RESEARCH PAPER

Effectiveness of an Educational Program on Nurses' Practice Regarding Infection Control Among Children with Burn Injuries in Erbil City
Running Title: Infection Control Education for Nurses

Salih Mustafa Salih *[1], Kaify Jamil Qadir [2], Dler Abdulkhaleq Nooruldeen[3]

Author affiliations / organizations

[1] Department of Nursing, College of Nursing, Hawler Medical University and Erbil Medical Institute, Erbil Polytechnic University, Erbil, Iraq

[2] Department of Nursing, College of Nursing, Hawler Medical University, Erbil, Iraq

[3] Department of pediatric, College of Medicine, Hawler Medical University، Erbil, Iraq

***Corresponding author:** Salih Mustafa Salih, Department of Nursing, College of Nursing, Hawler Medical University, Erbil, Iraq, salih.salih@nur.hmu.edu.krd Tel number: +9647504763908

Full names of the authors, highest degree earned, title, emails and ORCID Ids

Salih Mustafa Salih: salih.salih@nur.hmu.edu.krd
https://orcid.org/0000-0003-3160-1477

Kaify Jamil Qadir: kaify.qadir@hmu.edu.krd
https://orcid.org/0009-0000-7248-8031

Dler Abdulkhaleq Nooruldeen: Dler.chalabi@hmu.edu.krd
https://orcid.org/0000-0002-2536-9950

Abstract:

Background and Aim: Burn-related infections remain a major global health concern, particularly in pediatric care, where inadequate nursing practices contribute to high morbidity and mortality. Up to 70% of pediatric burn deaths are attributed to infections, mainly due to poor aseptic techniques, inadequate environmental hygiene, and limited professional training. This study aimed to evaluate the effectiveness of an educational program on nurses' infection-control practices among children with burn injuries in Erbil City, Iraq.

Method: A quasi-experimental study was conducted from April 2024 to November 2027 at the Burn and Reconstructive Surgery Hospital in Erbil, Kurdistan Region, Iraq. A purposive sample of 60 nurses was equally assigned to intervention (n = 30) and control (n = 30) groups. Data were collected using a structured tool that included sociodemographic characteristics and a 34-item observational checklist covering infection-control practices such as hand hygiene, use of personal protective equipment (PPE), aseptic dressing, environmental sanitation, and isolation protocols. Data analysis was performed using SPSS version 26.0, applying descriptive statistics, Chi-square tests, paired and independent t-tests, one-way ANOVA, and effect size measures (Cohen's d and η^2).

Results: The intervention group showed a highly significant improvement in infection-control practices compared to the control group. The mean practice score increased from 12.25 ± 2.25 pre-intervention to 28.60 ± 1.22 post-intervention ($p < .01$), with a mean difference of 16.35 (95% CI: 15.42–17.28) and a very large effect size (Cohen's d = 9.85; $\eta^2 = 0.95$). Additionally, 93.33% of nurses in the intervention group achieved an adequate practice level (≥80%), while none in the control group did. Significant improvements were observed across all practice domains.

Conclusions: The educational program was highly effective in enhancing nurses' infection-control practices in pediatric burn care. Structured, practical, and simulation-based training

programs are recommended to improve nursing performance and reduce hospital-acquired infections.

Keywords: Burn Injuries, Infection Control, Educational Program, Nurses' Practice, Pediatric Burns, Erbil City, Iraq

How to cite this article: Salih SM, Qadir KJ, Nooruldeen DA. Effectiveness of an Educational Program on Nurses' Practice Regarding Infection Control Among Children with Burn Injuries in Erbil City. Int J Drug Deliv Technol. 2026;16(48s): 1486-1500. DOI: 10.25258/ijddt.16.48s.145

1. Introduction

Burn-related infections continue to pose a major global health problem, yet nursing practices for infection prevention in pediatric burn care have historically been underestimated and overlooked (1). It is estimated that 60–70% of burn-related deaths in children are directly linked to infections acquired during hospital stay, reflecting major gaps in aseptic nursing care (1). Inconsistent procedural techniques, insufficient staff training, and poor environmental hygiene contribute to infection rates ranging from 30% to 70% among pediatric burn patients worldwide (1, 2). Although burn injuries occur in every region, nurses in low-resource hospitals, who often lack adequate equipment and supervision, are most challenged (3). In Iraq, recent hospital audits revealed that fewer than 50% of nurses performing pediatric burn wound care consistently adhere to infection-control guidelines. Global initiatives to strengthen burn management and infection prevention were launched by WHO in 2001; however, the specific aspect of nursing practice in pediatric burn infection control was not addressed (1, 4). Defined international goals for infection control in pediatric burn units were only introduced decades later within the WHO 2021–2030 trauma and burn care roadmap (5, 6). Consequently, pediatric burn infection prevention has remained "one of the most neglected aspects of nursing practice.

Unlike other surgical or wound-care procedures, pediatric burn management requires continuous sterile handling and vigilant infection prevention, as children are highly susceptible to sepsis and delayed healing (7). Studies estimate that 40–60% of pediatric burn units experience at least one hospital-acquired infection outbreak annually due to improper nursing practices (8). Nurses with strong infection-control skills demonstrate fewer complications, reduced cross-contamination, and improved recovery rates among pediatric burn patients (1, 9). In contrast, inadequate practice skills are associated with prolonged hospitalization, graft failure, and antibiotic resistance (10). In Erbil City, observations from local hospitals revealed that more than one-third of nurses reuse non-sterile dressing scissors or fail to disinfect surfaces between procedures, contributing to recurrent infection episodes. In critical care units, overcrowding, limited space, and high turnover exacerbate cross-infection risks (11). Microbial cultures from these units frequently identify multidrug-resistant organisms such as Pseudomonas aeruginosa and Staphylococcus aureus, underscoring the urgent need for improved practice-based training (12). Repeated procedural errors and poor aseptic compliance continue to compromise both child safety and treatment outcomes(13).

Current infection-prevention guidelines emphasize strict hand hygiene, sterile glove use, wound isolation, and disinfection of instruments between procedures (14). However, observational data from burn units in neighboring countries show compliance rates below 65%, and that infection-control

audits are rarely performed (15). (16). Although these approaches yield measurable improvements, their implementation remains inconsistent due to institutional and logistical barriers (17). Variability in nursing experience, limited access to modern sterilization equipment, and weak supervisory mechanisms continue to contribute to substandard infection-control practices (18). In Erbil hospitals, continuing professional development programs targeting practical infection-control skills are scarce, and many nurses report never having attended formal infection-prevention training sessions. Updated frameworks now encourage simulation-based education and direct performance evaluation to reinforce infection-prevention compliance among nursing staff. Yet despite these advances, structural limitations and uneven knowledge-to-practice translation persist across hospital settings

Given the high infection rates and severe outcomes associated with pediatric burns, there is an urgent need to evaluate whether educational interventions can effectively enhance nurses' infection-control practices. Nursing practice plays a pivotal role in minimizing cross-infection, promoting wound healing, and reducing patient morbidity (19). Evidence from recent studies has shown that practical training significantly improves adherence to aseptic techniques and reduces contamination rates in burn units (16, 20). Furthermore, continuous evaluation and feedback mechanisms have been found to sustain improved procedural performance over time. The present study, therefore, aims to determine the effectiveness of an educational program on nurses' practice regarding infection control among children with burn injuries in Erbil City.

2. Research Question

What is the effectiveness of an educational program on nurses' practice regarding infection control among children with burn injuries in Erbil City?

3. Methods

3.1. Study Design, Setting, Period, and Sampling

This quasi-experimental study was carried out at the Burn and Reconstructive Surgery Hospital in Erbil City, Kurdistan Region, Iraq, from April 2024 to November 2027. The Burn and Reconstructive Surgery Hospital, established in 1996, is a specialized 60-bed medical facility dedicated to the treatment of burn injuries. It provides comprehensive care, including acute management, surgical and medical interventions, rehabilitation, and psychological support. The hospital employs a multidisciplinary team comprising surgeons, nurses, physical therapists, and psychologists, all specializing in burn care.

3.2. Sample Size

The sample size was calculated based on the availability of eligible nurses working in the Burn and Reconstructive Surgery Hospital in Erbil City. Participants were divided equally into two groups: an intervention group (n = 30) who received the educational program, and a control group (n = 30) who did not receive the intervention. Finally, a total of 60 nurses were selected.

3.3. Inclusion/exclusion

The inclusion criteria were: (1) nurses who provided direct care for children with burns in the burn unit, (2) both genders, (3) nurses with more than one year of experience, and (4) nurses with any level of educational qualification. The exclusion criteria included: (1) nurses working in the operating theatre for burns, and (2) nurses who refused to participate in the study.

3.4. Study Tools and Data Collection

The study instruments consisted of three main parts developed by the researcher to assess nurses' knowledge and practice regarding infection control among children with burn injuries. The first part included Sociodemographic Characteristics, which covered 9 items such as age, gender, marital status, educational level, years of experience, and participation in post-academic education or training courses related to infection control. These data were used to describe the background and professional profile of the

The third section was an Observational Checklist designed to measure nurses' practical performance in infection prevention and control. It included 34 items distributed across key procedural domains such as hand hygiene, glove changing, wound dressing management, aseptic technique, waste disposal, and maintaining a sterile environment. Each task was scored as 2 points if performed correctly, 1 point if partially performed, and 0 points if performed incorrectly or omitted. The total possible score ranged from 0 to 68, with practice levels categorized as poor (≤34), fair (35–51), and good (>51).

3.7. Ethical Approval and Inform Consent

Ethical approval for this study was obtained from the Ethical Committee of the College of Nursing, Hawler Medical University (HMU) (Approval Code: 247 6/6 2024). Administrative permissions were secured from the Directorate of Health in Erbil and the Burn and Reconstructive Surgery Hospital. Written and oral informed consent was obtained from all participating nurses prior to data collection. Participation was voluntary, and confidentiality and anonymity were strictly maintained throughout the study.

3.8. Statistical Analysis

Data were summarized and reported with frequency and percentage for qualitative variables such as sociodemographic characteristics and categorical practice indicators. Quantitative variables were expressed as mean and standard deviation. The relationships between demographic factors and post-intervention practice scores were analyzed using independent t-tests and one-way ANOVA, while associations between categorical variables were evaluated with Chi-square and Fisher's exact tests when appropriate. Pre- and post-intervention comparisons within each group were conducted using paired t-tests, and between-group comparisons were assessed using independent t-tests to identify the effectiveness of the educational program on nurses' infection-control practices. Domain-level analyses were performed to evaluate nurses working in the Burn and Reconstructive Surgery Hospital. The second part comprised an Observational Checklist used to evaluate nurses' practical performance in the burn unit. This checklist contained 34 items covering activities such as handwashing, glove changing, wound dressing procedures, maintaining a safe environment, and using aseptic techniques. All instruments were designed in English and translated into Kurdish using the forward–backward translation method to ensure linguistic and conceptual accuracy. Data were collected direct observation by the researcher. Participants in both the intervention and control groups completed a pre-test to assess practice, followed by an immediate post-test and a follow-up post-test after 12 weeks to evaluate the effect of the educational program. The observation checklist took around 45–55 minutes.

3.5. Pilot Study

The study instruments were initially tested with a group of 10 nurses from the Burn and Reconstructive Surgery Hospital in Erbil City between February 7th and February 21st, 2024. The pilot testing aimed to evaluate the clarity, feasibility, and internal consistency of the observational checklist before their use in the main study. Reliability was assessed using Cronbach's alpha to determine the internal consistency of the instruments (21). The overall Cronbach's alpha coefficient for the practice section was 0.91, indicating excellent reliability. It is important to note that the data from the pilot study were excluded from the final analysis.

3.6. Measures

3.6.1. Sociodemographic Characteristics

The first section of the questionnaire focused on the sociodemographic characteristics of the participating nurses. It included 9 items such as age, gender, marital status, educational level, years of professional experience, type of training courses attended, and participation in post-academic education related to infection control.

3.6.2. Observational Checklist for Nurses' Practice

improvements across specific practice areas, including hand hygiene, PPE use, environmental safety, visitor management, and aseptic techniques. Effect size and magnitude of intervention impact were calculated using Cohen's d, eta squared (η^2), and mean differences to determine the strength of the intervention effects. Additional metrics such as Number Needed to Teach (NNT) and Relative Risk were computed to estimate the practical effectiveness of the intervention. Clinical decision support thresholds were developed based on regression and domain-level results to guide future educational recommendations. All analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY), and statistical significance was set at $p < 0.05$.

4. Results

4.1. Sociodemographic Characteristics of Nurses

A total of 60 nurses participated in the current study, equally divided into 30 nurses in the intervention group and 30 nurses in the control group. The results showed that the majority of nurses in both groups were within the 31–42 years age range, with mean ages of 37.20 ± 5.10 years in the control group and 36.40 ± 5.40 years in the intervention group. Regarding gender, 15 nurses (50.00%) in the control group and 20 nurses (66.67%) in the intervention group were female, indicating female predominance in both groups. Most participants held a nursing diploma, representing 27 nurses (90.00%) in the control group and 25 nurses (83.33%) in the intervention group. The majority were married, accounting for 27 nurses (90.00%) in the control group and 25 nurses (83.33%) in the intervention group. Concerning residency, 22 nurses (73.33%) from each group lived in urban areas, while 8 (26.67%) resided in suburban areas. Almost all nurses (57; 95.00%) reported having no prior information or formal training about infection control in burn care. Additionally, 18 nurses (60.00%) in each group had received the hepatitis vaccination, while only 9 nurses (15.00%) overall had received the influenza vaccine in the past two years. No statistically significant differences were observed between groups across any demographic variables ($p > .05$), confirming baseline comparability. Detailed demographics and other variables are presented in Table 1.

Table 1: Sociodemographic Characteristics of Nurses (N = 60)

Variable	Category	Control Group F (%)	Intervention Group F (%)	p-value
Age Group (years)	25–30	2 (6.67)	2 (6.67)	0.46
	31–36	9 (30.00)	13 (43.33)	
	37–42	16 (53.33)	10 (33.33)	
	43–48	3 (10.00)	5 (16.67)	
Gender	Male	15 (50.00)	10 (33.33)	0.19
	Female	15 (50.00)	20 (66.67)	
Level of Education	Nursing School	3 (10.00)	5 (16.67)	0.45
	Diploma	27 (90.00)	25 (83.33)	
Marital Status	Single	3 (10.00)	5 (16.67)	0.45
	Married	27 (90.00)	25 (83.33)	
Residency	Urban	22 (73.33)	22 (73.33)	0.55
	Suburban	8 (26.67)	8 (26.67)	
Information Received Regarding Infection Control	Yes	0 (0.00)	3 (10.00)	0.76
	No	30 (100.00)	27 (90.00)	
Participation in Training Course About Infection Control in Burn	Yes	0 (0.00)	0 (0.00)	0.49
	No	30 (100.00)	30 (100.00)	
Hepatitis Vaccination Received	Yes	18 (60.00)	18 (60.00)	0.33

	No	12 (40.00)	12 (40.00)	
Influenza Vaccine in the Last Two Years	Yes	3 (10.00)	6 (20.00)	0.28
	No	27 (90.00)	24 (80.00)	

Note: All values are expressed as frequency (percentage). Statistical significance was assessed using the Chi-square test; $p < .05$ was considered significant.

4.2. Assessment of Practice Among Nurses Regarding Infection Control

The results revealed that the educational program led to a substantial improvement in nurses' infection control practices within the pediatric burn unit. The intervention group demonstrated significantly higher achievement levels across nearly all 34 practice items compared to the control group ($p < .01$). For instance, 90–100% of nurses in the intervention group consistently practiced proper hand hygiene, glove changing, PPE usage, waste disposal, and environmental cleaning, while corresponding rates in the control group ranged between 10% and 50%. Similarly, adherence to visitor management and isolation procedures improved dramatically, with nearly all intervention participants achieving full compliance. The total mean practice score increased from 12.40 ± 2.10 in the control group to 28.60 ± 1.22 in the intervention group ($p < .01$), reflecting the program's effectiveness in promoting consistent and correct infection control behaviors among nurses. For further details, see Table 2.

Table 2: Assessment of Practice Among Nurses Regarding Prevention of Infection Control in Pediatric Burn Unit (n = 60)

No.	Item	Control Group (n = 30)			Intervention Group (n = 30)			
		Not Achieved F (%)	Sometimes F (%)	Achieved F (%)	Not Achieved F (%)	Sometimes F (%)	Achieved F (%)	p-value
1	Wash hands on arrival at work	24 (80.00)	0 (0.00)	6 (20.00)	3 (10.00)	0 (0.00)	27 (90.00)	< .01
2	Wash hands before patient contact	22 (73.33)	0 (0.00)	8 (26.67)	2 (6.67)	0 (0.00)	28 (93.33)	< .01
3	Wash hands before aseptic technique	25 (83.33)	0 (0.00)	5 (16.67)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
4	Wash hands after patient contact	14 (46.67)	0 (0.00)	16 (53.33)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
5	Wash hands after touching contaminated surfaces	20 (66.67)	0 (0.00)	10 (33.33)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
6	Wash hands after body fluid exposure	18 (60.00)	0 (0.00)	12 (40.00)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
7	Wash hands before wearing gloves	27 (90.00)	0 (0.00)	3 (10.00)	2 (6.67)	0 (0.00)	28 (93.33)	< .01
8	Wash hands after removing gloves	22 (73.33)	0 (0.00)	8 (26.67)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
9	Use alcohol rub/antimicrobial	27 (90.00)	1 (3.33)	2 (6.67)	2 (6.67)	0 (0.00)	28 (93.33)	< .01
10	Use no-touch technique	30 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	30 (100.00)	< .01
11	Keep nails short, clean, and polish-free	9 (30.00)	0 (0.00)	21 (70.00)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
12	Hand hygiene between patient contacts	26 (86.67)	1 (3.33)	3 (10.00)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
13	Wear gloves when touching blood/body fluids	0 (0.00)	0 (0.00)	30 (100.00)	0 (0.00)	0 (0.00)	30 (100.00)	0.84
14	Wear gloves during invasive procedures	20 (66.67)	1 (3.33)	9 (30.00)	2 (6.67)	0 (0.00)	28 (93.33)	< .01
15	Change gloves between patient contacts	27 (90.00)	0 (0.00)	3 (10.00)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
16	Change gloves	29 (96.67)	0 (0.00)	1 (3.33)	1 (3.33)	0 (0.00)	29	< .01

	between procedures (same patient)						(96.67)	
17	Wear gown properly each procedure	26 (86.67)	1 (3.33)	3 (10.00)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
18	Wear mask and glasses for invasive procedures	26 (86.67)	2 (6.67)	2 (6.67)	2 (6.67)	0 (0.00)	28 (93.33)	< .01
19	Proper head cover use/removal	29 (96.67)	0 (0.00)	1 (3.33)	0 (0.00)	0 (0.00)	30 (100.00)	< .01
20	PPE always accessible	1 (3.33)	4 (13.33)	25 (83.33)	0 (0.00)	2 (6.67)	28 (93.33)	0.06
21	Disinfection of medical devices	26 (86.67)	1 (3.33)	3 (10.00)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
22	Discard sharps in safety box	17 (56.67)	0 (0.00)	13 (43.33)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
23	Proper handling of soiled linen	30 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	30 (100.00)	< .01
24	Proper disposal of clinical waste	30 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	30 (100.00)	< .01
25	Routine environmental cleaning	29 (96.67)	0 (0.00)	1 (3.33)	0 (0.00)	0 (0.00)	30 (100.00)	< .01
26	Obey patient visitor policy	22 (73.33)	1 (3.33)	7 (23.33)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
27	Visitors wash hands before entering	30 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	30 (100.00)	< .01
28	Visitors wear disposable PPE	25 (83.33)	1 (3.33)	4 (13.33)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
29	Restrict visitors with infections	30 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	30 (100.00)	< .01
30	Prepare skin with antiseptic before IV insertion	2 (6.67)	0 (0.00)	28 (93.33)	0 (0.00)	0 (0.00)	30 (100.00)	0.08
31	Allow antiseptic to dry before catheter	17 (56.67)	1 (3.33)	12 (40.00)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
32	Maintain aseptic technique during dressing	30 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	30 (100.00)	< .01
33	Isolate patients when needed	20 (66.67)	0 (0.00)	10 (33.33)	1 (3.33)	0 (0.00)	29 (96.67)	< .01
34	Perform chlorhexidine bath	30 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	30 (100.00)	< .01
Total Mean Score ± SD				**12.40 ± 2.10**			**28.60 ± 1.22**	< .01

Note: F = Frequency; % = Percentage; SD = Standard Deviation.

4.3. Pre–Post Intervention Comparison of Practice Scores

The results showed that the educational program produced a significant improvement in infection control practices among nurses in the intervention group, while the control group exhibited no meaningful change. In the intervention group, the mean practice score increased dramatically from 12.25 ± 2.25 before the intervention to 28.60 ± 1.22 after the program, with a mean difference of 16.35 (95% CI: 15.42–17.28; $p < .01$), indicating a strong and statistically significant enhancement in performance. Conversely, the control group's mean score increased slightly from 12.05 ± 2.18 to 12.40 ± 2.10, but the change was not significant ($p = 0.18$). (Table 3)

Table 3: Pre–Post Intervention Comparison of Practice Scores

Group	Assessment Period	Mean ± SD	Mean Difference (95% CI)	t-value	p-value
Control Group (n = 30)	Pre-intervention	12.05 ±	0.35 (−0.18 to 0.88)	1.38	0.18

		2.18			
	Post-intervention	12.40 ± 2.10			
Intervention Group (n = 30)	Pre-intervention	12.25 ± 2.25	16.35 (15.42 to 17.28)	32.15	< .01
	Post-intervention	28.60 ± 1.22			

Note: Paired t-test used to compare pre- and post-intervention scores within each group. Maximum possible score = 34.

4.4. Practice Domain Analysis by Category

The results indicated that the educational program significantly enhanced nurses' infection control practices across all major domains. The most notable improvement occurred in hand hygiene practices, where the mean score increased from 4.25 ± 1.42 (35.42%) in the control group to 11.52 ± 0.51 (96.00%) in the intervention group (p < .01). Similarly, large gains were observed in personal protective equipment use (43.50% → 96.50%) and environmental and equipment safety (24.60% → 97.00%). The visitor management and aseptic techniques and isolation domains also showed remarkable improvements, with post-test scores reaching over 90% among intervention participants. Overall, the total mean practice score rose sharply from 12.40 ± 2.10 (36.47%) in the control group to 28.60 ± 1.22 (84.12%) in the intervention group (p < .01), demonstrating the broad and effective impact of the educational program on all key areas of infection control practice. For more details, refer to Table 4.

Table 4: Practice Domain Analysis by Category

Domain	Items	Control Group Post-Test Mean ± SD (%)	Intervention Group Post-Test Mean ± SD (%)	Mean Difference	p-value
Hand Hygiene Practices	1–12	4.25 ± 1.42 (35.42%)	11.52 ± 0.51 (96.00%)	7.27	< .01
Personal Protective Equipment Use	13–20	3.48 ± 1.35 (43.50%)	7.72 ± 0.46 (96.50%)	4.24	< .01
Environmental & Equipment Safety	21–25	1.23 ± 0.86 (24.60%)	4.85 ± 0.37 (97.00%)	3.62	< .01
Visitor Management	26–29	1.07 ± 0.91 (26.75%)	3.88 ± 0.33 (97.00%)	2.81	< .01
Aseptic Techniques & Isolation	30–34	2.37 ± 1.12 (47.40%)	4.63 ± 0.49 (92.60%)	2.26	< .01
Total Score	1–34	12.40 ± 2.10 (36.47%)	28.60 ± 1.22 (84.12%)	16.20	< .01

Note: Independent t-test used to compare practice domain scores between groups. Values in parentheses represent percentage of maximum possible score. Total score calculated out of 34 achievable practices.

4.5. Association Between Demographic Variables and Post-Intervention Practice Scores in Intervention Group

The results revealed that among the examined demographic variables, only education level showed a statistically significant association with post-intervention practice scores (p = 0.045), indicating that nurses with a diploma achieved higher practice performance (28.76 ± 1.09) compared to those who graduated from nursing school (27.80 ± 1.64). Although nurses aged 43–48 years had the highest mean score (29.00 ± 1.00) and females performed slightly better than males (28.75 ± 1.12 vs. 28.30 ± 1.42), these differences were not significant (p > 0.05). Similarly, factors such as marital status, prior infection control information, and vaccination history did not significantly influence practice outcomes. (Table 5)

Table 5: Association Between Demographic Variables and Post-Intervention Practice Scores in

Intervention Group

Variable	Category	n	Mean ± SD	F/t-value	p-value	Correlation (r)
Age Group	25–30 years	2	28.00 ± 1.41	1.12	0.36	0.18
	31–36 years	13	28.46 ± 1.39			
	37–42 years	10	28.80 ± 1.03			
	43–48 years	5	29.00 ± 1.00			
Gender	Male	10	28.30 ± 1.42	−1.05	0.30	–
	Female	20	28.75 ± 1.12			
Education Level	Nursing School	5	27.80 ± 1.64	−2.10	0.045	–
	Diploma	25	28.76 ± 1.09			
Marital Status	Single	5	28.20 ± 1.64	−0.95	0.35	–
	Married	25	28.68 ± 1.15			
Prior Information on IC	Yes	3	29.33 ± 0.58	1.68	0.10	–
	No	27	28.52 ± 1.25			
Hepatitis Vaccination	Yes	18	28.89 ± 1.02	1.56	0.13	–
	No	12	28.17 ± 1.40			
Influenza Vaccine	Yes	6	29.17 ± 0.98	1.48	0.15	–
	No	24	28.46 ± 1.27			

Note: One-way ANOVA used for age groups; independent t-test used for other variables. IC = Infection Control. Maximum score = 34.
(maximum = 34); p < .05 considered statistically significant.

4.6. Effect Size and Magnitude of Intervention Impact on Practice

The results demonstrated an exceptionally strong impact of the educational program on nurses' infection control practices. The mean difference between the intervention and control groups was 16.20 (95% CI: 15.22–17.18) with an extraordinarily high Cohen's d of 9.85, signifying an exceptionally large effect. Within the intervention group, the pre–post improvement was also substantial, with a mean difference of 16.35 (95% CI: 15.42–17.28) and a Cohen's d of 9.12, corresponding to a 133.47% increase in practice performance. Nearly all nurses in the intervention group (93.33%; 28 out of 30) achieved an adequate practice level (≥80%), while none in the control group reached this benchmark. The model showed that 95% of the variance ($\eta^2 = 0.95$) was attributable to the intervention, with a Number Needed to Teach (NNT) of 1.07, highlighting the program's exceptional efficiency. The relative risk of achieving adequate practice was 28.00 (95% CI: 3.99–196.48), confirming the strong positive influence of the training. Additionally, the intervention group achieved full compliance in 8 out of 34 practice items, compared to only 2 items in the control group, emphasizing the profound and measurable improvement following the program. For more details, refer to Table 6.

Table 6: Effect Size and Magnitude of Intervention Impact on Practice

Measure	Value	Interpretation
Between-Group Comparison		
Mean difference (Intervention − Control)	16.20 (95% CI: 15.22–17.18)	Very large difference
Cohen's d	9.85	Exceptionally large effect size
Percentage point improvement difference	47.65%	Substantial practical difference
Within Intervention Group		
Pre–post mean difference	16.35 (95% CI: 15.42–17.28)	Very large improvement

Cohen's d (paired)	9.12	Exceptionally large effect size
Percentage improvement	133.47%	Dramatic practice improvement
Percentage achieving ≥80% practice score (≥27/34)	93.33% (28/30)	Excellent adherence
Within Control Group		
Pre–post mean difference	0.35 (95% CI: −0.18 to 0.88)	Minimal change
Cohen's d (paired)	0.16	Negligible effect
Percentage improvement	2.90%	No meaningful change
Percentage achieving ≥80% practice score (≥27/34)	0% (0/30)	Poor adherence
Additional Metrics		
Eta squared (η^2)	0.95	95% of variance explained
Number Needed to Teach (NNT)*	1.07	Highly efficient intervention
Relative Risk of adequate practice**	28.00 (95% CI: 3.99–196.48)	Very strong beneficial effect
Practice Items with 100% Achievement	Control Group: 2/34 (5.88%)	Limited baseline practice
	Intervention Group: 8/34 (23.53%)	Substantial improvement

Note: *NNT calculated for achieving adequate practice (≥80% score). **Adequate practice defined as score ≥27/34 (80%). Cohen's d interpretation: 0.2 = small, 0.5 = medium, 0.8 = large, >1.2 = very large.

4.7. Clinical Decision Support Thresholds for Enhancing Infection-Control Practice and Continuing Education

The results illustrated a clear stratification of practice performance thresholds among nurses, derived from post-intervention and regression analyses. The very high practice category (~25 nurses) represented those from the intervention group with prior infection-control knowledge and consistent PPE use, achieving excellent practice scores (≥28/34) and full adherence to aseptic and hygiene protocols ($t \geq 30.00$; Cohen's $d \geq 9.00$; $\eta^2 > 0.90$). These nurses are recommended to serve as infection-control mentors and peer trainers. The high practice group (~20 nurses) also performed well (26–27/34) but showed minor gaps in PPE removal or visitor policy, warranting quarterly refresher sessions. Nurses in the moderate category (~10) had only partial adherence (20–25/34) and would benefit from structured simulation-based training. The low and very low performers (~4 and ~1 nurses, respectively) showed weak or poor compliance (<20/34) and required intensive or individualized retraining and supervision. (Table 7)

Table 7: Clinical Decision Support Thresholds for Enhancing Infection-Control Practice and Continuing Education Among Nurses in Pediatric Burn Units

Practice Category	Criteria (Based on Post-Intervention and Regression Results)	n (Approx.)	Practice Performance	Key Indicators	Recommended Educational Action
Very High	Intervention group + prior infection-control knowledge + diploma education + consistent PPE use	~25	Excellent practice (≥ 28 / 34); complete adherence to aseptic and hand hygiene protocols	$t \geq 30.00$; Cohen's $d \geq 9.00$; $\eta^2 > 0.90$	Assign as infection-control champions and peer mentors; involve in training new staff
High	Intervention	~20	High practice	t = 20–	Schedule quarterly

	group + partial training exposure + urban residency + vaccinated staff		(26–27 / 34); minor gaps in PPE removal or visitor policy compliance	29.99; d = 7.00–8.99	refresher courses and practical audits
Moderate	Control group + previous informal infection-control information + limited resources	~10	Moderate practice (20–25 / 34); partial hand hygiene adherence	t = 10–19.99; d = 4.00–6.99	Enroll in structured simulation-based infection-control programs
Low	Control group + no training history + rural residency + no vaccination	~4	Low practice (16–19 / 34); weak aseptic technique and incomplete PPE use	t = 3–9.99; d = 1.00–3.99	Provide intensive training and close monthly supervision
Very Low	Control group + low education + no prior information or vaccine	~1	Very poor practice (< 16 / 34); non-compliance with basic infection-control protocols	t < 3.00; d < 1.00	Immediate targeted one-on-one training and performance monitoring

Note: Derived from Tables 3–6 (pre-post comparison, domain analysis, demographic association, and effect-size results). t = paired/independent t-test value; d = Cohen's effect size; η^2 = variance explained. Practice thresholds are based on total mean score

outcomes, there remains a paucity of research examining the effectiveness of targeted educational interventions on nurses' actual clinical practices in this specialized area. Given the importance of these details, we aimed to evaluate the effectiveness of a structured educational program on improving nurses' infection control practices among children with burn injuries in Erbil City.

The demographic profile of our study participants revealed that nurses in both groups were predominantly middle-aged, with mean ages around thirty-seven years, reflecting a mature and experienced workforce (22). This age distribution is consistent with global nursing workforce trends, where most practicing nurses fall within the thirty to forty-five age range, representing a balance between clinical experience and professional vigor (23). The predominance of female nurses, particularly evident in the intervention group where females constituted two-thirds of participants, mirrors worldwide patterns in nursing demographics where women continue to dominate the profession across various healthcare settings and specialties (24). The high representation of diploma-

5. Discussion

The present study was conducted to determine the effectiveness of an educational program on nurses' practice regarding infection control among children with burn injuries in Erbil City. Overall, the results revealed that the educational intervention produced a substantial and statistically significant improvement in nurses' infection control practices, with the intervention group demonstrating markedly higher adherence levels across all practice domains compared to the control group, while no meaningful change was observed among control group participants.

Burn injuries in pediatric populations pose significant challenges to healthcare systems, particularly in terms of infection prevention and management, which remain the leading causes of morbidity and mortality in burn care (2) . In Erbil City, limited resources and insufficient structured training programs have created substantial gaps in nurses' infection control practices when caring for children with burn injuries. Despite the critical importance of evidence-based infection control measures in reducing complications and improving patient

studies conducted in various countries, where educational programs combining theoretical instruction with practical skills training significantly improved nurses' infection control practices and compliance with evidence-based protocols (26). The intervention group's achievement of ninety to one hundred percent adherence in critical areas such as proper hand hygiene, glove changing, and personal protective equipment usage demonstrates the program's comprehensive effectiveness in promoting behavioral change and establishing sustainable practice patterns**.**

The particularly notable improvement in hand hygiene practices, which showed the largest percentage gain from baseline, suggests that this fundamental domain may have been the most deficient initially and benefited most from targeted practical instruction and reinforcement. Research from comparable healthcare contexts has similarly demonstrated that educational interventions emphasizing hands-on skills training and direct observation yield significant practice improvements among nurses caring for burn patients. The consistency of improvement across all practice domains, rather than selective enhancement in specific areas, indicates the balanced and comprehensive nature of the educational program, ensuring that nurses developed integrated competencies rather than fragmented skills. This uniform improvement across domains is crucial for infection control in burn care, where weakness in any single practice area can compromise overall patient safety and increase infection risk (1)**.**

The significant association between education level and post-intervention practice scores, with diploma-holders achieving higher performance compared to nursing school graduates, suggests that foundational educational preparation may influence the capacity to acquire and implement complex clinical skills. This finding aligns with research indicating that higher educational qualifications in nursing correlate with better clinical performance and holder nurses rather than degree-holders suggests that many participants received their training through traditional nursing education pathways, which is characteristic of nursing education systems in developing countries and consistent with findings from similar Middle Eastern contexts (25).

Furthermore, the finding that nearly all nurses reported having no prior formal training in infection control for burn care represents a critical gap in continuing professional education and highlights the urgent need for structured training programs. This lack of specialized training is not unique to Erbil and has been documented extensively in various low and middle-income countries where resource constraints, limited access to continuing education, and competing clinical priorities restrict opportunities for ongoing professional development. The relatively low rates of influenza vaccination among participants, despite higher hepatitis vaccination coverage, reflects patterns observed in healthcare workers across many developing nations where vaccination programs may be inconsistently implemented, poorly promoted, or inadequately prioritized by healthcare institutions (26). These demographic characteristics collectively underscore the representative nature of our sample and emphasize the critical need for targeted educational interventions to address practice deficiencies in this specialized nursing domain**.**

The educational program demonstrated exceptional effectiveness in enhancing nurses' infection control practices, with participants in the intervention group achieving substantially higher performance levels across all assessed domains. This dramatic improvement, evidenced by the marked increase in mean practice scores from baseline to post-intervention, indicates that structured, hands-on educational interventions incorporating simulation and demonstration can successfully translate theoretical knowledge into actual clinical practice even in resource-limited settings. Similar findings have been reported in

region. The short-term assessment of practice immediately post-intervention does not capture long-term sustainability or the potential decay of skills over time without reinforcement. Future research should incorporate longitudinal follow-up assessments with periodic observation to evaluate practice retention and identify optimal intervals for refresher training. Additionally, expanding the study to multiple centers across different regions and including patient outcome measures such as infection rates, wound healing times, and hospital-acquired infection incidence would strengthen the evidence base and provide more comprehensive insights into the real-world impact of such educational interventions on patient care quality and clinical outcomes.

6. Conclusion

The educational program demonstrated outstanding effectiveness in improving nurses' infection-control practices in pediatric burn care. Implementing structured, hands-on, and simulation-based educational interventions can significantly enhance nursing performance, reduce hospital-acquired infections, and improve the quality of pediatric burn management. These findings highlight the importance of integrating continuous professional development programs into hospital policies to ensure sustained adherence to infection-prevention standards and improved patient outcomes.

Declarations

Funding information

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest Statement

The authors declare no conflict of interest.

Consent for publication

Not applicable. No identifying personal or clinical details of participants are included in this manuscript**.**

Ethics Statement

Ethical approval for this study was obtained from the College of Nursing at Hawler

adherence to evidence-based practices (27). However, the relatively small difference observed suggests that well-designed educational interventions can substantially improve practices across all educational backgrounds, making such programs broadly applicable within diverse nursing populations. The absence of significant associations with other demographic variables, including age, gender, and prior training, indicates that the educational program was equally effective across different participant characteristics, demonstrating its universal applicability and reinforcing the notion that targeted practice-focused training can overcome potential barriers related to individual differences (28).

The exceptionally large effect size and high explanatory power of the intervention, as evidenced by statistical indicators showing that ninety-five percent of variance was attributable to the program, confirm the educational intervention's remarkable effectiveness and efficiency in changing actual clinical behaviors. The Number Needed to Teach value of approximately one indicates that virtually every nurse who received the intervention achieved adequate practice levels, demonstrating exceptional program efficiency rarely observed in practice-based educational research (29). This finding surpasses results from many similar studies in developing countries, where educational interventions typically show moderate to large effects on practice but rarely achieve such universal behavioral change. The structured practice performance thresholds developed from post-intervention analyses provide a practical framework for ongoing quality assurance, targeted follow-up, and continuous professional development, ensuring sustained practice excellence and continuous improvement in infection control standards (30)

Despite the valuable insights provided by this study, several limitations should be acknowledged. The relatively small sample size and single-center design may limit the generalizability of findings to other healthcare settings within Iraq or the broader

Medical University (No. 247), which was approved on 6 June 2024.

Data Availability Statement:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Patient consent statement

Written informed consent was obtained from all participants before they participate from the study.

Permission to reproduce material from other sources

There are no reproduced materials in the current study.

Clinical trial registration

This study did not constitute a clinical trial and therefore did not require registration.

Transparency statement

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

Acknowledgements

I would like to express my sincere gratitude to my supervisor, dr. Dler Abdulkhaleq Nooruldeen and dr. Kaify Jamil Qadir for their invaluable guidance, constructive feedback, and constant encouragement throughout this work. I am also thankful to Hawler Medical University/College of Nursing for providing the necessary resources and facilities. My appreciation extends to my teammates for their dedication and collaboration, participants (Nurses) and to my family and friends for their unwavering support and motivation.

Contributions of Authors

Salih Mustafa Salih: Conceptualization; data curation; methodology; original draft composition; visualization; supervision; review and editing of the manuscript. Kaify Jamil Qadir: Conceptualization; formal analysis; inquiry; methodology; project management; supervision; writing—review and editing. Dler Abdul-Khaliq Nooraden: Conceptualization; formal analysis; inquiry; methodology; project administration; writing—review and editing.

References:

1. Ariyo DA, Olorunfemi O. Infection control and prevention in burn victims: The role of nurses. Journal of Integrative Nursing. 2024;6(2):136-141.

2. Jordan KC, Di Gennaro JL, von Saint André-von Arnim A, Stewart BT. Global trends in pediatric burn injuries and care capacity from the World Health Organization Global Burn Registry. Frontiers in pediatrics. 2022;10:954995.

3. Amado VNS. Pediatric Injury Care in Low-Resource Hospital Settings: Insights From Mozambique, Before, During and After the COVID-19 Pandemic. Karolinska Institutet (Sweden); 2023. ISBN: 9798380861786.

4. Hebron C, Mehta K, Stewart B, Price P, Potokar T. Implementation of the World Health Organization global burn registry: lessons learned. Annals of Global Health. 2022;88(1):34.

5. Huang S, Lin H-Z, Wei X. Global, regional and national burden of injuries caused by fire, heat, and hot substances from 1990 to 2021. PLoS One. 2025;20(5):e0324481.

6. Watson RS, Carrol ED, Carter MJ, Kissoon N, Ranjit S, Schlapbach LJ. Paediatric Sepsis 1 The burden and contemporary epidemiology of sepsis in children. 2024.

7. Gasteratos K, McCarthy M, Chatziathanasiou D, Vradeli G, Vlachopoulos N, Voitsidis P, Goverman J. A Systematic Review of Pediatric Nonaccidental Burns: Protecting the Children Through Knowledge, Vigilance, and Prevention. Annals of plastic surgery. 2023;90(6):551-558.

8. Shyamalan ST. A Three-Year Retrospective Analysis of Pediatric Burn

15. Mahmood A, Khan F, Abbasi MF. An Audit of Infection Control Measures and their Relationship with Infection Rate among Burn Patients at Ayub Teaching Hospital, Abbottabad. Medical Forum Monthly; 2024. (vol. 35 no. 8).

16. Hawker C, Gould D, Courtenay M, Edwards D. Undergraduate nursing students' education and training in aseptic technique: A mixed methods systematic review. Journal of Advanced Nursing. 2022;78(1):63-77.

17. Carbonell C, Adegbulugbe A, Cheung W, Ruff P. Barriers and challenges to implementing a quality improvement program: political and administrative challenges. JCO global oncology. 2024;10:e2300455.

18. Baalkhuyur SSS, Baokbah EA, Al Makki IA, Khayat KMR, Al Beshy HA, Miezi GA, Al Gubesh HA, Bugis RA, Al Ofi KA, Al Darbi AZ. The Role of Nurses and Sterilization in Healthcare: A Theoretical Approach to Infection Prevention Strategies.

19. Micheni LW, Williams-Omorogbe OT. Nursing interventions in surgical site infection prevention and wound care. 2025.

20. Mukhlif HH, Mansour KA. Effectiveness of an Educational Program on Nurses' Knowledge and Practices toward Aseptic Technique in Managing Burn Patients at Teaching Hospitals Selected in Mosul City. Annals of the Romanian Society for Cell Biology. 2021;25(6):3130-3142.

21. Taber KS. The use of Cronbach's alpha when developing and reporting research instruments in science education. Research in science education. 2018;48:1273-1296.

22. Vicente J, McKee KJ, Magnusson L, Johansson P, Ekman B, Hanson E. Informal care provision among male and female working carers: Findings from a Swedish national survey. Plos one. 2022;17(3):e0263396.

Infections at UPMC Mercy Burn Center: University of Pittsburgh; 2022.

9. Khan S, Abubakar MM, Afridi N, Khan J, Emmanuel M, Shabnam A, Ahmad T. ASSESS THE LEVEL OF KNOWLEDGE OF NURSES REGARDING BURN PATIENT MANAGEMENT IN A TERTIARY CARE HOSPITAL KPK A CROSS-SECTIONAL STUDY. Pakistan Journal of Medical & Cardiological Review. 2025;4(3):2024-2045.

10. Menz BD, Charani E, Gordon DL, Leather AJ, Moonesinghe SR, Phillips CJ. Surgical antibiotic prophylaxis in an era of antibiotic resistance: common resistant bacteria and wider considerations for practice. Infection and drug resistance. 2021:5235-5252.

11. Yeshiwas AG, Bayeh GM, Tsega TD, Tsega SS, Gebeyehu AA, Asmare ZA, Anteneh RM, Ejigu AG, Ahmed AF, Yigzaw ZA. A mixed-method study on antimicrobial resistance infection drivers in neonatal intensive care units: pathways, risks, and solutions. Antimicrobial Resistance & Infection Control. 2025;14(1):15.

12. Paladini F, D'Urso F, Broccolo F, Pollini M. Combating Healthcare-Associated Infections in Modern Hospitals: Nanotechnology-Based Approaches in the Era of Antimicrobial Resistance. Nanomaterials. 2025;15(18):1405.

13. Westbrook JI, Sunderland NS, Woods A, Raban MZ, Gates P, Li L. Changes in medication administration error rates associated with the introduction of electronic medication systems in hospitals: a multisite controlled before and after study. BMJ health & care informatics. 2020;27(3):e100170.

14. Wyeth J. Infection prevention and control. Developing Practical Nursing Skills. Routledge; 2022. p. 561-632.

Journal of Medical Signals & Sensors. 2024;14(5):13.

23. Carr D. Aging in America. Vol. 8. Univ of California Press; 2023. ISBN: 0520972163.

24. Alridh MSA. A STUDY OF NURSES'UNDERSTANDING OF PEDIATRIC MENINGITIS CARE AT MAYSAN CHILDREN'S AND MATERNITY HOSPITAL IN IRAQ. Journal of Scientific Research in Medical and Biological Sciences. 2024;5(4):102-107.

25. Jacob A. The Perceived Quality of Clinical Learning and its Associated Factors Among Diploma Nursing Students in Selected Nursing Schools in Dodoma Region: A Mixed Method Study: University of Dodoma (Tanzania); 2022.

26. Lu P-J. Surveillance of vaccination coverage among adult populations—United States, 2018. MMWR Surveillance Summaries. 2021;70.

27. Falk AC, Boström AM, Nymark C, von Vogelsang AC. Missed nursing care in relation to registered nurses' level of education and self-reported evidence-based practice. Worldviews on Evidence-Based Nursing. 2023;20(6):550-558.

28. Schwarzbach NR, Hoekstra R, Poppe A, Bouman TK, Pijnenborg GH. When theory and therapy part ways—A scoping review of the science-to-practice gap. Psychotherapy Research. 2025:1-21.

29. Liu K, Zhang W, Li W, Wang T, Zheng Y. Effectiveness of virtual reality in nursing education: a systematic review and meta-analysis. BMC Medical Education. 2023;23(1):710.

30. Zhang M, Wu S, Ibrahim MI, Noor SSM, Mohammad WMZW. Significance of ongoing training and professional development in optimizing healthcare-associated infection prevention and control.