Original Article

Effectiveness of the Environmental Safety Measures Program on Nurses' Knowledge and Practices in Hemodialysis Units

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ABSTRACT

Objective: To evaluate the effectiveness of an environmental safety measures educational program on nurses' knowledge and practices in hemodialysis units.

Study Design: A quantitative, quasi-experimental study

Place and Duration of Study: This study was conducted at the Adult Health Nursing, University of Babylon, College of Nursing, Iraq from 8th January 2024 to 18th June 2025.

Methods: A quantitative, quasi-experimental study was conducted at Adult Health Nursing, University of Babylon, College of Nursing, Iraq. A total of 100 nurses from hemodialysis units was selected and divided equally into control and interventional groups.

Results: Unsatisfied levels of knowledge and practices in both groups during the pre-test. However, the interventional group showed significant improvement in knowledge and practices in both post-tests.

Conclusion: The educational program proved its effectiveness to improve nurses' knowledge and practices toward environmental safety measures in hemodialysis units. Ongoing training and mentorship at the unit levels were recommended.

Key Words: Effectiveness, Safety measures, Hemodialysis, Knowledge, Practices.

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INTRODUCTION

Environmental safety encompasses the physical layout, waste disposal, and emergency preparedness. Proper spacing, adequate ventilation, and ergonomic designs reduce cross-contamination and occupational hazards. Effective waste management systems protect staff and patients from infectious agents.[1]

Maintaining humidity at 55-60% prevents the growth of microorganisms, reducing infection risk.[2] The dialysis area should be 70°F-72°F (21.11°C–22.22°C). Adequate temperature control insure patient comfort environment and minimize risks like hypothermia or overheating.[3] Proper lighting is crucial for visibility and preventing errors. Sufficient lighting in treatment areas and corridorsis essential.[4] Ventilation systems must ensure sufficient air exchange to remove airborne contaminants.[3]

The World Health Organization (WHO) recommends hospital noise levels not exceed 35 dB during the day and 30 dB at night. though actual levels are around 72 dB during the day and 60 dB at night.[5] Thenoise range in HD unit ranges from 48.40 to 72 dB.[6] Therefore, controlling noise sources is vital, raising awareness and education of nurses, doctors, and other staff is the most effective way to change behavior.[7]

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METHODS

This quantitative quasi-experimental was conducted at in hemodialysis centers at Imam Al-Hussein Medical City and Imam Al-Hassan Al-Mujtaba Teaching Hospital in Karbala from 8th January 2024 to 18th June 2025 vide letter No. 57 dated 17th December 2024. Nurses who met inclusion criteria provided written informed consent after the study's purpose and data confidentiality were explained. A non-probability purposive sample of 100 nurses was selected and randomly divided into two equal groups (control and interventional) using the lotto method. All hemodialysis nurses with one year or more of experience, scoring less than 60% in the pre-test, and with patient's direct contact (care provider) were included. Needs

assessment was conducted using a 14-question questionnaire for 30–45-minute educational program was then developed based on WHO guidelines. A special questionnaire and checklist were used, the questionnaire adapted from Wadi RJ 2022 after obtaining permission via email[8], included four parts: Demographical characteristic (6 items), clinical workplace data (3 items), and nurses' knowledge about environmental safety measures (9 items).

Facility availability and policies, nurses practices were evaluated using an Observational Checklist adopted from the CDC[9], it was observed three times and included dialysis station routine disinfection checklist includes: before beginning routine disinfection (6 items), and after patient has left station (7 items) and sharp disposable checklist (6 items).

For the questionnaire, a correct answer scored (2) and an incorrect (1). Levels were defined as: Poor (>1.5), Fair (=1.5), Good (<1.5). For the practice checklist, observations were scored: Always (3), Sometimes (2), Never (1). Levels were: Poor if the mean (1-1.6), Fair (1.7-2.39), Good (2.4-3). Content validity of the instruments was assessed by a panel of 9 faculty members with at least 15 years of experience. A pre-test was given to all participants. The control group took post-tests after two and four weeks. The interventional group received the educational program in sessions of 4-6 nurses, followed by post-tests at the same intervals.

Data were analyzed using SPSS-26. T-test and Pearson Chi-square were used to assess homogeneity at baseline. Significance levels were set at $P<0.05$.

RESULTS

There was no significant difference in age (p=0.162) or sex (p=0.134). Both groups had identical gender ratios. There was no significant difference in marital status (p=0.160) or residency (p=0.069). A significant difference was found in educational qualifications (p=0.036), with the control group having a higher percentage of bachelor's degree holders (68% vs. 52%) and the interventional group having more diploma holders (44% vs. 22%) [Table 1].

Table 2 showed a statistically significant difference in years of experience (p=0.023), though the majority in both groups had 1–5 years of experience (88% interventional, 78% control). No significant difference was found in working shifts (p=0.690). A near-significant difference was noted in prior participation in safety courses (p=0.028), with more in the control group (78%) having attended courses than the interventional group (64%). The number of courses attended did not differ significantly (p=0.639).

The significant positive change in the knowledge scores of the interventional group over time. For example, knowledge on distinguishing surface disinfection from physical cleaning improved from a mean of 1.30 in the pre-test to 1.68 in post-test 2. Similarly, knowledge on proper lighting, temperature, and humidity increased, with post-test 2 means ranging from 1.70 to 1.80. The control group, however, showed minimal or no improvement. This emphasizes the educational program's effectiveness (Table 3).

The interventional group showed a continuous increase in mean scores across all items related to pre-disinfection procedures, indicating improved compliance. Significant gains were seen in disposal practices, contamination checks, glove removal, and hand hygiene. In contrast, the control group had slight and mostly insignificant changes. The educational intervention positively influenced the promotion of adequate disinfection practices in the interventional group (Table 4). The checklist for disinfection after a patient has left was not applicable, as this task was handled by a services company, not nurses.

Table No. 1: Demographical Characteristics (n=50)

Characteristics		Control group		Interventional group		P value
		No.	%	No.	%	
Age (years)	22-26	26	52.0	14	28.0	0.162
	27-31	8	16.0	21	42.0	
	32-36	7	14.0	7	14.0	
	37-41	5	10.0	6	12.0	
	42-46	4	8.0	3	6.0	
Gender	Female	17	34.0	17	34.0	0.134
	Male	33	66.0	33	66.0	
Marital status	Single	20	40.0	31	62.0	0.160
	Married	30	60.0	19	38.0	
Educational Qualifications	Secondary Nursing School	4	8.0	2	4.0	0.036
	Diploma	11	22.0	22	44.0	
	Bachelor	34	68.0	26	52.0	
	Postgraduate	1	2.0		100.0	
Residence	Rural	12	24.0	13	26.0	0.69
	Urban	38	76.0	37	74.0	

Table No. 2: Employment Characteristics (n=50)

Clinical workplace		Control group		Interventional group		P value
		No.	%	No.	%	
Period of working in hemodialysis unit (years)	1-5	39	78.0	44	88.0	0.023
	6-10	7	14.0	6	12.0	
	11-15	4	8.0			
Working Shift	Morning	23	54.0	22	44.0	0.693
	Evening	27	46.0	28	56.0	
A tendency of special courses related to safety measure	Yes	11	22.0	18	36.0	0.028
	No	39	78.0	32	64.0	
The number of courses	No there	11	22.0	18	36.0	0.639
	1-3	30	60.0	25	50.0	
	4-6	9	18.0	7	14.0	

Table No. 3: Nurses' knowledge toward environmental safety

Control Group				Interventional Group			
Pre-test	Post-test 1	Post-test 2	P value	Pre-test	Post-test 1	Post-test 2	P value
1.40±0.49	1.42±0.49	1.38±0.49	0.243	1.30±0.46	1.58±0.49	1.68±0.47	0.095
1.58±0.49	1.42±0.49	1.42±0.49		1.34±0.47	1.52±0.50	1.80±0.40	
1.00±.0.0	1.00±0.0	1.08±0.27		1.34±0.47	1.38±0.49	1.74±0.44	
1.54±0.50	1.66±0.47	1.62±0.48		1.44±0.51	1.70±0.46	1.80±0.43	
1.28±0.54	1.16±0.37	1.18±0.38		1.40±0.49	1.58±0.49	1.70±0.46	
1.38±0.49	1.36±0.45	1.32±0.47		1.56±0.50	1.44±0.50	1.74±0.44	
1.38±0.49	1.30±0.46	1.26±0.44		1.54±0.53	1.62±0.49	1.94±0.24	
1.42±0.49	1.74±0.44	1.64±0.48		1.58±0.49	1.72±0.45	1.80±0.40	
1.02±0.14	1.04±0.19	1.04±0.19		1.54±0.53	1.84±0.37	1.94±0.24	

Table No. 4: Nurses' practices: before routine disinfection

Control Group				Interventional Group			
Pre-test	Post-test 1	Post-test 2	P value	Pre-test	Post-test 1	Post-test 2	P value
2.20±0.99	2.92±0.39	2.28±0.97	0.028	1.84±0.99	2.60±0.80	2.60±0.80	0.116
2.18±0.98	2.76±0.55	2.42±0.88		1.84±0.99	2.60±0.80	2.60±0.80	
1.12±0.35	1.12±0.38	1.14±0.35		1.08±0.39	2.36±0.85	2.36±0.85	
2.02±0.97	2.84±0.37	2.22±0.92		1.82±0.98	2.60±0.80	2.60±0.80	
1.54±0.70	1.52±0.61	1.84±0.79		1.36±0.72	2.48±0.81	2.48±0.81	
1.28±0.45	1.30±0.46	1.28±0.45		1.10±0.36	2.32±0.79	2.32±0.79	

Table No. 5: Nurses' practices: sharps disposal

Control Group				Interventional Group			
Pre-test	Post-test 1	Post-test 2	P value	Pre-test	Post-test 1	Post-test 2	P value
1.58±0.64	2.92±0.27	2.16±0.97	0.242	2.06±0.99	2.32±0.95	2.80±0.60	0.038
1.00±0.0	1.00±0.0	1.00±0.0		1.00±0.0	1.98±0.82	2.34±0.65	
1.58±0.64	2.98±0.14	2.14±0.99		2.02±1.0	2.32±0.97	2.96±0.28	
1.92±0.75	1.92±0.72	1.70±0.81		1.58±0.64	2.32±0.95	2.80±060.	
1.56±0.73	1.46±0.67	1.56±0.78		1.24±0.47	2.24±0.91	2.62±0.66	
1.20±0.57	1.20±0.60	1.08±0.39		1.42±0.70	2.32±0.95	2.80±0.60	

Table No. 6: Comparison of Post-Test Knowledge and Practices

Responses of sample	Control Group		Level	Interventional Group		Level	P value	Significance
	Post-test 1	Post-test 2		Post-test 1	Post-test 2			
Nurses' knowledge toward environmental safety at hemodialysis units	1.34±.381	1.32±.415	Poor	1.59±.474	1.79±.390	Good	0.013	Significance

Knowledge: Poor level <1.5 Fair level = 1.5 Good level >1.5

Table No.7: Comparison of Post-Test Results Between the Control and Interventional Groups Regarding Nurses' practices

Responses of sample	Control Group		Level	Interventional Group		Level	P value	Significance
	Post-test 1	Post-test 2		Post-test 1	Post-test 2			
Nurses' practices toward before beginning routine disinfection of the dialysis station: at hemodialysis units	2.07±.463	1.86±.730	Fair	2.49±.813	2.79±.409	Good	0.032	Significance
Nurses' practices toward sharp disposable at hemodialysis units	1.91±.403	1.60±.660	Poor	2.25±.927	2.72±.571	Good		

Knowledge: Poor level <1.5 Fair level = 1.5 Good level >1.5

Table 5 shows the interventional group's improvement in sharp material disposal. Mean scores for immediately placing sharps in containers increased from 2.06 (pre-test) to 2.80 (post-test 2). The control group's scores remained lower and inconsistent. A significant deficit was noted in both groups regarding the placement of sharps containers close to the point of use, with the control group showing no change (mean = 1.00). Overall, the interventional group exhibited improved compliance compared to the control group.

Table 6 reveals a significant improvement in the interventional group's knowledge compared to the control group (P=0.013). The control group consistently demonstrated "poor" knowledge (mean ≈ 1.32-1.34), while the interventional group achieved "good" knowledge levels (mean ≈ 1.59-1.79).

Table 7 clear improvement in the interventional group's practices, the control group remained at "poor" to "fair" levels for disinfection and sharps disposal, while the interventional group reached "good" practice levels in both post-tests, with a significant difference noted for pre-disinfection practices (P = 0.032).

DISCUSSION

The demographic profile of the participants is similar to previous studies in similar settings. The age distribution with most nurses being young, aligns with findings by Mahmood and Khudur.[10] Younger nurses may be more adaptable to new knowledge, which is a factor in evaluating educational programs.

The sex distribution (66% male) differs from some other in Egypt and Arab nations where nursing is female-dominated[11], suggesting educational materials should be gender-neutral.

A significant difference was found in educational levels (p= .036), with more bachelor's degree holders in the control group. This disparity is in line with regional and international research-based results. Such as study by Abdelsatir.[12] This suggests that training programs should consider participants' educational backgrounds. Most participants were from urban areas, which could influence access to professional development opportunities compared to nurses in rural areas.

There was a significant difference in work experience (p=0.023), with most nurses having 1-5 years of experience. Novice nurses often show greater improvement after structured training programs, as demonstrated by Singh et al.[13] Although not statistically significant, working shifts can influence training outcomes, as morning shifts may offer more learning opportunities.[14]

The fact that many nurses in both groups had previously attended safety courses suggests a desire for professional development, which impacts baseline knowledge. This result was guaranteed by the study of Aldawaha et al.[15]

In the interventional and control groups, 50% and 60% respectively completed one to three courses. Although statistically insignificant (p= .639). This can have an influence on the practice and knowledge retention. Similar to the current literature Eltib et al[16] which found that recurrent training supports safety standards and enhances long-term adherence.

An educational study significantly improved the interventional group's knowledge of environmental safety. Participants better understood surface disinfection, lighting, noise control, and patient station spatial needs. These results support that educational programs boost knowledge and compliance with safety protocols[17], and that environmental design awareness is vital for quality of care.[18]

The improvement in the environmental knowledge of the interventional group due to effective lighting and noise control corresponds to the findings by Koon.[19] In addition Himmelfarb et al[20] support the study findings, by emphasized that sufficient spatial planning of dialysis units is essential to avoid cross-contamination and provide safe care delivery.

The control group showed no improvement, supporting the need to reinforce safety education. This aligns with

existing research that emphasizes continuous professional learning to improve healthcare and patient safety, specifically in hemodialysis units.[21]

The findings also prove positive changes in routine disinfection and sharps disposal practices for the interventional group. These findings are supported by the recent literature that outlines the significant role of structured educational program to improve the infection control and safety competencies.[22] Additionally, the findings align with recent study results showing that trained nurses better follow safe sharp disposal in hemodialysis.[23]

The progressive improvement in mean scores for practices like hand hygiene and proper sharps handling demonstrates greater adherence to safety protocols post-intervention. These results align with recent literature showing that specific training enhances nurses' safety competencies in dialysis units.[24]

The greater post-test scores in the interventional group in all safety practices validate the success of the program in improving compliance, which are consistent with previous studies that note that well-structured training increases nurse safety compliance.[25]

The study recommended implementing regular, targeted safety training for novice nurses using interactive methods, and advanced workshops for experienced nurses.

CONCLUSION

Most participants were young, male, urban residents with less than ten years of experience. At pre-test, both groups showed unsatisfied levels of knowledge and practices. The educational program was effective, as the interventional group showed significant improvements in knowledge and practices in both post-tests.

Author's Contribution:

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