Infection Control Knowledge and Practices: Program Management in Labor Units According to Standard Infection Control Precautions in Northern Upper Egypt

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Abstract **Background:** Birth-infection is known to be a major cause of maternal perinatal morbidity and mortality. Globally, it has been reported that better care during birth and labor, and newborns' care, as well, immediately after birth can avert up to 1.49 million maternal and newborn deaths and stillbirths. Infection Control is the most important field of concern in labor and delivery rooms. **Aim:** study the effect of an educational program on maternity nurses' knowledge and practices towards infection control in labor units according to standard infection control precautions. **Subject & Methods:** This study was conducted on 30 nurses worked in labor units of three hospitals in Fayoum city, Egypt. The method for data collection consists of a questionnaire based on standard infection control precautions. Checklists were used for 11 procedures to assess nurses' practices. **Results:** Nurses' knowledge and practices regarding infection control, according to standard infection control precautions, were poor. Statistically significant improvement in the maternity nurse's knowledge and practices after the implication of the program was found. The majority (87.0%) of nurses had expressed their satisfaction to participate with a high level of significant. **Conclusion:** Results indicate that prevention and control of infections aren't adequately applied in Fayoum hospitals. Therefore, after the program was implemented; all nurses reported higher scoring in both awareness and skills than before. The satisfactory score progressed while unsatisfactory one regressed. This is mirrored to the program's effect. **Recommendations**: Activate hospitals' infection control committees which should be combined with maternal death reviews, audits, training and feedback on infection rates in upper Egyptian Hospitals.

Keywords: *infection control, knowledge, practices, program management, labor units*

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1. Introduction

Healthcare-associated infections (HAI) were a major global concern in developing countries. [1] The most recent estimates in developing countries found the prevalence of HAI to be 15·5 per 100 patients (95%, CI 12.6-18.9). [2] The financial burden of HAI includes direct costs to the hospital for prolonged stay and readmission, as well as costs to the community and the patients themselves. [3] Hospital-acquired infection (HAI) is a major health problem in all societies. According to the WHO, 7.1 million cases of HAI occur every year. One in every 20 people is suffering from a hospital infection. This leads to 99,000 cases of death per year, which imposes an annual cost to society of $32 million. [4]

Infections during pregnancy are relatively prevalent due to changes in cell-mediated immunity of pregnant women. [5] Despite improvements in health care and global momentum in reducing maternal mortality, sepsis continues to be a leading cause of preventable maternal death. Most postpartum infections occur after hospital discharge, usually 24-hours after delivery. [6] Sepsis constitutes around 10.0% of all maternal deaths. [7] About 50 women suffer life-morbidity from sepsis for every maternal death associated with puerperal infections. [8] Research from high-income countries showed that the rate of sepsis-related maternal morbidity increased from 0.1 to 0.6 cases per 1000 deliveries. [9] Many wounds and

genital tract infections can be introduced during childbirth. Estimates of the contribution of sepsis to maternal death differ considerably. A study showed that sepsis was a leading cause of maternal mortality, which accounted for 41.9% of mortality. [10] In addition, it has been estimated that about 36.0% of neonatal deaths occur in low-and middle-income countries due to infections. [11]

Through previous studies, it was identified that several factors could cause infection. These factors and their relationships of cause and effect were grouped under 6 broad headings including staff, practices, equipment, environment, factors related to patients and others [12]. For example, staff-related factors included a lack of knowledge and information about the causes of infection. Similarly, concerning equipment in the labor room, warmers were not found to be disinfected properly according to the hospital infection control policy. Likewise, patient-related factors included increased age, high parity, and history of additional co-morbid. This was diagrammatically represented through the "Fishbone" diagram (Figure 1). The Fishbone approach was chosen because it is the best comprehensive way to analyze complex issues and to define their causes and effects. It is a type of method which sorts out ideas into useful categories and also helps to identify the root causes of any problem.

Many patients' predisposing factors for infection; include home birth under unhygienic conditions, prolonged labor with or without membrane rupture, frequent vaginal exams, obstetric maneuvers, retained secundines within the uterus and postpartum hemorrhage. [6] Also, it has been shown that pre-existing medical conditions, febrile disease or antibiotic treatment 2-weeks prior presentation, operative-vaginal-delivery, and CS may be associated with severe puerperal infection. [8] Postpartum endometritis (PPE) and Neonatal sepsis, as well, are often caused by organisms as flora in the mothers' vagina. Simple steps to manage infection will dramatically reduce the risk of these infections. However, they also cause significant morbidity and mortality in under-resourced nations in both hospital and community settings. There is uncontrolled and often frequent contact with blood and other body fluids during labor. If preventive measures are ignored, the risk of transmission of blood borne pathogens is high. [14]

Investment by the National Health Mission in a scaled-up drive to promote institutional delivery stipulates commitment to the quality of care at health facilities during childbirth. The high availability of maternity care services highlights the value of the increase in health facilities' quality of care. One of the markers of quality care is the prevention and treatment of infections, so attention to infection control during the provision of maternity services is paramount to achieve reductions in maternal mortality. [10] Infection control is a more substantial area of concern, particularly in Labor and delivery room. [11]

Infection acquired during birth is considered a common cause of maternal mortality and morbidity. It has been estimated that; globally, better care during birth, and care of newborns immediately after birth can avert up to 1.49 million maternal and newborn deaths and stillbirths. [15] Infection Control is the most important field of concern in labor and delivery rooms. [16]
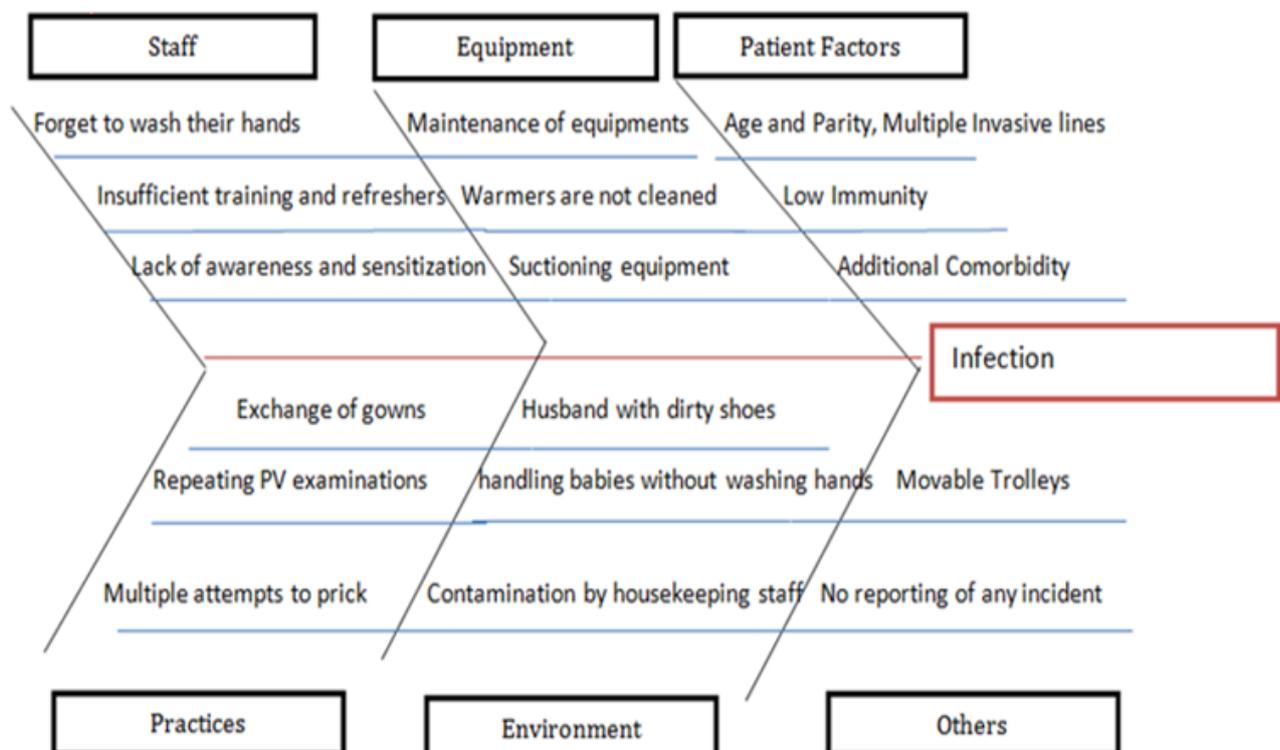

Figure 1. Fish Bone Diagram Infection control in labor and delivery room [13]

Infection prevention and control (IPC) is defined as all technical means and material intended to prevent pathogens from penetrating and developing into the body. [17,18] To this end, healthcare-associated infections (HCAIs) and nosocomial infections (NIs) must be avoided. Healthcare-associated infections are a major concern for health professionals. [19] In Africa, the prevalence of NIs varied between 10.0% and 60.0% and they represented the 3rd cause of maternal mortality, the 2nd cause of early neonatal mortality, and the 1st cause of postoperative morbidity. This prevalence was estimated at 10.9% in Senegal, 12.0% in Côte d'Ivoire, 10.0% in Benin, 14.0% in Mali, and 23.7% in Burkina Faso. [20] To achieve a reduction in infection rates among parturient women, an infection prevention and control program is needed. There are rationale and evidence to support the idea that involvement in health care facilities, by qualified infection control practitioners, is correlated with improved results if adherence with infection control precautions is assured. [21]

World health organization (WHO), Center for Diseases Control and Prevention (CDC) and Associated of Professionals in Infection Control (APIC) present best practices for unit infection control based on various evidence guidelines and recommend that the major safety measure such as hand hygiene, use of personal protective equipment (PPE), injection safety, handling patients' items, cleaning and disinfecting the external surface of dialysis, and the surrounding environment. Standard infection control measures should be taken pre/Intra/postnatal. Gloves should be worn at all times during labor and wearing a gown, a mask, and eye protection during all procedures is preferable. During vaginal delivery at 4-hour intervals, antibiotic prophylaxis should be given to high-risk patients to avoid G'BS sepsis in the neonate. Cleaning of the birth canal with a disinfectant during vaginal examinations and other instrumental procedures can be used, in limited-resource settings, to minimize the risk of both neonatal sepsis and maternal infections. To limit the risk of infection, the vaginal exams should be kept to a minimum. In case of delivery outside the hospital, and case of unsafe abortion, anti-tetanus prophylaxis should be given. In settings with a high risk of infection; care of the cord stump, post-delivery, should be performed with Chlorhexidine washings. [14]

Hand washing is one of the safety measures at units can protect women in labor from infection; because women in delivery are vulnerable for infection such as hepatitis 'B virus (H'BV), hepatitis C virus (HVC) and human immunodeficiency virus (HIV), those infections may be happening regarding too many malpractices of hand hygiene and/or improper aseptic technique. [22]

1.1. Significant of the Study

Hospital-acquired infection (HAI) is one of the common problems and difficulties faced by hospitals in all countries around the world. Since nurses are part of the healthcare team that plays a unique role in preventing hospital infection, this study is conducted to assess nurses' knowledge and practice according to standard precautions of infection control. As members of the health care team,

nurses play a very important role in HAI control. [4] They are the key health caregivers, meanwhile responsible for applying the main principles of infection control measures throughout providing all skills and application of infection control measures reflects their attitude based on powerful knowledge toward infection control principles. [14] Nurses must, therefore, have adequate knowledge and required skills in this area. [4] Absolutely, Nurses need to ensure that they provide a high standard of care by carrying out meticulous infection control measures throughout delivering safe and effective care for women on maintenance delivery. Nurses play a crucial role in the quality of care improvement, which provides women care and support. At the same time, the nurse can provide health promotion. [23-33] women at delivery units are venerable for healthcare-associated infections (HAI), following infection control measures is very important particularly hand hygiene is considered the most effective tool to prevent (HAI). [34]

To what has been experienced in some developing countries, regarding poor infection control (IC) practices in labor and delivery units. [35] Therefore, it would be wise to review the procedures, activities, and practices in labor and delivery units related to infection control and to identify factors that contribute to the development of infections. Such data could be used to prevent and parturient women's health-associated infections. [36] Therefore, the objectives of this study were to assess the knowledge of maternity nurses in Fayoum hospitals regarding infection control measures according to standard infection control precautions; to assess the actual infection control practices of maternity nurses during normal labor. This study is highlighted the nurse's compliance for applying infection control measures at labor units. Moreover, design, implement and evaluate the effect of program about infection control according to the results obtained from assessing knowledge and observation maternity nurses' practices in labor units. In this study; the guidelines used to inform were based on the standard infection control precautions. The health-related infection control program includes advice on safety procedures, safety supplies, a clean environment, and correct aseptic techniques. [37] An Educational program is an important contribution made by maternity health nurses to improve pregnancy outcomes without infection. [38]

2. Aim of the Study

The study was conducted to evaluate the effect of an educational program on maternity nurses' knowledge and practices towards infection control in labor units in Fayoum city in Upper Egypt according to standard infection control precautions. *The aims of this study achieved through:*

a. Assessing the maternity nurses' knowledge and practices towards infection control in labor units according to standard infection control precautions.

b. Developing and implementing an educational program for maternity nurses regarding infection control in labor units according to standard infection control precautions.

c. Evaluating the effect of an educational program on maternity nurses regarding infection control in

labor units according to standard infection control precautions.

3. Research Hypothesis

The primary research hypothesis was; maternity nurses' knowledge and practices towards infection control according to standard infection control precautions will be improved after implementation of the program, in the labor areas about:

A- Basic Infection Prevention and Control Guidelines (Disinfection and sterilization, Environmental infection control, Hand hygiene, and Isolation precautions)

B- Device-associated Guidelines (Catheter-associated urinary tract infections)

C- Healthcare Personnel Guidelines (Infection control in healthcare personnel Vaccines for healthcare personnel)

D- General Considerations (Standard infection control measures should be taken in pre/intra/postpartum period)

4. Subjects and Methods

4.1. Research Design

A quasi-experimental design (one group pretest-posttest design) was used in the current study.

4.2. Study Setting

This research was performed from July 2019 to January 2020. It was conducted in labor units of the obstetric wards of El-Fayoum hospitals (University, Health Insurance, The Ministry of Health and Population hospital).

4.3. Subjects

A purposive sample of 30 maternity nurses was selected from the available nurses worked in the above-mentioned setting.

4.4. Tools of Data Collection

Data of the current study were collected using the following tools:

1. A structured interviewing schedule that includes personal and socio-demographic data. The questionnaire included the personal characteristics of nurses (age, educational qualifications, attended training sessions on infection control, and years of experience).
2. The data collection tool was prepared by the researchers based on standard infection control precautions (2019). [39] A pre-designed standardized questionnaire was used to assess maternity nurses' awareness about infection control.
3. For assessment of practice, observation checklists (according to standard infection control precautions) for infection control practices were used.

4. Knowledge of maternity nurses was assessed regarding standard infection control precautions. The following items were assessed and scored: (1) Basic infection prevention and control guidelines include (Disinfection and sterilization, environmental infection control "Waste management", Hand hygiene "its time and technique", and Isolation precautions "PPE" "type and timing of using gloves, using protective eyewear, using and changing masks, sterile gowns & boots"). In addition to dealing with contaminated surfaces, linen, and used instruments, and appropriate method for dealing with body fluid spills and for disposal of waste; (2) Device-associated Guidelines includes catheter-associated urinary tract infections (CAUTI) (appropriate urinary catheter use; (3) Healthcare Personnel Recommendations includes infection prevention in healthcare personnel and vaccinations for healthcare workers (Diseases for which vaccination is required/recommended, diseases for which vaccination may be suggested in some situations, vaccinations required for adults, immunobiologics that may be suggested in certain cases, quadrivalent meningococcal conjugate vaccine, and quadrivalent meningococcal polysaccharide vaccine for HCP age >55 years); (4) General Considerations include (standard infection prevention steps to be taken pre/intra/postpartum period, antibiotic prophylaxis administration, a disinfectant during vaginal examinations and other (instrumental) procedures).

Scoring system

A scoring system was prepared and applied by the researchers. In the Knowledge subsection, each correct answer to the items was scored "one" and each incorrect, and/or do not know were scored "zero". The overall score for knowledge was determined by summing the scores of all questions (26 items). The scores were eventually measured in percentages. The number of correct answers multiplied by 100 and divided by the total number of items. The level of knowledge was classified as: good score of knowledge ($\geq$ 75%, $\geq$ 20 points), an average score of knowledge (50% to < 75%, 13 to 19 points) and a poor score of knowledge (< 50%, 0 to 12 points).

5. The practices subsections were comprised of ideal and standard 11 checklists for 11 procedures. Checklist (1) Hand hygiene (steps and proper hand washing technique), Isolation precautions (PPE) including the timing of use of wearing sterile gowns and gloves; Checklist (2) gowning. Checklist (3) gloving, which indicated using a new pair of gloves for each woman, changing gowns and gloves. Checklist (4) wearing protective eyewear and using face mask, using protective clothing during labor and wearing boots during labor. Checklist (5); It included cleaning, sterilization, and disinfection of equipment (using a sterile set of equipment for each woman. Checklist (6) perineal care including the disinfectant perineal area with antiseptic solution downward and backward motion. Checklist (7) Waste management (disposing sharps and non-sharps) instruments; using the hands-free technique to pass or transfer sharps. Checklist (8)

umbilical cord care; using an antiseptic agent to clean umbilical cord before clamping, Checklist (9) fixing the cannula under aseptic technique. Checklist (10) immersing used instruments in a container full of soap and water or disinfectant before their processing. Checklist (11) urinary catheter insertion and maintenance.

Scoring system

To calculate the percentage of practice scores, another scoring system was prepared and applied by the researchers. For each of the 11 procedures observations, the correct practice was scored "one" and incorrect one was scored "zero" for the score of each procedure. For all procedures the cumulative score was determined by summing scores of all procedures. Individual practice scores were calculated based on the frequency of adopting preventive behaviors against HAI (according to standard infection control precautions) divided by the total number of listed behaviors multiplied by 100. The level of practice was classified as: good when the score≥was 75%, average when it was 50% to < 75% and poor when it was < 50%.

4.4.1. Validity and Reliability of the Tool

The questionnaire was developed in consultation with two medical surgical, two maternity & gynecological nursing professors, and an expert in questionnaire validation. The validity of the used tool was evaluated by a health-care specialist and modifications were done accordingly based on their judgment, while its reliability assessed by piloting & measuring the related Cronbach Alpha value (Alpha = 0.89).

4.4.2. Administrative and Ethical Considerations

Legal permission for data collection was obtained by sending an official letter from the Faculty of Nursing to the study-setting responsible authorities to seek permission for data collection. At all phases of the study, all ethical issues were taken into account by the researcher; the researcher maintained the confidentiality/ anonymity of the subjects. The researcher introduced herself and explained the nature of the study to every nurse and asked questions in Arabic for all patients. The study was conducted after obtaining informed consent from nurses

4.4.3. Pilot Study

A pilot study of 3 nurses (10 percent of the total number) was performed to test the feasibility and applicability of the tools and to estimate the time needed for data collection. Necessary modification/omission/addition was followed as needed according to the results of the conducted pilot study.

4.4.4. Program Sessions

An educational program was designed and tailored according to the needs of the nurses included 5 sessions: 45-120 minutes each, on 3 days (Table 1). In the opening ceremony session, the researcher introduces herself to the participants and get their expectations, then she distributes the pre-test to assess participants' baseline-knowledge regarding infection control. The 1st session covers an introduction and overview regarding the definition of infection, infection control, and its importance. The 2nd session covers infection control guidelines and practices include hand hygiene, and isolation precautions "PPE". The 3rd session declares knowledge and practices regarding cleaning and sterilization. It covers the basic infection control guidelines and practices include disinfection and sterilization, waste management. In addition to dealing with contaminated surfaces, linen and used instruments, and the appropriate method for dealing with body fluid spills and for disposal of waste. Fixing a cannula, perineal care, and umbilical cord care under aseptic technique were demonstrated in the same session. The 4th was on device-associated guidelines includes catheter-associated urinary tract infections (CAUTI). The 5th included healthcare personnel guidelines include infection control in healthcare personnel vaccines for healthcare personnel. All points regarding the general considerations included in the same session. Immediately after and 2-months weeks later the implementation of the after program, the practices of the nurses in the labor rooms of the obstetric wards were reassessed using the same tools. The educational methods consisted of lectures, discussions, and demonstrations. Educational materials as PowerPoint presentations, videos, posters, and booklets about infection control were used. The researchers adopted a problem-solving approach in sessions that allowed participants to participate and discuss their concerns. During the sessions, short films, presentations, illustrated pictures, and group discussion were held. At the end of each session, the researcher summarized the important points of this session and the participants were encouraged to ask and show their personal experience. Brochures, booklets, and leaflets, accompanied by illustrated figures, were distributed as take-home notes.

4.5. Statistical Analysis

All the data obtained were tabulated and statistically analyzed by using SPSS 16.0. Mean, standard deviation (mean ± SD) and number and percent (for qualitative data) were used for descriptive statistics. Paired "τ" test (to compare between different outcomes in the same group). Column and pie chart used for graphic presentations. The significance level (P-value) was estimated at 0.05.

5. Results

Table 2 indicates how the maternity nurses are divided according to their socio-demographic and personal characteristics. The age of nurses ranged between 17 and 50 years with a mean age of 24.7 ± 8.37 years. As regards educational qualification, 33.0% had only an intermediate education (secondary school of nursing) and 43.3% had a technical institute of nursing, 20.0% had a Bachelor's degree and 3.4% had a Master's degree. The mean years of experience were 3.62 ± 3.4 years. More than half (63.3%) of nurses didn't, previously, attended training programs related to infection control.

Table 1. Overview of the elements in the program on nurses' knowledge and practices regarding infection control in labor units according to standard infection control precautions (duration 3 days)

day	No.	Elements	Objectives	Method
1st day		Opening Ceremony	• The researcher introduces herself to the participants. • Welcome and presentation sessions objectives. • Enumerate the participants' expectations on a Philip chart. • Distribution of pre-test.	• Philip chart
	Session (1)	An overview regarding infection control its guidelines and importance	• Define infection, infection control • List importance of infection control	• Discussion • PowerPoint
	Session (2)	Knowledge and practices regarding hand hygiene and personal protective equipment (PPE)	• Demonstrate hand washing • isolation precautions (PPE) a. Demonstrate gowning. b. Demonstrate gloving. c. Demonstrate wearing protective eyewear, face mask, protective clothing and boots.	• PowerPoint • Videos • demonstrations
2nd day	Session (3)	Knowledge and practices regarding cleaning and sterilization techniques	• Recognize disinfection and sterilization • Describe environmental infection control • Apply cleaning and sterilization a. Demonstrate sterilization/disinfection of equipment. b. Demonstrate perineal care c. Demonstrate waste management d. Demonstrate umbilical cord care e. Demonstrate fixing the cannula under aseptic technique.	• PowerPoint • Videos • demonstrations
3rd day	Session (4)	Knowledge and practices regarding device-associated guidelines	• Recognize Appropriate Urinary Catheter Use • Demonstrate urinary catheter insertion and maintenance	• PowerPoint • Videos • demonstrations
	Session (5)	Knowledge regarding healthcare personnel guidelines	• Mention the infection control in healthcare personnel (vaccines for healthcare personnel) a. Diseases for which vaccination is recommended (Hepatitis 'B, Influenza, Measles, Mumps, Rubella, Pertussis, Varicella). b. Diseases for which vaccination might be indicated in certain circumstances (Typhoid Fever, Meningococcal Disease, and Poliomyelitis). c. Other vaccines recommended for adults (Pneumococcal polysaccharide vaccine "PPSV", Tetanus and diphtheria toxoids "Td", Human papillomavirus "HPV" vaccine, Zoster vaccine, Hepatitis A vaccine). d. Other immunobiologics that might be indicated in certain circumstances for HCP e. Quadrivalent meningococcal conjugate vaccine (tetravalent (A, C, Y, W) for HCP ages 19-54 years. f. Quadrivalent meningococcal polysaccharide vaccine for HCP age >55 years.	• PowerPoint
		Knowledge regarding general considerations	• Summarize the standard infection control measures should be taken before, during and after labor a. Gloves should be worn at all times during labor and wearing mask, a gown, and eye cover is recommended for all procedures. b. Antibiotic prophylaxis c. In limited-resource settings, cleaning of the birth canal with a disinfectant during vaginal examinations and other (instrumental) procedures d. Vaginal exams should be kept to a minimum to limit the risk of infection.	• PowerPoint • Video • pictures
		Closing	• Distribution of post-test.	• Thanks

Knowledge about infection control according to standard infection control precautions is presented in Table 3 & Figure 2. This part assesses the nurses' knowledge about infection control, which included; (A) Basic infection prevention and control guidelines (disinfection and sterilization, environmental infection control, hand hygiene, isolation precautions), ('B) Device-associated guidelines (catheter-associated urinary tract infections (CAUTI)), (C) Healthcare personnel guidelines (vaccines for healthcare personnel), (D) General considerations (standard infection control measures should be taken before, during and after labor). Additionally, the total score of nurses' knowledge is presented in Figure 2.

Table 3 revealed that there was an increase in the knowledge of maternity nurses in all infection control items according to standard infection control precautions. Improvement was sustained immediately after the implication of the program and maintained after that. These improvements were statistically significant ($P < 0.01$).

Table 2. Socio- Demographic Characteristics of the Study Sample

Items	No	%
Age:		
17-	14	46.7
20-	10	33.3
30+	6	20.0
Mean ± SD	24.7 ± 8.37	
Qualifications:		
Intermediate education (Secondary School of Nursing)	10	33.3
Above-average education (Technical Institute of Nursing)	13	43.3
high education (Faculty of nursing)	6	20.0
Post-graduate education (master degree)	1	3.4
Experiences		
< 1 years	9	30.0
1-3 years	11	36.7
3-5 years	3	10.0
5+ years	7	23.3
Mean ± SD	3.62 ± 3.41	
Attendance a training program previously		
Yes	11	36.7
No	19	63.3

Table 3. Distribution of nurses' mean Knowledge scores pre and post-program according to Standard Infection Control precautions

Knowledge items Regarding Standard IC precautions	Pre-program	Immediately Post-program			2 months Post-program		
	Mean ± SD	Mean ± SD	Paired (t1)	(p) value	Mean ± SD	Paired (t2)	(p) Value
A- Basic Infection Prevention and Control Guidelines							
1- Disinfection and sterilization							
Define infection	0.52 ± 0.49	1.27 ± 0.43	10.52	< 0.001*	1.99 ± 0.28	9.18	< 0.001*
Define infection control	0.56 ± 0.51	1.33 ± 0.48	12.29	< 0.001*	1.79 ± 0.44	11.01	< 0.001*
Importance of infection control	0.46 ± 0.52	1.79 ± 0.38	11.49	< 0.001*	2.19 ± 0.19	9.89	< 0.001*
Differentiate between disinfection and sterilization	0.57 ± 0.49	1.26 ± 0.43	10.53	< 0.001*	1.54 ± 0.28	9.19	< 0.001*
Disinfectant substances	1.58 ± 0.52	2.46 ± 0.52	11.79	< 0.001*	2.79 ± 0.54	16.87	< 0.001*
2- Environmental infection control (Waste management)							
Disposal of needles in safety boxes	0.67 ± 0.57	1.66 ± 0.48	12.55	< 0.001*	1.95 ± 0.50	10.18	< 0.001*
Disposal of syringes without recapping	0.52 ± 0.50	1.71 ± 0.36	10.28	< 0.001*	1.84 ± 0.19	9.93	< 0.001*
Disposal of non-sharps in specific bags	0.44 ± 0.56	1.80 ± 0.45	13.45	< 0.001*	2.11 ± 0.31	10.47	< 0.001*
Washing contaminated surfaces	0.59 ± 0.56	2.28 ± 0.45	12.98	< 0.001*	2.93 ± 0.34	9.16	< 0.001*
Washing contaminated linen	0.25 ± 0.44	1.20 ± 0.00	18.53	< 0.001*	1.90 ± 0.00	18.31	< 0.001*
Cleaning then sterilizing used equipment	0.53 ± 0.50	1.51 ± 0.36	10.28	< 0.001*	1.95 ± 0.19	9.93	< 0.001*
3- Timing of Hand hygiene							
Before and after dealing with patients	0.52 ± 0.50	1.72 ± 0.37	10.39	< 0.001*	1.96 ± 0.18	9.97	< 0.001*
Before and after invasive procedures	0.58 ± 0.49	1.25 ± 0.43	10.53	< 0.001*	1.98 ± 0.28	9.19	< 0.001*
After removing gloves	0.58 ± 0.51	1.34 ± 0.48	12.27	< 0.001*	1.76 ± 0.44	11.02	< 0.001*
When soiled	0.44 ± 0.56	1.77 ± 0.45	13.45	< 0.001*	1.91 ± 0.31	10.47	< 0.001*
Before leaving the labor room	0.51 ± 0.50	1.06 ± 0.24	11.59	< 0.001*	1.02 ± 0.13	10.25	< 0.001*
4- Isolation precautions (PPE)							
types of PPE	0.22 ± 0.42	1.04 ± 0.01	18.54	< 0.001*	1.50 ± 0.00	18.33	< 0.001*
Type of gloves	0.52 ± 0.51	1.74 ± 0.35	10.27	< 0.001*	1.95 ± 0.17	9.95	< 0.001*
Time of using sterile gloves	0.76 ± 0.55	1.67 ± 0.49	12.52	< 0.001*	1.99 ± 0.50	10.16	< 0.001*
Time of using disposable gloves	0.50 ± 0.51	1.70 ± 0.36	10.28	< 0.001*	1.98 ± 0.19	9.92	< 0.001*
Timing of using puncture-resistant gloves	1.23 ± 0.45	1.62 ± 0.38	10.39	< 0.001*	1.77 ± 0.45	8.40	< 0.001*
Types of masks	0.45 ± 0.51	1.89 ± 0.39	11.39	< 0.001*	2.09 ± 0.19	9.99	< 0.001*
Time of wearing protective eyewear	0.58 ± 0.49	1.29 ± 0.44	10.55	< 0.001*	2.09 ± 0.29	9.17	< 0.001*
Time of wearing sterile gowns	0.59 ± 0.54	1.86 ± 0.49	12.29	< 0.001*	2.27 ± 0.44	11.05	< 0.001*
Time of use of boots	0.44 ± 0.58	1.59 ± 0.47	13.47	< 0.001*	1.94 ± 0.31	10.47	< 0.001*
B- Device-associated Guidelines							
Catheter-associated urinary tract infections (CAUTI)							
Appropriate Urinary Catheter Use	0.58 ± 0.56	1.99 ± 0.45	12.98	< 0.001*	2.14 ± 0.34	9.16	< 0.001*
C- Healthcare Personnel Guidelines							
Infection control in healthcare personnel Vaccines for healthcare personnel							
• Diseases for which vaccination is recommended (Hepatitis B, Influenza, Measles, Mumps, Rubella, Pertussis, Varicella)	0.25 ± 0.44	1.60 ± 0.00	18.53	< 0.001*	2.00 ± 0.00	18.31	< 0.001*
• Diseases for which vaccination might be indicated in certain circumstances (Typhoid Fever, Meningococcal Disease, and Poliomyelitis)	0.54 ± 0.50	1.60 ± 0.36	10.28	< 0.001*	2.04 ± 0.19	9.93	< 0.001*
• Other vaccines recommended for adults (Pneumococcal polysaccharide vaccine "PPSV", Tetanus and diphtheria toxoids "Td", Human papillomavirus "HPV" vaccine, Zoster vaccine, Hepatitis A vaccine)	1.29 ± 0.45	2.81 ± 0.39	10.37	< 0.001*	2.95 ± 0.44	8.38	< 0.001*
• Other immunobiologics that might be indicated in certain circumstances for HCP	1.01 ± 0.57	1.66 ± 0.48	12.55	< 0.001*	1.95 ± 0.50	10.18	< 0.001*
• Quadrivalent meningococcal conjugate vaccine (tetravalent (A, C, Y, W) for HCP ages 19–54 years	0.52 ± 0.50	1.44 ± 0.36	10.28	< 0.001*	1.94 ± 0.19	9.93	< 0.001*
• Quadrivalent meningococcal polysaccharide vaccine for HCP age >55 years	0.45 ± 0.56	1.27 ± 0.45	13.45	< 0.001*	1.81 ± 0.31	10.47	< 0.001*
D- General Considerations							
Standard infection control measures should be taken before, during and after labor							
Gloves should be worn at all times during labor, and it is best to wear a cap, mask and eye protection during all procedures	1.02 ± 0.57	1.25 ± 0.48	12.55	< 0.001*	1.85 ± 0.50	10.18	< 0.001*
Antibiotic prophylaxis should be given to high-risk patients at 4-hour intervals during vaginal delivery to avoid neonatal GBS sepsis.	0.58 ± 0.49	1.26 ± 0.43	10.53	< 0.001*	1.44 ± 0.28	9.19	< 0.001*
Cleaning the birth channel with a disinfectant during vaginal exams, and other instrumental procedures can be used in limited-resource settings to minimize the risk of both neonatal and maternal sepsis.	1.03 ± 0.51	1.52 ± 0.48	12.27	< 0.001*	1.76 ± 0.44	11.02	< 0.001*
To reduce the risk of infection, vaginal exams should be held to a minimum.	0.51 ± 0.50	1.56 ± 0.24	11.59	< 0.001*	1.92 ± 0.13	10.25	< 0.001*

A statistical significant difference (P ≤ 0.05)
Paired (τ1): Before program and immediately after

A highly statistical significant difference (P ≤ 0.001)
Paired (τ2): Before program and after 2 months.

Figure 2 summarizes maternity nurse's total knowledge score about the infection control according to standard infection control precautions. This figure showed that 23.0% of the nurses recorded good scores in the pre-test compared with 75.5% in the immediate posttest and 90.0% after 2-months. However, 27.0% of the nurses recorded an average score in the pre-test compared with 10.0% in the immediate posttest and 9.0% after 2-months. Moreover, 50.0% of the nurses recorded poor scores in the pre-test compared with 15.0% in the immediate posttest and 0.50% after 2-months.

Infection control practices according to standard infection control precautions are presented in Figure 3 and Table 4

as well. This part assesses the nurses' practices about infection control, which included: (A) Basic Infection Control Guidelines as; (1) Disinfection and sterilization (disinfecting perineal area, use of a sterile set of equipment, touching sterile and non-sterile area while donning gloves), (2) Disposal of sharps in safety boxes, (3) Hand hygiene, (4) Isolation precautions (gloving, gowning, masks, boots, and protective eye wear). (B) Device-associated Guidelines as; correct techniques for the installation and maintenance of urinary catheters. (C) General considerations (standard infection control measures should be taken pre/intra/post-labor). Additionally, the total score of nurses' practice is presented in Figure 3.
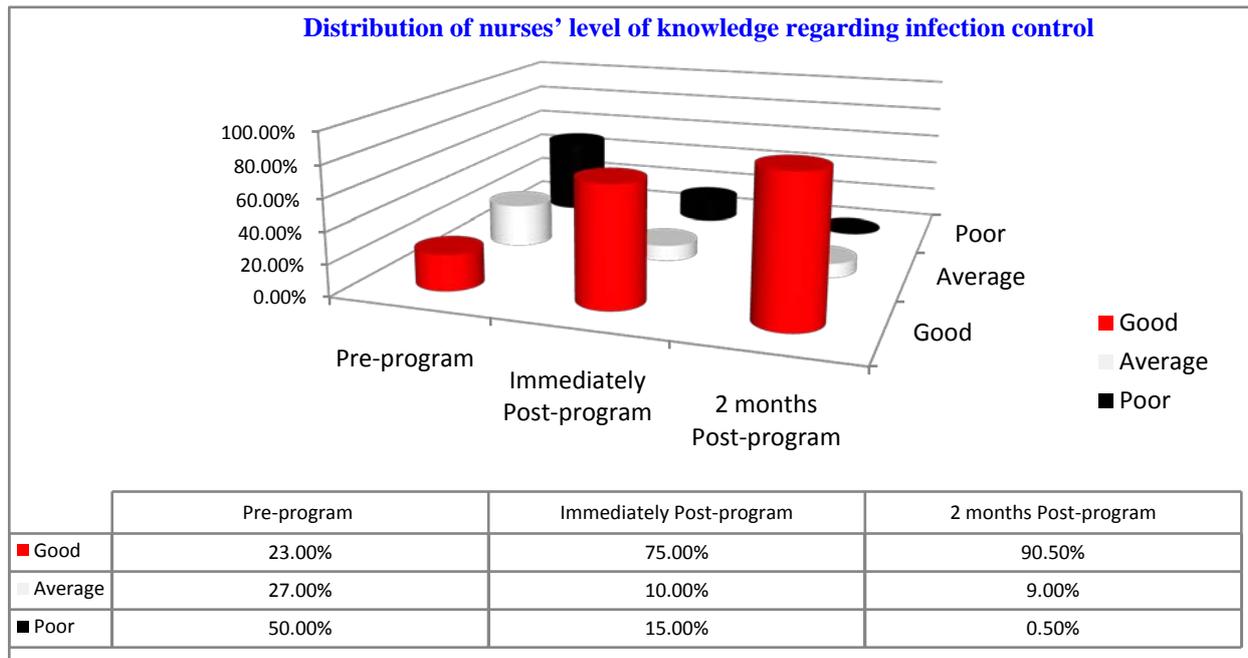
Distribution of nurses' level of knowledge regarding infection control

	Pre-program	Immediately Post-program	2 months Post-program
Good	23.00%	75.00%	90.50%
Average	27.00%	10.00%	9.00%
Poor	50.00%	15.00%	0.50%

Figure 2. Distribution of nurses' level of total knowledge score regarding infection control according to Standard Infection Control precautions

Distribution of nurses' practice regarding infection control

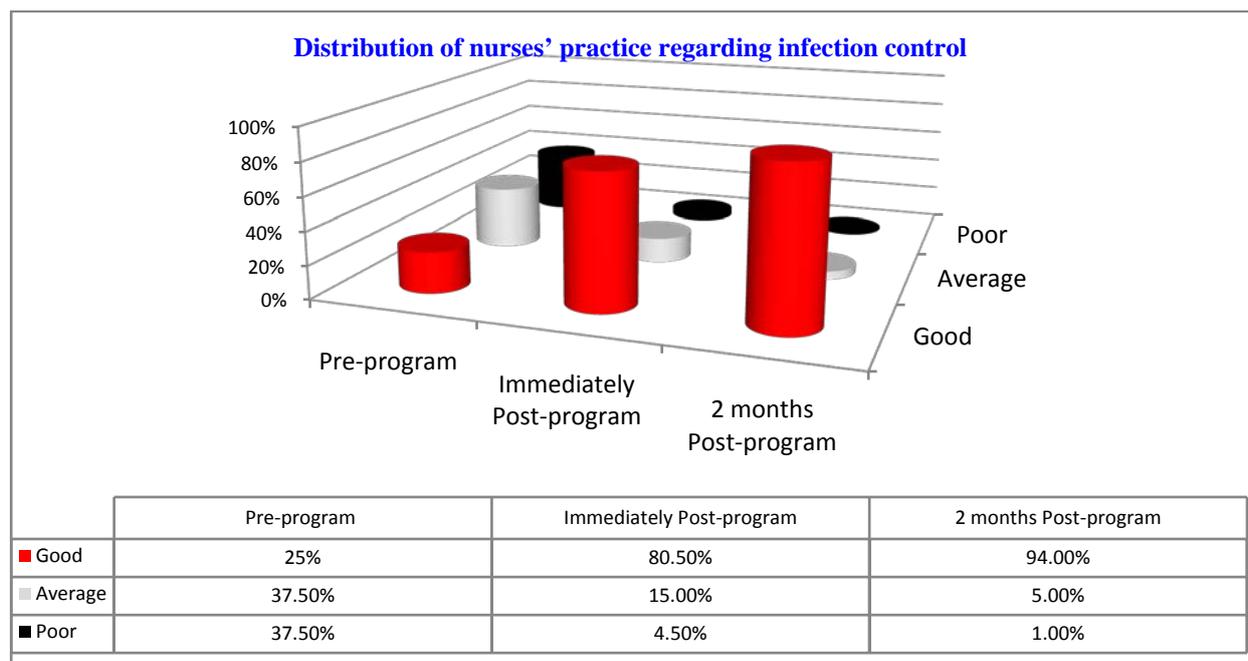|	Pre-program	Immediately Post-program	2 months Post-program
Good	25%	80.50%	94.00%
Average	37.50%	15.00%	5.00%
Poor	37.50%	4.50%	1.00%

Figure 3. Distribution of nurses' practice regarding infection control according to Standard Infection Control precautions

Table 4. Distribution of nurses' mean infection control practices' scores pre and post-program according to Standard Infection Control precautions

Practices' items regarding Standard IC precautions	Pre-program	Immediately Post-program			2 months Post-program		
	Mean ± SD	Mean ± SD	Paired (t1)	(p) value	Mean ± SD	Paired (t2)	(p) Value
A- Basic Infection Prevention and Control Guidelines							
1- Disinfection and sterilization							
Use of a sterile set of equipment	1.40 ± 0.56	2.39 ± 0.63	11.38	< 0.001*	2.78 ± 0.52	16.65	< 0.001*
Disinfecting perineal area with antiseptic	2.66 ± 0.48	2.85 ± 0.44	3.47	< 0.001*	2.95 ± 0.36	5.09	< 0.001*
Touching a non-sterile area while donning gloves isn't done	1.45 ± 0.50	2.13 ± 0.40	11.68	< 0.001*	2.37 ± 0.51	14.57	< 0.001*
2- Environmental infection control (Waste management)							
Disposal of sharps in safety boxes	1.42 ± 0.50	2.56 ± 0.54	11.82	< 0.001*	2.77 ± 0.59	15.35	< 0.001*
Needles not recapped	1.42 ± 0.49	2.16 ± 0.44	13.66	< 0.001*	2.33 ± 0.54	18.43	< 0.001*
3- Hand hygiene							
Washing hands when visibly soiled	2.86 ± 0.32	2.96 ± 0.24	2.38	< 0.05*	2.99 ± 0.09	3.85	< 0.001*
Washing hands before donning gloves	2.61 ± 0.54	2.71 ± 0.48	2.06	< 0.05*	2.73 ± 0.47	2.72	< 0.008*
Washing hands after removing gloves	1.41 ± 0.62	1.94 ± 0.70	8.02	< 0.001*	2.28 ± 0.58	11.38	< 0.001*
Rings removed before washing	2.76 ± 0.44	2.82 ± 0.39	0.21	> 0.05*	2.90 ± 0.31	2.35	< 0.05*
Hands rubbed up to elbow	1.19 ± 0.49	1.71 ± 0.64	9.04	< 0.001*	1.78 ± 0.66	8.57	< 0.001*
Hands washed without missing webs	2.91 ± 0.22	2.87 ± 0.16	1.16	> 0.05	2.98 ± 0.13	1.42	> 0.05
Hands dried with disposable tissue paper	1.17 ± 0.49	1.79 ± 0.64	9.11	< 0.001*	1.73 ± 0.66	8.55	< 0.001*
4- Isolation precautions (PPE)							
Non-sterile gloves used for vaginal examination	2.60 ± 0.54	2.74 ± 0.48	2.07	< 0.05*	2.83 ± 0.45	2.72	< 0.008*
New pair of gloves used for each woman	1.45 ± 0.63	1.95 ± 0.70	8.01	< 0.001*	2.30 ± 0.58	11.38	< 0.001*
Sterile gloves used for delivery	2.77 ± 0.44	2.81 ± 0.39	0.21	> 0.05	2.90 ± 0.31	2.34	< 0.05*
Sterile gloves used before handling newborn	0.80 ± 0.49	1.77 ± 0.64	9.03	< 0.001*	1.83 ± 0.66	8.58	< 0.001*
Gloves changed immediately after use	1.19 ± 0.49	1.71 ± 0.64	8.58	< 0.001*	1.78 ± 0.66	9.0	< 0.001*
Gloves changed when moving to clean area	1.47 ± 0.50	2.14 ± 0.40	11.62	< 0.001*	2.36 ± 0.51	14.54	< 0.001*
Gloves changed when soiled	1.23 ± 0.49	2.14 ± 0.43	13.65	< 0.001*	2.38 ± 0.53	18.44	< 0.001*
Use of masks before labor	1.45 ± 0.50	2.11 ± 0.40	11.62	< 0.001*	2.29 ± 0.51	14.52	< 0.001*
Wearing protective eyewear and face shield	1.96 ± 0.22	2.14 ± 0.36	3.11	< 0.002*	2.29 ± 0.42	5.37	< 0.001*
Wearing gowns	2.87 ± 0.32	2.97 ± 0.24	2.37	< 0.05*	2.99 ± 0.09	3.82	< 0.001*
Use of boots	1.78 ± 0.32	2.02 ± 0.51	2.46	< 0.05*	2.25 ± 0.39	5.29	< 0.001*
B- Device-associated Guidelines							
Catheter-associated urinary tract infections							
Correct techniques for the installation of urinary catheters	1.29 ± 0.45	1.82 ± 0.39	10.37	< 0.001*	1.95 ± 0.44	8.38	< 0.001*
Correct techniques for cleaning urinary catheter	0.58 ± 0.56	1.0 ± 0.43	12.99	< 0.001*	1.22 ± 0.36	9.16	< 0.001*
D- General Considerations							
Standard infection control measures should be taken before, during and after labor							
Wear gloves for all procedures during labor	2.95 ± 0.22	2.97 ± 0.16	1.14	> 0.05	2.99 ± 0.13	1.42	> 0.05
Wear a gown for all procedures during labor.	1.08 ± 0.25	1.22 ± 0.27	0.33	> 0.05	1.22 ± 0.30	0.90	> 0.05
Wear a mask for all procedures during labor	1.48 ± 0.52	2.26 ± 0.52	11.79	< 0.001*	2.59 ± 0.54	16.47	< 0.001*
Wear eye protection for all procedures during labor	76.0 ± 0.58	1.68 ± 0.48	12.85	< 0.001*	1.75 ± 0.60	10.28	< 0.001*
Administration of prophylaxis antibiotics for delivery of high-risk women at 4-hour intervals.	1.97 ±0.22	2.14 ± 0.36	3.11	< 0.002*	2.29 ± 0.42	5.39	< 0.001*
Birth canal washing with a disinfectant during vaginal exams.	1.49 ± 0.52	2.29 ± 0.52	11.79	< 0.001*	2.49 ± 0.55	16.47	< 0.001*
Cleaning of other instrumental procedures.	2.56 ± 0.48	2.60 ± 0.44	3.47	< 0.001*	2.95 ± 0.36	5.07	< 0.001*
Reduce the risk of infection by limited vaginal exams.	2.88 ± 0.32	2.93 ± 0.24	2.38	< 0.05*	2.99 ± 0.09	3.82	< 0.001*

A statistical significant difference (P ≤ 0.05)   A highly statistical significant difference (P ≤ 0.001)
Paired (τ1) before program and after 3 months   Paired (τ2) before program and after 6 months.

Figure 3 portrayed that maternity nurse's total practices score about the infection control according to standard infection control precautions. This figure showed that 25.0% of the nurses recorded good scores in the pre-test compared with 80.5% in the immediate posttest and 94.0% after 2-months. However, 37.5% of the nurses recorded average scores in the pre-test compared with 15.0% in the immediate posttest and 5.0% after 2-months. Moreover, 37.5% of the nurses recorded poor scores in the pre-test compared with 4.5% in the immediate posttest and 1. 0% after 2-months.

According to Table 4, all the maternity nurses showed a general improvement of their practices in all items of infection control related to standard infection control precautions. This finding was evident in the various phases of the assessment as opposed to their performance level before the program was introduced. Paired t-test (τ1 & τ2) revealed highly statistically significant differences between pre and posttest (P < 0.01)

Regarding nurses' satisfaction with participation in the program of infection control according to standard infection control precautions; the results in Figure 4 show that the majority (87.0%) of nurses had expressed their satisfaction to participate with a high level of satisfaction.
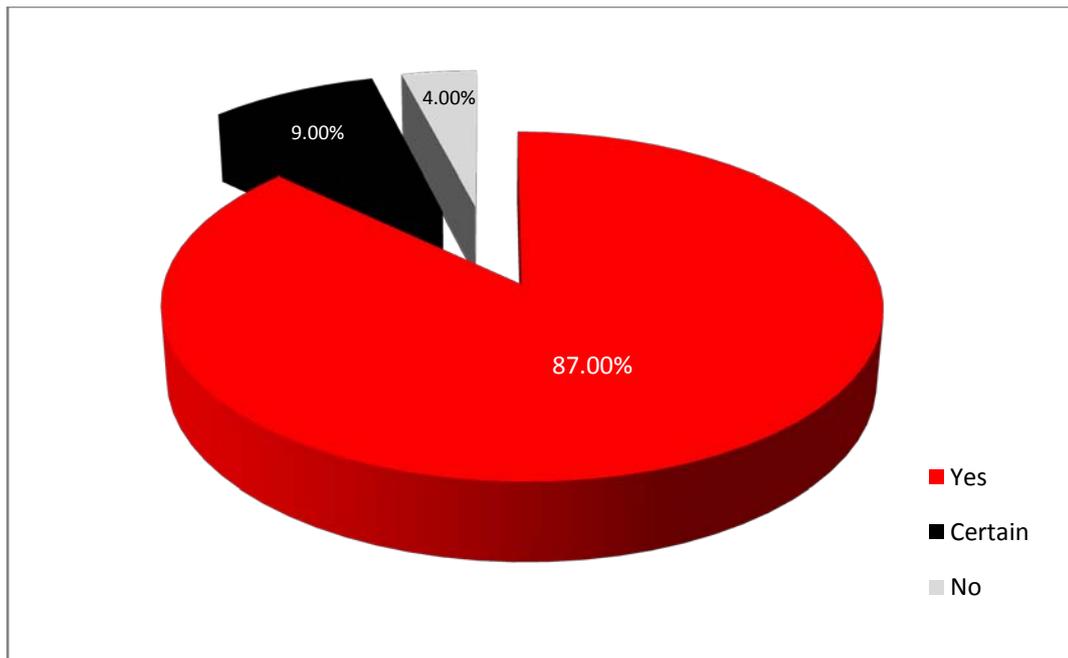
Figure 4. Nurses' Satisfaction with Participation in the Program

6. Discussion

Prevention of infection remains a significant public health challenge for health-care systems, especially in delivery and maternity units. [7] Infection during childbirth is one of the world's leading causes of maternal mortality, responsible for approximately one-tenth of the global maternal deaths burden. [40,41] Apart from deaths and acute morbidities associated with infections during childbirth, long-term disabilities such as chronic pelvic pain, fallopian tube blockage, and secondary infertility can also occur. Maternal infections during childbirth can have, also, a major effect on newborn mortality. [42] Around 1.5 million annual neonatal deaths occur in the first week of life; one of the main causes, in developing countries, is infection. Neonatal sepsis also closely linked to maternal genital tract during delivery. [43]

Neonates and Mothers are vulnerable to having infections from the hospital's surrounding environment. [44] The chances of infection increase, if the precautions aren't taken appropriately, especially by nursing staff who is the prime person, responsible for taking care in the hospital. Infection control is a more serious area of concern in the labor rooms as neonates don't adapt to their environment immediately after they come out of the uterus of mothers. Additionally, moms can be exposed to infection due to numerous inspections and multiple vaginal examinations by health care providers during the process of labor. [45] Moreover, in lower-middle-income countries, neonatal deaths are due to infections acquired at home or in the hospital; this infection causes about 36.0 percent of neonatal deaths. [46] Healthcare professionals often committed to maintaining maternal and newborn wellbeing, but little neglect may often jeopardize their wellbeing which should not be ignored. Multiple factors can cause infection in the labor room, and it is, therefore, necessary to assess the experience and practices of maternity nurses regarding infection control measures in labor units

in northern Upper Egypt according to standard infection control precautions; hence, implement an educational program to enhance their knowledge and practices. [11]

Although the duration of contact with the facilities is generally brief, the infection risk associated with care in labor rooms is probably quite high. So, a properly assist delivery with skilled personnel and following infection control (IC) precautions is highly advantageous for both mother and fetus during delivery. [41] Patient safety is considered by the World Health Organization (WHO) as a quality component for improving the overall quality of care. [47] From this perspective, all health workers, regardless of their role and work environment, must be involved in infection prevention and control (IPC). [48]

The objective of this study accessed the effect of the implementation of the infection prevention principles in labor units at Fayoum functional university and health district hospitals. We also found that the IC practices among maternity nurses were suboptimal and their behavior was not always in accordance with scientific rationale. As the main finding, a big slid (50.0%) of nurses had poor knowledge regarding infection control according to standard infection control precautions prior to the implementation of the program. Also, the practices total score on infection control practices was poor (37.5%). In addition, no area of practice by nurses was of a good level. This may be attributed that a considerable percentage (47.6%) of nurses were young (20 years old), the majority of them (76.6%) were less than a university education, 30.0% had less than one year of experience, moreover, 63.3% of them didn't attend a training program previously. These causes may reflect the poor scored points. Sarani et al., reported that it is important to note that the knowledge of nurses about HAI depends on many factors, including individual and educational characteristics, training courses, and managerial and motivational factors. [4]

The current study shows that infection control measures are likely to be suboptimal in many delivery units in

Fayoum city. These findings were in accordance with Méda et al., (2019) who study the "Assessing the implementation of the infection prevention principles' in maternity wards from the functional health district hospitals of the region of Hauts Bassins, Burkina Faso: and found that the level of nurses' total knowledge on IPC was 64.7%. Moreover, no areas of practice by midwives were of a satisfactory level. [18] However, Rajeshet al., who study "Infection control in delivery care units, Gujarat state, India: A needs assessment" reported that 70.0% of participant reported that standard infection control procedures were being followed in their facility. [10] Additionally, the results of a study conducted by Sarani et al., on "Knowledge, attitude and practice of nurses about standard precautions for hospital-acquired infection in teaching hospitals affiliated to Zabol university of medical sciences" and their results clarified that most of participant's nurses had a poor knowledge (43.0%), and an average practice (42.0%). [4] Darawad et al., who studied nursing students in Yemen showed that most nursing students have low levels of knowledge, and a moderate practice about infection control. [49] It seems that since infection control topics are not included in academic nursing courses and since they are not dealt with in the work environment either, in this area nurses have limited awareness. Consequently, it is possible to understand the recommendations on the management of hospital infection that nurses should be trained and retrained at least twice a year. [4] The study conducted by Tabatabaei et al., (2016) highlighted the fact that midwives' compliance with optimal IC practices was low. Likewise, the findings from an IC analysis in labor and delivery units in Gujarat state, India showed substantial shortcomings in existing practices and procedures. For example, a standard IC procedure was only available in 5.0% of facilities. Reuse of surgical gloves for vaginal examinations in the labor room was commonly practiced in over 70.0% of facilities and only 15.0% of facilities cleaning of surfaces were done. [7] Finally, the results of Méetda et al., showed that no area of practice by agents was of a satisfactory level. In his study, d'Alessandro pointed out that there are many dysfunctions in care practices and that careers largely neglect infection control recommendations. [50]

On the other hand, the results of the present study are not consistent with other researchers' results. A study by Hinkin et al., showed most students have adequate levels of awareness about hand hygiene, glove usage, and effective action should be taken after being injured by a sharp object. The results also showed that their level of knowledge depended on working pressure, time and access to facilities. [51] The study on 130 nurses conducted by Ghanbari et al., their results showed that most nurses hadn't sufficient knowledge and practice necessary to prevent hospital infection. [52] The observation of health procedures is, therefore, the most fundamental health principle and the most basic health behavior. [53] The prevention of HAI requires attention to three concepts: knowledge, attitude, and practice. [54] Moreover, the results of the present study aren't consistent with the findings of a study conducted by Yang Luo et al. on 1,444 nurses in China in which nurses' awareness of standard precautions was measured as an average. [55] In

their study on the knowledge, attitude and practice of nurses in the context of HAI control, Ghadamgahi et al. concluded that most nurses do not have a good knowledge of HAI. [56] The results of a study by D'Alessandro et al. It has been shown that 90.8% of students have poor knowledge regarding infection control. [57] Chan's study also revealed that 56.0% of nurses had good knowledge regarding infection control and 79.0% had a good practice of standard infection control precautions. [58] The results of Nasirudeen et al.'s on the knowledge and practice of Singapore students showed that 66.3% had a good practice and 48.9% had good knowledge about hand hygiene. [59]

The results of the current study regarding the maternity nurses' knowledge of infection control according to standard IC precautions; the pre-test of the present study revealed that the total score of nurses' knowledge and the mean score of nurses' knowledge about all item, including previously mentioned sub item, of standard IC precautions were poor and unsatisfied. This unsatisfied score of knowledge may be attributed to the lack of or defective curriculum as one-third (33.3%) and around half (43.3%) of the participant nurses had a secondary or technical level of nursing education, respectively. Egyptians' health sector is suffering from a severe shortage of qualified nurses. The shortage has implications both for the quality of health care as well as the efficiency of the production of health services. The majority of nurses in Egypt (about 90.0%) are nurses at the secondary school level reflecting an insufficient quality of education not only by internationally but even by the region's local standard. The current approach by the ministry of health and population is to upgrade the standard of quality of nursing education in Egypt to eliminate high school level nursing education in the future; this seems to be the right approach. [60]

After the implication of the program, the results indicated that there is a significant improvement in the nurses' knowledge immediately after the program. This change was also kept until the follow-up evaluation (2-months after the program). This improvement can be attributed to the attendance at sessions of program sessions and the lecture and positive reinforcement or long-term knowledge retention. In this respect, Masters K. (2013) and Yeh et al. (2011) mentioned that it is widely cited that people remember 10.0% of what they hear, 20.0% of what they read. [61,62,63] Furthermore, nurses' knowledge about guidelines of infection control in healthcare personnel vaccines for healthcare personnel; the findings of this study showed that the awareness of nurses was weak prior to the program. The majority of the nurses were unfamiliar with the diseases for which vaccination is recommended (Hepatitis 'B, Influenza, Measles, Mumps, Rubella, Pertussis, Varicella), diseases for which vaccination might be indicated in certain circumstances (Poliomyelitis, Typhoid Fever, Meningococcal Disease), other vaccines recommended for adults (Pneumococcal polysaccharide vaccine "PPSV", Tetanus and diphtheria toxoids "Td", Human papillomavirus "HPV" vaccine, Zoster vaccine, Hepatitis A vaccine), other immunobiologics that might be indicated in certain circumstances for HCP, quadrivalent meningococcal conjugate vaccine (tetravalent (A, C, Y, W) for HCP ages 19-54 years, and quadrivalent meningococcal polysaccharide

vaccine for HCP age >55 years. This lack of awareness can be due to the lake of, or defective of basic nursing education. The findings showed that there is a substantial improvement in the knowledge of nurses since completing the program. This enhancement was also retained until the post-test assessment. This improvement could be attributed to the attendance at program sessions and the lecture and positive reinforcement.

In brief, the total score of maternity nurses' retained knowledge regarding infection control according to standard IC precautions was significantly improved in the post-test. This improvement may be due to the researcher's varieties of instructional methods such as lectures, audiovisual materials, and discussion as well as the Arabic booklet that was given to each nurse. So much emphasis on the dissemination of written materials in the form of booklet is imposed on many educational programs. They can remind the nurses in many ways of the topics they have already learned. They can provide additional information about any health practice for those who have a special interest in it. Booklets are better used when they're short, written in plain language, full of good pictures and used to back up certain educational types. This is in-accordance with Edgar Dale's or the NTL's Pyramid of Learning as cited by Masters K. (2013) as the pyramid illustrated that individuals can retain 10.0% of what he read and 20.0% of what he sees and hear (audiovisual). The same author added that ones can retain 50.0% of what he learned by a discussion. [61]

In the present study, nurses' practices of the skills were important factor in producing real change in nurses' practices. The overall total score of noticed checklists were presented at the study findings was describe the nurses' performance, and found the highest met steps were immediately and 2-months after implementation regarding hand washing, gowning, gloving, wearing protective eyewear, and using a face mask, using protective clothing during labor and wearing boots during labor, sterilization and disinfection of equipment, perineal care waste management, umbilical cord care, fixing the cannula, immersing used instruments in a container full of soap and water or disinfectant prior to their processing, and urinary catheter insertion and maintenance. It is noticed that the pre-test showed unsatisfactory performance, and all nurses in the post-test performed skills satisfactorily after the guidelines were implemented. This result is in agreement with Edgar Dale's or the NTL's Pyramid of Learning and/or articles that deal with medical education which examines the percentages of learning retention associated with the Pyramid. They describe the retention rates of knowledge. After two weeks a person tends to remember 30.0% of what he sees, 50.0% of what he sees and hear as watch live demonstration. [61-62] In the same line, the National Training Laboratories Institute has found that one can retain 30.0% of what he learned by demonstration and 75.0% by Practice by doing. [64] Hence, the present program has been active in educating nurses with the skills needed. This is anticipated as various authors reflected on the value of training programs in fostering technical competence. [65]

Therefore, the impact of an educational program on nursing performance was positive for all of them and progress their knowledge and practices. These findings are supported by Sabilu Y. et al. (2016) who reported, the level of education affects the learning process, the higher the person's level of education the easier the person to receive information. However, it should be emphasized that low education does not mean an absolute knowledge also lower. Increased knowledge is not absolute acquired in formal education. There are several factors that influence a person's knowledge, among others, intelligence, experience, information, health education given through the media information. [66] Moreover, Suchitra et al in their study on the knowledge, attitude and practice of different groups of healthcare personnel about infection control concluded that training has a positive impact on the improvement of practice and knowledge of healthcare personnel. [67] Training courses have been shown to be effective in promoting the knowledge and practice of health care personnel in the UK. [68] Training and knowledge improvement are the most effective ways to fight HAI. [4]

7. Conclusion

According to the results, and based on the finding of this study using NOTICE checklists, most of the maternity nurses in Fayoum city have poor knowledge and practice about infection management procedures despite having mediocre efficacy. Our findings indicate that prevention and control of infections are not adequately applied in these district hospitals, therefore, strengthening staff skills and reorganizing maternity services in the area of infection control by quality assurance is necessary. The results highlighted to develop and follow a strict infection control system at the labor unit focusing on nursing staff to prevent infection transmission. Based on the results of the present study, it is presumed that the hypotheses of the study are accepted. After the program was implemented; all nurses reported higher scoring in both awareness and skills than before. The satisfactory score progressed while unsatisfactory one regressed. This is mirrored to the program's effect.

8. Recommendations

In light of the findings of this study, the following is recommended.

1. Nurses are playing a crucial role in the complex unique unit as labor and delivery units, and provide holistic nursing care for women. Because health care providers and women are venerable for infection contamination, must all health care providers and especially nurses following meticulous infection control skills.

2. Continuous training and enhancement of skills, in addition to the use of appropriate and efficient methods of disinfection and sterilization for all healthcare workers, are obviously important to reduce the frequency of development of HAI.

3. Every hospital should update the guidelines regarding infection control according to updated Standard Infection Control precautions.

4. It is, therefore, necessary that Egypt Ministry of Health and Medical Education and the subsidiary universities do their best to inform the maternity nurses about the prevention of HAIs according to Standard Infection Control precautions. It is also necessary to improve the knowledge of standard precautions, develop programs for HAI control, and hold training courses based on successful educational models.

5. Along with maternal death reports, evaluations, training and input on infection trends, active hospital infection management committees should be set up. State-level leaders should be involved in these programs to ensure that such practices are incorporated into the overall health care system. Their role will also be to ensure that there is a correlation between that usage (e.g. through incentives) and enhancing the standard of treatment that women receive once they enter health centers.

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