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Effectiveness of educational intervention about prevention and control of health-care associated infection on knowledge of nurses in outpatient clinics

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Abstract

Aim: Evaluate the effectiveness of the educational intervention on the level of outpatient nurses' knowledge, concerning prevention and control principles of health care-associated infections.
Material Methods: Quasi-experimental design (pre /post-test) was used. The setting was Health insurance training center at El Helal hospital, Shebin El-kon, Menoufia, Egypt. The sample was a convenience sample of 150 nurses working in outpatients' clinics affiliated to the health insurance sector. The instrument was structured self-administered questionnaire composed of four parts: socio-demographic data, nurses' knowledge about the principles of prevention and control of health care-associated infections, nurses' self- rated practices of health care-associated infections prevention and control principles and the barriers of practicing infection control principles.
Results: Most of the nurses (96.0 %) had previous training on infection control and17.94 ±6.78 mean years of experience. In pre-intervention, the percentage of nurses who had a good level of knowledge ranged from 0.7% to 19.3% across all assessed infection prevention and control principles and 29.59±6.41mean overall score of knowledge; while in post-intervention, the percentage of nurses who had a good level of knowledge was significantly increased to range from 58.0% to 90.0% across all principles and 50.69±3.22 mean overall score of knowledge.. All of the nurses had poor (44.7%) to fair (55.3%) level of self-rated practice, with 73.08±4.59 mean overall score of practice, positive correlation between years of experience and pre-intervention overall score of knowledge. The barriers of practicing infection prevention and control principles were lack of time, increased numbers of patients, lack of resources, inadequate knowledge, inadequate facilities and equipment, and frequent forgetfulness respectively.
Conclusion: The results indicated the significant effect of the implemented educational intervention in improving nurses' level of knowledge about prevention of health care-associated infections.

Keywords: Infection prevention and control, Nurses, Healthcare-Associated Infections, Barriers, Outpatient, Knowledge, Self-rated practice.

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1. Introduction

The outpatient clinics are health care settings that provide diagnosis and care for patients who don't in need to stay overnight [1]. Shifting of healthcare delivery from hospital base to outpatient or ambulatory care settings results in a continuous increase in the services that required to be provided in outpatient settings [2,3]. Ambulatory care settings including outpatient clinics are lacking the infrastructure, resources, and strategies that supporting infection prevention and surveillance activities [3]. Moreover, the increased use of advanced technologies of invasive devices and procedures in outpatient clinics increase the risks for infection associated with contaminated equipment [2]. Healthcare-associated infections (HCAIs) are infections that acquired during the health care process and not found or incubated at the time

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of admission to healthcare facilities [4-6]. HCAIs are one of the main safety concern facing healthcare facilities worldwide [7] and the most frequent consequences that result from unsafe patient care [8]. The incidence rate of HCAIs is varying from country to country [9]. In Australia, about 200,000 patient acquired HAIs annually [10]. The morbidity and mortality associated with HCAIs are substantial, 1 of every 25 patients in U. S. acquire a healthcare-associated infection [5, 11] and annually cost the US healthcare system about 30 billion dollars [12]. In a study conducted by Amazing et al. [13] in 27 hospitals in Algeria, Egypt, Italy, Morocco, and Tunisia they found that the prevalence rate of the nosocomial infections was 10.5%. Developing countries are likely to have 20 times the risk of HCAIs compared to developed countries [14] with estimates that up to 15% of patients admitted to hospitals in developing countries acquire at least one kind of nosocomial infections HCAIs, that associated with significant increase in mortality rates [8,9]. Several outbreaks have been linked with outpatient services due to lack of commitment of recommended infection-prevention techniques [15]. Most of HCAIs are caused by the contaminated hand of health care providers or patients, contaminated environment, contaminated patient's skin [12, 16] and contaminated equipment used in invasive procedures [17]. HCAIs have a significant impact on patients, their families, and the community in large. The impact of HCAIs implies in prolonged hospitalization, disability, increased resistance to antimicrobials and increased financial burden for health system [18, 8 and 19]. Developing educational programs and training of health care providers for continuous updating of staff's knowledge and keeping aseptic technique and disinfection practices are an essential priority [2]. Continuing education and training of outpatient staff are required to maintain competency and ensure that infection prevention policies and procedures are understood and followed [20]. In addition, surveillance of HCAIs and adherence to standard precautions can decrease the risks of HCAIs [21].Nurses are an essential component of the healthcare team that plays a unique role in the control of HCAIs [7]. Nurses are in a position to have the professional and ethical responsibility to protect the health of their patients and share the responsibility to sustain and safeguard the natural clinical environment. They have to make sure that their knowledge and skills regarding infection control are up-to-date and they always practice safely and competently [22]. Evaluating the existing level of knowledge and practices acts as a prerequisite for planning and developing any new educational program in nursing education, and provides a beneficial database that guides the development and implementation of future educational programs directed for reducing and eliminating HCAIs [23]. Therefore, the aim of this study was to evaluate the current level of outpatient nurses' knowledge and self-rated practice as well as the effectiveness of the educational intervention on their level of knowledge concerning and prevention of HCAIs.

The aims of the study

1. Evaluate the effectiveness of the educational intervention on the level of outpatient nurses' knowledge, concerning prevention and control principles of HCAIs.
2. Determine the nurses' level of self-rated practices concerning prevention and control principles of HCAIs.
3. Determine the barriers of practicing prevention and control principles of HCAIs.

Research hypotheses

1. Nurses will have a significant increase in the level of the general knowledge about HAIs after implementation of the educational intervention than before the implementation of the educational intervention.
2. Nurses will have a significant increase in the level of knowledge about the principles of HAIs prevention and control after the implementation of the educational intervention than before the implementation of the educational intervention.

Research questions

1. What are the levels of nurses' self-rated practice of HAIs prevention and control principles in outpatient clinics?
2. What are the barriers that hinder the nurses from practicing the principle of HAIs prevention and control in outpatient clinics?

2. Methods and material

Research design: Quasi-experimental design (pre /post-test) was used to test the research hypothesis.

Study setting: This study was conducted at the training center at El Helal hospital that affiliated to the health insurance sector at Shebin El -Kom, Menoufia governorate.

Subjects: The subjects of the study was a convenience sample of 150 nurses working for at least 3 years in health insurance' outpatient clinics.

The tool of data collection

Structured self-administered questionnaire: The researchers developed it after reviewing the relevant literature. The questionnaire was composed of four main parts. The first part concerned with socio-demographic data as nurses' age, gender, educational qualification, years of experience, job title and the previous training about infection control. The second part was concerned with the assessment of nurses' knowledge about HCAIs and the essential principles of prevention and control. The

assessment of nurses' knowledge was categories into (A) general knowledge about HCAIs. It was included 8 questions as the definition of HCAIs, the burden of HCAIs, factors influencing the spread of HCAIs, sources of HCAIs, high-risk individuals for acquiring HCAIs, methods of transmission of HCAIs, elements of the chain of infection, and importance of following infection control practices. (B) The principles of prevention and control of HCAIs that included: (1) Hand hygiene composed of 4 questions as when to perform hand hygiene, types and technique of hand hygiene. (2) Using personal protective equipment composed of 5 questions as when to use unsterile gloves, sterile gloves, eye protection, mask, and aprons. (3) Safe handling and disposal of sharps composed of 2 questions about separation and disposal of clinical waste. (4) Safe handling and disposal of clinical waste composed of 2 questions about separation and disposal of clinical waste. (5) Managing spilled blood and body fluids composed of 2 questions about cleaning and disinfecting the contaminated area. (6) Decontaminating equipment included 2 questions about cleaning and sterilizing the equipment. (7) Collecting and handling specimens composed of 2 questions about safe taking samples and disposal of unused or old samples. (8) Maintaining a clean, clinical environment composed of 2 questions. The scoring system of the second part that concerned with the assessment of pre-intervention and post-intervention nurse's knowledge about HCAIs and the principles of its prevention and control was carried out by giving 2 scores for the correct answer, 1 for an incomplete answer and 0 for the wrong answer. The scores were calculated and the overall total score for this part was ranged from 0 to 58 scores. The range of score for general knowledge about HCAIs ranged from 0 to 16 scores. The range of score for the principles of prevention and control of HCAIs were: hand hygiene ranged from 0 to 8 scores, using personal protective equipment ranged from 0 to 10 scores, safe handling and disposal of sharps ranged from 0 to 4 scores, safe handling and disposal of clinical waste ranged from 0 to 4scores, managing spilled blood and body fluids ranged from 0 to 4 scores, decontaminating equipment ranged from 0 to 4, collecting and handling specimens ranged from 0 to 4 and maintaining clean clinical environment ranged from 0 to 4 scores. The scores were categorized into: scores less than 60% of the total score indicated poor knowledge; scores from 60 % to 80 % of total scores indicated moderate knowledge score and scores greater than 80% of total scores indicated good knowledge score [24].The third part of the questionnaire was consisted of 36 statements that concerned with nurses' self- rated practices of HCAIs prevention and control principles. In this part the nurses were asked to rate to what extent they were practicing HCAIs prevention and control principles according to scale: rarely done, sometimes done and always done. These principles where: performing hand hygiene included 7 statements, using personal protective equipment included 8 statements, safe handling and disposing sharps included 4 statements, safe handling and disposal of waste included 4 statements, managing spilled blood and body fluids included 3 statements, decontaminating the equipment included 3 statements, collecting and handling specimens included 2 statements, safe injection practice included 3 statements and maintaining clean environment included 2 statements. The scoring system of the third part was carried out by asking the participants to rate their practice for each statement in scale of always done 3 scores, sometimes done 2 scores and rarely done 1 score. The score of all statements in each principle was calculated. The range of score for self-rated practice of prevention and control of HCAIs principles where: performing hand hygiene ranged from 7 to 21, using personal protective equipment ranged from 8 to 24, safe handling and disposal of sharps ranged from 4 to 12, safe handling and disposal of waste ranged from 4 to 12, managing spilled blood and body fluids ranged from 3 to 9, decontaminating equipment ranged from 3 to 9, collecting and handling specimens ranged from 2 to 6, safe injection 3 to 9 and maintaining clean clinical environment ranged from 2 to 6 scores. The overall score of practice ranged from 36-108. The scores were categorized to scores less than 60% of the total score indicated poor practice; scores from 60 % to 80 % of total scores indicated fair practices and score greater than 80% of total scores indicated good practice. The fourth part included 1 open-ended question about the barriers that hinder the nurses from practicing infection prevention and control principles in outpatient clinics.

Validity and reliability of tool: The developed questionnaire was tested for content validity by a panel of three experts in community medicine and community health nursing and modifications were carried out according to the panel recommendation on the clarity of the statements and appropriateness of the contents. The reliability of the questionnaire was carried out using test-retest for a group of 15 participants (10%) who were asked to answer the questions and were asked to fill the same questions after two weeks. The answers of the two occasions were tested and compared and computed for reliability using correlation coefficient and r =.88, which is considered reliable.

Pilot study: A Pilot study was conducted on 15 nurses to test the applicability and clarity of the questionnaire and to detect any problems that might arise during the actual collection of data. According to the results of the pilot study, the necessary modifications or clarifications were done and the final form was developed and used for data collection. The sample of the pilot was not included in the total sample of the study.

Ethical considerations

The official permission to conduct the study was obtained by the researchers from the official authorities after detailed explanation of study purpose and data collection

procedures. The informed consent was obtained from each participant participate in the study. The participants were informed that the participation in this study is voluntary and they can withdraw at any time without giving reasons. The purpose of the study was explained to the nurses and they reassured that the obtained information will be confidential.

Data collection procedure:

The data collection was carried out through the following phases:

Phase I:

After the development of the study tool, the educational intervention was developed after comprehensive reading of related information especially Royal College of Nursing 2005, 2012; CDC infection control guidelines, and Sunley et al., [25, 22, 21 26]. The educational intervention included detailed information about HCAIs and the principles of prevention and control (hand hygiene, using personal protective equipment, safe handling, and disposal of sharps, safe handling and disposal of clinical waste, managing spilled blood and body fluids, decontaminating equipment, collecting and handling specimens and maintaining clean clinical environment).

Phase II:

This phase concerned with data collection and implementation of the educational intervention. The study sample was divided into three groups with 50 nurses in each group. The data collection and intervention for each group took two consecutive days started from 9 am to 1 pm with 20 minutes break time. In the first day, the researchers introduced themselves and a brief explanation about the purpose of the study followed by distribution of the questionnaire and the nurses asked to fill it out (pre-intervention test). Then the researchers initiated the implementation of the first part of the educational intervention that included detailed contents of general knowledge about HCAIs. In the second day, the researchers completed the second part of the educational intervention that included the previously mentioned principles of prevention and control of HCAIs. Any question took full attention from the researchers' side; then the researchers distributed the questionnaire that includes participants' name and the second part of the questionnaire that concerned with nurses' general knowledge about HCAIs and the principles of prevention and control of HCAIs. The nurses asked to fill it out to have their knowledge of post-intervention. By the end of the second day, the researchers provided their appreciation to the nurses for their cooperation and participation in the study and a copy of handout about the implemented educational intervention is given to each nurse. The process that applied to the first group was repeated with the second and third group, till the end of the data collection. The methods of teaching used in the implementation of the educational intervention were lecture, group discussion, and demonstration. Powerpoint presentation combined with videos and posters were used to enhance learning. The score of nurses' knowledge in pre and post-intervention was calculated and compared using suitable statistical analyses to test the research hypothesis and answer the research questions.

Study period:

The study was conducted during January and February 2017.

Statistical analysis:

The collected data were organized, tabulated and statistically analyzed using SPSS software (Statistical Package for the Social Sciences, version 20, SPSS Inc. Chicago, IL, USA). The qualitative data was presented in the form of number and percent. For quantitative data, descriptive statistics were presented in the form of number and percent; mean and standard deviation and the range. To compare the normally distributed quantitative data of two related groups, paired samples t-test was used. For comparison between more than two means of parametric data, one-way analysis of variance (ANOVA) was used. Comparison between data before and after the intervention was performed using Marginal homogeneity test for quantitative non-parametric categorical variables. The correlation between quantitative variables was carried out using Pearson correlation coefficient test (r). Significance was adopted at $p<0.05$ for interpretation of results of tests of significance.

3. Results

The total subjects of the study were 150 nurses who recruited to participate in the study. The data collected was used to evaluate the effectiveness of the educational intervention on the level of outpatient nurses' knowledge, concerning prevention and control of HAIs, determine the level of self-rated practices of HCAIs prevention of HCAIs, and determine the barriers of practicing infection prevention principles.

Table 1 displays the socio-demographic characteristics of study subjects. The majority of nurses (91.4%) aged from 25 to 49 years, with mean age 39.67 ±7.35. All of the study samples were female nurses, about two-thirds of them (65.3%) had an educational certificate or diploma in nursing, while who had a Bachelor in nursing was 16.7 %. More than half of nurses (52.0%) had 20 or more years of experience, the mean year of experience was 17.94 ±6.78 years, most of them (92.7%) worked as a staff nurse. Concerning previous training about infection prevention and control, most of the nurses (96.0 %) had previous training, but slightly less than two thirds (60.7%) of them receive their last training on infection control since 3 years or more.

Table 1. Distribution of socio-demographic characteristics among studied nurses (n = 150)

Socio-demographic characteristics	No (%)
Age(years):	
<40 40-50 >50	64 (42.7) 73 (48.7) 13 (8.6)
Mean ±SD Range	39.67 ±7.35 25-51
Sex	
Male Female	0 (0.0) 150 (100.0)
Level of education:	
Diploma in nursing Technician nursing Bachelor of nursing	98 (65.3) 27 (18.0) 25 (16.7)
Years of experience	
<10 10-19 20 or more	21 (14.0) 51 (34.0) 78 (52.0)
Mean ±SD Range	17.94 ±6.78 3-30
Occupational title:	
Staff nurse Head nurse	139 (92.7) 11 (7.3)
Date of last previous training about infection prevention and control:	
No previous training Last previous training since ≤ 3 years Last previous training since >3 years	6 (4.0) 53 (35.3) 91 (60.7)

Table 2: Nurses' levels of knowledge about HCAIs and the principles of prevention and control in pre-and post-intervention.

Principles of HCAIs	Pre- intervention	Post- intervention	test	P value
	No (%)	No (%)		
General knowledge about HCAIs (Total score= 0- 16)				
Mean score ±SD	6.95±2.31	13.83±1.50	t =29.78	0.00
Knowledge level: Poor Moderate Good	 135 (90.0) 14 (9.3) 1 (0.7)	 1(0.7) 30 (20.0) 119(79.3)	MH =11.60	0.00
Principles of HCAIs prevention and control				
Hand hygiene (Total score= 0- 8)				
Mean score ±SD	3.89± 1.58	6.90± 1.09	t= 20.20	0.00
Knowledge level: Poor Moderate Good	 97 (64.7) 47 (31.3) 6 (4.0)	 4 (2.7) 45 (30.0) 101 (67.3)	MH =10.51	0.00

Table no: 02 Continued…

Principles of HCAIs	Pre- intervention No (%)	Post- intervention No (%)	test	P value
Using personal protective equipment (Total score= 0-10)				
Mean score ±SD	4.94±1.66	8.97± 1.200	t =25.04	0.00
Knowledge level: Poor Moderate Good	 89 (59.3) 54 (36.0) 7 (4.7)	 3 (2.0) 12 (8.0) 135 (90.0)	MH =9.90	0.00
Safe handling and disposal of sharps (Total score= 0 - 4)				
Mean score ±SD	2.43±1.14	3.49±0.81	t =8.57	0.00
Knowledge level: Poor Moderate Good	 73 (48.7) 48 (32.0) 29 (19.3)	 19 (12.7) 34 (22.7) 97 (64.6)	MH =7.27	0.00
Safe handling and disposal of clinical waste(Total score=0- 4)				
Mean score ±SD	2.01±0.99	3.55± 0.71	t =15.55	0.00
Knowledge level: Poor Moderate Good	 102 (68.0) 38 (25.3) 10 (6.7)	 13 (8.7) 38 (25.3) 99 (66.0)	MH =9.83	0.00
Managing spilled blood and body fluids (Total score=0- 4)				
Mean score ±SD	2.46±1.07	3.45±0.74	t =9.60	0.00
Knowledge level: Poor Moderate Good	 72 (48.0) 51 (34.0) 27 (18.0)	 18 (12.0) 45 (30.0) 87 (58.0)	MH =7.45	0.00
Decontaminating equipment (Total score=0- 4)				
Mean score ±SD	2.06±0.99	3.49± 0.75	t =13.58	0.00
Knowledge level: Poor Moderate Good	 101 (67.3) 37 (24.7) 12 (8.0)	 21 (14.0) 33 (22.0) 96 (64.0)	MH =9.08	0.00
Collecting and handling specimens (Total score= 0- 4)				
Mean score ±SD	2.47±1.03	3.45± 0.72	t =9.95	0.00
Knowledge level: Poor Moderate Good	 80 (53.3) 42 (28.0) 28 (18.7)	 18 (12.0) 45 (30.0) 87 (58.0)	MH =7.64	0.00
Maintaining a clean clinical environment (Total score= 0- 4)				
Mean score ±SD	2.37±1.04	3.52± 0.83	t =10.62	0.00
Knowledge level: Poor Moderate Good	 80 (53.3) 47 (31.3) 23 (15.4)	 19 (12.6) 28 (18.7) 103 (68.7)	MH =8.15	0.00
Overall score of nurses' knowledge (0 to 58 scores)				
Overall score Mean ±SD	29.59±6.41	50 .69±3.22	t =35.87	0.00
Knowledge level: Poor Moderate Good	 113 (75.3) 36 (24.0) 1 (0.7)	 3 (2.0) 15 (10.0) 132 (88.0)	MH =1.4	0.00

MH= Marginal homogeneity, t= Paired t-test

Table 2: Concerning nurses' general knowledge about HCAIs, most of the nurses (90.0%) had a poor level of knowledge, and the mean score of knowledge was 6.95±2.31 and minority (0.7%) had a good level of knowledge in pre-intervention; while in post-test the percentage of nurses with good level of knowledge was significantly increased to 79.3% and the mean score was 13.83±1.50. Regarding the principles of HCAIs prevention and control; the findings of the table revealed that in pre-intervention, a minority of the nurses had a good level of knowledge in across all principles of HCAIs prevention and control. The percentage of the nurses who achieved a good level of knowledge ranged from 4.0% to 19.3% across all assessed principles. On the other hand, in post-intervention large percentage of the nurses had achieved good level of knowledge and the percentages of nurses ranged from 58.0% to 90.0% across all principles; the highest percentage (90.0%) was in using personal protective equipment and the lowest percentage (58.0%) was in both of management of spilled blood and body fluids and collecting and handling specimens. These findings indicated significant improvement in nurses' knowledge about HCAIs and across all principles of prevention and control as a result of educational intervention and this significant improvement can be seen also from the difference in mean scores in pre-intervention and post-intervention, p-value <0.001 in all principles of HCAIs prevention and control as well as in overall score of knowledge about HCAIs and the principles of prevention and control (overall score in post-intervention = 50 .69±3.22 compared to pre-intervention 29.59±6.41, P<0.001) . Moreover, a statistically significant increase in the percentage of nurses who had a good level of overall knowledge about HCAIs and the principles of prevention and control in post-intervention (88.0%), compared to pre-intervention (0.7%) P<0.001. The results from table 2, provide support to the first and second research hypotheses.

Table 3: Comparison of nurses' overall mean score of knowledge in pre-intervention among the levels of nurses' educational qualification

Educational Qualification	Overall score of knowledge in pre-intervention (n=150) Mean±SD	F	P value
Diploma	30.37±6.60	2.162	0.119
Technician	28.44±5.98		
Bachelorate	27.80±5.74		

Table 3: Represents the result of one-way analysis of variance (ANOVA), which was used to compare the pre-intervention mean score of overall nurses' knowledge among nurses' levels of educational qualification. Results revealed no statistically significant differences in nurses' pre-intervention overall mean scores of knowledge among the three level of nurses' educational qualification F = 2.162, P = 0.119

Table 4: The Self-rated practice of HAIs prevention and control principles among studied sample

Infection control principles	Rarely done (1) No (%)	Sometimes done (2) No (%)	Always done (3) No (%)
To what extent you are performing hand hygiene			
Before touching each patient	62 (41.0)	52 (34.7)	36 (24.0)
Before performing an injection	85 (56.7)	48 (32.0)	17 (11.3)
Between procedures during individual patient care.	9 (6.0)	116 (77.3)	25 (16.7)
Before performing wound dressings	85 (56.7)	48 (32.0)	17 (11.3)
After performing wound dressings	58 (38.7)	44 (29.3)	48 (32.0)
After contact with blood and body fluids	72 (48.0)	59 (39.3)	19 (12.7)
After removal of gloves	9 (6.0)	113 (75.3)	28 (18.7)

Table no 04 Continued…

To what extent you are using personal protective equipment			
Wear gloves before contact with blood and body fluids.	50 (33.3)	60 (40.0)	40 (26.7)
Wear gowns when contact with blood or body fluids.	55(36.7)	58 (38.7)	37 (2.7)
Wear mask if splashes of blood or other body fluids are anticipated.	74 (49.3)	57 (38.0)	19 (12.7)
Wear eye protection if splashes of blood or other body fluids are anticipated.	55 (36.7)	87 (58.0)	8 (5.3)
Changing gloves for the care of more than one patient.	39 (26.0)	68 (45.3)	43(28.7)
Wear gloves when handling any contaminated sharps	67 (44.7)	57(38.0)	26(17.3)
Wear appropriate protective equipment when handling clinical and chemical wastes	60 (40.7)	68 (45.3)	21 (14.0)
Wear appropriate personal protective equipment when collecting and handling specimens.	30 (20.0)	91(60.7)	29 (19.3)
To what extent you are handling and disposing of sharps safely			
Never recap used needles	27 (18.0)	23 (15.3)	100 (66.7)
Used needles and sharps are discarded into puncture-proof containers.	16 (10.7)	29 (19.3)	105 (70.0)
Sharps box is replaced when it 70-80% full.	47 (31.3)	64 (42.7)	39 (26.0)
Sharps box is discarded into the red plastic waste bag with the biohazard sign.	70 (46.7)	65 (43.3)	65 (43.3)
To what extent you are practicing safe handling and disposal of waste			
Domestic waste is placed in the black plastic waste bag.	3 (2.0)	22 (14.7)	125 (83.3)
Clinical waste is placed in red plastic waste bags.	37 (24.7)	29 (19.3)	84 (56.0)
Unused pharmaceutical products are disposed as chemical waste.	76 (50.7)	59 (39.3)	15 (10.0)
Waste bags are securely fastened when reaching 70-80% full.	77 (5.3)	53 (35.3)	20 (13.3)
To what extent you are cleaning spills of blood and body fluids			
Safe clean of the visible blood or body fluid	21 (14.0)	51 (34.0)	78 (52.0)
Decontaminate the area using suitable disinfectant	24 (16.0)	49 (32.7)	77 (51.3)
Disinfect the surface and the neighboring area with appropriate disinfectant.	70 (46.7)	69 (46.0)	11 (7.3)
To what extent you are decontaminating equipment appropriately			
Devices are disinfected at the appropriate temperature and length of time.	11 (7.3)	37 (24.7)	102 (68.0)
Re-usable equipment is cleaned and disinfected or sterilized after each patient use.	14 (9.3)	83 (55.3)	53 (35.3)
Decontaminated equipment is left in a sterile state for subsequent use.	7 (4.7)	43 (28.7)	100 (66.7)
To what extent you are collecting and handling specimens safely.			
Specimens' container is securely closed.	4 (2.7)	10 (6.7)	136 (90.7)
Specimens are placed in leak-proof bags during transportation.	99 (66.0	43 (28.7)	8 (5.3)
To what extent you are practicing safe injection.			
Following aseptic technique in preparation and administration of parenteral medications.	21 (14.0)	81 (54.0)	48 (32.0)
Use of a sterile single-use needle and syringe for each injection.	82 (54.7)	45 (30.0)	23 (15.3)
Needles and sharps are discarded into puncture-resistant containers	5 (3.3)	32 (21.3)	113 (75.3)
To what extent you are maintaining a clean environment			
Clean clinical environment frequently after each patient	5 (3.3)	112 (74.7)	33 (22.0)
Maintaining devices in a clinical environment always clean.	61 (40.7)	65 (43.3)	24 (16.0)

Table 4 provides a detailed description of nurses' self-rated practice of HAIs prevention and control and principles. The principles that the nurses always done were: specimens' container is securely closed (90.7%), domestic waste is placed in a black plastic waste bag (83.3%), used needles and sharps are discarded into puncture-proof containers (75.3%), devices are disinfected at the appropriate temperature and length of time (68.0%), never recap used needles (66.7%), decontaminated equipment is left in a sterile state for subsequent use (66.7%), clinical waste is placed in red plastic waste bags (56.0%), safe clean of the visible blood or body fluid (52.0%) and decontaminate the area using suitable disinfectant (51.3%) respectively. The principles that rated by the nurses as sometimes do were hand hygiene between procedures during individual patient care (77.3%), hand hygiene after removal

of gloves (75.3%), clean clinical environment frequently after each patient (74.7%), wear appropriate personal protective equipment when collecting and handling specimens (60.75), wear eye protection if splashes of blood or other body fluids are anticipated (58.0%), re-usable equipment is cleaned and disinfected or sterilized after each patient use (55.3%), following aseptic technique in preparation and administration of parenteral medications (54.0%), changing gloves for the care of more than one patient (45.3%), wear appropriate protective equipment when handling clinical and chemical wastes (45.3%), maintaining devises in clinical environment always clean (43.3%), sharps box is replace when it 70-80% full (42.7%) and wear gloves before contact with blood and body fluids (40.0%) respectively. As regard the principles that the nurses rated as rarely done were: specimens are placed in leak-proof bags during transportation (66.0%), hand hygiene before performing an injection (56.7%), hand hygiene before performing wound dressings (56.7%), use of a sterile single-use needle and syringe for each injection (54.7%), waste bags are securely fastened when reaching 70-80% full (51.3%), un-used pharmaceutical products are disposed as chemical waste (50.7%), wear mask if splashes of blood or other body fluids are anticipated (49.3%), hand hygiene after contact with blood and body fluids (48.0%), sharps box is discarded into red plastic waste bag with biohazard sign (46.7%), disinfect the spills of blood from surface and the neighboring area with appropriate disinfectant (46.7%), wear gloves when handling any contaminated sharps (44.7%), hand hygiene before touching each patient (41.0%), maintaining devises in clinical environment always clean(40.7%) and hand hygiene after performing wound dressings (38.7%).

Table 5: Mean score and levels of self-rated practice of HCAIs prevention and control principles

Principles of HCAIs practice	**Level of self-rated practice**	Mean ±SD **score of self-rated practice**
	No (%)	
Performing hand hygiene (Total score= 7-21):		
Poor	62 (41.3)	12.92±1.74
Fair	87 (58.0)	
Good	1 (0.7)	
Using personal protective equipment (Total score= 8-24):		
Poor	67 (44.6)	14.61±2.08
Fair	82 (54.7)	
Good	1 (0.7)	
Safe handling and disposing of sharps (Total score= 4 - 12):		
Poor	31 (20.7)	8.66±1.49
Fair	104 (69.3)	
Good	15 (10.0)	
Safe handling and disposal of waste (Total score= 4 - 12):		
Poor	43 (28.7)	8.34±1.50
Fair	92 (61.3)	
Good	15 (10.0)	
Cleaning spills of blood and body fluids (Total score=3- 9):		
Poor	34 (22.7)	6.34±1.10
Fair	116 (77.0)	
Good	0 (0.0)	
Appropriate decontamination of equipment (Total score= 3- 9):		
Poor	4 (2.6)	7.49±1.02
Fair	61 (40.7)	
Good	85 (56.7)	
Safe collection and handling of specimens (Total score=2-6):		
Poor	10 (6.7)	4.27±0.71
Fair	133 (88.7)	
Good	7 (4.7)	
Safe practice of injection (Total score= 3- 9):		
Poor	29 (19.3)	6.51±1.19
Fair	90 (60.0)	
Good	31(20.7)	
Maintaining clean clinical environment (Total score= 2- 6):		
Poor	53 (35.3)	3.94±0.90
Fair	89 (59.3)	
Good	8 (5.3)	
Total score of self-ratted practice (Total score= 36-108):		
Poor	67 (44.7)	73.08±4.59
Fair	83 (55.3)	
Good	0 (0.0)	

Table 5 represents that large percentage of nurses had fair level of practice of HCAIs prevention and control principles [safe collecting and handling of specimens, (88.7%) with 4.27±0.71 mean score of practice out of 6, cleaning spills of blood and body fluids (77.0%) with 6.34±1.10 mean score of practice out of 9, safe handling and disposal of sharps (69.0%) with 8.66±1.49 mean score of practice out of 12, safe handling and disposal of waste (61.3%) with 8.34±1.50 mean score of practice out of 12, safe practice of injection (60.0%) with 6.51±1.19 mean score of practice out of 9, maintaining clean clinical environment (59.3%) with 3.94±0.90 mean score of practice out of 6, performing hand hygiene (58.0%) with 12.92±1.74 mean score of practice out of 21, using personal protective equipment (54.7%) with 14.61±2.08 mean score of practice out of24 and appropriate decontamination of equipment (40.7%) with 7.49±1.02 mean score of practice out of 9], respectively. Moreover, more than half of nurses (56.7%) rated the good level of practice in appropriate decontamination of equipment with a 7.49±1.02 mean score of practice out of 9. Concerning the overall score of self-rated practice, 55.3% of nurses had a fair level of self-rated practice and 44.7% of them had a poor level of self-rated practice, with 73.08±4.59 mean overall score of practice out of 108. The results of table 5 provide an answer to the first research question.

Table 6: Pearson correlation (r) matrix of years of experience and pre-test overall knowledge score, the overall score of self-rated practice

	Years of experience	A pre-intervention overall score of knowledge
Years of experience		
A pre-intervention overall score of knowledge	r=.168* P =.039	
Overall score of self-rated practice	r=.073 P =.373	r=.100 P =.222

* Correlation is significant at the 0.05 level (2-tailed).

Table 6 represents the correlation matrix of years of experience and pre-test overall score of knowledge, overall score of self-rated practice. A statistically significant positive correlation was revealed between years of experience and pre-test overall score of knowledge, r=0.168, p< the 0.05. Meanwhile, no statistically significant correlation could be found between either year of experience and an overall score of self-rated practice, r=0.073, p> 0.05; or overall pre-test score of knowledge and an overall score of self-rated practice, r=0.100, p> 0.05.

Table 7: Reported barriers of practicing HCAIs prevention and control principles among studied sample

Barriers	**No (%)**
Inadequate knowledge	88 (58.7)
Increased numbers of patients	59 (60.3)
Inadequate facilities and equipment	83 (55.3)
Frequent forgetfulness	79 (52.7)
Lack of resources	90 (60.0)
Lack of time	110 (73.3)

Concerning the reported barriers of practicing HCAIs prevention and control principles, table 7 displays that, the most frequently reported barrier was lack of time 73.3% followed by increased numbers of patients 60.3%, lack of resources 60.0%, inadequate knowledge 58.7%, inadequate facilities and equipment 55.3% and frequent forgetfulness 52.7%. The results of Table **7** provide an answer to the second research question.

4. Discussion

Nurses are the most professions that evolved in more contact with the patient during administration of medications, wound dressing, sterilization, and disinfection, thus they are more exposed to nosocomial infections[27] and also playing a vital role in transmitting infections. So that nurses compliance with infection control principles is essential for the prevention and control of nosocomial infections [7]. For these circumstances, nurses should be conscious and have sound knowledge about the prevention of nosocomial infection and its consequences. This study was carried out to evaluate the effectiveness of the educational intervention on the level of outpatient nurses' knowledge concerning the prevention and control principles of HCAIs.

The present findings indicated that most of the nurses worked as a staff nurse and about two-thirds of them had a diploma in nursing. More than half of the nurses had twenty or more years of experience, with 17.94±6.785 mean years of experience. Most of the nurses had received previous training about infection control, and more than sixty percent of them had their last training for more than three years. Similar results were reported by Victor et al. in India; Phan et al. revealed that most of the healthcare workers including nurses from Hung Vuong Hospital, Vietnam had previous training about hand hygiene [28, 29]. Nakhaei and Mofrad, reported that more than two-thirds of operating rooms' nurses in Iran had received in-service educations about infection control [30]. On the other hand, the current result was higher than many studies including those of Tirivanhu, Ancia, and Petronella, they reported that 32% of the nurses had attended a workshop about infection control [31]. Alrubaiee et al. found that about three-quarters of Yemeni Nurses had no in-service training courses regarding infection control measures [32]. Fashafsheh et al. found that around two-thirds of the nurses in the governmental hospitals of Palestine never attended any continuing education courses about infection control [33]. This can be explained that the setting of the current study provide emphases on the importance of training about HCAIs but still need to be more efficient to affect the level of knowledge and practices of nurses.

In pre-intervention, the current results indicated that a minority of the nurses had good level of knowledge, while the knowledge level of the majority of them ranged from poor to moderate regarding general knowledge about HCAIs, hand hygiene, using personal protective equipment, safe handling, and disposal of sharps, managing spilled blood and body fluids, decontaminating equipment, collecting and handling specimens and maintaining a clean clinical environment as well as overall nurses' level of knowledge about HAIs and principles of its prevention and control. These results were consistent with many studies; Alrubaiee et al. reported that the majority Yemeni nurses had poor level of knowledge on hand hygiene, personal protective equipment, safe injection practices, routine hospital cleaning, safe hospital waste handling & disposal and the overall level of knowledge. [32]. Tirivanhu et al. in Bindura Provincial Hospital, Zimbabwe reported that 72.0% of nurses had poor to moderate knowledge regarding infection control measures [31]. Abu Salam et al. concluded that more than half of nurses working in family health settings in Shebin El-Kom district, Egypt had poor to moderate knowledge regarding infection control measures [34]. Eskander, Morsy, and Elfeky reported that approximately two-thirds of the nurses at Intensive Care of a selected Cancer Hospital in Egypt had unsatisfactory level of knowledge about infection control [35]. Mukthar, Karani and Miriein Kenya reported that the general knowledge score of nurses about the standard precautions was 58.5%[36]. Moreover, Shrestha revealed that nurses form Patan Hospital in Nepal had poor (18%) to moderate (82%) level of Knowledge, but that percentage of nurses with moderate level of knowledge was more than the current study this can be explained that her study subjects might still have fresh knowledge form their basic education, as most of the nurses in her study were in early stage of career with less than five years of experience, while in the current study most of the nurses had 10 years and more years of experience [37].

Regarding post-intervention, the knowledge level of the majority of nurses ranged from moderate to good level of knowledge with increasing percentage of nurses with the good level of Knowledge across all principles of HCAIs and the highest percentage was in using personal protective equipment principle and the general knowledge about HCAIs. Moreover, the majority of nurses achieved good level in overall knowledge about HCAIs and the principles of prevention and control with the significant increase in the mean overall score of Knowledge in post-intervention compared to the mean overall score of Knowledge in pre-intervention. These findings indicated the significant effect of the educational intervention in improving the level of nurses' Knowledge about principals of HCAIs prevention and control. These results were compatible with many studies; Phan et al. illustrated that educational intervention significantly improve hand hygiene knowledge and compliance among healthcare workers including nurses [29]. Shrestha revealed that nurses' knowledge about decontamination, high-level disinfection and sterilization was significantly increased after educational intervention [37]. Abdel-Rasoul et al. reported that health education intervention has successful effect in increasing the knowledge of health care workers including nurses regarding transmission and prevention of HCAIs, improving the risk perception and increasing compliance of universal precautions [38]. Adly et al. found that the nurses from intensive care units, at El Mansoura University Children's Hospital had significant improvement in their knowledge, practices, and compliance of standard precautions of infection control after implementation of training sessions [39]. Additionally, Hefzya et al. revealed a significant reduction in all indicator organisms after

health education intervention on cleaning and disinfection for doctors and nurses working at outpatient clinics of the teaching hospital at Fayoum Governorate, Egypt [15]. Mukthar, Karani and Miriein Kenya reported significant improvement in nurses' knowledge about the standard precautions, self-reported compliance with the standard precautions, as well as the observed compliance scores with standard precautions after the educational intervention [36]. Osuala and Oluwatosin revealed that the majority of nurses in selected hospitals in Anambra State, Nigeria had a knowledge score above ≤60%. From that context, the findings of the current study, as well as the other supported study, greatly emphasized the necessity of updated in-service education and training about infection control measures and principles to improve the level of nurses and other healthcare workers' knowledge and practices that in turn reduces the rate of HCAIs [40].

As regard self-rated practice of HCAIs prevention and control principles, the current study indicated that large percentage of nurses had fair level of practice regarding safe collecting and handling of specimens, cleaning spills of blood and body fluids, safe handling and disposal of sharps, safe handling and disposal of waste, safe practice of injection, maintaining clean clinical environment, performing hand hygiene, using personal protective equipment and appropriate decontamination of equipment, respectively. Moreover, more than half of nurses rated the good level of practice in appropriate decontamination of equipment. Concerning the overall score of self-rated practice more than half of the nurses had a fair level and slightly less than half had a poor level of self-rated practice, these results were in agreement with those of Mukthar, Karani and Miriein Kenya they found that nurses' standard precautions self-reported compliance score was forty-six percent [36]. Alrubaiee et al. they found that more than half of Yemeni nurses had a poor level of practices of precautions to prevent nosocomial infections [32]. Chuc et al. clarified that self-reported practices of hospital staff at a rural and an urban hospital in Vietnam were not completely satisfactory [41]. Slightly higher results were reported by Osuala and Oluwatosin they found that more than sixty percent of nurses had ≥60% score of the practice of infection control[40]. In contradiction to the current results, those of Haile, Engeda, and Abdella they found a higher proportion of healthcare workers in Gondar University Comprehensive Specialized Hospital, Northwest Ethiopia were always compliant with washing hands after body fluid exposure, washing hands immediately after removal of gloves, wearing clean gloves before exposure to body fluids, changing gloves between contacts with different patients and placing used sharps in puncture-resistant container after use [42].

As regarding the relationship between some socio-demographic characteristics of nurses and their level of knowledge and self-rated practice about HCAIs and its principles of prevention and control, the current findings indicated that the educational qualification has no effect on the nurses' level of knowledge about HCAIs and its principles of prevention and control. In contradiction, Eskander, Morsy, and Elfeky; Gruda and Sopjani reported the significant impact of the educational level on the nurses' knowledge about the prevention of spreading of hospital-acquired infections; this contradiction might be attributed to the large percentage their sample that holds Bachelor to master degree in nursing[35,43]. Also in this study, a significant positive association was revealed between years of experience and a pre-intervention overall score of knowledge, but no association with an overall score of self-rated practice; and no association between a Pre-intervention overall score of knowledge and an overall score of self-rated practice. Similarly, Mukthar, Karani and Miriein Kenya found that the self-reported knowledge means scores are not related to compliance with standard precaution mean scores [36]. In contrast, Eskander, Morsy, and Elfeky found positive correlations between mean knowledge scores and mean practice scores; negative correlations between years of experience and mean knowledge scores, and mean scores of practice [35].

Regarding the barriers of practicing HCAIs prevention and control principles, in the present, the reported barriers were lack of time followed by increased numbers of patients, lack of resources, lack of equipment and frequent forgetfulness. In spite of 96.0% of current study participants had received some forms of programs about HCAIs prevention and control, more than half of them reported that inadequate knowledge was one of the barriers of practicing HCAIs prevention and control principle. This could be explained that these programs may be poorly organized or the participants didn't value the benefits from these programs. These results were convenient with Tirivanhu et al. indicated that lack of knowledge, lack of equipment and resources as and lack of time were the factors impeded the nurses from proper infection control practice [31]. Travers et al. revealed that workload, forgetfulness, and lack of knowledge were perceived as factors affecting the effective implementation and adherence to infection prevention and control practices among nurses working in nursing homes in USA [44]. Moreover, Adly et al. illustrated that inadequate equipment, increase the number of patients and the limited number of nurses were from the factors affecting the compliance of intensive care units' nurses with standard precautions of infection control [39]. Chalya, Mbunda, and Chalyap illustrated that lack of knowledge, lack of personal protection equipment; time constraints and heavy workload were the factors of poor compliance with universal precautions among health care workers at Bugando Medical Centre, Tanzania [45].

Conclusion

Based on the findings of this study, it can be concluded that the majority of outpatient nurses had lack of knowledge in pre-intervention that significantly improved in post-intervention; indicating the positive effect of the implemented educational intervention about HCAIs prevention and control principles. Almost all of the nurses had poor to a fair level of self-rated practice. Lack of time, increased numbers of patients, lack of resources, inadequate knowledge, inadequate facilities and equipment, and frequent forgetfulness were the barrier of practicing HCAIs prevention and control principles.

Recommendation

Providing a well-organized, evidence-based in-service education to reinforce the nurses' knowledge and practice about HCAIs prevention and control on regular basis is needed; sustainability of enhanced infrastructure and human and non-human resource that help in improving infection control practices as well. Further researches are needed to provide applicable strategies for overcoming the obstacles that may hinder the nurses from adherence to infection prevention and control practices.

Conflict of Interest

The authors declared that they don't have any conflict of interest

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