who met the inclusion criteria were recruited using a convenience sampling method. After explaining the study objectives and obtaining informed consent, training on the use of the SafePad device was provided. This training was conducted face-to-face, supplemented with educational posters displayed in the wards, and an instructional video shared via WhatsApp.

The SafePad device was distributed across the designated hospital wards for a period of 6 months, from August 3, 2022, to February 1, 2023. During this time, the researcher conducted regular follow-ups with study participants across various shifts and wards by visiting the hospital several times each week.

Initially, the number of SafePad devices distributed to each ward was based on the number of inpatient beds and treatment rooms. As follow-ups progressed, the specific needs of each ward were assessed, and additional devices were provided accordingly. It is noteworthy that, in consideration of hygiene and environmental sustainability, the SafePad devices were made of plexiglass—durable and washable. After each use, the sponge component was removed and disinfected according to a standardized protocol provided to each ward, allowing for repeated use.

Throughout the 6-month implementation period, any incidents of needlestick injuries were documented by the hospital's Infection Control Committee. At the end of the intervention, a questionnaire was used to assess the incidence of needlestick injuries over the previous 6 months. These data were then compared with the pre-intervention period to evaluate the effect of the SafePad intervention.

2.7 | Sample Size

The sample size was determined based on the study by Fuladvandi et al., with a power of 80%, a significance level of 5% ($\alpha = 0.05$), and an estimated prevalence of 0.4 [26].

- The formula $n = (Z\text{^}2 * P * (1 - P))/d\text{^}2$ is pivotal for sample size calculation, where:
- n represents the required sample size.
- Z is the Z-score corresponding to the desired confidence level (e.g., 1.96 for a 95% confidence level).
- P denotes the expected prevalence (expressed as a proportion between 0 and 1).
- d represents the desired margin of error (precision).

$n = (1.96*1.96*0.4*0.6)/(0.05*0.05)\sim 369$

FIGURE 1 | The SafePad.

Thus, the initial sample size was calculated to be approximately 369 participants. This calculation assumes a normal distribution, an expected prevalence of 40%, and a confidence interval of 95% with a 5% margin of error. After accounting for participant attrition and applying exclusion criteria, the final number of participants included in the study was 323.

2.8 | Blinding

To reduce potential bias, the study incorporated a single-blind design. The individuals responsible for conducting the intervention, collecting pre- and post-intervention data, and performing follow-up procedures (led by researcher N.Y.) were different from the person who performed the data analysis (A.H.). The data analyst was blinded to participant identities and groupings to ensure objectivity during the statistical analysis phase. This separation between intervention administration and data analysis helped maintain the integrity and impartiality of the study results.

2.9 | The Data Collection Tool

The data collection tool included a questionnaire of demographic characteristics (comprising work history in the hospital, age, gender, education level, workplace department, and vaccination status), and for assessing the history of needle stick injuries in the past 6 months, the Rashidi questionnaire and colleagues' questionnaire from 2021 were used [27].

2.10 | Statistical Analysis

Data were analyzed using SPSS version 21 [28]. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize demographic and outcome variables.

To compare the incidence of needlestick injuries before and after the intervention, we employed the McNemar test, which is appropriate for analyzing paired nominal data (i.e., binary outcomes from the same individuals pre- and post-intervention).

Given the within-subject design, participants served as their own controls, reducing the potential for confounding. No additional multivariate adjustments were made. A p value of less than 0.05 was considered statistically significant.

2.11 | Outcomes

The primary outcome was the incidence of needlestick injuries among healthcare workers in the 6 months before versus after the SafePad intervention.

Secondary outcomes included:

- Type and context of injuries (e.g., type of sharp instrument, procedure, department).
- Participant responses and behaviors following injury.
- Perceptions regarding the safety and ease of use of SafePad.

2.12 | The Ethics Committee Approval

The study was approved by the Ethics Committee of the School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences (IR.SBMU.PHARMACY.REC.1400.332). All participants provided informed consent prior to participating in the study. The study protocol was registered with the Iranian Clinical Trials Committee under the code IRCT20220316054307N1.

3 | Results

3.1 | Demographic Characteristics

In total, 323 individuals participated in this study, of which 312 (96.6%) were nurses, and 11 (3.4%) were nursing assistants. Seventy (21.7%) were men and 253 (78.3%) were women. The average age of these individuals was 32.5 years with a standard deviation of 7.2. The average working hours of the participants in the study were 53.4 with a standard deviation of 13.25 h. As shown in Table 1, which depicts the demographic and occupational characteristics of the studied employees, 294 (91%) held a bachelor's degree, 11 (3.4%) held a diploma, and 18 (5.6%) held a master's degree. Regarding hepatitis B vaccination status, 295 (91.3%) had complete vaccination, 26 (8%) had incomplete vaccination, and only 2 (0.6%) were unvaccinated. The highest number of participating nurses was employed in the emergency department (76; 23.5%), while the fewest were employed in the maxillofacial department (4; 1.2%).

3.2 | The Impact of SafePad Implementation on the Incidence of Needlestick Injuries

As shown in Table 2, before the intervention, 63 individuals (19.5%) had a history of needlestick injury in the past 6 months. After the intervention (use of the SafePad tool), 21 individuals (6.5%) had a history of needlestick injury, indicating a 66.66% reduction in the incidence of needlestick injuries. According to the statistical test results, the intervention (use of the SafePad tool) significantly reduced the number of needlestick injuries among the study participants, with $p < 0.001$.

3.3 | Participants' Distribution in the Hospital Departments and Needlestick Incidents Pre- and Post-Intervention

Table 3 presents the frequency distribution of participants across different hospital departments and the incidence of needlestick injuries before and after the implementation of the SafePad intervention, calculated as the percentage of participants in each department who experienced an injury.

A total of 323 nurses and nurse aides participated in the study. The highest number of participants were from the Emergency Department (76, 23.5%) and the Intensive Care Unit (ICU) (73, 22.6%).

Before the intervention, the overall incidence of needlestick injuries was 19.5% (63 out of 323 participants). The highest departmental injury rates were observed in Orthopedics (66.7%,

TABLE 1 | Demographic characteristics.

No.	Variable		Mean/Frequency	SD/Frequency percent
1	Age (year)		32.5	7.2
2	Sex	Male	70	21.7%
		Female	253	78.3%
3	Occupation type	Nurse	312	96.6%
		Caregiver	11	3.4%
4	Vaccination status	Complete	295	91.3%
		Incomplete	26	8%
		Unvaccinated	2	0.6%
5	Educational qualification	Diploma	11	3.4%
		Bachelor's degree	294	91%
		Master's degree	18	5.6%

TABLE 2 | Impact of SafePad implementation on the incidence of needlestick injuries.

	Needlestick injuries	Participants	Proportion (percent)
Before implementation	63	323	19.5%
After implementation	21	323	6.5%
Test type	**Difference in proportions**	**One-sided *p***	**Two-sided *p***
McNemar	0.13	0.001	0.001

TABLE 3 | Frequency distribution of participants in different hospital departments and the relationship between department type and needlestick incidents before and after intervention.

Department	Participants *N* (%)	Pre-intervention injuries *N* (row %)	Post-intervention injuries *N* (row %)
Emergency	76 (23/5%)	14 (18.4%)	2 (2.6%)
ICU	73 (22.6%)	10 (13.7%)	6 (8.2%)
Oncology	16 (5%)	2 (12.5%)	1 (6.3%)
Infectious diseases	11 (3.4%)	1 (9.1%)	2 (18.2%)
Post CCU	10 (3.1%)	1 (10%)	0
Surgery	23 (7.1%)	2 (8.7%)	1 (4.3%%)
Obstetrics and gynecology	17 (5.3%)	7 (41.2%)	2 (11.8%
Internal medicine	22 (6.8%)	6 (27.3%)	5 (22.7%)
CCU	15 (4.6%)	2 (13.3%)	0
Orthopedics	9 (2.8%)	6 (66.7%)	0
Neurosurgery	13 (4%)	6 (46.2%)	0
Gastroenterology	10 (3.1%)	0	0
Neurology	11 (3.4%)	2 (18.2%)	0
Maxillofacial	4 (1.2%)	1 (25%)	0
Pediatrics	8 (2.5%)	1 (12.5%)	1 (12.5%)
Endoscopy	5(1.5%)	2 (40.0%)	1 (20.0%)
Overall	323 (100%)	63 (19.5%)	21 (6.5%)
p value		0.003	0.1

6 out of 9 participants), Neurosurgery (46.2%, 6 out of 13), and Obstetrics & Gynecology (41.2%, 7 out of 17). The ICU had a pre-intervention injury rate of 13.7% (10 out of 73), while the Infectious Diseases unit had a rate of 9.1% (1 out of 11).

After the intervention, the overall incidence of needlestick injuries decreased significantly to 6.5% (21 out of 323 participants). Most departments showed substantial reductions. The Emergency Department's injury rate dropped from 18.4% to

2.6%. The ICU decreased from 13.7% to 8.2%. Orthopedics, Neurosurgery, CCU, Post CCU, Neurology, and Maxillofacial departments all reported zero needlestick injuries post-intervention.

However, the Infectious Diseases unit showed a minor increase from 1 injury before the intervention (9.1%) to 2 injuries after the intervention (18.2%). The Pediatrics department remained unchanged (12.5%), and Endoscopy showed a decrease from 40.0% to 20.0%.

The overall chi-square test showed a statistically significant association between department type and needlestick injuries before the intervention ($p = 0.003$), but not after the intervention ($p = 0.1$), indicating that the intervention reduced injury rates across most departments, thereby diminishing departmental differences.

3.4 | Needlestick Variables in Nurses and Aides Before and After SafePad Implementation

Table 4 shows the frequency distribution of the types of needlestick incidents among participants. The most common type of needlestick incident, both before and after the intervention, was needle penetration. The most frequent situation during needlestick incidents before the intervention was venipuncture (27%), followed by blood sugar checks (25.4%). After the intervention, the most frequent situations were blood sugar checks and venipuncture, each accounting for 28.5%.

Continuous monitoring of the participants by the researcher during the study and direct questioning about their needlestick experiences revealed that none of the needlestick incidents occurring during the intervention were reported while using the SafePad tool. This indicates that these injuries happened when the tool was not used with sharp instruments. Nurses' responses to questions about their experiences with the SafePad tool included statements like, “When I use the SafePad tool at the patient's bedside, my stress about needlestick injuries significantly decreases”.

Regarding the frequency distribution of the causes of needlestick injuries among the studied participants, the most common cause before the intervention was high workload (45.3%). After the intervention, the most common causes were high workload and sudden patient movement, each accounting for 37%.

The most frequent action taken after a needlestick injury, both before and after the intervention, was washing the wound with water and soap, accounting for 37.3% and 45.2%, respectively. The majority of needlestick incidents occurred during the night shift, with 49.2% before and 47.6% after the intervention. Follow-up actions revealed an increase in checking patient's tests (from 44.1% to 52.9%) and a decrease in conducting control tests for both patients and nurses.

Table 5 examines the relationship between various demographic variables and needlestick injuries among nurses and nursing assistants before and after the intervention. The majority of the study population were female nurses (253 individuals), and consequently, the highest number of needlestick incidents before the intervention was reported among female nurses. Statistically, the results showed no significant correlation between gender and needlestick injuries ($p = 0.487$ and $p = 0.4$).

Table 5 also shows the relationship between job type and needlestick injuries. As indicated in the table, the results showed no significant correlation between job type and needlestick injuries ($p = 0.634$ and $p = 0.65$). The age range of 20–29 years had the highest incidence of needlestick injuries, indicating a significant correlation between age and needlestick injuries before the intervention ($p = 0.001$), but no significant correlation between age and needlestick injuries after the intervention ($p = 0.4$). The highest number of needlestick injuries occurred among nurses with 1–5 years of work experience (27.4%) and less than 1 year of experience (25%), showing no significant correlation between work experience and needlestick injuries ($p = 0.074$ and $p = 0.66$). Since nurse's experience working in different departments throughout their careers, this study also examined work experience in the current department. The results in Table 5 show that the highest number of needlestick injuries occurred among nurses with less than 1 year of experience in the current department (27.8%) and 1–5 years (22.9%). Statistically, the results showed a significant correlation between work experience in the current department and needlestick injuries ($p = 0.05$ and $p = 0.01$).

Most nurses had a bachelor's degree, and statistically, the results showed no significant correlation between education level and needlestick injuries ($p = 0.6$). The table also shows the relationship between vaccination status and needlestick injuries. As indicated, the highest number of needlestick injuries occurred among nurses with incomplete vaccination status (38.5%), followed by those with complete vaccination status (18%). Statistically, the results showed a significant correlation between vaccination status and needlestick injuries before the intervention ($p = 0.032$), but no significant correlation between vaccination status and needlestick injuries after the intervention ($p = 0.9$).

3.5 | Key Summary

A total of 63 (19.5%) participants reported needlestick injuries in the 6 months prior to intervention, while only 21 (6.5%) reported injuries post-intervention. This represents a 66.7% reduction, which was statistically significant ($p < 0.001$) and clinically important, given the occupational risks associated with needlestick exposure. Notably, no injuries occurred during the actual use of the SafePad device, indicating potential effectiveness in injury prevention when properly used.

The most substantial reduction occurred in high-risk departments such as the emergency and ICU. Participants also reported a sense of increased psychological safety when using SafePad, further supporting its utility in clinical settings.

4 | Discussion

The aim of this study was to evaluate the impact of a safety-engineered device (SafePad) on the incidence of needlestick

TABLE 4 | Frequency distribution of various needlestick variables in nurses and aides before and after the implementation of the SafePad intervention.

	Before using SafePad tool (frequency/percent)	After using SafePad tool (frequency/percent)
Type of needlestick incident		
Needle puncture	42 (66.6%)	9 (42.8%)
Angio catheter puncture	7 (11.1%)	5 (23.8%)
Lancet puncture	10 (15.9%)	6 (28.6%)
Needle and lancet puncture	1 (1.6%)	1 (4.8%)
Needle and scalp vein set puncture	1 (1.6%)	0
Needle and angio catheter puncture	2 (3.2%)	0
Overall	63	21
Type of situation during needlestick		
Blood sugar check	16 (25.4%)	6 (28.5%)
Venipuncture	17 (27%)	6 (28.5%)
Blood collection	5 (7.9%)	1 (4.8%)
Needle disposal	14 (22.2%)	3 (14.3%)
Drug injection	8 (12.7%)	3 (14.3%)
Venipuncture and needle disposal	2 (3.2%)	0
Blood sugar check and needle disposal	1 (1.6%)	0
Blood sugar check and drug injection	0	1 (4.8)
Needle disposal and drug injection	0	1 (4.8)
Overall	63	21
Cause of needlestick incident		
Lack of awareness of risks	1 (1.3%)	0
Lack of attention during work	24 (32%)	6 (22.2%)
High workload	34 (45.3%)	10 (37%)
Lack of protective equipment	6 (8%)	1 (3.7%)
Patient's sudden movement	10 (13.3%)	10 (37%)
Overall	75	27
Actions taken after needlestick		
Washing wound with water and soap	50 (37.3%)	19 (45.2%)
Washing with disinfectants	29 (21.6%)	5 (11.9%)
Encouraging bleeding from the wound	19 (14.2%)	4 (9.5%)
Informing supervisor or head nurse	24 (17.9%)	8 (19%)
Informing infection control officer	12 (9%)	6 (14.3%)
Overall	134	42
Shift timing during needlestick		
Morning	16 (25.4%)	6 (28.6%)
Evening	12 (19%)	4 (19%)
Night	31 (49.2%)	10 (47.6%)

(Continues)

TABLE 4 | (Continued)

	Before using SafePad tool (frequency/percent)	After using SafePad tool (frequency/percent)
Morning and evening	2 (3.2%)	1 (4.8%)
Evening and night	2 (3.2%)	0
Overall	63	21
Follow-up on tests		
Checking patient's tests	45 (44.1%)	18 (52.9%)
Conducting control tests for the patient	36 (35.3%)	11 (32.6%)
Conducting control tests for the nurse	21 (20.6%)	5 (14.7%)
Overall	102	34

injuries among nurses and nurse aides. Our findings demonstrated a significant reduction of over 66% (from 19.5% to 6.5%) in the incidence of needlestick injuries following the introduction of SafePad, highlighting its potential as a practical intervention to improve occupational safety in healthcare settings. The incidence of needlestick injuries before the intervention (19.5%) was close to that reported among healthcare workers in Saudi Arabia (22.2%) [29].

Subgroup analysis by department revealed that the reduction in needlestick injuries was observed across most clinical units. The Emergency Department, which had the highest number of participants (23.5%), showed a marked reduction from 18.4% to 2.6%. Similarly, the ICU demonstrated a decrease from 13.7% to 8.2% following the intervention. However, the Infectious Diseases unit showed a minor absolute increase from 1 case pre-intervention to 2 cases post-intervention (from 9.1% to 18.2%). Given the very small number of cases in this department ($n = 11$ participants), this increase should be interpreted with caution and may be due to chance variation rather than a true adverse effect of the intervention. Nevertheless, future implementations of SafePad should include monitoring and targeted training in smaller, high-risk units such as Infectious Diseases to ensure optimal compliance and safety.

Although several international studies have examined the effectiveness of various SEDs, such as safety syringes and catheters, few have focused on multi-purpose sharps disposal tools like SafePad. In contrast to previous research, which predominantly addressed SEDs used during specific procedures (e.g., injections, IV insertions) [30], this study explored a device designed for immediate sharps disposal, addressing a known high-risk step in the injury chain.

A study by Ottino et al., aimed at examining injuries caused by needlestick among healthcare workers after using SEDs showed that SEDs reduce the risk of needlestick injuries among healthcare workers, with 45% of all injuries related to SEDs occurring during the disposal of these devices [21]. Dulon et al. showed that these devices can prevent injuries if they are safely used and properly disposed of. In this study, the SafePad tool, which has the feature of safe disposal of sharp objects, was used. Healthcare personnel, by using this tool, not only reduced the stress of needlestick injuries but also remained safe from the risk of injuries resulting from unsafe disposal of sharp objects [20]. Moreover, besides nurses, other healthcare workers can also use it for the safe disposal of needles depending on their profession. It should be noted that relocating injection equipment from the procedure site to another room for disposal poses the greatest risk of sharp object injuries, which the SafePad tool, with the feature of immediate disposal of sharp objects at the procedure site, has addressed. Generally, two factors determine the reduction of needlestick injuries: organizational measures and regular training for healthcare workers and students [31].

A semi-experimental study by Fuladvandi et al. regarding the impact of safety-engineered angiocaths in preventing needlestick injuries showed a significant difference in the incidence of these injuries before and after the use of safety angiocaths over a 6-month period, reducing from 11 cases before tool deployment to 2 cases afterward. However, it is worth mentioning that procuring such angiocaths is costly, and despite their effectiveness, due to the high cost, they have not yet been able to find their place in healthcare systems facing significant financial challenges [26].

In a study by Kaur et al. in Germany, stress, time pressure, excessive workload, inaccuracy, and distraction were identified as the main reasons for needlestick injuries [31]. However, in the current study, after using SafePad, nurses identified high workload (54%) and patient movement (47.6%) as the main reasons for needlestick injuries. In another study by Garus-Pakowska et al., lack of sufficient skill in using SED tools (32%), patient movement (30%), and inaccuracy (23%) were involved in needlestick injuries with these tools. Also, significant differences were found in the incidence of needlestick injuries based on the type of safety devices (active or passive) and the age of nurses, with younger nurses often experiencing injuries with passive devices, and the incidence of needlestick injuries being higher in nurses with less work experience [32].

In the current study, the majority of needlestick incidents occurred in the orthopedic and neurosurgery departments before performing the intervention, while in studies conducted by Kebede and Sriram, most needlestick incidents occurred in surgical departments [33]. However, in a study by Weldesamuel

TABLE 5 | Relationship between demographic variables and needlestick incidents in nurses and aides before and after the intervention.

Variables	Before using SafePad tool (frequency/percent)	After using SafePad tool (frequency/percent)
Gender		
Male	13 (18.6%)	3 (4.3%)
Female	50 (19.8%)	18 (7.1%)
p value	0.487	0.4
Job type		
Aide	1 (9.1%)	0
Nurse	62 (19.9%)	21 (6.7%)
p value	0.375	0.37
Age		
20–29 years	42 (27.8%)	10 (6.6%)
30–39 years	11 (10.2%)	9 (8.3%)
40 years and older	10 (15.6%)	2 (3.1%)
p value	0.001	0.4
Work experience		
Less than 1 year	4 (25%)	2 (12.5%)
1–5 years	31 (27.4%)	8 (7%)
5–10 years	13 (16.7%)	4 (5.1%)
10–15 years	5 (11.4%)	4 (9.1%)
More than 15 years	10 (13.9%)	3 (4.2%)
p value	0.074	0.66
Experience in current department		
Less than 1 year	15 (27.8%)	8 (14.8%)
1–5 years	36 (22.9%)	6 (3.8%)
5–10 years	6 (10.7%)	2 (3.6%)
10–15 years	2 (7.4%)	4 (14.8%)
More than 15 years	4 (13.8%)	1 (3.5%)
p value	0.05	0.01
Education level		
Diploma	1 (9.1%)	0
Bachelor's	59 (21.1%)	20 (6.8%)
Master's	3 (16.7%)	1 (5.6%)
p value	0.634	0.65
Vaccination status		
Complete	53 (18%)	19 (6.4)
Incomplete	10 (38.5%)	2 (7.7%)
Unvaccinated	0	0
p value	0.032	0.9

et al., almost one-third (31%) of incidents occurred in the emergency department [34].

5 | Strengths and Limitations

Importantly, the observed reduction in injuries may also reflect psychological benefits reported by users, including reduced stress and increased perceived safety. This suggests that the SafePad could contribute not only to physical safety but also to a safer working environment, especially under high-pressure conditions.

Despite its strengths, this study has limitations that must be considered. The single-center design limits the generalizability of findings. The lack of a control group prevents definitive causal conclusions. Data collection relied partly on self-reported questionnaires, which may be subject to recall bias and

underreporting, especially for incidents not resulting in visible injury or occurring during night shifts. Furthermore, nonadherence to the intervention due to workflow interruptions may have led to an underestimation of its true effectiveness. Additionally, the small sample size in certain departments (e.g., infectious diseases, $n = 11$) limits the reliability of subgroup analyses, and the observed increase in injuries in that unit may reflect random variation rather than a true effect of the intervention.

6 | Implications for Practice and Future Research

The findings of this study underscore the significant potential of SafePad in reducing needlestick injuries among healthcare workers, particularly nurses and aides. Given the marked reduction in injury rates observed, the implementation of SafePad in hospital settings could have wide-reaching implications for improving occupational safety. For healthcare systems, this study suggests that adopting SafePad as part of a comprehensive sharps safety program could be an effective strategy to mitigate needlestick injuries and their associated risks, including bloodborne infections. In practice, SafePad offers a promising tool to enhance the safety of healthcare workers by providing a safe, on-site disposal mechanism for sharp objects, thereby reducing the risk of injury during and after procedures.

Future studies should involve randomized controlled trials (RCTs) across multiple hospitals, with larger and more diverse sample sizes, to provide stronger evidence on the effectiveness of SafePad. These trials should include both intervention and control groups to assess their direct impact while controlling for potential confounders. Evaluations should not only measure the incidence of needlestick injuries but also examine the long-term effects of SafePad, such as any changes in healthcare workers' safety behaviors and attitudes towards sharps disposal practices.

Further, future research should include cost-effectiveness analyses to evaluate the financial sustainability of SafePad in healthcare systems, considering both the costs of acquisition and any potential savings from fewer injury-related medical costs, lost work time, and worker compensation. This would be particularly important for hospitals with limited budgets, where cost considerations are paramount.

In addition to clinical outcomes, studies should explore user behavior and device usability to better understand how healthcare workers interact with SafePad, identifying any barriers to its use and ways to improve adherence. Research on training programs would also be vital, focusing on how best to educate healthcare workers on SafePad's proper use and integration into daily workflows. Furthermore, examining the environmental impact of SafePad, including its disposal and sustainability, would provide a more comprehensive understanding of its long-term feasibility in healthcare settings.

Finally, longitudinal studies could investigate the psychological and social benefits of SafePad adoption, such as reducing anxiety among healthcare workers and improving their perceptions of safety, which could contribute to increased compliance and a sustained reduction in injuries. Addressing these various aspects of SafePad's implementation and outcomes will not only strengthen the evidence base for its effectiveness but also inform strategies for improving its integration into healthcare systems worldwide.

By investigating these areas, future research can ensure that SafePad and similar safety-engineered devices reach their full potential in preventing needlestick injuries, improving the safety and well-being of healthcare workers while maintaining cost-effectiveness and sustainability.

7 | Conclusion

This study evaluated the effectiveness of the SafePad device in reducing needlestick injuries among nurses and nurse aides. The results demonstrated a statistically and clinically significant reduction in injury rates, suggesting that SafePad may be an effective intervention for enhancing occupational safety. Its ability to facilitate immediate disposal of sharps at the point of care addresses a critical gap in injury prevention, particularly in high-pressure and resource-limited healthcare settings.

These findings support broader implementation of SafePad as part of a comprehensive safety strategy, which should also include training, workload management, and organizational support. While promising, these results should be interpreted in light of study limitations, and further research is needed to confirm the generalizability and long-term impact of this intervention.

Author Contributions

Nima Yadollahzade: data curation, investigation, project administration, writing – original draft, writing – review and editing. **Mitra Zandi:** conceptualization, methodology, investigation, writing – original draft, writing – review and editing, supervision, formal analysis. **Soheila Sadeghi:** investigation, project administration, supervision, writing – review and editing, data curation, validation. **Farzaneh Ghodsi:** Investigation, writing – review and editing, data curation. **Aram Halimi:** investigation, methodology, writing – review and editing, writing – original draft, formal analysis, conceptualization, validation.

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Ethics Statement

The study was approved by the Ethics Committee of the School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences

(IR.SBMU.PHARMACY.REC.1400.332), and was conducted in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The study protocol was registered with the Iranian Clinical Trials Committee under the code IRCT20220316054307N1.

Consent

All participants provided informed consent prior to participating in the study.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Transparency Statement

Dr. Mitra Zandi, as the lead author, affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

References

1. I. Falade, G. Gyampoh, E. Akpamgbo, et al., "A Comprehensive Review of Effective Patient Safety and Quality Improvement Programs in Healthcare Facilities," *Medical Research Archives* 12, no. 7 (2024).

2. A. Sahebi, S. Tahernejad, E. Rezaei, F. Shahmahmoudi, S. Pirhadi, and A. Tahernejad, "Needle Stick Injuries Among Emergency Medical Services Personnel: A Systematic Review and Meta-Analysis," *BMC Nursing* 24, no. 1 (2025): 697.

3. Z. Desalegn, "Epidemiology of Needle Stick-Sharp Injuries (NSSIs) and Potential High Risk Exposures Among Health Professionals in Ethiopia: Neglected Public Health Concern," *American Journal of Health Research* 3, no. 5 (2015): 298–304.

4. A. Mannocci, G. De De Carli, V. Di Di Bari, et al., "How Much Do Needlestick Injuries Cost? A Systematic Review of the Economic Evaluations of Needlestick and Sharps Injuries Among Healthcare Personnel," *Infection Control and Hospital Epidemiology* 37, no. 6 (2016): 635–646.

5. C. Wang, L. Huang, J. Li, and J. Dai, "Relationship Between Psychosocial Working Conditions, Stress Perception, and Needle-Stick Injury Among Healthcare Workers in Shanghai," *BMC Public Health* 19, no. 1 (2019): 874.

6. Ghanei, R. Gheshlagh, M. Nazari, et al., "Underreporting of Needlestick Injuries Among Healthcare Providers in Iran: A Systematic Review and Meta-Analysis," *Journal of Hayat* 23, no. 3 (2017): 201–213.

7. R. Ghanei Gheshlagh, M. Aslani, F. Shabani, S. Dalvand, and N. Parizad, "Prevalence of Needlestick and Sharps Injuries in the Healthcare Workers of Iranian Hospitals: An Updated Meta-Analysis," *Environmental Health and Preventive Medicine* 23, no. 1 (2018): 44.

8. J. Yasin, R. Fisseha, F. Mekonnen, and K. Yirdaw, "Occupational Exposure to Blood and Body Fluids and Associated Factors Among Health Care Workers at the University of Gondar Hospital, Northwest Ethiopia," *Environmental Health and Preventive Medicine* 24, no. 1 (2019): 18.

9. A. Halimi, R. G. Gheshlagh, M. Ansari, S. S. Zakariaee, and M. Zandi, "Prevalence of Needle-Stick Injury in Iranian Nurses: An Updated Systematic Review and Meta-Analysis of Observational Studies," *BMC Nursing* 23, no. 1 (2024): 268.

10. N. Coppola, "Hepatitis B Virus and Hepatitis C Virus Infection in Healthcare Workers," *World Journal of Hepatology* 8, no. 5 (2016): 273.

11. A.-N. Elzouki, R. Lubbad, I. Elzouki, A. Elhaddad, and A. Ibrahim, "Frequency of Hepatitis B and C in Health Care Providers at Three Referral Hospitals in Libya," *Pan African Medical Journal* 37 (2020): 214.

12. D. A. Mengistu, S. T. Tolera, and Y. M. Demmu, "Worldwide Prevalence of Occupational Exposure to Needle Stick Injury Among Healthcare Workers: A Systematic Review and Meta-Analysis," *Canadian Journal of Infectious Diseases and Medical Microbiology* 2021 (2021): 9019534.

13. A. P. Jackson, L. A. Almerol, J. Campbell, and L. Hamilton, "Needlestick Injuries: The Role of Safety-Engineered Devices in Prevention," *British Journal of Nursing* 29, no. 14 (2020): S22–S30.

14. S. Reda, M. Gebrehiwot, M. Lingerew, et al., "Occupational Blood Exposure Beyond Needle Stick Injuries: Hospital-Based Cross-Sectional Study Among Healthcare Workers in Governmental Hospitals of Northern Ethiopia," *BMC Health Services Research* 21, no. 1 (2021): 1136.

15. S. Rezaei, M. Hajizadeh, H. Zandian, A. Fathi, and B. Nouri, "Period Prevalence and Reporting Rate of Needlestick Injuries to Nurses in Iran: A Systematic Review and Meta-Analysis," *Research in Nursing & Health* 40, no. 4 (2017): 311–322.

16. H. Akbari, F. Ghasemi, H. Akbari, and A. Adibzadeh, "Predicting Needlestick and Sharps Injuries and Determining Preventive Strategies Using a Bayesian Network Approach in Tehran, Iran," *Epidemiology and Health* 40 (2018): e2018042.

17. N. Akpuh, I. Ajayi, A. Adebowale, et al., "Occupational Exposure to HIV Among Healthcare Workers in PMTCT Sites in Port Harcourt, Nigeria," *BMC Public Health* 20, no. 1 (2020): 451.

18. Z. Berhan, A. Malede, A. Gizeyatu, et al., "Prevalence and Associated Factors of Needle Stick and Sharps Injuries Among Healthcare Workers in Northwestern Ethiopia," *PLoS One* 16, no. 9 (2021): e0252039.

19. S. Hassanipour, M. Sepandi, R. Tavakkol, et al., "Epidemiology and Risk Factors of Needlestick Injuries Among Healthcare Workers in Iran: A Systematic Reviews and Meta-Analysis," *Environmental Health and Preventive Medicine* 26, no. 1 (2021): 43.

20. M. Dulon, J. Stranzinger, D. Wendeler, and A. Nienhaus, "Causes of Needlestick and Sharps Injuries When Using Devices With and Without Safety Features," *International Journal of Environmental Research and Public Health* 17, no. 23 (2020): 8721.

21. M. C. Ottino, A. Argentero, P. A. Argentero, G. Garzaro, and C. M. Zotti, "Needlestick Prevention Devices: Data From Hospital Surveillance in Piedmont, Italy—Comprehensive Analysis on Needlestick Injuries Between Healthcare Workers After the Introduction of Safety Devices," *BMJ Open* 9, no. 11 (2019): e030576.

22. A. Szczypta, A. Różańska, M. Siewierska, K. Drożdż, M. Szura, and K. Talaga-Ćwiertnia, "Did Safety-Engineered Device Implementation Contribute to Reducing the Risk of Needlestick and Sharps Injuries? Retrospective Investigation of 20 Years of Observation in a Specialist Tertiary Referral Hospital," *International Journal of Occupational Medicine and Environmental Health* 37, no. 2 (2024): 234–243.

23. H. Fukuda and N. Yamanaka, "Reducing Needlestick Injuries Through Safety-Engineered Devices: Results of a Japanese Multi-Centre Study," *Journal of Hospital Infection* 92, no. 2 (2016): 147–153.

24. M. Kakolarimi, "Prevalence and Causes of Occupational Injuries Caused by Sharp Objects in Shahid Beheshti University of Medical Sciences Hospital from 2013 to 2018" (master's thesis, Shahid Beheshti University of Medical Sciences, 2018).

25. D. C. Des Jarlais, C. Lyles, and N. Crepaz, "Improving the Reporting Quality of Nonrandomized Evaluations of Behavioral and Public Health Interventions: The TREND Statement," *American Journal of Public Health* 94, no. 3 (2004): 361–366.

26. M. Fuladvandi, F. Rayani, H. Aliabadi, G. Fuladvandi, and R. Rajabi, "Effect of the Use of a Safety Intravenous Catheters to Prevent Needle Stick Injuries," *International Journal of Medical Research & Health Sciences* 5, no. 7 (2016): 189–194.

27. R. Rashidi, M. Khoshnamvand, R. Mohammadi, and K. Anbari, "The Frequency and Causes of Occupational Injuries Caused by Needle Stick Among Nurses in Educational Hospitals in Khorramabad in 2020," *Scientific Magazine Yafte* 22, no. 4 (2021): 107–119.

28. M. Islam, R. Kabir, and M. Nisha, *Learning SPSS Without Pain: A Comprehensive Guide for Data Analysis and Interpretation of Outputs*, Second Edition, SPSS Version 25 (ASA Publications, 2021).

29. A. Abalkhail, R. Kabir, Y. M. Elmosaad, et al., "Needle-Stick and Sharp Injuries Among Hospital Healthcare Workers in Saudi Arabia: A Cross-Sectional Survey," *International Journal of Environmental Research and Public Health* 19, no. 10 (2022): 6342.

30. J. Schuurmans, S. P. Lutgens, L. Groen, and P. M. Schneeberger, "Do Safety Engineered Devices Reduce Needlestick Injuries?," *Journal of Hospital Infection* 100, no. 1 (2018): 99–104.

31. M. Kaur, S. Mohr, G. Andersen, and O. Kuhnigk, "Needlestick and Sharps Injuries at a German University Hospital: Epidemiology, Causes and Preventive Potential—A Descriptive Analysis," *International Journal of Occupational Medicine and Environmental Health* 35, no. 4 (2022): 497–507.

32. A. Garus-Pakowska, M. Górajski, and P. Sakowski, "Non-Safety and Safety Device Sharp Injuries-Risk of Incidents, SEDs Availability, Attitudes and Perceptions of Nurses According to Cross-Sectional Survey in Poland," *International Journal of Environmental Research and Public Health* 19, no. 18 (2022): 11315.

33. A. Kebede and H. Gerensea, "Prevalence of Needle Stick Injury and Its Associated Factors Among Nurses Working in Public Hospitals of Dessie Town, Northeast Ethiopia, 2016," *BMC Research Notes* 11, no. 1 (2018): 413.

34. E. Weldesamuel, H. Gebreyesus, B. Beyene, M. Teweldemedhin, Z. Welegebriel, and D. Tetemke, "Assessment of Needle Stick and Sharp Injuries Among Health Care Workers in Central Zone of Tigray, Northern Ethiopia," *BMC Research Notes* 12, no. 1 (2019): 654.