Effectiveness of a Training Program on Nurses' Knowledge of Catheter Associated Urinary Tract Infection Prevention

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Abstract

Introduction: Catheter-Associated Urinary Tract Infection (CAUTI) is the most common healthcare-associated infection, accounting for 80% of all hospital-acquired infections. The prevalence of this problem and indwelling urinary catheter use is still a major issue. This study aimed to assess the level of knowledge for nurses and the effectiveness of educational course on nurses' knowledge regarding Catheter-Associated Urinary Tract Infection -prevention guidelines.

Method: A quasi-experimental design study has been carried at four hospitals. A total of 143 nurses were recruited from four hospitals. The Knowledge Survey CAUTI prevention guidelines were used to evaluate the effectiveness of an educational course on nurses' knowledge.

Results: Approximately, 40% of the nurses had poor knowledge about the CAUTI prevention guidelines before the educational course. On the other hand, the revealed significant effectiveness of the educational course in improving nurses' knowledge. Bachelor's academic degree and working in double shifts were significant predictors of knowledge of CAUTI prevention guidelines.

Conclusion: The findings of this study concluded that the nurses showed improvement in their knowledge after participating in an educational session about preventing CAUTI.

Keywords: Knowledge, CAUT, Nurses.

Introduction

Hospital-acquired infections (HAIs) are infections that occur 48 hours after hospital admission and are not present or incubating at the time of admission (Hensley & Monson, 2015). There are multiple types of HAIs, classified according to their origin, including skin and surgical site infections, and infections from medical devices such as catheters or ventilators (Hensley & Monson, 2015). Although IUC is used for therapeutic and diagnostic purposes, the risk of acquiring Catheter-Associated Urinary Tract Infections (CAUTI) increases with extended use and poor insertion and maintenance (Lo et al., 2014).

Urinary tract infection (UTI) is one of the most common hospital-acquired conditions and a large proportion directly results from the presence of urinary catheters (Boev & Kiss, 2017). Catheter-Associated Urinary Tract Infections are related to the presence of a urinary catheter in the bladder for more than two days from the start of infection, and it was not present at the time of admission (Control & Prevention, 2015). The symptoms may include fever, dysuria, frequency of urination, and suprapubic tenderness (C. V. Gould et al., 2010).

Catheter-Associated Urinary Tract Infections are extortionate, morbid, and may be fatal (Klevens et al., 2007). It is related to the inappropriate use of urinary catheters and the unjustifiable extended period of catheterization (Shehab, 2017). Despite the emergence of CAUTI prevention guidelines, some clinical settings still have an increase in the rate of infection (Al Nasser et al., 2016; Krein, Kowalski, Harrod, Forman, & Saint, 2013). Catheter-Associated Urinary Tract Infections rates rose by 9% between 2010 and 2013and according to theResearch and Quality (2016), there are few guidelines and evidence on the etiology and clinical indications of CAUTI that can be used to prevent its occurrence. Even as nursing plays a vital role in following the best guidelines and achieving better catheter monitoring, it is essential to assess the needs of catheter usage and the length of time for which it is employed. Assessing these details can be achieved by implementing the best guidelines backed by evidence-based knowledge to advocate for patients (Lo et al., 2014).

Accordingly, educating nursing staff in CAUTI prevention guidelines and implementing them can reduce the rate to 45.0% (Smith, 2015) and the number of catheter days (Drekonja, Kuskowski, & Johnson, 2010). Therefore, when nurses have sufficient knowledge of CDC guidelines for CAUTI prevention, serious complications related to CAUTI can be avoided, with improved clinical outcomes and shorter length of stay. Also minimizing the waste of resources. Therefore, it is essential to conduct a study that assesses the level of knowledge about CDC guidelines for CAUTI prevention among Jordanian nurses, to identify their current knowledge, determine any gap in this knowledge, and subsequently meet the desired outcomes.

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In Jordan, nurses' level of knowledge of the CAUTI prevention guidelines has not yet been thoroughly investigated and there is limited information about their compliance. Thus, the present study could help evaluate nurses' knowledge about CAUTI and be a good basis for follow-up research. The results could also be a useful source of information for healthcare workers, particularly nurses. The study findings could contribute to nursing education, practice, and guidelines to improve the quality of care.

Research hypothesis

1.   The levels of nurses' knowledge toward the prevention of catheter-associated urinary tract infection will be higher in post-test compared with pre-test among those who participated in an educational program in the four hospitals.

2.   Socio-demographic characteristics of the nurses who participated in an educational program can influence on level of knowledge toward the prevention of catheter-associated urinary tract infection in the four hospitals.

Materials and Methods
Research design
A Quasi-experimental pre-post-test design was used to assess knowledge before and after the educational course to evaluate the effectiveness of the course.

Setting and samples

The research was conducted in four government hospitals in four main provinces. Selection of these hospitals was based on their location within the capital and the Northeast of Jordan, their large capacity and staff numbers, and the granting of ethical permission.

The sample size was calculated using G* Power version 3 (Erdfelder, Faul, & Buchner, 1996). Based on a medium effect size of 0.3, power of 0.95, and a statistical significance of 0.05, the required sample size to run paired sample t-test was 143 nurses. Both male and female nurses, at least one year of clinical experience, Jordanian, Work full-time, in Medical-Surgical, Critical Care Units (ICU, CCU, CICU), and Emergency who provide direct patients care were included as they are the first line of defense in the prevention of CAUTI. While, head and managerial nurses, and infection control nurses were excluded.

Around 170 questionnaires were distributed to account for the missing or incomplete questionnaires. The final number of nurses who met the inclusion criteria and signed the consent form was indeed 143.

Intervention (Educational Course)
The educational course in this study was based on CAUTI prevention guidelines from the CDC(C. Gould et al., 2017). The course was presented in three sessions with one hour per session. All sessions were presented by the principal investigator.

Measurement and data collection
After obtaining the approval of the university's Institutional Review Board (IRB) and the targeted settings (hospitals) IRB as well, the study has been conducted in the participating hospitals. Nurses who accepted to participate were directed to a special registration office in each hospital. A brief meeting was held with the potential participants and an explanation was given. A Pilot study was conducted with 15 nurses, who were excluded from the main study to figure out difficulties and shortcomings that may appear in the primary study and initial verbal approvals were obtained.

A schedule for educational sessions was arranged with the participants in each of the participating hospitals as gathering all participants in one session was not possible. At the day of the study, the participants were gathered in the assigned room, and three educational sessions were conducted for each group of participants in each hospital. At the beginning of the first educational session, participants were asked to take the pre-test, which involved completing a questionnaire and structured checklist. Participants were given 15-20 minutes to complete the questionnaire. After completion of the pretest, the educational sessions took place. The participants completed the post-test a week after education. Participants were assembled in the post-test as small groups based on their availability.

Data Collection Tool
A questionnaire was constructed based on the CAUTI prevention guidelines from the Center for Disease Control and Prevention by the author (C. Gould et al., 2017). It included two parts:
Part one: Demographic characteristics. This section is comprised of 12 questions about the demographic characteristics of participants including gender, age, education level, years of experience, working units and shifts, previous CAUTI information, and previous CAUTI education about CDC guidelines. As shown in Appendix C.

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Part two: Level of Knowledge Questionnaire. This part was developed by the author(s) to examine the level of knowledge of nurses' CAUTI prevention guidelines. The questionnaire consisted of two sections as the following: eight multiple-choice test questions with four options each, consisting of the correct answer and three distracters; and 22 questions requiring true or false answers, the correct answer is awarded one mark. Each question of 30 questions has only one correct answer. A correct answer deserved to score one while the incorrect scored as zero. The highest possible score in the test was 30 and the lowest zero in both pretest and posttest findings. Once the nurses gain knowledge scores in pretest and posttest below the 50th percentile, they are considered as having "low knowledge", while nurses who achieved scores above 50thpercentile they described as received "high knowledge". Also, in the pretest, the 50thpercentile was equal to"14", and "27" in the posttest. As shown in Appendix D.

Validity and Reliability of the Tool

The validity of the questionnaire was determined by matching its contents against the research questions and aim. Content validity is the degree to which a tool measures what it is supposed to measure. A panel of five nurse educators, two urologists, and three registered nurses participated in revising and validating the content of the questionnaire and agreed that the knowledge questions were suitable for the current study. A content validity index was compiled, by asking the experts to rate the relevance of each item in both parts of the questionnaire using a 4-point ordinal scale: 1 = not relevant, 2= somewhat relevant, 3= quite relevant, and 4 = highly relevant (Polit, Beck, & Owen, 2007; Waltz & Bausell, 1981). The item-level content validity index (I-CVI) was > 0.78, reflecting an excellent level for the test, rated by at least seven of the nine experts (Polit et al., 2007).For the first part, the I-CVI for two of the eight items was equal to 1, and for the rest 0.89, giving a mean I-CVI of 0.92 and scale-level content validity index (S-CVI) of 0.81. For the second part, the I-CVI for six of the 22 items was equal to 1, for 14 items it was 0.89, and for the rest 0.78. The mean I-CVI was therefore 0.91, and the S-CVI 0.92. Many authors have reported that an S-CVI of 0.80 or above is acceptable (Davis, 1992; Grant & Davis, 1997; Polit & Beck, 2004).

Lastly, the content of the questionnaire was given independently to the 15 nurses in the pilot study currently working in one hospital. They evaluated the simplicity of the questions, clarity of language, accuracy, and adequacy of the items. The questions were refined to facilitate ease of answering, confirm the reliability of the tool, and thus reduce the number of data collection errors. To test the reliability of the questionnaire Cronbach's alpha was calculated after a test-retest by administering the survey to 15 nurses, and the value was 0.74, which is acceptable.

Data Analysis

Data were entered into the Statistical Package for the Social Sciences (SPSS) version 25. Screening and cleaning were first made, data entry errors were fixed. Cases with missing data in more than one variable were excluded. Descriptive statistics; mean (M), standard deviation (SD), frequency and percentages were used to describe the sample. Multivariate linear regression was used for factors that affect nurses' changing of knowledge following the educational course. A paired sample t-test was used to measure the change in knowledge scores between the pre-post-tests. The knowledge score percentile was calculated, and scores below the 50th percentile were considered poor. And chi-square tests were used to determine whether the course affected each participant's response.

Ethical Consideration

Ethical permission for the study was obtained from the University Faculty of Nursing and the Ministry of Health (MOH). The nurses who agreed to participate in the study were given brief information about the study enclosed by a cover letter. For those who show the intention to be included in the study, the consent form was provided with full details to sign if agreed to be officially included. Nurses were informed that participation is completely voluntary and they had the right to withdraw from the study at any time without penalties. Hence, the data were to be used only for research purposes and not for their assessment.

The participants' confidentiality was maintained through a master code list to facilitate the matching of the results of the pre and post-tests; the master code list was electronically constructed, stored, and password protected in the personal computer of the researcher. All hardcopy materials relating to the study were kept in the supervisor's office, accessible only to the investigator.

Results

Participant's characteristics

A total of 143 nurses completed and returned the study questionnaire. As shown in Table- 1,57.0% of participants were females (n=82) and 42.0% were males (n=61) and the mean of nurse's age was 31.8 years (SD=6.22), more than half of the participants55.9% were married (n=80) The majority of nurses 67.8% had bachelor's degrees and were working in critical care units. The participants' mean of nursing experience was 7 years (SD=5.10) and ranged from 2 to 27 years, and all have been one year at least in their current unit 3.86 (SD=3.02). Of the participants,33.6% had

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fixed working shifts (n=48) and 11.9% of nurses are working double shifts (B/C, D/N) (n=17). Seventy-one percent reported that they had some information in CAUTI prevention guidelines, while 77.6% had not attended a previous course or training on the guidelines to prevent CAUTI.

The largest group acquired their knowledge from hospital policy (43.4%), with 38.5% of through university courses and reading textbooks, 27.0% used websites or read articles on the topic. The least-used sources were the guidelines themselves and communicating with other healthcare providers and colleagues.

Level of Knowledge of Jordanian Nurses about the CAUTI Preventive Measures before and after the Implementation of the Educational Course

The finding in Table -2 revealed that the mean knowledge score toward the prevention of CAUTI guidelines was 14.5 ±3.46 (range=25- 6) before the educational course. More than half of the nurses (60.0%) had a high level of knowledge. While about one-third (40.0%) of nurses had a low level of knowledge.

The results of the study indicated a significant improvement in nurses' answers to most of the questions. A noteworthy finding was that 85.0% of the nurses correctly identified who is authorized to insert Foleys' catheter. Furthermore, after education 123(86%) of nurses knew which antiseptic is recommended to clean the urethral orifice area while the catheter is in place compared to only 35(24.0%) in a pre-test. Furthermore, the percentage increased to 130(90.0%) after the course compared to 45% of nurses who agreed that "silicone might be preferable for long-term catheterized patients who have frequent obstruction as it has less complication"(n=65). Moreover, the question about the required materials for the insertion of a Foley catheter was answered correctly by the majority of participants in pre-test (78.3%) and then increased to 133(93.0%) after education. Furthermore, 81.0% did not know that the routine use of antiseptic lubricants to decrease the risk of infection is not necessary for urinary catheter insertion and this percentage decreased to (19.0%) after the course.

Effectiveness of an Educational Course on the Improvement in Nurses' Knowledge

Results of the paired-samples t-test showed a statistically significant increase in the knowledge scores from the pretest to the posttest, t (142) = 31.40, $p < 0.01$. In the pretest, the mean knowledge score was 14.5 (SD =3.46) compared to 26.5 (SD = 2.98) in the posttest. The data were analyzed using chi-square. Results showed, $X2(1) = 5.881, p = 0.015$.

Factors that Affect Nurses' Changing of Knowledge Following the Educational Course

The Multiple-linear regression analysis was conducted to examine the significant predictors of knowledge about CAUTI prevention guidelines. The following five variables were entered the regression equation (working shift, current department, education level, receiving previous training/course, and experience in nursing). Results showed that the full model was statistically significant, F (8,143) = 3.43, $p < 0.01$, R= 0.418, R^2= 0.175, adjusted R^2= 0.119. The model explained 12.0% of the variance in knowledge. Working on double shifts, t (143) = - 4.373, $p < 0.001$, and the BSN educational level, t (143) = -1.371, $p < 0.05$ were the significant predictors of knowledge. Nurses who worked on double shifts were less likely to have changed in their level of knowledge in contrast to nurses who have BSN degrees who were more likely to have a positive change in their knowledge (Table 3).

Discussion

Nurses play an essential role in the prevention of CAUTI (Drekonja et al., 2010; C. V. Gould et al., 2010; Nicolle, 2014), and are responsible for applying the guidelines to prevent CAUTI and improve patients' outcomes (Banks, Abdella, & Willmann, 2016).Few studies investigated CAUTI prevention guidelines in Jordan. In this study, it was found that around 40.0% of the nurses have poor knowledge of the CAUTI prevention guidelines and relatively low with a knowledge deficit in some aspects of CAUTI prevention guidelines such as the qualified person for insertion of a Foley Catheter (FC), changing the FC is recommended on a regular interval, a systematic antibiotic is recommended to prevent CAUTI, and routine use of antiseptic lubricants is a necessary.

The results were consistent with previous studies by Algarni, Sofar, and Wazqar (2019) and Mukakamanzi (2017) which showed that the level of knowledge about CAUTI prevention guidelines was low among nurses. Also, the results are consistent with those found by Köse et al. (2016) that nurses have an inadequate level of knowledge concerning some aspects of the guidelines. Specifically, the study findings revealed an excellent knowledge of proper techniques to insert the UC the majority of respondents included in the study knew that a catheter should be inserted aseptically with sterile equipment C. Gould et al. (2017) find similar results through CDC guidelines on the prevention of CAUTI. In (67%) of the study nurses secure the catheter and only (33.0%) of nurses didn't secure it, this was not similar to the finding of Revello and Gallo (2013) who found that 79% of the catheters were secured and 21% were not secured. In this study, more than half of nurses did not know that the routine use of antiseptic lubricants to decrease the risk of infection is not necessary for urinary catheter insertion. This result is consistent with the finding of Opina and Oducado (2014), who stated that 66.7% of nurses did not know that routine use of antiseptic lubricants is not necessary for decreasing the infection caused by urinary catheters insertion.

On the other hand, the results of the study were inconsistent with some previous studies Drekonja et al. (2010) and Prasanna and Radhika (2015) which indicated that the knowledge level about CAUTI prevention guidelines was good and acceptable among nurses. While this result is inconsistent with Köse et al. (2016), who found that only 31.9% of nurses in Turkey while taking culture or samples, aspirate the urine from the needleless sampling port with a syringe after cleansing the port with a disinfectant. According to (Gesmundo, 2016), there is a strong recommendation, supported by evidence, that if urine samples needed for urinalysis or culture, aspirate the urine from the needleless sampling port with a sterile syringe after cleansing the port with a disinfectant.

One reason was that most of the nurses had not received any previous training on the guidelines. Moreover, many nurses in this study reported a lack of educational programs. This is supported by the study of Seyhan Ak and Özbaş (2018) to assess the effect of an education program on CAUTI prevention, who indicated that the lack of education programs may be the reason for a low level of knowledge about ETTS among nurses. Another reason was that many participants had no access to educational courses considering being scheduled on the night shift constantly. This is supported by the study of Fashafsheh, Ayed, Eqtait, and Harazneh (2015) who indicated that the lack of education program may be the reason for the low level of knowledge about infection control to prevent CAUTI. Furthermore, nurses reported that heavy workload and the rotation of shift entailed significant fatigue and stress that could interfere with their desire to participate in educational courses. In this study, more than half of the participants in this study had a rotation schedule.

Concerning the effectiveness of nurses' knowledge after attending the education course, this study revealed significant improvement in an educational course in improving nurses' knowledge. These results are consistent with previous studies (Ali, 2018; Freeman-Jobson, Rogers, & Ward-Smith, 2016; Gordon, 2015; Mohammed & Hamza, 2019; Revello & Gallo, 2013; Suchitra & Devi, 2007) which showed that there were highly statistically significant differences between the level of acquired nurses knowledge in pre and posttest about CAUTI prevention guidelines. The same results were found by Schneider (2012) which were significant improvement in mean scores after the workshop as compared with pre-workshop scores. Drekonja et al. (2010) also revealed that a more effective form of teaching with the explanation of concepts is the best method to improve knowledge and application of best practice technique for the invention and significant improvement in post-test scores.

However, the result was inconsistent with some previous studies such as Najjar, Hdaib, and Al-Momany (2015)which indicated that the one educational session is insufficient to change the level of knowledge regarding CAUTI prevention, in addition to considering the level of a nursing student when conducting the educational session. The results showed that educational level bachelor's (BSN), working in double shifts were significant predictors of knowledge of CAUTI prevention guidelines. The other variables such as experience, working in a single shift, current department, and receiving previous

training/course were not significant predictors of knowledge about CAUTI prevention guidelines. These results are consistent with the study of Köse et al. (2016) and Prasanna and Radhika (2015) which showed a significant association between educational level and knowledge about CAUTI prevention guidelines. However, our findings contradicted those of Anwar, Nawaz, Afzal, Majeed, and Waqas (2017) and Mukakamanzi (2017) which indicated that there is no significant between demographical data and knowledge about CAUTI prevention guidelines. This result is inconsistent with the previous study by Mohammed and Hamza (2019) and Jain, Dogra, Mishra, Thakur, and Loomba (2015) who revealed no effect for participants' characteristics on the outcomes of the educational course.

The result of the present study indicated that having a BSN degree was a significant predictor of the knowledge about CAUTI prevention guidelines this finding was in agreement with those of Wicks (2015) that which indicated that the higher education level nurses received more detailed information about guidelines. To the researcher's knowledge, no previous studies have examined the factors associated with nurses or the effectiveness of the educational course in Jordan. This study showed the importance of the course and the need for teaching to prevent CAUTI. Similarly, previous studies stressed the importance of education before and after IUC. It was reported that hospitals with continuous education have less rate of CAUTI (Nicolle, 2014).

Limitations

This study used a relatively large sample size in addition to the selection of nurses in the present study from different hospitals which could help to improve the generalizability of findings. Moreover, this study used pre-posttest designs which help to unveil the effect of education on nurses' knowledge. The post-test was conducted after more than seven days instead of immediately. Furthermore, this study was an interventional study that used an educational course that was based on the CDC guidelines. Our study would be used as a base for future educational programs on the national level.

In this study lacks of control group may affect the results (internal and external). The study didn't measure the retention of knowledge among nurses, so a future study is encouraged to assess nurses' retention of knowledge. Finally, as data were collected through self-report questionnaires, it relies on the honesty of the respondents.

Conclusion

Catheter-associated urinary tract infection is a serious complication for urinary catheters and is associated with mortality and morbidity, and an increase in the cost of care. The study showed significant improvement in nurses' knowledge following an educational course. Having a BSN degree and working double shifts were factors that affected the change in knowledge. Based on the study results, it is recommended to mandate CAUTI prevention guidelines education on the national level for both undergraduate and postgraduate nurses. Providing funding for such education is essential to facilitate implementation. Finally, revision of nurses' curriculum is recommended to identify shortcomings and make an improvement plan.

Recommendations

Based on the study results, it is recommended to provide nurses in hospitals with regular courses on CAUTI prevention guidelines and research updates in the field. This study raised a red flag about the need for postgraduate training and education. A nurse's lack of knowledge would have a serious impact on the quality of care, morbidity, and mortality. Educating nurses with CAUTI would help in the reduction of CAUTI and alleviate the cost of care. Also, in light of the universal shortage of qualified nurses, education is substantial in preparing newly competent nurses for the staff to practice in different units. All of these points could improve the nurse's rate. Findings from this study would inform stakeholders about the importance of CAUTI education. Integrating CAUTI prevention guidelines is imperative to improve the nurse's knowledge. That would entail a significant reduction in the cost of care, morbidity, and mortality. Finding from this study would serve as a base for CAUTI prevention policies. Although; this study paves the road for future research on CAUTI prevention guidelines on the national level.

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Table 1. Participants 'characteristics; mean (M); standard deviation (SD) and percent (%) for the nurses (N=143).

Variables		N (%)	
Hospital	First	60	(41.9)
	Second	21	(14.7)
	Third	27	(18.9)
	Fourth	35 (24.5)	
Gender	Male	61	(42.7)
	Female	82 (57.3)	

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Marital status	Married	80	(55.9)
	Unmarried	63 (44.1)	
Educational level	Diploma	18	(12.6)
	BSN	97	(67.8)
	MSN or PhD	28 (19.6)	
Current department	Wards	36	(25.2)
	Critical units	90	(62.9)
	ER	17 (11.9)	
Working shift	Fixed single	48	(33.6)
	Fixed double	17	(11.9)
	Rotating	78 (54.5)	
Previous information about CAUTI prevention	Yes	102	(71.3)
	No	41 (28.7)	
Previous training/ workshop about CAUTI prevention	No	111	(77.6)
	Yes	32 (22.4)	
Age (years)	Mean± SD	31.80± 6.22	
Experience in nursing (years)	Mean± SD	7.90 ± 5.10	
Experience in the current unit (years)	Mean ±SD	3.86 ±3.02	

Table 2. Correctly Answered Items in the Questionnaire before and after the educational course for CAUTI prevention guidelines and P values of the chi-square Test (N=143).

Item Content		**Correct Responses**		**P-value**
		Pre	**Post**	
Multiple Choice Question		N (%)	N (%)	
1	The qualified person for insertion of a Foley Catheter.	22(15.4)	123(86.0)	.001**
2	The required materials for insertion of a Foley catheter.	112(78.3)	133(93.0)	.001**
3	The recommended positioning technique for the urine bag that reduces the risk of CAUTI.	72(50.3)	117(81.8)	.933
4	The recommendation material to clean the urethral orifice area while the catheter is in place.	35(24.5)	123(86.0)	.001**
5	The indications for a Foley catheter.	68(47.6)	133(93.0)	.558
6	The advised time to remove catheter post-operative.	48(33.6)	127(88.8)	.001**
7	The action when the catheter is obstructed during your patient assessment.	53(37.1)	119(83.2)	.002**
8	The proper technique used for indwelling urinary catheter Insertion.	85(59.4)	121(84.6)	.024*
	True or false questions			
9	In case of incontinence, the condom is preferred over FC to prevent CAUTI.	67(46.9)	136(95.1)	.452
10	FC must only be inserted if there is an appropriate indication and routine catheterization is strongly not recommended.	89(62.2)	134(93.7)	.003**
11	Silicone might be not preferable for long-term catheterized patients who have frequent obstruction as it has less complication.	65(45.5)	130(90.9)	.277
12	Routine use of antiseptic lubricants is a necessary.	26(18.2)	116(81.1)	.001**
13	Appropriately secure catheter to prevent movement and urethral traction through sufficient balloon inflation and fixed the bag aimed to prevent CAUTI.	96(67.1)	128(89.5)	.001**

14	If patients have urine retention, insert a large-bore catheter is preferred over small to prevent urethral trauma.	65(45.5)	129(90.6)	.277
15	A systematic antibiotic is recommended to prevent CAUTI.	51(35.7)	120(83.9)	.001**
16	Hand washing is recommended before and after insertion the catheter.	133(93.0)	140(97.9)	.001**
17	Replacing the catheter is recommended if there is a leakage or contamination.	70(49.0)	130(90.9)	.802
18	In the non-acute care setting, clean technique for intermittent catheterization is acceptable alternative to sterile technique for patients requiring chronic intermittent catheterization.	38(26.6)	117(81.8)	.001**
19	Changing the FC is recommended on a regular interval	28(19.6)	115(80.4)	.001**
20	Frequent emptying the urine bag regularly would help to increase the risk of CAUTI.	66(46.2)	126(88.1)	.358
21	In the case of urine culture, the correct technique is first disinfected the sampling port then aspirate the sample from a sampling port using a sterile syringe.	107(74.8)	137(95.8)	.001**
22	For patients who need intermittent catheterization performing catheterization on a regular interval is preferable in order to prevent over distention.	67(46.9)	131(91.6)	.452
23	Patients who need intermittent catheterization, using ultrasound to assess bladder urine volume can prevent CAUTI by avoiding unnecessary insertion.	56(39.2)	118(82.5)	.010*
24	Use of urinary catheter is appropriate in case of incontinence	65(45.5)	124(86.7)	.277
25	After insertion of the FC, the nurse must maintain the urinary drainage system closed (e.g. avoid unnecessary disconnection of the urine bag from the FC).	66(46.2)	129(90.2)	.358
26	Keeping the catheter with no kinking can help to prevent CAUTI.	90(62.9)	131(91.6)	.002**
27	Closed continuous irrigation with antimicrobials is recommended in case of obstruction.	51(35.7)	116(81.1)	.001**
28	If a large amount of urine is requested for analysis, obtaining the sample from the drainage bag directly is inappropriate.	47(32.9)	115(80.4)	.001**
29	Implement quality improvement programs and training courses for the staff would help to prevent CAUTI.	111(77.6)	137(95.8)	.001**
30	Documentation regarding (indications, timing,) would help to prevent CAUTI.	121(84.6)	139(97.2)	.001**

*Significant at * p < 0.05, ** p < 0.01*

Table 3. Multivariate linear regression for factors that affect nurses' changing of knowledge following the educational course (N=143).

Variable	B	Beta (ß)	t	*p*-value	upper-lower CI
Constant	14.373		6.906	0.001	
BSN education level	-1.119	-.114	-1.371	0.022*	0.74- -2.97
Nursing experience	-0.078	-0.087	.173	0.413	0.29- 0.25
Current Critical department	-1.081	0.856	1.479	0.209	2.80- -7.40
Current Ward department	-2.113	1.338	.686	0.117	4.50- -0.66
Receiving previous training	-1.092	0.898	-1.33	0.226	0.58- -2.98
Working in single shift	-.681	.913	.420	0.457	18.5- -10.3
Working in double shift	-5.716	1.307	-4.373	0.001**	2.10 - -1.40

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Knowledge adjusted R^2 = 0.120					

Note: *$p<0.05$, **$p<0.01$, B - beta, SE - standard error

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