



Effect of Using a Tabletop Ampoule Opener on the Incidence of Skin Injuries in Nurses Working in Selected Hospitals Affiliated with Shahid Beheshti University of Medical Sciences in 2024–2025

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Abstract

Introduction: Skin injuries from opening glass ampoules pose a significant threat to healthcare personnel, particularly nurses. This study investigated the effect of a tabletop ampoule opener on the incidence of these injuries among nurses at selected teaching hospitals affiliated with Shahid Beheshti University of Medical Sciences (2024-2025).

Methods: A quasi-experimental pre-test/post-test design was employed at Loghman Hakim Hospital in Tehran. The study population included nurses and nurse assistants meeting inclusion criteria. Prior to intervention, demographic and ampoule-related skin injury data were collected over six months. Subsequently, participants received training on the tabletop ampoule opener (face-to-face, posters, videos). The device was then used for six months, with ongoing skin injury data collection. SPSS version 20 was used for analysis.

Results: Notably, none of the injured were using the tabletop device at the time. Of 294 participants (254 nurses, 40 assistants; 197 female, 97 male), 103 (36.78%) reported prior skin injuries. Post-intervention, only 31 (11.07%) reported injuries, a statistically significant 25.71% reduction ($P < 0.0023$). Intensive care units had the highest injury incidence, infectious diseases the lowest.

Conclusions: The use of a tabletop ampoule opener significantly reduces skin injuries from ampoule breakage among nurses, demonstrating its potential as a crucial preventive tool for occupational safety in healthcare settings.

INTRODUCTION

The health and safety of healthcare personnel are paramount and directly influence patient well-being and recovery [1]. Healthcare workers face numerous occupational hazards in their clinical setting, including skin and dermal injuries from opening ampoules [2]. Nurses, who routinely handle injectable products, frequently perform the manual opening of ampoules—a common yet high-risk task [3]. Injuries from ampoule breakage account for approximately 20.8% to 32.5% of all sharp object injuries among nurses and are considered high-risk incidents [4].

The sharp, broken edges of glass ampoules can cause severe cuts to nurses' fingers, potentially hindering their ability to perform clinical duties. These injuries can serve as entry points for microorganisms, posing a significant risk of bloodborne infections [5]. Potential

pathogens include hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), all requiring attention following skin injury from ampoule breakage. However, nurses often underestimate these risks, perceiving ampoule-related injuries as minor and low-risk, and therefore continue working without proper reporting or care [6]. A serious bloodborne infection can incur costs exceeding one million dollars, considering expenses related to medication, follow-up, laboratory testing, clinical evaluations, lost wages, and disability-related payments [7].

Contributing factors to ampoule-related skin injuries include fatigue, drowsiness at work, limited clinical experience, frequent shifts, lack of participation in training sessions, failure to observe safety protocols

while opening ampoules, haste, and not using safety devices and the presence of safe devices seems to help reduce these risks [2]. In clinical environments, it is crucial for nurses to continuously enhance their clinical skills. Injuries from sharp objects often stem from a lack of awareness, inadequate training, and outdated safety protocols [8]. Reporting ampoule-related injuries and their associated factors is critical for reducing future sharp-object injuries. While numerous studies have confirmed the risk of injury from ampoule breakage among nurses, limited data exist on methods that effectively minimize this risk. The Centers for Disease Control and Prevention (CDC) estimates that 62% to 88% of sharp injuries can be prevented through the use of safety-engineered devices [9]. Therefore, the use of ampoule openers is recommended to prevent such injuries.

Currently, many developed countries mandate the use of safety-engineered devices (SEDs) in healthcare

systems to reduce occupational hazards [10]. While SEDs decrease the risk of percutaneous injuries among healthcare workers, half of such injuries still occur in patient care areas, with nurses accounting for 78% of all cases [11].

Given these concerns and the significant risks associated with sharp injuries in hospitals, coupled with the limited availability and high cost of safety-engineered devices in our country, the research team decided to investigate the effect of using a newly designed tabletop ampoule opener on the incidence of ampoule-related skin injuries among nurses before and after its introduction. Today, the use of care equipment to maintain the safety and health of healthcare workers has received much attention, and designing simple, easy-to-use equipment is a priority for hospital managers [10]. This study introduces a newly designed tabletop ampoule opener aimed at improving safety during ampoule opening procedures.

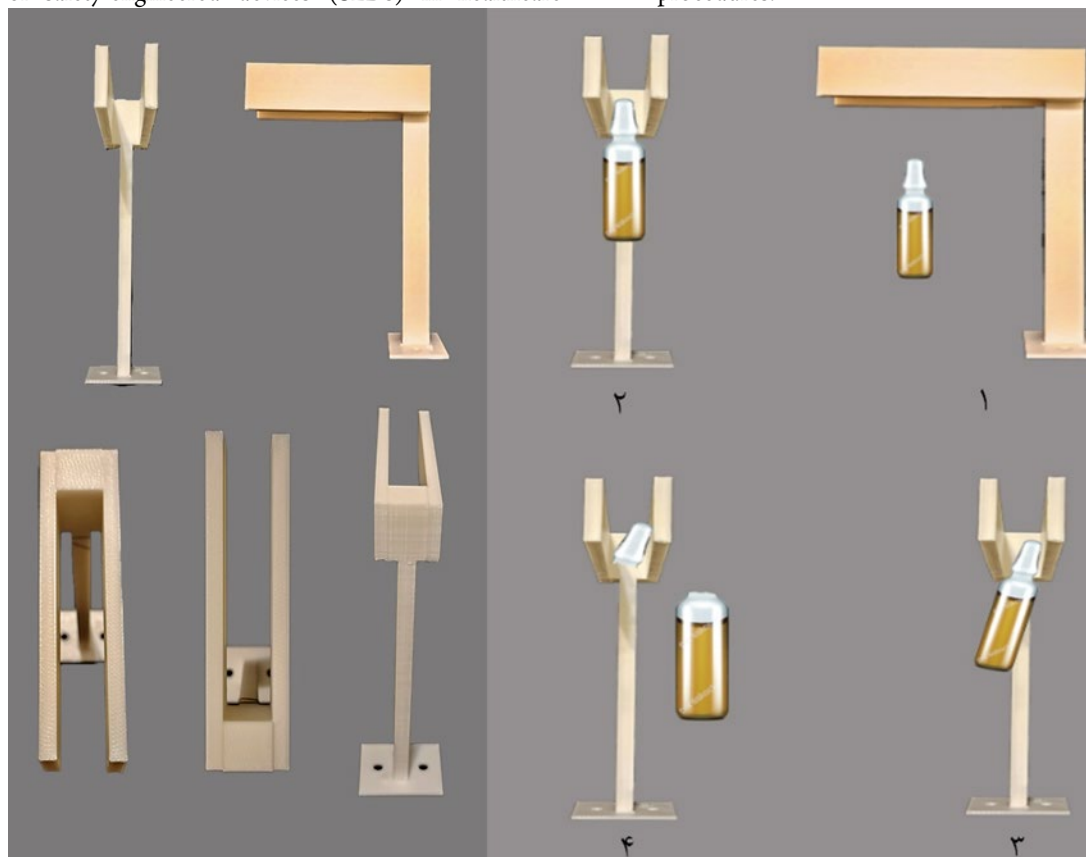


Figure 1. Tabletop ampoule opener

METHODS

This tabletop ampoule opener features an inverted "L" shape and a sturdy base that can be screwed or adhered to various surfaces, providing enhanced stability during use. The base height is customizable to allow ergonomic hand positioning for optimal force application. The main component consists of two durable blades positioned at a specific distance apart and attached to

the base on one side, leaving the other side open. The ampoule head is placed between these blades and locks in securely due to their narrowing structure. Minimal force is required to open the ampoule head effortlessly. All steps can be performed single-handedly, ensuring that nurses can operate it even when their other hand is occupied.

The inner surface of the blades is lined with a softer material to prevent direct contact with the ampoule,

thereby minimizing the risk of glass shattering. This lining is replaceable in case of wear.

This device offers several advantages:

Operable with one hand.

Usable by multiple individuals simultaneously from opposite sides.

Securely fixed to prevent loss, misplacement, or breakage from dropping, as it is attached to treatment carts.

Adjustable dimensions to suit user needs, allowing easy modification of base height and blade length.

Mountable anywhere using screws or adhesives, including carts, walls, or beds.

More durable than pocket models and cost-effective for mass production.

This quasi-experimental study used a pre- and post-test design and was conducted at Lohman Hakim Hospital from 2024 to 2025. The study population comprised nurses and nursing assistants working in various hospital wards. Based on the study by Akyol et al., and considering an initial skin injury incidence of 8 per 328 individuals before intervention and 2 per 332 individuals after intervention, with 80% power, a 5% alpha error, and a correlation coefficient of 0.4, the required sample size was calculated to be 286. To account for potential attrition, 310 eligible participants were enrolled. Ultimately, after 16 individuals dropped out (10 due to non-response and 6 due to relocation), 294 participants completed the study, and their data were analyzed.

Inclusion criteria were nurses and nursing assistants with at least six months of work experience before the implementation of the tabletop safety ampoule opener and continued use of the device for six months. Exclusion criteria were inconsistent use of the device during the study period, transfer to a ward without the device, or leaving the healthcare facility.

Study Procedure

After obtaining ethical approval from the Ethics Committee of the Vice-Chancellor for Research and Technology at Shahid Beheshti University of Medical Sciences and official permission to conduct the study, the researcher approached hospital authorities, explained the study objectives and procedures, and obtained their cooperation. Before the intervention, data on participants' history of ampoule-related skin injuries in the previous six months were collected using a self-reported questionnaire.

Eligible nurses and nursing assistants were recruited via convenience sampling. After explaining the study aims and obtaining informed consent, detailed instructions on using the tabletop ampoule opener were provided in face-to-face sessions. Additionally, educational posters were placed in the wards, and an instructional video was presented.

The devices were installed in various hospital wards and used for six months, from October 23, 2024, to April 2, 2025. The number of devices installed in each ward was proportional to the number of beds and treatment stations. Throughout the intervention period, the researcher conducted regular follow-up visits several times per week during different shifts to monitor and ensure proper use of the devices.

During these six months, any occurrence of skin injury was documented, and the incidence rate was compared with the rate recorded during the six months before the intervention.

Device validation was performed through expert review by three biomedical engineers and five senior nurses who assessed its safety and usability. Injuries were recorded via a self-report form and verified by the ward supervisor. Proper device usage was monitored weekly using a researcher-developed checklist, and user feedback was documented.

Data Collection Tools

The data collection tool had two parts:

1-The first part was a demographic questionnaire that included items on work experience in the hospital, age, gender, educational level, work ward, and vaccination status.

2-The second part focused on ampoule-related skin injuries within six months, including the shift when the injury occurred, the action taken after the injury, the injury's severity, and the injury's cause.

Data were analyzed using SPSS version 20. Descriptive statistics were calculated, and the paired Z test was applied to compare the incidence of skin injuries before and after intervention. Statistical significance was set at $P < 0.05$.

RESULTS

Analysis of participants' demographic data showed a mean age of 36.6 years ($SD = 7.2$). The majority of participants were female, worked as nurses, and held a bachelor's degree. Most participants were based in intensive care units, while the fewest worked in the men's surgical ward. Additionally, the largest proportion of participants had 1 to 5 years of work experience (Table 1).

Furthermore, analysis revealed that the most common time of skin injury occurrence, both before and after the intervention, was during the night shift. Participants reported that the primary cause of injuries, in both phases, was the poor quality of ampoules (Table 2).

The study results indicated that before the intervention, 103 participants (36.78%) reported experiencing skin injuries related to opening ampoules in the previous six months. Following the intervention period, during which the tabletop ampoule openers were used, only 31 participants (11.07%) reported injuries, representing a

statistically significant reduction of 25.71% in skin injury incidence ($P < 0.0023$) (Table 3).

Most participants worked in intensive care units. However, since the study primarily aimed to evaluate

the overall reduction in injury rates, ward-level comparisons were not statistically analyzed.

Table 1. Frequency and Percentage of Demographic Characteristics of Nurses and Nursing Assistants (N = 294)

	Frequency	Percentage (%)
Gender		
Male	97	32.86
Female	197	67.14
Occupation		
Nurse	254	86.39
Nursing Assistant	40	13.61
Education Level		
Diploma	25	8.51
Bachelor's Degree	233	79.25
Master's Degree	36	12.24
Ward		
Infectious diseases	30	10.2
Internal Medicine (Men)	25	8.5
Internal Medicine (Women)	30	10.2
Orthopedics	24	8.1
Surgery (Men)	19	6.8
Surgery (Women)	21	7.1
Neurology & Neurosurgery	29	9.8
Intensive Care Unit	45	15.3
Toxicology (Men)	20	6.8
Toxicology (Women)	22	7.4
Emergency Department	29	9.8
Work Experience		
<1 year	61	20.74
1-5 years	88	29.93
5-10 years	79	26.87
>10 years	66	22.46

Average: 36.6; Standard Deviation: 7.2

Table 2. Frequency of Shift and Causes of Skin Injury before and after Intervention

	Before Intervention		After Intervention	
	Frequency	Percentage	Frequency	Percentage
Shift of Injury Occurrence				
Morning	3	3.1	2	6.52
Evening	2	2.9	4	12.9
Night	50	48.5	11	35.48
Morning & Evening	15	14.5	4	12.9
Evening & Night	33	31	10	32.2
Total	103	100	31	100
Cause of Injury				
Lack of awareness	2	1.95	0	0
Carelessness	2	1.95	0	0
Heavy workload	17	16.5	3	9.69
Lack of protective tools	29	28.15	10	32.25
Poor ampoule quality	53	51.45	18	58.06
Total	103	100	31	100

Table 3. Comparison of Skin Injury Incidence before and after Use of the Tabletop Safety Ampoule Opener

Skin Injury Incidence	Before Intervention	After Intervention	Paired Z Test
Number of cases	103	31	$P < 0.0023$

DISCUSSION

Our study results demonstrated that the use of a tabletop ampoule opener significantly reduced the incidence of skin injuries from opening ampoules among nurses and nursing assistants. Furthermore, our analysis revealed that skin injuries most commonly occurred during night shifts, and the primary cause was related to the type of ampoule. Female staff members in

our study used this tool more frequently, with the highest usage recorded in intensive care units. Notably, staff with less than one year of work experience and those working night shifts experienced significantly more skin injuries than their colleagues. However, no significant correlation was found between skin injury incidence and demographic variables such as age, gender, education level, employment status, or workplace unit.

Rahiyo et al. (2020) similarly found that a wooden ampoule opener was easier and safer to use compared to traditional methods, and significantly reduced injury rates [12], consistent with our findings. Lin et al. (2024) also demonstrated that using an ampoule opener resulted in fewer sharp glass fragments, directly reducing the risk of skin injury—a result that aligns with our study [5]. Mao et al. (2024) highlighted that using tools for ampoule opening not only prevents skin injuries but also lowers the risk of infection from scratches, supporting our findings on the protective role of such devices [13]. Collectively, these studies suggest that tabletop ampoule openers can effectively enhance healthcare worker safety, although larger randomized trials are needed for more definitive confirmation.

Garus-Pakowska et al. (2022) reported that one-third of nurses experienced injuries from glass ampoules, with an inverse relationship between injury rates and both work experience and age. Fatigue was also identified as a contributing factor—supporting our findings of more frequent skin injuries among less experienced staff and those on night shifts, likely due to workload and sleep deprivation. The discrepancy between our study and theirs regarding age correlation may stem from differences in participant age ranges [14]. Burhan et al. (2021) similarly reported that nurses had the highest rate of sharp object injuries, with sleepiness as a major risk factor, which aligns with our observation of higher injury rates during night shifts [15].

An Iranian cross-sectional study (2023) reported higher sharp object injuries among younger staff and students, which also aligns with our findings of more injuries among less experienced staff [16]. Additionally, Chianlikulchai et al. (2021) showed that more experienced staff generated fewer glass particles when opening ampoules, reducing contamination risk—a result consistent with our finding of lower injury rates among experienced staff [17]. Akbari et al. (2023) reported no significant link between injury rates and demographic factors like gender, age, or education level, supporting our study's findings [18]. Similarly, Umemoto et al. (2023) confirmed no association between educational level and injury rates among nurses [19]. Therefore, more foundational and meta-analytic research is needed to clarify the predictive role of demographic factors.

Al-Hameed et al. (2021) conducted a systematic review highlighting knowledge gaps among healthcare workers regarding sharp injury prevention, underlining the need for enhanced training [20]. This may also explain why intensive care nurses in our study, who typically have more infection control knowledge, used the ampoule opener more frequently.

These findings highlight the potential of low-cost safety innovations to enhance occupational safety policies in healthcare settings. Implementing similar devices could be integrated into hospital safety standards. Future

randomized controlled trials and cost-benefit analyses are warranted to evaluate long-term efficacy and economic feasibility.

Recommendations

Based on our findings, which demonstrated a significant reduction in ampoule-related skin injuries, we recommend the broader adoption of tabletop ampoule openers across hospital units. To further validate these results and improve generalizability, future studies with larger and more diverse samples are needed. We also suggest implementing continuous and varied training programs—including face-to-face sessions, educational posters, and instructional videos—to ensure nursing staff are proficient in using these tools. Additionally, ergonomic improvements to the device design should be explored to enhance user comfort and safety. Finally, prospective studies assessing the economic impact of this intervention on healthcare costs and staff absenteeism are warranted.

Limitations

Despite providing valuable insights, our study has several limitations.

- It was conducted in a single hospital (Loghman Hakim Hospital in Tehran), limiting generalizability to other settings.
- The six-month evaluation period, while demonstrating significant results, may not capture long-term effects; longer follow-up studies are recommended.
- Injury data were self-reported, potentially introducing recall or social desirability bias.
- Environmental and individual factors (e.g., fatigue, stress, shift frequency, personal skill) were not controlled.
- The quasi-experimental design, lacking a control group, limits our ability to infer causality, as confounding variables may have influenced the outcomes.

CONCLUSION

Our findings demonstrate that using a tabletop ampoule opener significantly reduced skin injuries from opening glass ampoules among nurses and nursing assistants at Loghman Hakim Hospital. Notably, no injuries occurred while using the device during the intervention. This suggests the effectiveness of the tool as a preventive measure in clinical settings. We contend that such tools not only enhance healthcare worker safety but also have the potential to alleviate the financial and psychological burden associated with these injuries. Further research is crucial for advancing healthcare worker safety policies and informing future policy development in this area. It seems that one of the important reasons for nurses' satisfaction with the product and its use is its appearance, simple use, and its installation in appropriate locations in the treatment wards.

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AUTHORS' CONTRIBUTIONS

All authors contributed significantly to the conception, design, and execution of this study. NS and MS conceptualized and designed the study protocol. NS and MS coordinated the implementation, data collection, and follow-up procedures at Loghman Hakim Hospital. SS and NS carried out the statistical analysis and data interpretation. MS drafted the original manuscript. NS and SS critically reviewed and revised the manuscript for important intellectual content. All authors read and approved the final manuscript for publication and agree to be accountable for all aspects of the work.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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ETHICAL CONSIDERATION

The study was fulfilled at Shahid Beheshti University of Medical Sciences, Tehran, Iran (ethical code: IR.SBMU.RETECH.REC.1403.606). The researcher explained the purpose and method of conducting the research to the relevant officials. In all stages of the research, ethical considerations such as obtaining informed consent, information confidentiality and the possibility of withdrawing from the study at each stage was taken into account.

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