

In-services Education Program for Improving Nurses' Performance Regarding Infection Control Measures in a Rural Hospital

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Abstract

Nowadays, Nosocomial infection and hospital-acquired infection are a worldwide problem that increases morbidity and mortality among the hospitalized patients and surges an additional cost. Rural nurses have a paramount role in preventing infection and providing high quality of patient care. Aim: This study existed to assess the effectiveness of an in-service education program for improving nurses' performance concerning the application of infection control measures in rural hospitals. Setting: This study was conducted in a selected government rural hospital in Fayoum Governorate, Egypt. Sample: A purposive sample of 100 nurses working in the rural hospital were included. Tools: A structured interview guide was used to assess nurses' level of knowledge, and an observation checklist to assess their performance level before and after program implementation. Results: Nearly half of nurses had correct performance concerning infection control pre-program and improved to around 88.0% post-program implementation. There were statistically significant differences between nurse's total knowledge scales and subscales in pre and post-program. Likewise, there were highly statistically significant differences associated with nurses' correct performance score level pre and post-program. Conclusion: In-service education intervention reported incredible improvement in nurses' knowledge and performance toward infection control measures in the rural hospital. Recommendations: There is a desire for endless training courses for nurses to validate nurses' knowledge, performance regarding utilization of standard safeguards of infection control in the rural hospital. Finally, at the community level, the government has to consider the distribution of continuous education programs to expand all health services and resources in rural areas.

Keywords: Infection control measures, In-service education, rural hospital.

Introduction

Health acquired infections (HAIs), previously called nosocomial infections, are associated with admission to health care resources as hospitals, long-term care facilities, community care facilities, ambulatory care settings, and home care (Ehsani et al., 2013 and Weber et al. 2018). Healthcare-associated infections (HAI) can be acquired through the introduction of invasive devices during medical procedures. These infections are classified as central line-associated bloodstream infections, catheter-associated urinary tract infections, ventilator-associated pneumonia, surgical site infections (Centers for Disease Control, 2014), as well as the transmission of communicable

diseases in healthcare environments which could be localized or systemic (Cheraghi et al., 2011 and Jain 2012). HAI's are a substantial cause of patient morbidity which require early intervention and management for reducing the risk of associated complications (Wasswa et al., 2015).

According to the recent literature, HAIs occur in any health care organization worldwide where 1.4 million patients acquire HAIs each day. The International Classification of Diseases (ICD-10) and the Centers for Disease Control and Prevention (CDC) appraised that around 1.7 million with HAIs led to 99,000 deaths each year and is considered as one of the top ten leading causes of death (BC Ministry of Health, 2011). The

World Health Organization (WHO, 2018) specified that it is considered as an HAI if infection showed from 48 to 72 hours after admission to health care settings.

Complying with infection control measures, specifically hand hygiene, is one of the most effective measures for controlling and prevent transmission of HAIs. Compliance with hand hygiene recommendations is often sub-optimal and is influenced by many factors, including equipment, supplies, time constraints, and behavioral factors (NHS 2018 & Jafari et al., 2012).

Standard precautions is defined as all the steps that should be taken to prevent the spread of infection from person to person or from contaminated environmental surfaces when there is an anticipated contact with blood, body fluids, secretions, and excretions such as urine and feces (International Council of Nurses-ICN, 2009 and Ibrahim, 2011). Standard precautions are the fundamental practices used to prevent the transmission of infectious agents during healthcare personnel interactions with patients in any healthcare setting and includes the prevention of infections that spread from healthcare personnel to patients and from patients to healthcare staff. This must be implemented by all healthcare workers for each patient encounter, (Galal et al. 2014, Frello & Carraro 2013 and Kilpatrick et al., 2018) and includes: hand hygiene, the routine of personal protective equipment, safe patient injection, safe handling of contaminated equipment or within all patient environment, as well respiratory hygiene.

The nurse plays an important role in the translation of knowledge about infection prevention and control into attitudes and practice. Florence Nightingale's model proposed a link between cleanliness and disease transmission indicating that there is a correlation between handwashing and a decrease in infection rates. Nightingale acted out prevention and control practices through her knowledge, attitude regarding infection prevention and control which placed the patient in the best possible position for healing (Soliman 2014 and Kilpatrick et al., 2018). The nurse has to provide a clean environment to the patient, and proper hand hygiene is the

primary method for reducing infection (Wasswa, 2015).

Continuing education is very important for all health care professions. Attendance in in-service education provides nurses with theoretical and practical evidence needed to attain certain types of skills and continuous improvement practice (Abd-Elhamid et al. 2016). It was reported that nurses in rural areas require collaborative and comprehensive practice to build on a broad knowledge base of nursing and health sciences to continuously implement infection control measures and clinical skills based on the nursing process (Benson & Powers 2011 and Belal 2017). Moreover, utilizing evidence-based information across a variety of departments and outpatient units helps achieve and ensure patient safety and high quality of care to improve patient outcomes (Galal 2014 and Oliveira et al., 2018). Garrett (2015) and Belal S.(2017) also emphasized that rural nurses have to perform routine infection control measures, promote optimal wellness, participate in the management of acute or chronic illness, assist the patient to manage the disease or disability, as well provide support in end-of-life care.

Healthcare-associated infections occur worldwide and affect both developed and resource-limited countries. About 5%–10% of patients admitted to acute care hospitals in developed countries acquire healthcare-associated infections at any given time but the risk of acquiring infection is 2–20 times higher in developing countries (Iliyasu et al., 2016 and WHO 2018).

Significance of the study

Caring for patients in rural areas required specialized skills to overcome specific challenges in nursing management. Body of literature reported that there are numerous nosocomial infections that occur annually which have far-reaching consequences leading to considerable morbidity, or mortality, and increase the cost due to the prolonged hospital stay (Gurler 2014 and Weber et al. 2018). Regular intervention training of health care professionals especially nurses about infection control measures is required, so we can prevent nosocomial infections and their associated expenses can be avoided (Reilly et

al 2002 and Kritsotakis, et al., 2018). The control the spread of infection is a vital role for nurses and regular updating should be considered to safeguard the welfare of the staff and community at large. The findings from the current study may be used in expanding interventions to make infection control practices mandatory competencies for all nurses in government and rural Hospitals.

Aim of the work

The aim of this study was to investigate the effect of an in-service education program on improving nurses' performance regarding infection control measures in a rural hospital through achieving the following:

- Assessing nurse's level of knowledge and performance regarding infection control standards to perceive their needs.
- Developing and implementing an infection control program based on nurse's needs.
- Evaluating the effectiveness of training program about infection control measures on nursing performance in the selected rural hospital.

Research Hypothesis:

Application of of an in-service education program will have a positive effect on knowledge and practical skills for nurses regarding infection control measures in a rural hospital.

Material and Method

Research Design

A Quasi-experimental research design was used to accomplish the aim and objectives of the study.

Setting and Population:

The study was conducted in a rural setting, Fayoum Governmental Hospital, which has most of the government medical facility located in Fayoum district, Egypt. A purposeful non-probability sample was used to include 100 nurses. They were enlisted according to the following inclusion criteria: male and female nurses, diploma and high qualified nurses, those who were working in the above mentioned setting with at least two-year

experience in their unit, and agree to participate voluntarily in the study program. The exclusion criteria include all nurses who refused to participate in the study. The nurses were scattered as; 15 nurses from the medical ward, 17 nurses from the surgical ward, 13 from the orthopedic ward, 10 nurses from the Hemodialysis unit, 25 nurses from outpatient clinics, and 20 nurses from daycare units and recovery room.

Tools and Procedure for Data Collection:

Data were collected by researchers using a structured interview guide and an observational checklist. Tools were adopted based on related references (Arenas 2005, Mohamed 2011 and Abd-Elhamid et al 2016). Both instruments were anonymous and were developed in the English Language.

I. Tool I. Interview questionnaire Include.

Socio-demographic and work experiences data: This part was designed from eight open-ended & closed multiple choices questions and collected before the training program. The questions were written in simple English language to assess nurses' socio-demographic and work experiences information. Likewise, this part includes; age, gender, marital status, level of education, working hours, experiences, and previous training sessions attended before.

Nurses' level of knowledge: This part was completed by nurses in the presence of the researchers before and after the program implementations. The questions in this part were designed from forty-five multiple choices questions in English and scattered as: services in a rural hospital, infection control, standard precautions, universal precaution, types of & chain of infection, modes of transmitting infection, obstacles, and challenges for preventing infections, disinfection, sterilization, and isolation.

Scoring system: The nurses' responses related to nurses' knowledge assessment were assigned one point for every correct answer and zero score if incorrect answer, while the total

scoring system in knowledge part was 70% for satisfactory & less than 70%, if unsatisfactory.

II. Tool II. Observation checklist:

This tool was completed before and after the program application to assess nurses' performance regarding infection control precautions. It includes fifteen assessment items as; performing hand hygiene, usages of personal protective equipment, insertion of a peripheral intravenous catheter, manage IV fluids and medication, Injection, linen management, waste management, and washing medical instruments.

Scoring system: For the observation checklist, one point was likewise assigned for every correct answer and zero score for incorrect answer. The total scoring system for this part was 70% for satisfactory & less than 70%, if unsatisfactory.

III. Field work: .

- Official approval was taken from Fayoum Governmental Hospital before the study was conducted. The study started at the beginning of January 2019 until the end of June 2019 for a total of 6 months. The researcher interviewed the participants individually to explain the purpose of the study. Anonymity and confidentiality of data was maintained all throughout the study. Nurses were informed that they have the right to withdraw from the study at any time throughout the program phases. Nurses filled in the interview questionnaire in the conference room, an empty room in outpatient clinics. Interview was written and verbal and conducted in Arabic language. The average time consumed in answering the knowledge and practices questionnaire is about thirty minutes duration, but the checklist filled by the researcher in average time 10 to 20 minutes. The researcher started the program after finishing the pre-assessment form of the questionnaire.

IV. Program Construction:

The main objective of the program was to improve the nurses' level of knowledge and practice when applying infection control measures in their departments and units. The program was designed by the researcher, based on the outcomes from the pre-assessment interview guide. The program was completed in three phases as the following:

First: Preparatory Phase:

Prior to the start of data collection, the researchers briefly explained the aim of the study to the nurses who consented to participate in the study; verbal consent was likewise taken. Paper guidelines, including program framework, objectives, the content were also designed to be disseminated to them during the implementation phase.

Second: Planning Phase:

Through this phase, the researchers settle the program mechanics as the classroom, resources, content, number of sessions, teaching methods, and evaluation methods for the program.

Third: Implementation Phase:

Nurses' assessment was completed to identify their knowledge and performance about infection control measures. Researchers started to collect data regarding knowledge assessment from the nurses in single individual interviews at the conference room. Two of the researchers were available to facilitate the data collection process. The time consumed for assessment of each nurse was around 15 -20 minutes. The assessment lasted for eight hours, once a week for one month.

The program content included the following:

Knowledge: It was about the nursing care, role of the nurse in each unit, Infection control as meaning, chain of infection, methods of transmitting infection, general precaution, disinfection, sterilization, and isolation.

Practice: It included items about applying

the standard precautions, hand washing, uses of personal protective equipment, re-use of machinery and medication, linen controlling, waste management, cleaning medical devices, and handling the environment.

Duration: For theoretical sessions, nurses were separated into four groups, and one hour was allotted for each group. For the practical part, it was divided into eight sessions, with two hours included in each session. During delivery of the session, Arabic & English languages were used. Re-demonstration was used for some procedures until correctly done during post-program implementation. The methods of teaching included lectures, demonstration & re-demonstration, video, role play, and group discussion were used as teaching methods. A copy of the guideline including program content was given to nurses as a reference. Some limitations were facing the researchers during data collection due to the shortage of nursing staff, which required some modifications in time during the period of program implementations.

Evaluation phase:

This phase includes evaluating the effect of the program related to improving nurses' knowledge and performance done once over three times by the investigator in the selected wards and units. The evaluation process was concluded immediately a week after program implementation and it was done for seven days. The result was compared pre and post up implementation phases to assess the effect of the program

Ethical Consideration:

Authorized approval was obtained from the Faculty of Nursing, Fayoum University Ethical Committee. Further approval was taken from the director of the rural hospital, as well as from unit managers in the same hospital. The aims and objectives of the study were explained to nurses to get their consent. In addition, the nurses have educated that contribution in the study will be voluntary, and

will not be harmed and the program implementation will be beneficial and will not affect their working time. Confidentiality and anonymity were likewise ensured for all participants in the program.

Validity and Reliability

Content validity were done by panel of medical-surgical and community nursing faculty experts from Faculty of Nursing, Fayoum University. They were critiqued for rationality, relevance, completeness, and applicability of the research instruments; changes were made based on their feedbacks.

Pilot Study:

A feasibility sample was carried out for ten nurses of the total subjects, to test the clarity, comprehensiveness, workability, and applicability of the tools, as well as to predict any difficulties and problems that may be encountered during the process of data collection. It helped the researchers to estimate the time required to complete the program. The feasibility sample was analyzed and the results were omitted from the total sample size. According to the obtained results, modifications as omission and interpretation were done. The feasibility study was excluded from the study sample.

Statistical analysis:

Data collected were reviewed, coded, analyzed, and tabulated using standard Microsoft office Excel and SPSS (Statistical Package for Social Studies) version 21 Descriptive analysis; as $x \pm SD$ for quantitative data and frequency and proportion for qualitative data were utilized. Chi-square (X^2) was used to compare between two groups or more regarding one qualitative variable. Correlation coefficient tests were used to create a correlation between two quantitative variables; Z tests and paired T-test were likewise used to test relation and correlation. The final results were considered not significant if $P > 0.05$, significant if $P < = 0.05$ and highly significant in $P < = 0.001$.

Result**Table (1):** Frequency and Percentage Distribution in Relation to Nurses' Sociodemographic data and work characteristics (n= 100).

Items	NO	%
Age:		
- 25 – < 35	51	51.0
- ≥ 35 – < 45	22	22.0
- ≥ 45	27	27.0
Gender		
- Male	11	11.0%
- Female	89	89.0%
Social status		
- Single.	18	18.0%
- Married.	72	72.0%
- Widowed.	8	8.0%
- Divorced.	2	2.0%
Academic qualification		
- Diploma Nurse.	62	62.0%
- Technician nurse.	27	27.0%
- Bachelor of nursing.	11	11.0%
Work experience		
- 2 – < 5	36	36.0
- 6 – < 10	48	48.0
- ≥ 10	18	18.0
Wworking hours:		
- 6 hours shift.	7	7.0
- 8 hours shift.	55	55.0
- 12 hours shiht.	38	38.0
Received training courses:		
- Infection control.	55	55.0
- Other related work areas courses	33	33.0
Exposed to injry(sharp) during work.	22	22.0
Exposed to other infection during work	2	0.2

Sociodemographic data and work characteristics of studied nurses are reported in the Table (1). It showed that most of them (51%) were from 25 to < 35 age ranges, the majority of them were female 89%, and around 72 % of them were married. As with educational level, 62% of them have a nursing diploma; 27% were technical nurses and 11% possess a bachelor's degree Regarding their work experiences, the table shows that 36% of the have one to five years of work experience, and 48% had (6-10) years of work experience. There were 50 % who received training courses about infection control and 33% received other courses related to their unit specialties. Finally, the table presents that 22% of the study nurses were exposed to sharps injury and 2% were exposed to infection during their working hours.

Table (2): Frequency and Percentage Distribution of nurses according to their Correct Knowledge about infection control pre and post program (n=100)

Items	Pre-Program Correct		Post- program Correct		Chi square	P Value
	No	%	No	%		
	Services offered in Rural Hospital.	17	17	80		
Meaning and causes of infection	54	54.0	89	89.0	30.058	<0.001
Transmission of Infection	24	24.0	50	50.0	14.500	<0.001
Important of infection control program.	24	24.0	50	50.0	14.500	<0.001
Meaning of Stander precautions	55	55.0	65	65.0	2.083	0.149
Target Patients for standard precautions and infection control in the selected units	71	71.0	77	77.0	0.936	0.333
Nursing role allied to infection control within multidisiplinary team.	37	37.0	78	78.0	34.394	<0.0001
Types of infectious agents	28	28.0	83	83.0	61.241	<0.0001
Component of chain of infection	29	29.0	72	72.0	36.984	<0.0001
Meaning of nosocomial infection	14	14.0	84	84.0	98.039	<0.0001
Common types of nosocomial infection	40	40.0	86	86.0	45.388	<0.0001
Causes of nosocomial infection	42	42.0	81	81.0	32.119	<0.0001

Table (2) shows that there were 17.0% who had correct knowledge about services offered in their units pre-program and changed to 80.0 % post-program implementation Around 54.0% had correct knowledge about the meaning of infection control program, which improved to 89.0% post-program implementation, 24.0% had correct knowledge about transmission of infection preprogram which increased to 50.0% post-program implementation. Also, 37.0%, 28.0, and 29.0%, respectively have correct knowledge about nursing roles related to infection control in the multidisciplinary team, types of infectious agents, and components of the chain of infection which was improved to 78.0%, 83.0%, and 72.0%, respectively with high significance at $P < 0.000$. As with nosocomial infection, it shows that 14.0%, 42.0,% 40.0%, respectively have correct knowledge about the meaning of nosocomial infection, causes of nosocomial infection, common types of nosocomial infection preprogram, which later increased to 84.0%, 81.0, 86.0% post-program implementation with, the highly statistically significant difference at $P < 0.0000$.

Table (3): Frequency and Percentage Distribution of Nurses according to their mean values of knowledge scales and subscales in Pre & Post program (N=100)

Knowledge item	Pre		Post		P value
	Mean± SD	Median (IQR)	Mean± SD	Median (IQR)	
Infection Control	31.13 ±11.47	33.00 (17.00-45.00)	74.34 ±19.60	75.00 (50.00-98.00)	<0.001
Hand washing	31.33 ±19.15	31.08 (9.60-57.00)	80.33 ±16.78	81.93 (59.00-100.00)	<0.001
Follow aseptic technique	30.09 ±17.68	38.08 (8.00-50.00)	62.62 ±16.73	67.71 (40.00-80.00)	<0.001
Using personal protective equipment.	29.55± 18.59	33.53 (5.00-50.00)	75.60 ±19.73	278.71 (50.00-98.00)	<0.001
Injection procedure.	32.79 ±22.88	34.34 (4.00-60.00)	75.05 ±19.74	78.51 (50.00-98.00)	<0.001
Mandgement and care of instrument & machines.	25.47± 18.37	24.820 (4.00-49.00)	69.79 ±24.30	72.290 (50.00-94.00)	<0.001
Appraising the isolation procedures	20.69± 9.41	21.690 (3.00-24.0)	73.70 ±16.55	75.700 (50.00-90.00)	<0.001
Vaccinations	28.19± 18.18	29.520 (15.0-50.00)	71.70 ±24.61	75.000 (40.00-100.00)	<0.001
Standard precautions	41.51± 9.32	40.000 (30.51-53.00)	75.92 ±16.33	75.870 (55.00-95.00)	<0.001

Table (3) observed that there were statistically significant differences between nurse's total knowledge scales and subscales in Pre & Post-program applications. This can be explained by the fact that the older nurses acquire more knowledge from their years of experience, exposure to continuous professional education than the younger nurse.

Table (4): Mean variances rendering to nurses correct performance related to infection control measures pre and post-program (N=100)

	Pre		Post		P value
	Mean	SD	Mean	SD	
Hand hygiene	44.1	14.5	71.6	16.3	0.00000
Personal Protective Equipment	43.6	17.9	85.5	16.6	0.00000
Aseptic technique	52.4	20.1	85.0	13.9	0.00000
Assistance in insertion of peripheral intravenous catheter:	60.3	25.2	94.6	16.5	0.00000
Preparation of IV fluids and medication.	92.9	24.0	92.8	26.1	0.98236
Injection safety	53.2	24.9	91.2	15.7	0.00000
Linen management	19.4	5.6	74.7	13.7	0.00000
Waste management sharp disposal	58.8	13.0	88.2	17.5	0.00000
dealing with specimen collected from the patient	66.8	8.2	94.3	21.6	0.00000
Disinfecting the instrument.	43.7	9.3	94.0	23.9	0.00000
Sterilization	43.7	9.3	94.4	18.6	0.00000
instruments storage	36.6	17.3	90.1	25.6	0.00000
Dealing with surgical instrument after use.	51.5	23.6	93.5	14.7	0.00000
Cleaning instrument	93.3	21.5	96.4	18.8	0.31917
Environmental sanitation	41.7	9.6	94.0	23.9	0.00000
Total Performance	53.8	19.8	87.4	7.8	0.00000

Mean variances rendering to nurses correct performance related to infection control pre and post program are reported in Table (4) and Figer (1). The data disclosed that there were greatly statistically significant differences related to nurses correct performance total level pre & post program, on the other hand, there were non-significant statistically differences related to preparing of IV fluids and cleaning instrument after patient use, p value 0.98236 and 0.31917

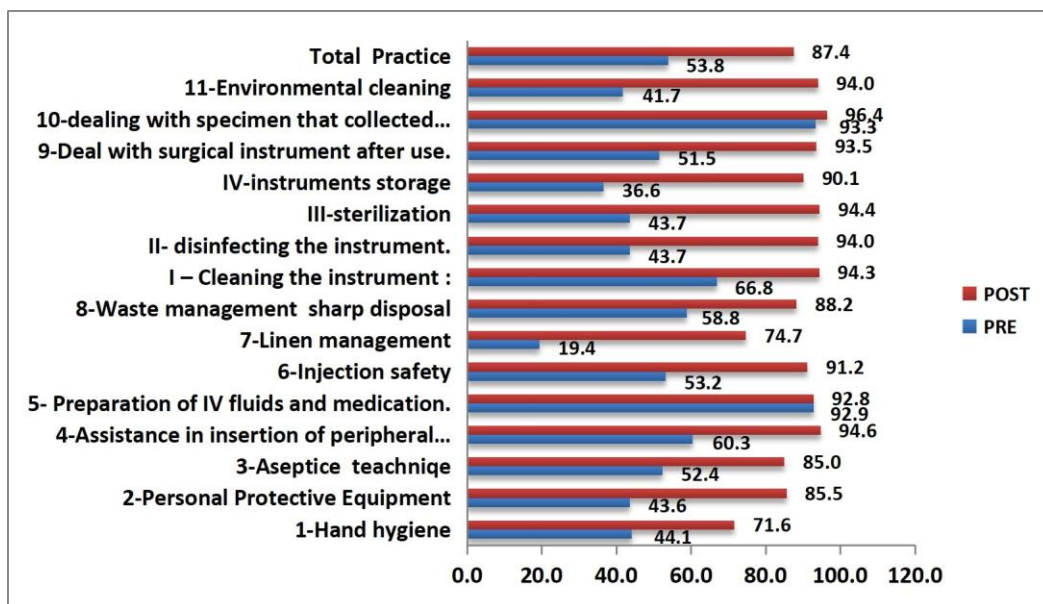


Fig (1): Mean variances rendering to nurses correct performance related to infection control pre and post program (n=100)

Table (5): Correlation between nurses correct knowledge, total factors scale and total performance score level (N=100)

		Total Factors Scale (Pre)	Total Performance (Pre)
Total Knowledge scale (Pre)	Pearson Correlation Coefficient r	0.634**	-0.131
	P value	.000	0.543
Total Factors Scale (Pre)	Pearson Correlation Coefficient r		-0.502
	P value		0.273
Total Knowledge scale (Post)	Pearson Correlation Coefficient r	0.531**	-0.131
	P value	.000	0.543
Total Factors Scale (Post)	Pearson Correlation Coefficient r		0.336
	P value		0.472

Table (5) Illustrates that they were a positive correlation between nurse's overall knowledge & factors facilitating the application of stander precaution pre & post-program

Table (6): Statistical relation between nurses socio demographic characteristics and their overall correct knowledge and performance related to infection control pre and post program application (n=100).

Item	No.	Total correct knowledge						Total correct performance					
		Pre			Post			Pre			Post		
		X ±SD	T	P.V	X ±SD	T	P.V	X ±SD	T	P.V	X ±SD	t	P.V
Age													
25<45	73	33.8±12.4	0.465		76.0±19.0			52.9±18.5			87.7±7.1		
≥45	27	32.4±13.1		0.642	71.8±17.6	1.004	4.2	56.5±23.7	-0.79	0.427	86.6±9.7	0.62	0.54
Gender													
Male	11	25.5±14.7	-2.27		61.9±25.1	-2.25		50.2±18.4	-0.58		88.9±8.1		0.55
Female	89	34.4±11.9	-	0.024	76.5±17.2		0.13	54.3±20.1		0.55	87.2±7.8	0.58	
Marital Status													
unmarried	28	36.1±13.7			79.51±15.0	1.36		55.1±21.2	0.50	0.612	84.9±8.6	-1.77	0.08
Married	72	32.5±12.0	1.09	0.28	73.2±19.6		0.123	53.2±19.5			88.3±7.4		
Years of experience													
1 <- 5	36	34.6±12.9	0.25	0.76	78.0±18.8	0.92	0.40	57.3±21.5			88.2±7.4	0.24	0.79
6 <- 10	46	32.5±11.8			72.1±20.3			51.7±18.4			86.9±7.4		
≥ 10	18	39.9±11.2			76.5±10.8			52.7±20.8	0.72	0.49	87.2±10.5		

The data reflected in table (6) exposed that, there were greatly statistically significant differences between nurses total correct performance score level and their years of experience.

Discussion

Socio-demographic data and work characteristics:

According to data from Socio-demographic characteristic of the study, results revealed that the total number of the participant was a hundred nurses, most of their age group ranges from 23 to 32 years, which had a better physical function, general health, and social function, and could be due to better physical ability in this age group. These results agreed with a study done by, Abolwafa et al.2013 who stated that the majority of the calculated sample was in the age group ranging from 20-30 years old. It could be due to the stability of job, family, and life in these ages. Also, the same results are in agreement with studies' findings accomplished in Iran and Turkey by (Jafari et al., 2013). Concerning their educational level, the study revealed that most of them wear diploma nurses and this agreed with a study done by Kabbash, et. al. (2007) in governmental Hospital to evaluate knowledge and practices towards risks of transmission of infection among patients and precautions taken by health care workers, and indicated that the majority of nurses were with a diploma degree. From the point of view of the researchers, this result may be due to the low level of education in Egypt, especially in rural areas. The findings of this study revealed that the majority of nurses did not join previous training courses toward infection control. This is in agreement with Abolwafa et al. (2013) who reported about ten percent of the nurses had prior training about infection control. This may be due to a shortage of nurses (Jafari et al., 2014). As well as lack specific courses related to infection control in the rural areas.

According to the research hypothesis: Application of of an in-service education program will have a positive effect on knowledge and practical skills for nurses regarding infection control measures:

The findings from the current study indicate that there were positive significant differences between the nurse's level of knowledge pre and post-program implementation concerning the infection control measures. According to the researchers, this insufficient

knowledge because most of them did not attend enough training sessions about knowledge related to infection control in their units as they stated. Also, data from the result reported that the nurses are responsible for providing medications, dressing, sterilization, and disinfection. They are involved in more contact with patients than other health care workers (HCWs), which makes them familiar with the hazard of infections. And recognized the importance of cleaning, disinfection, and infection control measures, to prevent themselves and patients from any infection. Therefore, they are more exposed to various NIs (Shinde and Mohite, 2014). Hence, nurses play a vital role in transmitting NIs, and their compliance with infection control measures seems to be necessary for preventing and controlling NIs (Sarani et al., 2016). This finding inconsistent with a highly significant educational program, Hassan, et. al.(2018) stated that the continuing education programs for health care workers who are responsible for direct patient care should include a comprehensive review of basic infection control.

This result also agreed with Kritsotakis et al. 2018, who revealed that the refresher training programs and courses on infection control measures should be conducted frequently for staff nurses to keep them up to date. Hospital personnel, especially nurses play an important role in spreading the infection and they are considered as key members of managing and controlling the hospital infections. Therefore, nurses must have correct, up-to-date, and appropriate scientific information regarding varieties of hospital infections, their effects on afflicting patients, the death toll and increased hospital costs, recognition of people at risk, and also the criteria to prevent and control (Nair et al., 2014). Nurses are the largest therapeutic team in hospitals, on the other hand, nurses' knowledge and practice regarding sanitary conditions play an essential role to guarantee individual and ultimately social health, an increased level of nurses' knowledge positively affects their performance (McCauley and Irwin, 2006 and Ehsani et al., 2013).

Corrected level of Knowledge for nurses about the standard precautions:

The current study revealed that personal protective equipment most of the time not

available, which making it difficult for the nurse to comply with infection control, example for changing soiled linen to make the patient comfortable need clean gloves. If gloves are not available, then it put the nurse in an awkward position to comply with infection prevention and control measures. A study to assess the implementation of infection control in health facilities and determine predictors of handwashing among health workers in Arua district, Uganda was conducted by, Wasswa et al., 2015 and revealed that most facilities (around ninety-three percent) had no infection control committees and lacked adequate supplies and equipment for infection prevention and control.

Personal protective equipment (PPE) refers to a range of barriers and respirators used alone or in combination to protect mucous membranes, airways, skin, and clothing from contact with infectious agents. According to Lemass et al. (2014) and Iliyasa et al., (2016). reported that practice staff should make a risk assessment of planned procedure/action and select PPE depending on the nature of the procedure, the risk of exposure to blood, body fluids, mucous membranes, and non-intact skin as well as the risk of contamination. Furthermore, glove use does not remove the need to comply with hand hygiene. Hands should be washed before putting on gloves and hand hygiene should be performed immediately after glove removal (Pang et. al 2014 & Benson and Powers 2011).

In the same line regarding the finding related to nosocomial infections, a study done by Pang et al (2014) reported that infectious diseases can be transmitted to patients who are taken care of by ill-health workers. Health-care workers have the responsibility to look after their health to avoid compromising patient safety. While Benson and Powers (2011) and WHO (2015) add nurses can also make a major influence in reducing the patient likeliness for contracting nosocomial infections. The results also demonstrates that there were unsatisfactory knowledge related to hand washing. It is important to wash hands with soap and water after removing gloves because there is a risk of hand contamination during the removal of gloves. In agreement, Weber et al. (2018) indicated that gloves should be removed

as soon as the episode of care is completed followed by decontamination of hands. Moreover, gloves provide an ideal, warm, moist environment where bacteria thrive; therefore, hand decontamination will remove any transient bacteria from a previous patient environment. Soliman et al. (2013) indicated that hand hygiene remains the cornerstone of infection prevention and all health workers must be aware that wearing PPE does not replace the need to carry out safe hand-hygiene practices and hand decontamination.

All staff must dispose of clinical waste according to the local policy with sharps in the gathered sharps containers. This finding in agreement with a study that was conducted in India, where Shinde and Mohite (2014) assessed knowledge, attitude, and practices of hand hygiene among medical and nursing students at a tertiary health care center, and he found the majority of nursing trainee had a poor knowledge concerning aseptic technique and dispose of clinical waste. Also, Pang et. al. (2015) add nursing staff is central to energies on green issues such as waste management as they represent the largest proportion of the health care worker workforce that purchase equipment and manage subsequent waste generated.

Accurate performance for nurses related to Infection control measures:

The results also indicate that there was unsatisfactory practice related to infection control measures and environmental cleaning, and it was improved after program implementation. These results agreed with EL-Shafey, El-Dakhakhny & Mohammed (2019) who confirmed that there was a significant statistical improvement in practical skills after implementing the intervenes educational program to the nurses. As well he highly recommended periodic in-service, training for nurses about standard percussions & infection control measures, and keeping references related to infection control guidelines to be available for all nurse stations. In the same line, **Rosenthal 2012 and Oliveira 2018** state that nosocomial infections may be transmitted to the patient by the nursing and healthcare providers who fail to practice or carry out the infection control measures. Compliance with

infection control practice may prevent nosocomial infections and will decrease the patient's hospital stay which leads to a decrease in the cost for the hospitals, whereas infections lead to increases institutional cost due to an increased length and complexity of hospital admission (**Cheraghi et al. 2011 and Kritsotakis, et al., 2018**). While **Royal College of Nursing, 2011** reported, the ineffective management of healthy environment and health care waste can also result in additional costs related to the disposal of waste if not segregated appropriately.

Sterile technique and infection control measures are the basis in the health care setting and therefore strict adherence to the recommended practices of sterile technique is mandatory for safety (**Oliveira et al., 2018**). **Mohamed et al. (2011)** suggest that adherence to the sterile technique principles by the sterile surgical team members, as well as by the unsterile members such as the anesthetist, must be observed, as it is the foundation of the prevention of nosocomial infection and contamination of wounds by potentially pathogenic microorganism. While **Mussa & Abass 2014** emphasize that, if there is non-compliance with aseptic technique principles, it may lead to the surgical wound becoming contaminated.

Preventing surgical site contamination requires the efforts of all surgical team members to use their theoretical knowledge and experience in aseptic practices to provide their patients with optimal care resulting in positive surgical outcomes **Garrett 2015 and Weber et al. (2018)**. **Sessa (2011)** reiterated that it is the responsibility of each member of the sterile surgical team to understand the meaning of principles and incorporate them into their everyday practice. **Lemass (2014) & Ilyasu (2016)** claimed that nurses in all health care facilities play important role as the patient's infection control advocate. As well nurses in the surgical ward and operating room must be well-equipped and demonstrate sound knowledge and practice in maintaining a sterile field at all times to minimize the spread of potential pathogens to other sites, wounds, or self and help patients in having a safe operation

Correlation between nurse's correct knowledge, and total performance score level:

The correlation table of the current study proved that there was a positive correlation between nurse's overall knowledge & factors facilitating the application of stander precaution pre & post-program implementation. This result consistent with the findings of **Ibrahim et al., (2011)** who found the majority of their studied group, had enough information about infection and prevention precaution. As well as the study by **Mussa and Abass, (2014)** and + emphasized that training programs about infection control measures for all members of staff lead to understanding the infection control policy and procedure as well as motivating them to adhere to it. This finding was supported by the study carried out by **Galal, et al. (2014)**, which showing improvement in knowledge and attitude after an educational program among the nursing staff. While **Soliman (2013)** found that only the minority of the studied nurses knew the definition of infection and carrier before receiving the educational program.

Statistical relation between nurses' socio-demographic characteristics and their overall correct knowledge and performance related to infection control pre and post-program application are exposed that there were greatly statistically significant differences between nurses' total correct performance score level and their years of experience. But **Hamid et al (2010)**, indicated that factors such as age and years of experience did not contribute to the achievement of knowledge about the practice of infection control. From the present study it can summarize that; the goal of continuous in-services education in nursing is to enhance the level of their knowledge to promote the safety and high quality of health care delivery to all patients. Nurses' knowledge and practices in infection prevention and control can affect the health environment of the patient. Education transforming nurses' awareness, growing knowledge, and lead to changes in work practice especially in rural areas. Nurses have a professional and moral obligation to protect the health of their patients and the natural environment.

Implication of the study

To update the quality of health care given and to acquire new knowledge and skills in rural hospitals. Educational programs are considered as means for providing nurses with the theoretical and technical information needed to acquire new skills and to continually improve nursing practice. Also, help nurses to accept responsibilities for their professional development. The knowledge and practices of nurses concerning infection control were deficient, for that such program has led to statistically significant improvements in nurses' knowledge and practices

Conclusion

Based on the findings and the research hypothesis of the present study, the application of in-services educations used in this study had statistically significant improvement in nurses' knowledge and performance towards standards of infection control post-program implementation. Also, increased nurse adherence to infection control measures. The study reinforced the desire for endless training courses for nurses to validate nurses' knowledge, performance regarding utilization of standard safeguards of infection control in the rural hospital.

Recommendation

In the light of the current study findings, the main recommendations can be stated as follows:

There is a desire for endless training courses for nurses to validate nurses' knowledge, performance regarding utilization of standard safeguards of infection control in the rural hospital. The implementation of in-service education for nurses must be mandatory. Finally, at the community level, the government has to consider the distribution of continuous education programs to expand all health services and resources in rural areas.

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The authors declare that they have no conflicts of interest.

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