Advances in Medical Education and Practice

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Evaluation of the Effectiveness of Standard Precaution Training on Disposition of Occupational Blood Exposure Among Healthcare Trainees: A Pre-Post Intervention Study

Xing Zhang[1], Hongwei Li[2], Ning Li[1], Yusen Li[1], Li Kong[1], Min Zhang[1], Peng Wang[1], Yonghui Ma[1], Leiping Ni[2], Lili Liu[1], Xiujuan Meng[1]

[1]Healthcare-Associated Infection Control Department, Affiliated Hospital of Jining Medical University, Jining, Shandong, People's Republic of China; [2]Medical Education Center, Affiliated Hospital of Jining Medical University, Jining, Shandong, People's Republic of China

Correspondence: Xiujuan Meng, Healthcare-associated infection control department, Affiliated Hospital of Jining Medical University, Jining, Shandong, People's Republic of China, Tel +86 537 2903180, Fax +86 537 2213030, Email mxj0324@163.com

Introduction: Blood-borne occupational exposure (OBE) is one of the major public health problem for healthcare workers globally. Effective education and training on post-exposure management and standard precautions for healthcare trainees, are important measures for reducing OBE and infection rates. The aim of this study was to evaluate the effectiveness of standard precaution training on OBE disposition for healthcare trainees, comparing the differences of "theoretical teaching" and "situational simulation" training methods.

Methods: A pre-post intervention study was conducted among 1347 healthcare trainees at a university teaching hospital located in Jining, Shandong Province from July 2023 to September 2023. Healthcare trainees who were undergoing training at the hospital from July 2020 to July 2023 were selected as the research subjects. They voluntarily participated in theoretical teaching group or situational simulation group. The two groups taught the same knowledge using different methods. Both groups were tested the same content before and after the training.

Results: The accuracy rates before and after training in different groups were 71.71% and 78.08%, respectively (P<0.001). The accuracy rate after training in the scenario simulation group (79.08%) was higher than that in the theoretical teaching group (76.60%), with a statistically significant difference (P<0.05). The accuracy rate for trainees who experienced OBE was 69.87% before training and 77.11% after training. For trainees who had not experienced OBE, the accuracy rates were 71.38% before training and 77.25% after training. The accuracy rates were higher after training compared to before training, with statistically significant differences (P<0.001).

Conclusion: Scenario simulation training exhibits significant advantages in improving accuracy due to its strong practicality, high level of participation, and timely feedback. The self-protection awareness, knowledge on OBE management, and standard precaution among healthcare trainees were enhanced through the training, and operational content can achieve better results through scenario simulation training.

Keywords: healthcare trainees, occupational blood exposure, standard precaution, theoretical teaching, situational simulation

Introduction

Exposure to blood-borne pathogens remains a major safety concern for healthcare workers (HCWs) in hospitals. Occupational blood exposure (OBE) is defined as a percutaneous injury or contact of mucous membranes or non-intact skin with potentially infectious blood, tissue, or other body fluids.[1] HCWs who come into contact with patients and their body fluids face a high risk of contracting various diseases transmitted through blood and body fluids.[2] According to the World Health Organization (WHO), approximately 3 million percutaneous injuries are sustained each year. Of these injured health workers, 70,000 are likely to become infected as a result of exposure to the hepatitis B virus, 15,000 with HCV, and 1000 with HIV.[3] Blood-borne occupational exposure, which can spread over 20 infectious disease agents through sharp objects or blood/body fluid spatter, has become a major public health problem for HCWs globally.[4,5]

Received: 8 October 2024
Accepted: 16 January 2025
Published: 23 January 2025

Healthcare trainees, as persons undergoing training in healthcare institutions, are acquiring skills and knowledge through education and practice to be able to provide high-quality services in future. They are particularly susceptible to OBE due to several factors. Such as: the nature of performed tasks, lack of experience and skills, hesitation before performing procedures, and close contact with patients.[6,7] In a cross-sectional study,[8] the incidence and related factors of OBE were investigated among nursing students, it was found that nearly half (40.34%) of clinical nursing interns had experienced at least one OBE during their clinical internship. Another study[9] surveyed the occurrence of OBE among medical staff in 30 hospitals within a specific city from 2019 to 2020. In this study, it revealed that the highest incidence rate was among interns and trainees at 3.8%, followed by nurses at 3.07% and doctors at 1.82%. Additionally, previous studies[10–12] indicated that the incidence of OBE among interns was higher than that of formal medical staff.

Appropriate post-exposure management can significantly reduce pathogen transmission and infection.[13,14] Standard precautions have been developed as the best intervention to prevent OBE among HCWs. Standard precautions involve implementing a set of hygiene measures during all contact with blood or body fluids from any patient or source, regardless of diagnosis or infection status.[15] Different educational methods yield varying outcomes for healthcare trainees. The current training mainly adopts the traditional teaching mode, which emphasizes the systematic transmission of knowledge through theoretical teachings. The mainly shortcoming of this training mode is the disconnection between theory and practice. It is difficult for trainees to cope with actual situation when faced with real situations. However, scenario simulation training designs scenarios based on specific teaching objectives and content, allowing trainees to participate in simulated scenarios where they acquire knowledge and skills.[16] It involves the use of technology to create realistic or virtual environments that mimic real-world situations. This method can better help us understand the problems encountered in reality and their solutions. In general, simulation training methods tend to be more effective in promoting active learning, skill development, and real-world application.[17,18]

Due to unfamiliarity with the occupational environment, various operations, insufficient clinical practice experience, and lack of occupational exposure knowledge, healthcare trainees are more likely to become "susceptible groups" to occupational injuries. In this study, we aimed to conduct a pre-post intervention study among healthcare trainees. Healthcare trainees were divided into two groups: one group received training on the disposition of OBE and standard precautions using the traditional teaching mode, while the other group underwent scenario simulation teaching. The effectiveness of the training was evaluated by testing both groups before and after the training.

Materials and Methods

Study Design

From July 2023 to September 2023, a pre-post intervention study was conducted among 1347 healthcare trainees at a university teaching hospital located in Jining, Shandong Province. The training focused on the disposition of OBE and standard precautions for healthcare trainees in hospitals. The training was divided into two phases, and participants voluntarily chose to participate in one of them. The first group received traditional theoretical teaching, referred to as the "Theoretical Teaching Group", while the second group underwent situational simulation teaching, known as the "Situational Simulation Group".

Setting and Participants

The hospital consisted of two campuses with a total of 4100 beds and 5700 hCWs. Currently, the hospital has 82 clinical departments and 15 intensive care units, serving a population of over 20 million people in the southwestern region of Shandong Province, China. In 2022, the hospital recorded 2.991 million outpatients, 183,000 discharged patients, 113,000 operations, and an average hospitalization duration of 6.5 days.

We issued an announcement titled "Training on Occupational Exposure Handling and Standard Precautions" to healthcare trainees undergoing training in the hospital. A total of 1347 participants were enrolled for the study based on single population proportion formula, $Z^2*p\,(1-p)/d^2$, and prevalence of OBE in a previous study among HCWs in Level III hospitals in Zaozhuang district.[19] A sample size of 1347 was calculated using a prevalence (p) of 16.34%, 2.1% margin error (d), 95% confidence interval (Z) given as 1.96,8.5% attrition rate to cater for non-response; with power of 80%. A 100% response rate was achieved since all the students who were recruited consented and partook in the study. The inclusion criteria included healthcare trainees trained in the hospital from July 2020 to July 2023, willingness to participate in the study, and not participating in similar training courses.

The exclusion criteria include medical trainees who did not undergo training in the hospital between July 2020 and July 2023, and refused to participate in the study.

Healthcare trainees in the hospital comprised interns, training personnel, training physicians for job transfer, resident physicians, and standardized training physicians from medical, medical technology, nursing, pharmaceutical, and pharmaceutical fields.

Education Content and Intervention

The training content was determined based on the occupational protection knowledge needs of healthcare trainees and the purpose of the training. It mainly included: (1) understanding the concept of OBE, (2) proper disposition of OBE, (3) follow-up procedures for OBE, (4) comprehension of standard precautions, and (5) hand hygiene and medical waste disposal.

To ensure both groups of participants received training of equivalent quality, the training content for both groups had been identical, and each group underwent training for a duration of 2 hours. The training faculty possessed equivalent levels of teaching expertise and professionalism, with instructors holding intermediate or higher professional titles as well as university teaching credentials. An effective training supervision and feedback mechanism was established, and a uniform evaluation standard was developed. Before and after the training, both groups were tested using questions of the same difficulty to assess their understanding of OBE principles and mastery of standard preventive measures.

The training methods encompassed situational simulation teaching and traditional theory teaching. The theoretical teaching group focused on providing a comprehensive understanding of the foundational knowledge and theoretical frameworks relevant to OBE and standard precautions. The simulation group emphasized skill development and problem-solving abilities. Firstly, teachers created multimedia courseware and designed simulated occupational protection scenarios based on the training content, such as how to disinfect hands in the operating room. Then, standardized operational videos were shown, covering topics like safe injection techniques, proper disposal of used sharps Teachers provided on-site explanations and demonstrations based on these videos. After healthcare trainees had gained a certain understanding of the operations, teachers assigned different roles to medical students for role-playing activities, such as how to handle an accidental needle stick injury during a doctor's diagnosis and treatment. Following the role-playing sessions, training teachers promptly provided feedback and guidance, pointing out any shortcomings in the students' performance and offering suggestions and methods for improvement.

Observation Index and Effect Evaluation

An electronic questionnaire was utilized to assess the occupational exposure management and standard precaution knowledge of the study participants. The test lasted for 20 minutes, and scores were calculated based on correct responses. The test consisted of 20 questions, including 10 single-choice, 5 multiple-choice, and 5 true/false questions, with a total of 100 points.

Statistical Analysis

Data analysis was performed using SPSS 20.0 statistical software. Quantitative data were expressed as median (quartile range), the non-parametric test was used for analysis. Categorical data were expressed as percentages (%), and the chi-square test was employed. A two-tailed p-value of less than 0.05 was considered statistically significant.

Results

Demographic Characteristics

A total of 1347 healthcare trainees voluntarily participated in either the theory teaching group or the scenario simulation group. Each group had more than 500 trainees, with 714 selecting the theoretical teaching group and 633 choosing the situational simulation teaching group. Figure 1 provides a visual representation of the participant flow.

As shown in Table 1, the participants had an average age of 24.76 (5.65) years old. The majority of participants were female (n=794, 58.95%), interns (n=439, 32.59%), and undergraduate students (n=965, 71.64%). Among them, 82 (6.09%) trainees had experienced occupational exposure.

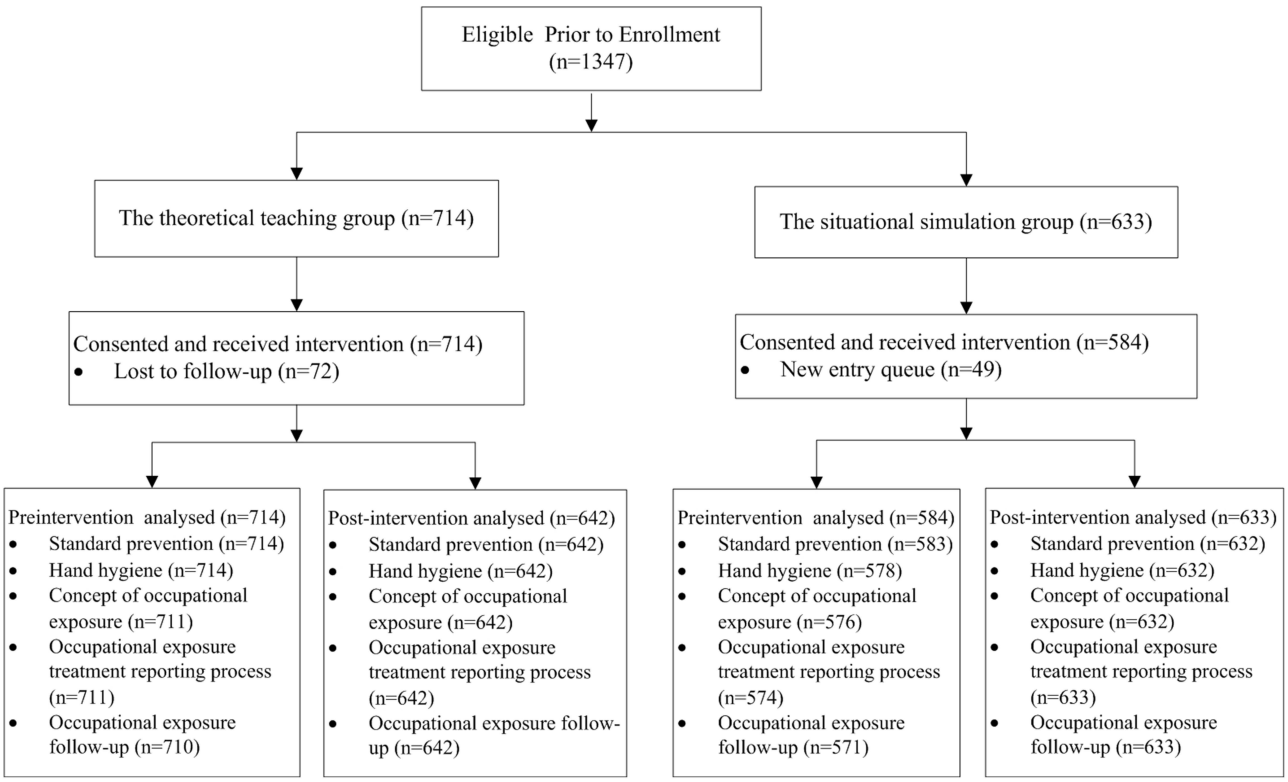

Figure 1 The complete participant flow of healthcare trainees.

Comparison of assessment results on the management and standard precaution of OBE before and after training in different groups

The median score before training was 69 (16), while the median score after training was 78 (15). There was a statistically significant difference in scores before and after training ($P<0.001$). Additionally, there was a statistically significant

Table 1 Demographic Characteristics of Medical Training Trainees

Demographic Characteristics	Before Training of Theoretical Teaching Group	After Training of Theoretical Teaching Group	Before Training of Scenario Simulation Group	After Training of Scenario Simulation Group
	N=714, n(%)	N=642, n(%)	N=584, n(%)	N=633, n(%)
Sex				
Male	306(42.86)	264(41.12)	229(39.90)	247(39.02)
Female	408(57.14)	378(58.88)	355(61.85)	386(60.98)
Age(years)				
≤20	53(7.42)	55(8.57)	66(11.50)	66(10.43)
21–25	460(64.43)	398(61.99)	330(57.49)	382(60.35)
26–30	102(14.29)	101(15.73)	109(18.99)	107(16.90)
31–35	49(6.86)	46(7.17)	54(9.41)	52(8.21)
>35	50(7.00)	42(6.54)	25(4.36)	26(4.11)
Personnel category				
Intern doctor	292(40.90)	236(36.76)	102(17.77)	147(23.22)
Resident physicians and standardized training physicians	174(24.37)	167(26.01)	256(44.60)	251(39.65)

(*Continued*)

Table 1 (Continued).

Demographic Characteristics	Before Training of Theoretical Teaching Group	After Training of Theoretical Teaching Group	Before Training of Scenario Simulation Group	After Training of Scenario Simulation Group
	N=714, n(%)	N=642, n(%)	N=584, n(%)	N=633, n(%)
Student nurse	137(19.19)	135(21.03)	82(14.29)	81(12.80)
Training physicians for job transfer	43(6.02)	42(6.54)	18(3.14)	17(2.69)
Trainee doctor	39(5.46)	35(5.45)	15(2.61)	17(2.69)
Intern Technician	14(1.96)	15(2.34)	110(19.16)	119(18.80)
Trainee technician	8(1.12)	6(0.93)	1(0.17)	1(0.16)
Trainee clinical Pharmacist	6(0.84)	6(0.93)	0	0
Training nurse	1(0.14)	0	0	0
Educational background				
Junior college and below	86(12.04)	86(13.40)	88(15.33)	88(13.90)
Undergraduate course	542(75.91)	480(74.77)	371(64.63)	423(66.82)
Master	85(11.90)	75(11.68)	123(21.43)	120(18.96)
Learned scholar	1(0.14)	1(0.16)	2(0.35)	2(0.32)
Whether experienced OBE				
Yes	40(5.60)	42(6.54)	35(6.10)	40(6.32)
No	674(94.40)	600(93.46)	549(95.64)	593(93.68)

Abbreviation: OBE, Blood-borne occupational exposure.

Table 2 Assessment Results of the Two Groups Before and After Training (Score, $\overline{M}(QR)$) (This Table Compares the Differences in Scores Both Between and Within Different Groups Before and After Training in OBE and Standard precautions. There Was No Statistically Significant Difference in Assessment Scores Between the Two Groups After Training.)

Group	Pre Training Score	Post Training Score	Z	P
Theoretical teaching group	68 (16)	78 (17)	−13.348	<0.001
Situational simulation group	72 (16)	78 (13)	−11.75	<0.001
Total	69 (16)	78 (15)	−17.799	<0.001
$Z_{\text{Comparison between two groups}}$	−2.983	−1.242		
$P_{\text{Comparison between two groups}}$	0.003	0.214		

Abbreviations: M, Median; QR, Quartile Range.

difference in assessment scores between the two groups before training (P=0.003). However, there was no statistically significant difference in assessment scores between the two groups after training (P=0.214) (Table 2).

Comparison of the Accuracy of the Management and Standard Precaution of OBE Before and After Training in Different Groups

The accuracy rates before and after training in different groups were 71.71% and 78.08%, respectively. The lowest accuracy rate before training was for standard precaution knowledge (70.66%), while the highest accuracy rate after training was for OBE follow-up knowledge (82.39%). There was a statistically significant difference in the accuracy rate of assessment before and after training (P<0.001) (Figure 2). The accuracy rates for the theoretical teaching group before and after training were 70.47% and 76.60%, respectively. For the scenario simulation group, the accuracy rates before and after training were 72.73% and 79.08%, respectively. There was statistically significant difference in the accuracy rates after training between the theoretical instruction group and the situational simulation group (P<0.05).The accuracy rates of hand hygiene had no statistically significant differences in the theoretical group (P=0.086), however, it had

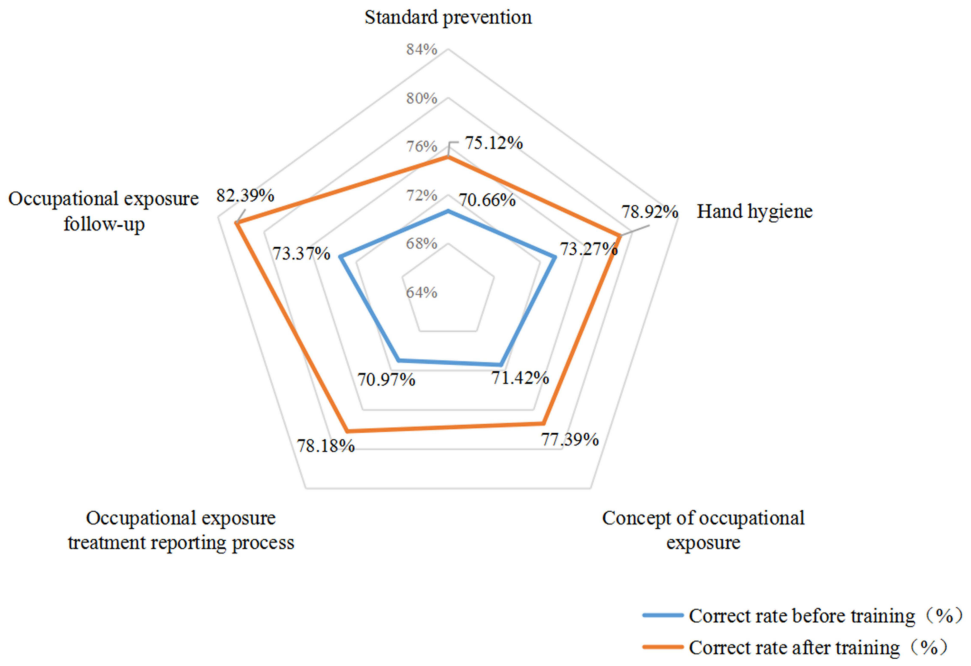

Figure 2 Accuracy of assessment before and after training (%).

statistically significant differences in Situational simulation group (P<0.001). Apart from hand hygiene in the theoretical group, the accuracy rates for other knowledge after training were higher than before training, with statistically significant differences (P<0.001) (Table 3).

Comparison of Accuracy Rate Before and After Training for Healthcare Trainees Whether Had Experienced OBE

Among the healthcare trainees, a total of 82 had experienced occupational blood exposure. The accuracy rate for trainees who experienced OBE was 69.87% before training and 77.11% after training. For trainees who had not experienced

Table 3 Accuracy Rate of Assessment Before and After Training for Different Groups (%) (Apart From Hand Hygiene in the Theoretical Group, the Accuracy Rates for Other Knowledge After Training Were Higher Than Before Training, With Statistically Significant Differences.)

Assessment Content	Theoretical Teaching Group				Situational Simulation Group			
	Correct Rate Before Training (%)	Correct Rate After Training (%)	χ^2	P	Correct Rate Before Training (%)	Correct Rate After Training (%)	χ^2	P
Standard precaution	69.83	74.58	22.763	<0.001	71.67	75.66	14.958	<0.001
Hand hygiene	76.75	77.10	0.049	0.086	71.83	79.54	58.779	<0.001
The concept of OBE	72.50	76.48	11.199	0.001	70.53	78.01	53.172	<0.001
The disposition of OBE	68.79	76.56	61.181	<0.001	73.66	79.83	38.657	<0.001
The follow-up of OBE	67.04	82.48	84.274	<0.001	75.98	82.36	44.707	<0.001
Total	70.47	76.60	129.722	<0.001	72.73	79.08	200.439	<0.001

Abbreviation: OBE, Blood-borne occupational exposure.

Table 4 Accuracy Rate of Healthcare Trainees Whether Had Experienced OBE Before and After Training (%) (The Accuracy Rates Were Higher After Training Compared to Before Training.)

Whether Had Experienced OBE	Accuracy Rate Before Training (%)	Accuracy Rate After Training (%)	χ^2	P
Yes	69.87	77.11	31.805	<0.001
No	71.38	77.25	326.638	<0.001
$\chi^2_{\text{Comparison between two groups}}$	2.364	0.024		
$P_{\text{Comparison between two groups}}$	0.124	0.878		

Abbreviation: OBE, Blood-borne occupational exposure.

Table 5 Accuracy Rate of Healthcare Trainees Who Had Experienced OBE on Related Knowledge Before and After Training (%) (Except for Standard Precaution Knowledge, the Accuracy Rates for All Other Related Knowledge Areas Were Higher After Training Compared to Before Training.)

Healthcare Trainees Experienced OBE	Accuracy Rate Before Training (%)	Accuracy rate after training (%)	χ^2	P
Standard precaution	70.00	73.37	1.32	0.251
Hand hygiene	70.89	78.05	6.363	0.012
The concept of OBE	69.11	75.81	5.308	0.021
The disposition of OBE	69.56	75.61	4.342	0.037
The follow-up of OBE	69.78	82.72	21.936	<0.001
Total	69.87	77.11	31.805	<0.001

Abbreviation: OBE, Blood-borne occupational exposure.

OBE, the accuracy rates were 71.38% before training and 77.25% after training. The accuracy rates were higher after training compared to before training, with statistically significant differences (P<0.001). Except for standard precaution knowledge, the accuracy rates for all other related knowledge areas were higher after training compared to before training, with statistically significant differences (P<0.001) (Tables 4 and 5).

Discussion

In this study, we observed that both groups of teaching modes showed higher scores and increased overall average and accuracy scores after training. This is consistent with the results reported by Dai Qinyun et al,[20] this study described that the score of interns in a certain hospital has increased from 62.22 to 82.33 before and after training. Before training, the scenario simulation group had significantly higher scores compared to the theoretical group. However, there were no statistical differences in scores between the two groups after training. As the two groups were voluntarily selected, controlling their scores before training was challenging. The focus of this study's training was on OBE and standard precaution. The theoretical exam questions encompassed five aspects: standard precaution concepts, hand hygiene, OBE concepts, disposition of OBE, and follow-up of OBE. Given the short duration of the training, healthcare trainees had not fully mastered this knowledge, and the training effects under different teaching modes were found to be equivalent.

The pre-training median score of 69 in this study, which indicates that lack of the knowledge on OBE and standard precaution among healthcare trainees. This result is consistent with the results reported by Zhu Jingrui et al[21] which described that the score of OBE protection knowledge before training was 68.8. Despite the increased risk of accidental exposure to blood and body fluids during clinical placements, preventive measures have received insufficient emphasis. Furthermore, healthcare trainees reported an information gap regarding standard precaution within medical institutions.[22,23] To prevent OBE, a set of infection prevention measures called standard precaution has been designed to combat diseases transmitted through contact with blood, body fluids, broken skin, and mucous membranes.[24] Strengthening training on standard precaution, improving occupational protection awareness, and consciously and correctly utilizing protective equipment are effective intervention measures for reducing occupational exposure and addressing occupational exposure incidents.[25,26]

This study found no statistically significant difference in the accuracy rate between healthcare trainees who had experienced OBE and those who had not. However, it was evident that trainees who had experienced OBE had not yet received standardized and systematic training on the management and standard precaution of OBE. Furthermore, the accuracy rate among trainees who had experienced OBE (69.87%) was lower than that of trainees who had not (71.38%), although the difference was not statistically significant. These findings indicate weak awareness and poor knowledge of standard precaution among healthcare trainees, particularly regarding the concept of OBE.[27]

To address these issues, continuous basic and refresher training on standard precaution is crucial to empower HCWs and ensure compliance with guidelines.[28] Previous studies by Victor Hugo Garcia and Katja Radon have shown that regular training, education, and strict implementation of comprehensive protective measures can prevent over 30% of needle stick injuries.[29] Other studies have revealed that one in four participants had experienced accidental OBE, while three in four students lacked adequate knowledge of standard precaution, especially post-exposure prophylaxis.[30] Untrained students were at a greater risk of needle stick injuries compared to their counterparts who underwent preventive training in Singapore.[31] Special lectures and training sessions can rectify irregular operations and behaviors among healthcare trainees, reducing the risk of OBE incidents.[32,33] Therefore, selecting an appropriate teaching method is essential for enhancing the effectiveness of training.

After training, the accuracy rates in both groups showed improvement compared to before training. Research by Zhou Xiaoxiao et al[34] also showed that the accuracy rates of OBE protection knowledge of medical interns after training (88.70%) was higher than that before training (66.82%). Specifically, in the theoretical group, the accuracy rate for "The follow-up of OBE" knowledge significantly increased from 67.04% to 82.48% after training. However, there was no significant difference in the accuracy rate of "Hand hygiene" knowledge before and after training in the theoretical group. On the other hand, the scenario simulation group demonstrated a significant increase in the accuracy rate of "Hand hygiene" knowledge before and after training.

Scenario simulation is an interactive educational method that involves simulating scenes or programs using similar elements.[35,36] It selects typical and representative cases as the foundation for simulation, integrating the necessary knowledge and theory into them.[37] Over the past few decades, scenario simulation-based medical education has gained significant influence in medical training.[38,39] Medical students consistently report educational benefits from scenario simulation, which improves their confidence in challenging and uncertain situations. Research by Wan-Sheng Peng[40] suggests that scenario simulation effectively enhanced students' knowledge and practical application abilities.

In this study, "Hand hygiene" knowledge was significantly improved in the scenario simulation teaching group. "Hand hygiene" is a practical aspect covered in scenario simulation teaching. Hand hygiene is a critical component for preventing the transmission of pathogens causing healthcare-associated infections, and hand hygiene of healthcare workers were improved after the COVID-19 pandemic.[41] Improving the hand hygiene awareness of healthcare trainers is very important, and only the correct training methods can achieve better results. We provided training by presenting hand hygiene operation videos, allowing healthcare trainees to gain a more intuitive understanding through on-site physical teaching.

Each teaching method in medical education has its own strengths and weaknesses. Theoretical teaching provides students with a systematic medical knowledge system, while scenario-based simulation teaching and virtual reality training enhance students' practical abilities and skill levels. Learning method combines the advantages of online and offline learning, can make it easier for students to master knowledge and skills. Only by flexibly utilizing various teaching methods, we can enhance students' medical literacy and practical abilities.

With the continuous development of technologies, such as VR and Augmented Reality (AR), scenario-based simulation training can provide highly realistic training environments. It can significantly reduce the incidence of medical errors and accidents, thereby saving considerable medical costs. Furthermore, the simulation equipment can be reused, further lowering the training cost per trainee. However, some challenges in practical promotion maybe faced, some institutions cannot adopt scenario-based simulation training due to funding or equipment limitations. In order to provide better training, we can establish a scientific evaluation system, including trainee feedback, simulation test results, actual operational performance, and other aspects, to ensure the quality of training.

There were some limitations. Firstly, this study used a convenient sample, which may introduce potential biases in the sample size. Secondly, this study only assessed theoretical knowledge and did not evaluate the level of skill operation. This may lead to biases or uncertainties in the research results. Without practical skill assessment, we can only rely on questionnaires to infer individuals' skill levels, resulting in findings can not accurately reflect the performance in actual work environments. Based on these limitations, we propose studies for future research. Firstly, we intend to develop effective assessment tools to measure practical skills, and integrate them with theoretical knowledge. Furthermore, interdisciplinary collaboration will be conducted with the aim of integrating knowledge and technology from different fields and promoting deep integration of theory and practice.

Conclusions

This study demonstrated that the self-protection awareness, knowledge on OBE management, and standard precaution among healthcare trainees were enhanced through the training, and "Hand hygiene" knowledge was significantly improved in the scenario simulation teaching group. It is essential to design the training specifically for healthcare personnel with different positions and responsibilities, when implementing scenario-based training. Although we have not tracked the long-term training effectiveness of participants after training, scenario-based simulation training could improve adaptability and decision-making abilities in emergency situations, and enhance teamwork and communication skills. Effective training has a potential long-term positive impact on improving safety awareness and reducing OBE incidents. The situational simulation method significantly outperformed traditional teaching methods in enhancing HCWs knowledge of OBE and their mastery of standard preventive measures. This finding not only validates the effectiveness of the situational simulation teaching method but also further supports the application of constructivist learning theory in medical education.

The limitation of this study is that it mainly focuses on the growth of theoretical knowledge, without directly evaluating the improvement of practical skills. Future research should include an assessment of practical skills to more comprehensively evaluate the effectiveness of training. Additionally, efforts should be made to establish a robust system and process for occupational protection education among healthcare trainees, ultimately reducing the occurrence of OBE incidents.

Data Sharing Statement

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

Ethics Statement

This study was approved by the Ethics Committee of Affiliated Hospital of Jining Medical University, China. Approval number: 2023-10-C002.Informed consent was obtained from all participants.

Acknowledgment

This paper has been uploaded to [Research Square] as a preprint: [https://www.researchsquare.com/article/rs-4562902/v1].

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

The study design, manuscript writing, data collection and analysis and interpretation were supported by 2023 Jining City key research and development plan (soft science) project (No. 2023JNZC052), and the Doctor Research Fund of the Affiliated Hospital of Jining Medical University(No. 2022-BS-01).

Disclosure

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Lee JH, Cho J, Kim YJ, et al. Occupational blood exposures in health care workers: incidence, characteristics, and transmission of bloodborne pathogens in South Korea. *BMC Public Health*. 2017;17(1):827. doi:10.1186/s12889-017-4844-0
2. Tawiah PA, Oppong K, Effah ES, Abaka-Yawson A, Arhin-Wiredu K. Occupational Exposure to Blood and Body Fluids among Medical Laboratory Science Students of the University of Health and Allied Sciences during Vocational Internship in the Volta Region of Ghana. *Sci World J*. 2020;2020:4878315. doi:10.1155/2020/4878315
3. Lemessa D, Solomon T. Occupational Exposure of Health-Care Workers to Blood and Body Fluids in West Shewa Zone, Ethiopia, 2018: a Cross-Sectional Study. *J Environ Public Health*. 2021;2021:2944158. doi:10.1155/2021/2944158
4. Bouya S, Balouchi A, Rafiemanesh H, et al. Global Prevalence and Device Related Causes of Needle Stick Injuries among Health Care Workers: a Systematic Review and Meta-Analysis. *Ann Glob Health*. 2020;86(1):35. doi:10.5334/aogh.2698
5. Auta A, Adewuyi EO, Tor-Anyiin A, et al. Health-care workers' occupational exposures to body fluids in 21 countries in Africa: systematic review and meta-analysis. *Bull World Health Organ*. 2017;95(12):831–841F. doi:10.2471/BLT.17.195735
6. Hajjaji Darouiche M, Chaabouni T, Jmal Hammami K, et al. Occupational blood exposure among health care personnel and hospital trainees. *Int J Occup Environ Med*. 2014;5(1):57–61.
7. Huang J, Li N, Xu H, et al. Epidemiology of needlestick injury exposures among dental students during clinical training in a major teaching institution of China: a cross-sectional study. *J Dent Sci*. 2022;17(1):507–513. doi:10.1016/j.jds.2021.07.018
8. El Bouazzi O, Toujami Z, Raoui SM, et al. Occupational exposure to blood and body fluids among nursing studentshv in clinical internship. *J Public Health Afr*. 2023;14(6):2336. doi:10.4081/jphia.2023.2336
9. Peng L, Liu C, Zhang W. Survey of blood occupational exposure among healthcare workers from 30 hospitals in a City from 2019 to 2020, China. *J Nosocomiol*. 2022;8(32):1239–1242. doi:10.11816/cn.ni.2022-216496
10. Chen M, Zhang D. The Influence of PDCA Process Management on the Incidence of Stab Wound and Psychological Anxiety of Nursing Interns. *Biomed Res Int*. 2022;2022(1):8453697. doi:10.1155/2022/8453697
11. Chen M, Zhang L. Prevalence of needlestick injuries among nursing interns: a systematic review and meta-analysis. *Ann Palliat Med*. 2021;10(7):7525–7533. doi:10.21037/apm-21-703
12. Hada V, Saurabh K, Sharma A, Nag VL, Gadepalli RS, Maurya AK. Nursing students: a vulnerable health-care worker for needlesticks injuries in teaching hospitals. *J Family Med Prim Care*. 2018;7(4):717–720. doi:10.4103/jfmpc.jfmpc_265_17
13. Keleb A, Lingerew M, Ademas A, Berihun G, Sisay T, Adane M. The magnitude of standard precautions practice and its associated factors among healthcare workers in governmental hospitals of northeastern Ethiopia. *Front Health Serv*. 2023;3:1071517. doi:10.3389/frhs.2023.1071517
14. Vaquero-álvarez E, Cubero-Atienza A, Martínez-Jiménez MP, Vaquero-Abellán M, Redel-Macías MD, Aparicio-Martínez P. Occupational Safety and Health Training for Undergraduates Nursing Students: a Spanish Pilot. *Int J Environ Res Public Health*. 2020;17(22):8381. doi:10.3390/ijerph17228381
15. Angaw DA, Gezie LD, Dachew BA. Standard precaution practice and associated factors among health professionals working in Addis Ababa government hospitals, Ethiopia: a cross-sectional study using multilevel analysis. *BMJ Open*. 2019;9(10):e030784. doi:10.1136/bmjopen-2019-030784
16. Casolla B. Simulation for Neurology training: acute setting and beyond. *Rev Neurol (Paris)*. 2021;177(10):1207–1213. doi:10.1016/j.neurol.2021.03.008
17. Şentürk EA, Yaman SŞ, Uzun Aksoy M, et al. Effect of Scenario-Based Simulation Training on the Obstetrics and Gynecology Nursing Clinical Practicum. *J Nurs Res*. 2021;29(2):e142. doi:10.1097/jnr.0000000000000417
18. Leiphrakpam PD, Armijo PR, Are C. Incorporation of Simulation in Graduate Medical Education: historical Perspectives, Current Status, and Future Directions. *J Med Educ Curric Dev*. 2024;11:23821205241257329. doi:10.1177/23821205241257329
19. Chen S, Li X. Investigation of Blood-borne Occupational Exposure of Medical Personnel in Zaozhuang Area. *Guide China Med*. 2023;21(15):98–101. doi:10.15912/j.cnki.gocm.2023.15.039
20. Dai Q, Fu H, Zeng M, et al. The application effect of situational simulation pre-job training in improving the ability of trainees to protect against blood-borne occupational exposure. *China Modern Medicine*. 2020;27:176–179. doi:10.3969/j.issn.1674-4721.2020.27.052
21. Zhu J, Cui Z, Zhang X, et al. Application of situational simulation teaching method in occupational protection training of medical staff. *Chin J Ind Hyg Occup Dis*. 2020;38:278–281. doi:10.3760/cma.j.cn121094-20190321-00110
22. Anteneh B, Belachew SA, Endeshaw A, Wubneh ZB, Sarkar BR. Knowledge, attitude and practices of medical and health science students on the antiretroviral based HIV post-exposure prophylaxis in an Ethiopian hospital: an institutional based cross-sectional study. *BMC Health Serv Res*. 2019;19(1):713. doi:10.1186/s12913-019-4611-2
23. Sodhi K, Chanchalani G, Arya M, et al. Knowledge and awareness of infection control practices among nursing professionals: a cross-sectional survey from South Asia and the Middle East. *World J Crit Care Med*. 2023;12(3):176–187. doi:10.5492/wjccm.v12.i3.176
24. Kassa A, Tadesse SE, Walelign F, Kebede N. Compliance with standard precaution of infection prevention practice and associated factors among health care workers in Ethiopia: mixed method study. *Health Sci Rep*. 2022;5(5):e830. doi:10.1002/hsr2.830
25. Jemal K, Gashaw K, Kinati T, Bedada W, Getahun B. Clean and Safe Healthcare Environment: knowledge, Attitude, and Practice of Infection Prevention and Control among Health Workforce at North Showa Zone Oromiya Region. *J Environ Public Health*. 2020;2020:6021870. doi:10.1155/2020/6021870
26. Alinejad N, Bijani M, Malekhosseini M, Nasrabadi M, Harsini PA, Jeihooni AK. Effect of educational intervention based on health belief model on nurses' compliance with standard precautions in preventing needle stick injuries. *BMC Nurs*. 2023;22(1):180. doi:10.1186/s12912-023-01347-0
27. Bekele T, Ashenaf T, Ermias A, Arega Sadore A. Compliance with standard safety precautions and associated factors among health care workers in Hawassa University comprehensive, specialized hospital, Southern Ethiopia. *PLoS One*. 2020;15(10):e0239744. doi:10.1371/journal.pone.0239744

28. Ogbonda PN, Douglas K, Moore BM. Knowledge and compliance with standard precautions amongst healthcare workers in selected hospitals in rivers state, Nigeria. *Asian J Med Health*. 2020;18(2):11–22. doi:10.9734/ajmah/2020/v18i230181
29. Garcia VH, Radon K. Preventive Training among Medical Interns in Mexico City and Its Association with Needlestick and Sharp Injuries - A Cross Sectional Study. *J Clin Diagn Res*. 2017;11(3):IC05–IC07. doi:10.7860/JCDR/2017/24606.9594
30. Iliyasu BZ, Amole TG, Galadanci HS, Abdullahi SS, Iliyasu Z, Aliyu MH. Occupational Exposure to Blood and Body Fluids and Knowledge of HIV Post-Exposure Prophylaxis among Medical and Allied Health Students in Northern Nigeria. *Int J Occup Environ Med*. 2020;11(4):196–209. doi:10.34172/ijoem.2020.2094
31. Seng M, Lim JW, Sng J, Kong WY, Koh D. Incidence of needlestick injuries among medical students after implementation of preventive training. *Singapore Med J*. 2013;54(9):496–500. doi:10.11622/smedj.2013171
32. Cheetham S, Ngo HT, Liira J, Liira H. Education and training for preventing sharps injuries and splash exposures in healthcare workers. *Cochrane Database Syst Rev*. 2021;4(4):CD012060. doi:10.1002/14651858.CD012060.pub2
33. Marusic V, Markovic-Denic L, Djuric O, Protic D, Dubljanin-Raspopovic E. Knowledge about Blood-borne Pathogens and the Prevalence of Needle Stick Injuries among Medical Students in Serbia. *Zdr Varst*. 2017;56(3):179–184. doi:10.1515/sjph-2017-0024
34. Zhou X, Wei L, Huang H. The effect of PDCA combined with PBL teaching method on reducing the incidence of blood borne occupational exposure among medical students. *China Continuing Medical Education*. 2023;24:58–62. doi:10.3969/j.issn.1674-9308.2023.24.013
35. Peek R, Moore L, Arnold R. Psychophysiological fidelity: a comparative study of stress responses to real and simulated clinical emergencies. *Med Educ*. 2023;57(12):1248–1256. doi:10.1111/medu.15155
36. Fredericks S, ElSayed M, Hammad M, et al. Anxiety is associated with extraneous cognitive load during teaching using high-fidelity clinical simulation. *Med Educ Online*. 2021;26(1):1994691. doi:10.1080/10872981.2021.1994691
37. Gomindes AR, Adeeko ES, Khatri C, et al. Use of Virtual Reality in the Education of Orthopaedic Procedures: a Randomised Control Study in Early Validation of a Novel Virtual Reality Simulator. *Cureus*. 2023;15(9):e45943. doi:10.7759/cureus.45943
38. Guan H, Xu Y, Zhao D. Application of Virtual Reality Technology in Clinical Practice, Teaching, and Research in Complementary and Alternative Medicine. *Evid Based Complement Alternat Med*. 2022;2022:1373170. doi:10.1155/2022/1373170
39. Alsuwaidi L, Kristensen J, Hk A, Al Heialy S. Use of simulation in teaching haematological aspects to undergraduate medical students improves student's knowledge related to the taught theoretical underpinnings. *BMC Med Educ*. 2021;21(1):271. doi:10.1186/s12909-021-02709-5
40. Peng WS, Wang L, Zhang H, et al. Application of virtual scenario simulation combined with problem-based learning for paediatric medical students. *J Int Med Res*. 2021;49(2):300060520979210. doi:10.1177/0300060520979210
41. Zhang X, Ma Y, Kong L, et al. The impact of COVID-19 pandemic on hand hygiene compliance of healthcare workers in a tertiary hospital in East China. *Front. Med*. 2023;10:1160828. doi:10.3389/fmed.2023.1160828