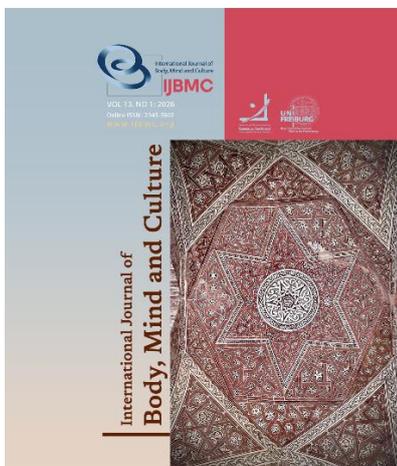


Article type:
Original Research

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Article history:

Received 18 Sep 2025
Revised 24 Nov 2025
Accepted 12 Dec 2025
Published online 01 Jan 2026

How to cite this article:

Sameen, F. Y., Abed, Q. J. O., & Hattab, W. A. A. (2026). Psychometric Evaluation and Normative Validation of the Beliefs and Attitudes Toward Transgenderism Scale in an Iranian Population. *International Journal of Body, Mind and Culture*, 13(1), 133-143.



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Evaluating the Effect of an Educational Program on Nurses' Infection Control Practices in Neurosurgical Units: A Pre-Post Study

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ABSTRACT

Objective: This study aims to evaluate the effectiveness of a training program on nurses' infection control practices for patients undergoing craniotomy in surgical wards. It also seeks to identify the relationship between various factors influencing nurses' infection control practices and the effectiveness of the training program.

Methods and Materials: A cross-sectional design was adopted to achieve the study objectives. The research was conducted in the surgical wards and operating rooms of Ibn Al-Kuff Spinal Cord Injury Hospital in Baghdad, Iraq. The study sample included 48 nurses working in these departments who were directly involved in infection control for craniotomy patients.

Findings: Following the implementation of the training program, nurses' practices were assessed using an observational checklist based on World Health Organization (WHO) infection control standards. A significant improvement in practice scores was observed after the training, with statistical analysis confirming the changes as highly significant ($P < 0.001$).

Conclusion: The findings demonstrate that the infection control training program, grounded in WHO standards, had a substantial positive impact on nurses' practices. The program facilitated the adoption of evidence-based infection-control procedures, enhancing the quality of care for patients undergoing craniotomy in both surgical wards and operating rooms.

Keywords: Nurses' Practice, Infection Control, Craniotomy Surgery.

Introduction

Healthcare-associated infections (HAIs) represent a critical global health challenge, affecting approximately 10% of hospitalized patients worldwide and resulting in increased morbidity, mortality, and healthcare costs (Wang et al., 2020). Among surgical patients, those undergoing neurosurgical procedures such as craniotomy face particularly elevated infection risks due to the invasive nature of the procedure and prolonged hospital stays (Jiménez-Martínez et al., 2019). Despite the implementation of evidence-based infection control protocols by international organizations, significant gaps persist between recommended practices and actual nursing performance in clinical settings (Erdmann et al., 2022). While infection control training programs have shown promise in improving healthcare worker compliance with safety protocols, limited research exists specifically examining their effectiveness in specialized neurosurgical contexts, particularly for craniotomy patients in resource-limited settings such as Iraq (Kourbeti et al., 2015). Current literature reports inconsistent findings on the optimal training methods and their sustained impact on nursing practice in surgical wards (Fang et al., 2017). The majority of hospitals in the region have successfully implemented these protocols by adopting preventive measures that are akin to daily precautionary steps. This study is grounded in Kolb's Experiential Learning Theory, which posits that effective learning occurs through a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation (Campioli et al., 2022). Additionally, it incorporates elements of the Theory of Planned Behavior, which suggests that behavioral change is influenced by attitudes, subjective norms, and perceived behavioral control (Grundy et al., 2020). These theoretical foundations provide a framework for understanding how structured training interventions can translate into improved infection control practices among nursing staff.

Despite extensive research on general infection control training, there remains a paucity of evidence specifically addressing the effectiveness of WHO-standardized training programs on nursing practices for craniotomy patients in Middle Eastern healthcare contexts. Furthermore, most existing studies lack rigorous evaluation of both immediate and sustained

behavioral changes following training interventions (Gundo et al., 2021). The challenge, however, is that any patient who stays in the hospital for more than ten days becomes vulnerable to these infections, particularly those with weakened immune systems (Hatch et al., 2020). In such cases, responsibility is shared among all healthcare providers involved in the patient's care (Hawkins et al., 2024). Special caution must be exercised when dealing with this group, and guidelines should be followed with utmost precision to minimize the risk of infection transmission and achieve a 0% infection rate (Herridge et al., 2016). This is now possible if the hospital is committed to implementing international standards and protocols to control the spread of infections within the hospital environment (Hodgson & Tipping, 2017). This section focuses on applying

the fundamentals of epidemiology and scientific principles to prevent or reduce hospital-acquired infection rates among hospital staff, patients, and visitors (Huang et al., 2023). The section is responsible for strict adherence to the antibiotic treatment policy, wound management, and compliance with the approved guidelines for isolation precautions in healthcare facilities, as well as with all policies related to other departments (Intiso et al., 2017). Additionally, it ensures the availability of resources and equipment that enable healthcare providers, including doctors and nurses, to maintain good infection control practices consistently (Iwasaki & Fukaya, 2018). The educational aspect is crucial in this regard, whether for healthcare providers, hospital staff, patients, or even visitors (Jolley et al., 2016). It is the responsibility of the infection control department to prepare brochures or booklets that highlight the importance of this matter and explain how to maintain general cleanliness and sterilization (Sameen & Abed, 2023). Additionally, they organize workshops and training courses for various departments to teach modern infection-control methods (Zhang et al., 2023). This department is also responsible for monitoring all hospital departments and collaborating with them to implement global infection control guidelines as outlined in international protocols (Young et al., 2018).

Methods and Materials

Study Design

Study Design: A cross-sectional design was employed to achieve the study objectives. The current study was conducted in the surgical wards and operating rooms of Ibn Al Kuff Spinal Cord Injury Hospital in Baghdad, Iraq. **Sampling and Study Subjects:** The study included 48 nurses who worked in surgical wards and operating rooms and were directly responsible for infection control of craniotomy surgery patients. **Sampling method:** Purposive sampling (non-probability) was used to select all eligible nurses meeting the inclusion criteria. All nurses working in the targeted departments during the study period who met the eligibility requirements were invited to participate, resulting in a census sampling approach within the defined population.

Inclusion Criteria: Nurses who had been working in medical and surgical wards for at least one year before data collection commenced and were directly involved in craniotomy patient care.

Exclusion Criteria: Nurses with less than one year of experience in surgical and medical wards, and those not directly responsible for infection control in craniotomy patients (e.g., ward supervisors, head nurses, and their substitutes).

Instruments

Questionnaire for Factors Affecting Infection Control: A structured questionnaire with 4 main domains was developed based on the WHO Standards for Infection Control and a literature review on craniotomy complications. The domains included: (1) Availability of infection control protocols, (2) Type of surgery, (3) Place of surgery, and (4) Level of education. **Nurse Practice Observation Checklist:** This comprehensive tool was designed following an extensive literature review and the WHO infection control guidelines.

Checklist Structure: Total Items: 14 items (9 surgical ward items + 5 operation room items)

Domains: Hand hygiene, PPE usage, sterile technique, wound care, environmental cleaning, patient isolation, medication safety, equipment sterilization, and documentation

Scoring Method: 3-point Likert scale: (2) Correctly performed, (1) Partially performed, (0) Not performed. Total possible score: 28 points

Validity and reliability of data collection tools

In the current study, **Content Validity:** Panel of 5 experts (2 infection control specialists, 2 neurosurgeons, 1 surgical nursing expert) validated the instruments. **Content Validity Index** = 0.89. **Cronbach's alpha coefficient** was 0.702 for the questionnaire, indicating acceptable internal consistency ($\alpha > 0.70$ is considered reliable). **Inter-rater reliability:** Cohen's kappa = 0.85 for the observation checklist, established through dual observations on 10% of participants.

Program regard training was in these details: **Participants:** All 48 eligible nurses received training

Duration: 3-month program with weekly 2-hour sessions (total: 24 hours)

Trainers: Two certified infection control specialists and one neurosurgical nurse educator

Content: WHO-based infection control protocols, hands-on demonstrations, case studies using 15 craniotomy patients as learning examples

Format: Interactive workshops combining theoretical knowledge and practical application. **Data Collection:** The data were collected in three stages. **Pre-training assessment:** Baseline observation of nursing practices, **Immediate post-training:** Assessment within 48 hours of program completion

Follow-up assessment: Evaluation 30 days post-training to assess retention. **Fieldwork:** The researchers developed a questionnaire and an observation checklist to collect data and evaluate the effectiveness of educational and training interventions in enhancing nurses' compliance with infection control measures for craniotomy patients. Data were collected at three time points: a pre-test, an immediate reassessment after program implementation, and a follow-up assessment 30 days after the initial evaluation. The data collection process consisted of three main phases: the initial and pre-test phase, the program implementation phase, and the post-test phase. **Limitations of the Current Study:** Data were collected only from nurses working in surgical wards who directly care for patients undergoing craniotomy. However, there is a similarity between the factors affecting nursing care quality and the direct implementation of infection control measures with patients, which allows for the possibility of generalizing the results.

Ethical considerations

Ethical Approval: Study approved by the Ethics Committee of Middle Technical University. Written permission obtained from Rusafa Health Department and hospital administration.

Informed Consent: All participants provided written informed consent after receiving detailed explanation of study purpose, procedures, risks, benefits, and their right to withdraw. Consent forms were administered individually, ensuring voluntary participation and confidentiality protection.

Findings and Results

The results from the Table 1 indicate that infection control practices for cranial surgery patients were weak, ranging from 19% to 30% in surgical wards and

operating rooms. This suggests the absence of training programs in this area. Most repetitions of practices adhering to infection control standards were very low.

Table 1

Nurses' practices before training on infection control for craniotomy patients (in surgical and operation rooms)

Observation of nurses' practices through standard precautions: Surgical wards	Nurses practice (1), (2) time observation	
	Frequency (n)	Percentage (%)
Open the dressing kit or box after checking the sterilization date and integrity of the packaging.	30	60%
Wash hands with soap and alcohol before surgically inserting paws	0	00.0
Proper disinfection of medical devices, thermometer	0	00.0
Properly dispose of personal protective equipment when finished	16	39.0
Wash hands with a clinical waste disposal kit	0	00.0
Adherence to the policy of visiting the patient and seeing him remotely by the family	10	24.4
He washed hands before sterilizing and cleaning the patient	12	25.0
Materials used to sterilize the wound, such as iodine or alcohol, focus on their proportions	0	00.0
Use a transparent cover to bandage the wound and evaluate the condition of the wound through the area around it	9	22.0
Total	19.8%	
Observation of nurses' practices through standard precautions: Operation room		
Hand washing and disinfection: Properly washing hands with soap and water or using alcohol-based hand sanitizers to eliminate germs.	17	35.4
Use of personal protective equipment (PPE): Wearing gloves, masks, surgical gowns, and head covers to prevent the transmission of infections.	0	00.0
Creating and maintaining a sterile field: Ensuring that all tools and equipment used are sterilized and preserving sterility during the procedure.	10	24.4
Isolating the surgical site: Cleaning and disinfecting the skin at the surgical site and using sterile drapes to isolate it.	12	25.0
Maintaining a safe environment in the surgical area: Keeping the operating room clean and disinfected, with controlled temperature and humidity levels suitable for safe practices	11	22.9
Total	22.6%	

Table 2

Nurses' practices after training on infection control for craniotomy patients (in surgical and operation rooms).

Observation of nurses' practices through standard precautions: Surgical wards	Nurses practice (1), (2) time observation	
	Frequency (n)	Percentage (%)
Open the dressing kit or box after checking the sterilization date and integrity of the packaging.	31	75.6
Wash hands with soap and alcohol before surgically inserting paws	41	100.0
Proper disinfection of medical devices, thermometer	18	37.5
Properly dispose of personal protective equipment when finished	17	35.4
Wash hands with a clinical waste disposal kit	41	100.0
Adherence to the policy of visiting the patient and seeing him remotely	16	39.0

by the family		
He washed hands before sterilizing and cleaning the patient	32	78.0
Materials used to sterilize the wound, such as iodine or alcohol, focus on their proportions	41	100.0
Use a transparent cover to bandage the wound and evaluate the condition of the wound through the area around it	25	61.0
Total	91.3%	
Observation of nurses' practices through standard precautions:		
Operation room		
Hand washing and disinfection: Properly washing hands with soap and water or using alcohol-based hand sanitizers to eliminate germs.	17	35.4
Use of personal protective equipment (PPE): Wearing gloves, masks, surgical gowns, and head covers to prevent the transmission of infections.	12	25.0
Creating and maintaining a sterile field: Ensuring that all tools and equipment used are sterilized and preserving sterility during the procedure.	30	62.5
Isolating the surgical site: Cleaning and disinfecting the skin at the surgical site and using sterile drapes to isolate it.	18	37.5
Maintaining a safe environment in the surgical area: Keeping the operating room clean and disinfected, with controlled temperature and humidity levels suitable for safe practices	11	22.9
Total	82.1%	

The results in Table 2 show that observation rates at two time points, with a one-month gap after the training program was implemented, demonstrated significant improvements in nurses' infection-control practices

while caring for cranial surgery patients in surgical wards and operating rooms. The rates ranged from 80% to 95%, a substantial improvement over the pre-training period.

Table 3

Statistical differences regarding the training program for nurses' infection control practices for craniotomy patients.

Observation of nurses' practices through standard precautions: Surgical wards	Before			After			After			F test	P value
	Training program	Mean	± SD	Training program (1)	Mean	± SD	Training program (2)	Mean	± SD		
Open the dressing kit or box after checking the sterilization date and integrity of the packaging.	10.34	± 1.4	5	14.95	± 2.03		17.90	± 1.8	2	671.72	.001
Wash hands with soap and alcohol before surgically inserting paws	39.0	± 7.9	2	43.12	± 6.14		49.5073	± 9.6	2	289.10	.0003
Proper disinfection of medical devices, thermometer	3.17	± .38		3.17	± .38		4.7805	± 1.4	7	53.28	.006
Properly dispose of personal protective equipment when finished	9.82	± 4.9	1	17.95	± 5.62		26.82	± 5.0	7	201.50	.001
Wash hands with a clinical waste disposal kit	7.51	± 1.6	4	8.95	± .21		13.36	± 2.3	4	94.85	.003
Adherence to the policy of visiting the patient and seeing him remotely by the family	12.5	± 3.3	3	16.43	± 2.54		19.31	± 2.0	3	120.96	.005
He washed hands before sterilizing and cleaning the patient	38.0	± 6.9	2	44.12	± 6.13		49.7073	± 9.5	2	289.10	.001
Materials used to sterilize the wound, such as iodine or alcohol, focus on their proportions	3.17	± .38		3.17	± .38		4.7805	± 1.4	7	53.28	.006
Use a transparent cover to bandage the wound and evaluate the condition of the wound through the area around it	9.82	± 4.7	1	17.95	± 5.52		24.82	± 5.0	7	201.50	.001
Observation of nurses' practices through standard precautions: Operation room											
Hand washing and disinfection: Properly washing hands with soap and water or using alcohol-based hand sanitizers to eliminate germs.	24.0	± 5.24	7	31.0	± 4.67		35.21	± 3.07		268.96	.001
Use of personal protective	18.5	± 4.35		25.5	± 3.49		26.60	± 2.39		199.48	.001

equipment (PPE): Wearing gloves, masks, surgical gowns, and head covers to prevent the transmission of infections.	8		3								
Creating and maintaining a sterile field: Ensuring that all tools and equipment used are sterilized and preserving sterility during the procedure.	14.3	±	4.14	22.0	±	3.47	24.58	±	2.53	1^1.26	.001
Isolating the surgical site: Cleaning and disinfecting the skin at the surgical site and using sterile drapes to isolate it.	38.0	±	6.92	44.1	±	6.13	49.7073	±	9.52	289.10	.001
Maintaining a safe environment in the surgical area: Keeping the operating room clean and disinfected, with controlled temperature and humidity levels suitable for safe practices	3.17	±	.38	3.17	±	.38	4.7805	±	1.47	53.28	.006

Statistically significant at p<0.01

The results in Table 3 indicate a significant improvement in nurses' infection-control practices for craniotomy patients. Before the training program, very low scores were observed in initial assessments of infection-control practices. After implementing the

training program, based on WHO infection-control standards, there was a notable improvement in nurses' practice scores. The improvements observed after the implementation of the training program were statistically significant at (P<0.001).

Table 4

Relationship between factors affecting nurses' infection-control practices and training programs.

Observation	Time	Relation	P Value
Time 1	Before Apply	.862	.0001
Time 2	After Apply	.720	.001
Time 2	After Apply	.325	.170

Time (1) before the application training program. Statistically significant at p<0.01, Time (2) after application training program, Time (3) after application training program.

The results of Table 4 revealed a positive correlation between the factors influencing the level of infection control during nurses' practices and the training program, at a statistical significance level of (P<0.001). This relationship was noticeable between the first time

point (before the program) and the second time point (after the program). This indicates that as the influencing factors increase, they positively impact the practices and adherence to infection control measures (Figure 1 & 2).

Figure 1

different level of nurse practice after and before application training program in surgical wards, operation room.

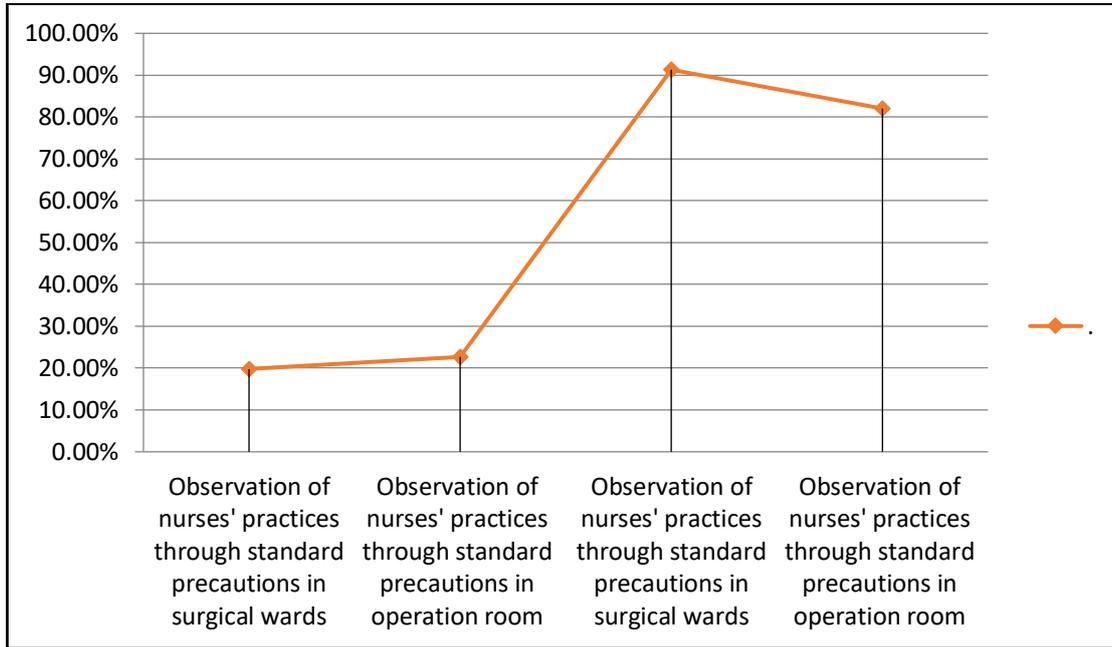
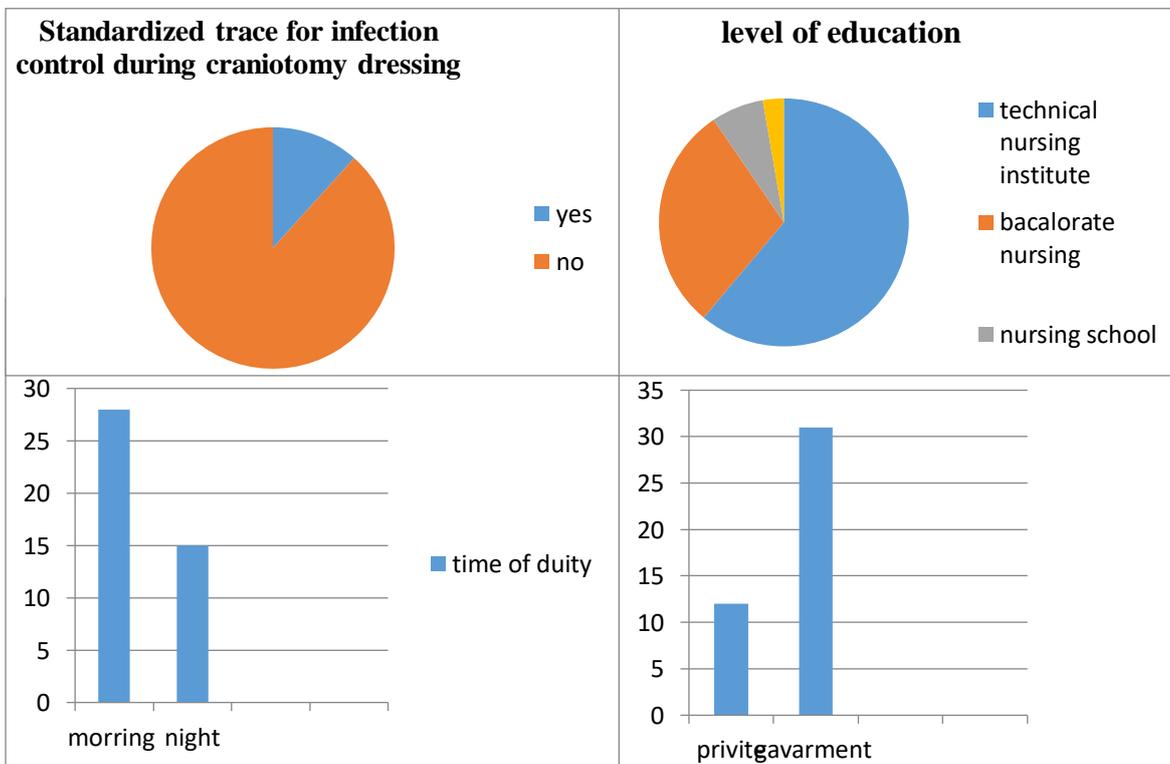


Figure 2

Distribution the Factors affecting on nurses’ practices concerning infection control for patients with craniotomy, Ibn Al Kuff Spinal Cord Injury Hospital, (n = 48).



Discussion and Conclusion

In the context of healthcare, particularly for critically ill patients such as those with brain injuries, infection control is a key factor that significantly impacts treatment outcomes (Abed et al., 2018). The findings of current study show significant improvement in nurses' infection control practices following implementation of training program, which aligns with established theoretical frameworks for healthcare behavior change. From a theoretical perspective, these findings support Kolb's Experiential Learning Theory, where the combination of concrete experience (hands-on practice with craniotomy patients), reflective observation (peer learning during training), and active experimentation (post-training practice implementation) facilitated sustained behavioral change among participants. However, this focus is not limited to healthcare staff alone; it also requires active participation from patients and their families (Robinson, 2021). Iodine: A Micronutrient Essential for Human Development and Survival. Understanding the importance of adhering to hygiene and sterilization procedures can have a significant impact on reducing the spread of infections within hospital (Abed et al., 2018). The inadequacy of the cross-sectional design to demonstrate causality, possible observer bias in practice evaluation, and the very little follow-up time (30 days) that would not account for long-term behavior maintenance are some of the limitations and important factors to take into account. Additionally, the intervention's longevity and real-world applicability may be limited by its emphasis on individual-level change at the expense of organizational impediments.

According to theoretical implications, in order to achieve more thorough and long-lasting improvements in infection control practices, future interventions should incorporate multilevel approaches, combining organizational change strategies, administrative policy reforms, and continuous quality improvement mechanisms with individual skill development. One of the fundamental aspects that should be part of the healthcare system is the thorough sterilization of all medical tools and equipment before and after use (Ghareeb et al., 2024). This simple yet essential practice is one of the key factors in preventing the transmission of infections from one patient to another or from the

surrounding environment to the body (AmerMuhssen Nasir, 2019). Additionally, regular hand washing according to global health standards is one of the basic factors in infection control (Yang et al., 2021). Everyone, whether healthcare staff, patients themselves, or visitors, must adhere to hand washing regularly, especially before and after interacting with patients (Wu et al., 2019). On the other hand, there must be careful monitoring of infection signs in patients (Sameen et al., 2021). Early intervention when any signs of infection appear can be the difference between recovery and deterioration in health (Abed et al., 2018). Therefore, a quick response to any warning signs of infection is crucial. Finally, infection control is not limited to healthcare staff; it must also include continuous health education for patients and their families on the importance of following preventive instructions (Berghmans et al., 2022). Awareness is one of the most effective tools in reducing the spread of infection, as patients and their families understand how to contribute to maintaining a safe, contamination-free environment. These steps come together in an integrated manner to enhance infection control standards within hospitals, directly improving the quality of healthcare provided. This approach not only increases the chances of recovery but also helps reduce the length of hospital stays and aids patients in returning to their normal lives more quickly (McKerr et al., 2017). The data was collected from a sample before and after the implementation of the training program, focusing on the practices of nurses regarding infection control for patients with cranial surgery in surgical wards and operating rooms. The results showed that the majority of nurses in the sample were from the Nursing Technical Institute, accounting for 72.7% of the total, which reflects a high level of education in this sector compared to other educational levels such as Nursing College graduates or Nursing Secondary School graduates. This suggests that specialized education at the Nursing Technical Institute may have contributed to improving infection control practices. Regarding nurses working in the public sector, they made up 69.8% of the total, a relatively high percentage, reflecting the significant reliance on this group in providing healthcare in public hospitals. This high percentage likely indicates the importance of continuous training and effective practices followed by this group of nurses. For nurses working in morning

shifts, their percentage was about 70.4%. The data showed that most of these nurses had not been exposed to any specific guidelines or standards for implementing infection control, indicating a gap in training and guidance for this group. However, a small percentage (5%) of nurses had received instructions on the importance of infection control practices, highlighting the need to enhance these programs to include everyone equally. In table (1), it is emphasized that there is a clear difference between nurse categories in terms of education and training, which directly impacts their effectiveness in implementing infection control practices in figure (1). The results of the current study align with a study conducted in Nigeria at Abuja Hospital regarding nurses' knowledge before and after the educational program aimed at reducing craniotomy complications. That study showed that the majority of participating nurses were graduates of nursing institutes, holding a diploma degree at a rate of 79.4%. Additionally, the results indicated that most nurses worked in the private sector at a rate of 68.3%, while the percentage of those working evening shifts was approximately equal to those working morning shifts at 50%. This consistency between the two studies highlights the importance of educational programs in improving nurses' knowledge, regardless of the healthcare system or country. It also underscores the influence of educational background and working conditions on the outcomes of such programs (Liu et al., 2024). Table (4): Statistical evidence indicates a relationship between the factors influencing nurses' practices regarding infection control during the care of craniotomy patients at a significance level of ($p < 0.001$). Specifically, as nurses' educational levels increase, their infection control practices improve when caring for these patients. However, there is an inverse relationship concerning nurses' workplaces, as working in the public or private sector negatively affects their adherence to the fundamentals of infection control. Therefore, nurses' practices should be linked to the provision of standardized infection control guidelines in both operating rooms and surgical wards. study conducted in Malaysia focused on measuring nurses' practices regarding infection control. It found that the majority of nurses improved their practices to 89% after implementing the internal program. Previously, their practices were significantly lower, and the improvement was statistically significant at a p-value of < 0.005 (Yang

et al., 2021). Additionally, a study conducted in Huai Province, China, at Hong Kong Hospital in the neurosurgery operating rooms revealed that several factors influence nurses' practices regarding infection control. Regular training sessions are therefore needed to update their standards periodically (Liu et al., 2024). The statement indicates that the application of infection control standards in surgical wards and operating room equipment heavily depends on the hospital's system and management. In private sector hospitals, nurses are more consistent in adhering to these standards. This is because private hospitals place significant importance on their reputation, relying on attracting patients and ensuring their satisfaction to maintain their competitive position. Thus, adherence to quality standards and infection control is considered part of the hospital's strategy to preserve its positive image. A critical evaluation of the intervention's efficacy highlights a number of crucial factors. Although the statistically significant improvement ($p < 0.001$) demonstrates program efficacy, the magnitude of change and its clinical significance warrant deeper examination. Although isolated training interventions may be helpful, they may not address underlying organizational factors like resource availability, administrative support, and workplace culture that influence sustained practice change. This is indicated by the pre-training compliance rates, which point to systemic gaps in infection control knowledge and practice.

Conclusion

This study showed that a structured infection control training program based on WHO standards significantly improved nurses' adherence to infection prevention protocols for craniotomy patients in both surgical wards and operating rooms. - Hospital administrations should integrate WHO-based infection control checklists and training modules into routine education for intensive care unit and surgical staff, especially for high-risk procedures like neurosurgery - Future research should include randomized controlled trials and longitudinal studies to assess long-term knowledge retention and evaluate patient outcomes alongside nursing practices for a more comprehensive understanding of the program's impact.

Acknowledgments

The authors express their gratitude and appreciation to all participants.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. Ethical considerations in this study were that participation was entirely optional.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

Authors' Contributions

All authors equally contribute to this study.

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