Mansoura Nursing Journal (MNJ) Vol. 9. No. 1 – 2022 Original Article

Print ISSN: 2735 – 4121 Online ISSN : 2735 – 413X

The Effect of Implementing CAUTIs Bundle on Prevention of Hospital-Acquired Urinary Tract Infections among Critically Ill Patients

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1.ABSTRACT

Background: Catheter-associated urinary tract infections (CAUTIs) are among the most common types of nosocomial infections. Approximately 30% of these cases have been reduced in the United States of America by using multidimensional preventive approaches including the CAUTIs bundle. **Aim**: This study aimed to investigate the effect of implementing the CAUTIs bundle on the prevention of hospital-acquired urinary tract infection among critically ill patients. **Method**: A quasi-experimental research design was used with a convenience sample of 80 patients recruited from three intensive care units affiliated with an Egyptian University Hospital. The participants were randomly assigned either in the CAUTIs bundle group who received the CAUTIs bundle care or the traditional care group who received the routine care of the unit. Data were collected using three tools: urinary catheter insertion tool, urinary catheter maintenance checklist, and CAUTIs rate checklist. **Results**: The results revealed statistically significant differences between both groups regarding the implementation of insertion and maintenance bundles. The implementation of the CAUTIs bundle has resulted in an approximately 50% decrease in the CAUTIs rate between the studied group. A low CAUTIs rate was noted among CAUTIs bundle patients (16.5 per 1000) than traditional care patients (30.7 per 1000). **Conclusion and Recommendations**: Implementation of the CAUTIs bundle was significantly effective in reducing the CAUTIs rates among critically ill patients. This urged the need for incorporating such bundle elements in patients' daily routine care in intensive care units. Further large-scale investigations are recommended to enrich the evidence related to urinary catheter care.

Keywords: Critically Ill Patients, Catheter-associated Urinary Tract Infections, Bundle, Hospital-Acquired Infection

2.Introduction:

Catheter-associated urinary tract infections are among the most common types of nosocomial infection universally. It accounts for 36% of hospital-acquired infections (HAIs) and has turned into a major challenge for hospital safety and health care quality in intensive care units (ICUs) (Cortese, Wagner, Tierney, Devine, & Fogarty, 2018). Additionally, it has been reported that more than 13,000 deaths were associated with urinary tract infections (UTIs) in the United States of America (USA) (Waller, Pantin, Yenior, & Pujalte, 2018). CAUTIs are attributed to the use of an indwelling urinary catheter (UC) which is the most used device in ICUs to monitor or manage critically ill patients' fluids status (Al Qas Hanna, Sambirska, Iyer, Szpunar, & Fakih, 2013). A UC is indicated for patients with acute urinary retention or obstruction, perioperative applications in selected procedures, and measurement of urine output for critically ill patients (Centers for Disease Control and Prevention [CDC], 2015). Unfortunately, this procedure is usually associated with UTIs that are common among those patients (Al Qas Hanna et al., 2013).

A study conducted by Amine, Helal, and Bakr (2014) reported that UTIs ranged from 30% to 50% in ICUs which is associated with increased morbidity and mortality rates. The main cause of this infection is the non-sterilized procedure of UC insertion. A significant portion of these infections can be preventable by using evidence-based strategies (Septimus & Moody, 2016). Most guidelines focused on the main pillars such as strict indications for catheter insertion, rapid removal of unnecessary catheters, and the proper insertion of and care for a UC (Conway & Larson, 2012; Hooton et al., 2010; Schweiger et al., 2020).

Widely, CAUTIs may be symptomatic and asymptomatic (Nicolle, 2014). The symptomatic type was defined as developing one or more of the following symptoms: fever > 38°C, supra-pubic tenderness or dysuria, urgency, and an increased

frequency with positive urine cultures containing ≥ 10^5 colony-forming units per mL with no more than two species of microorganisms (CDC, 2017). CAUTIs are associated with several complications including prostatitis, epididymitis, orchitis, cystitis, pyelonephritis, gram-negative bacteremia, endocarditis, vertebral osteomyelitis, septic arthritis, endophthalmitis, and meningitis (Al Mohajer & Darouiche 2013; CDC, 2018). Such disease sequelae can cause discomfort to the patient, prolonged hospital stay, and increased cost and mortality rate. Thus, using the multidimensional infection control measures as the CAUTIs bundle is used to reduce the incidence of CAUTIs among critically ill patients (Klevens et al., 2007).

A bundle of care is one of the main strategies that hospitals can apply to sustain patients' lives, improve their outcomes, and increase the quality of provided care. Salmond, Echevarria, and Allread (2017) defined a bundle of care as a trivial series of evidence-based care elements for a defined patient population and care setting that carried out together for significantly better outcomes than when applied discretely. The main aim of using the bundle is to improve the patients' quality of care, enhance their outcomes, and reduce the complications associated with UTIs. According to Resar et al. (2012), a bundle of care is established to deepen the communication and the spirit of cooperation with the health care teams that stimulates reliable and steady care.

A standardized practice associated with UC insertion, maintenance, and removal is developed in the new evidence of clinical practice guidelines (CPGs) for CAUTIs prevention (Evelyn, Lindsay, Susan, & Carolyn, 2014; Gould et al., 2010; Hooton et al., 2010). The International Nosocomial Infection Control Consortium (INICC) revealed that implementation of the present CPGs or bundles can reduce rates of CAUTIs from 8.2 to 6.9 per 1000 catheter days (Rosenthal et al., 2012). The UTIs are significantly declined by about 30% in developed countries hospitals as the USA due to the successful implementation of the CAUTIs bundle (Parry, Grant, & Sestovic, 2013). Thereby, this bundle can decrease CAUTIs rates monthly by about 50% in the USA tertiary care children's hospitals (Davis et al., 2014).

Despite the advances in infection prevention and control measures, CAUTIs remain problematic. This is because CAUTIs were associated with numerous complications and a higher risk of antimicrobial resistance which makes the patient's treatment more difficult (Mitchell et al., 2017). Recent international studies recommended the application of bundles, guidelines, or recommendations to reduce the CAUTIs rate. However, in Egypt, only a few studies investigated this topic (Abdesalam, Ahmed, & Khalil, 2018; Ahmed & Shehata, 2020; Aly, Tawfeek, & Mohamed, 2016; Amine et al., 2014). From our clinical experience in ICUs, most health care staff who are assigned for UC care does not adhere to any bundle, guideline, or protocol of care. Hence, the current study was thought to address this issue.

Aim of the study

This study aimed to investigate the effect of implementing the CAUTIs bundle on the prevention of hospital-acquired urinary tract infections (HAUTIs) among critically ill patients.

Research hypothesis

To fulfill the aim of this study, we hypothesized that critically ill patients who receive CAUTI bundles will exhibit a low rate of UTIs than those who receive the hospital's traditional care.

3.Method

3.1.Study Design

This study used a quasi-experimental research design. This type of designs is used to test or assess the effectiveness of an intervention on a certain outcome in the absence of randomization (Polit & Beck, 2018). This design is suitable for nursing research as it is practical and suitable for real-world natural settings than the true experimental research designs (LoBiondo-Wood & Haber, 2018).

3.2.Setting

The current study was conducted in three surgical ICUs (1, 2, and 3) affiliated with an Egyptian University hospital. ICU 1 and ICU 2 include ten beds and ICU 3 has four beds. These units are divided internally to receive patients with different medical and surgical diagnoses such as trauma, brain spontaneous hemorrhage, and poisoning. The nurse-patient ratio in these units is nearly 1:2. These ICUs are well equipped with advanced medical devices which are required for patient care. The selected ICUs receive patients from the emergency and operating rooms three times per week during the hot days (Sundays, Tuesdays, and Thursdays).

3.3.Subjects

A convenience sample of 80 adult critically ill patients admitted to the above-mentioned setting was enrolled in this study. Inclusion criteria involved critically ill adult patients aged 18– 45

years of both genders, who required insertion of a UC, and who were newly admitted within 24 hours to the selected ICUs and remained at least four days in the research setting. Patients who had UTIs or skin infections, diabetes mellitus, or sepsis anywhere in the body were excluded from the study.

3.4.Data Collection Tools

Three tools were used to collect data for the current study:

Tool I: Urinary Catheter Insertion Tool

This tool aimed to gather patients' demographic data, assess their need for UC insertion, and application of aseptic techniques for catheter insertion based on the recommended bundle. It consists of two main parts as follows:

Part 1: Critically Ill Patient's Demographic Characteristics and Clinical Data

This part was adapted from El-Gilany, El-Wehady, and El-Wasify (2012). It incorporated information about the patient's age, gender, date of admission, date of UC insertion, and the current diagnosis.

Part 2: Urinary Catheter Insertion Observation Checklist

This part was adapted from Hanchett (2012). It is used for unlimited time and used 'yes' or 'no' to the statements. However, in the current study, this part was applied for only four days, and 'done' and 'not done' were used to evaluate the patient's needs or provided interventions. This part comprised three main domains including verification of patient's need for catheterization, insertion of UC under aseptic technique, and maintaining UC based on the recommended bundle. The scoring system for this tool was as follows: "Done =1" and "Not done = 0".

Tool II: Urinary Catheter Maintenance Checklist

This tool was adapted from Hanchett (2012). It aimed to assess the maintenance of UC and its drainage system. It encompassed seven interventions covering the assessment of the daily need for catheterization, securing catheter device in place, performing hand hygiene and daily meatal hygiene, emptying the drainage bag, maintaining flow unobstructed, and ensuring catheter removal or continuity. The scoring system for these items was "Done =1" and "Not done = 0".

Tool III: Catheter-Associated Urinary Tract Infections Rate Checklist

This tool was developed by the researchers after reviewing the relevant literature to assess the rate of UTIs among the studied patients (APIC, 2014; CDC, 2018). This tool embraced the UC installation days and CAUTIs rates. The scoring system for this tool was as follows: "Present = 1" and "Absent = 0".

3.5.Validity and Reliability of the Tools

Data collection tools were tested for content validity by a panel of eleven experts from the Critical Care and Emergency Nursing Department-Faculty of Nursing, Mansoura University, and Anesthesia and Intensive Care Medicine and the Urology Unit-Faculty of Medicine, Mansoura University. Recommended modifications were made accordingly. The reliability of the tools was tested by using Cronbach's Alpha test.

The reliability of tool I, tool II and tool III were 0.91, 0.94, and 0.91 respectively which indicates reliable tools.

3.6.Pilot Study

A pilot study was conducted on eight patients (10% of the total sample) to assess the objectivity, clarity, and applicability of data collection tools. The participants in the pilot study were not involved in the main study. Accordingly, the required adjustments were done before data collection.

3.7.Ethical Considerations

Ethical approval was granted from the Research Ethical Committee (REC) of the Faculty of Nursing. Eligible patients were informed about the aim, procedure, benefits, and risks of the study. They were assured that their participation in this study was voluntary and that they had the right to accept or refuse to participate without penalty. They were also assured about the confidentiality of their personal data. Patients were also informed that they had the right to withdraw from the study at any time and this would not affect their care. Oral or written consent was taken from the patients/next of kin who accepted to take a part in this research.

3.8.Data Collection

Data were collected between July and December 2019 in three phases including preparation, implementation, and evaluation.

Preparation Phase:

- Ethical approval was granted from the REC.
- Official permission to conduct the study was secured from the director of the hospital after explaining the aim and nature of the study.
- The primary investigator (PI) interviewed the health care team in the selected ICUs introduced herself to them and explained the purpose of the study.
- The PI screened the newly admitted patients during the three hot days, and eligible patients were enrolled in this study according to the inclusion criteria.
- Informed consent was taken from the patients/next of kin who accepted to take a part in the study.
- Patients were assigned randomly into two groups: the CAUTI bundle group and the traditional care group using the coin toss method (40 patients in each group).

Implementation Phase

For both groups:

- Patients' demographic and health data were recorded by the PI using part 1 of tool I.
- Patients were assessed for the need for UC and the data were recorded using part 2 of tool I.
- The preparation for the UC insertion and the maintenance care was performed/ observed and recorded using part 2 of tool I.
- Urine samples were collected twice; the first urine sample was collected immediately after the UC insertion for culture and the data were noted using tool III**.** The second urine sample was collected on the last day of the study (4^{th} day) for culture and the data were recorded using tool III.

For the CAUTI bundle group

- The UC was inserted for male patients by the responsible physician and female patients by the PI, and the data were recorded using part 2 of tool I.
- The maintenance bundle was implemented for four consecutive days and the data were collected using tool II.
- Patients were assessed daily for catheterization needs; hand hygiene was performed for every contact with the patient and the catheter was secured in place (inner thigh for females and upper thigh for males). The data were collected using tool II.
- Daily meatal hygiene with soap and water was performed for four consecutive days and the data were recorded using tool II.
- The drainage bag was emptied using a clean container and the urine flow was maintained. The data were recorded using tool II.
- The UC was daily checked to ensure catheter removal or continuity. The data were recorded using tool II.

For the traditional care group

- A UC was inserted for the male patients by the responsible physician and for female patients by the critical care nurse assigned for patient care, and the data were recorded using part 2 of tool I.
- The UC was maintained according to the hospital's protocol for four consecutive days. The data were collected using part 2 of tool II.

Evaluation Phase:

- The CAUTIs rate per 1000 UC days was calculated by dividing the number of CAUTIs by the number ofcatheter days and multiplying the result by 1000 (**CDC, 2018**). CAUTIs Rate = $No.\ of\ CAUTIs \div No.\ of\ Catheter\ Days$ X 1000

3.9.Data Analysis

The collected data were organized and coded using IBM-SPSS software (IBM Corp. Released 2017 IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). The data were expressed as frequency and percentage. The chi-Square test (with the Bonferroni method to adjust p values when comparing column proportions) was used. Monte-Carlo significance was used when appropriate. A significant level value was considered when the p-value ≤ 0.05 and a highly significant level value was considered when the p-value ≤ 0.001

4.Results

Table 1 depicts the demographic characteristics and clinical data of the studied groups. It was noted that more than half (60%) of the CAUTIs bundle group and 67.5% of the TC group were males. In addition, 47.5% of the CAUTIs bundle group aged between 26 and 35 years old, while 42.5% of the TC group aged between 36 and 45 years old. The common medical diagnosis in both groups was head trauma (75% and 65% respectively). A considerable percentage of the two groups had no previous medical history

(40% and 37.5% respectively). No statistically significant differences were noted between the two groups concerning their gender, age, diagnosis, or medical history (p>0.05). However, the results illustrated a statistically significant difference between the two groups regarding the indications of UC insertion (p= 0.003). The vast majority (97.5%) of the CAUTIs group and 75% of the TC group were catheterized due to severe illness and immobility.

Table 2 compares the UC insertion bundle on the first day between the two studied groups. Statistically significant differences were noted in nurses' and physicians' performance of the UC insertion bundle between the two groups (p ≤0.0005 for all).

Table 3 compares the application of the UC maintenance bundle along the four days of the study between the two groups. Highly statistically significant differences were noted between the studied groups during the four days (p=0.0005) for all UC maintenance steps except for emptying the drainage bag using a clean container.

Table 4 compares the CAUTIs rate between the two studied groups. The results depicted a low CAUTIs rate among the CAUTIs bundle patients (16.5 per 1000) than the TC patients (30.7 per 1000). The current findings showed that the implementation of the CAUTIs bundle has resulted in an approximately 50% decrease in the CAUTIs rate in the bundle group than the TC group. Highly statistically significant differences were observed between both groups (p=0.0005).

Table 1 Demographic Characteristics and Clinical Data of the Studied Groups

Patient's data	Groups (n=80)			
	CAUTIs	TC	Significance test	
			x^2	p
Gender				
● Male	24 (60%)	27 (67.5%)	0.487	0.485
● Female	16(40%)	13 (32.5%)		
Age category				
● 18-25 years	9 (22.5%)	8 (20%)		
● 26-35 years	19 (47.5%)	15 (37.5%)	1.391	0 .499
● 36-45years	12 (30%)	17 (42.5%)		
Diagnosis				
● Head trauma	30 (75%)	26 (65%)		
● Chest trauma	1 (2.5%)	3 (7.5%)		
● Multiple trauma	3 (7.5%)	4 (10%)	3.943	0.20
● Poisoning	5 (12.5%)	4 (10%)		
● Post-operative bleeding	0 (0.0%)	1 (2.5%)		
● Neuroleptic malignant syndrome	1 (2.5%)	2 (5%)		
Medical history				
● Hypertension	6 (15%)	8 (20%)		
● Cancer	3 (7.5%)	2 (5%)		
● Stroke	2 (5%)	4 (10%)		
● Respiratory disease	3 (7.5%)	5 (12.5)	7.699	0.265
● Previous infection	4(10%)	3 (7.5%)		
● GI disorder	3 (7.5%)	1 (2.5%)		
● Neurologic disorder	3 (7.5%)	2 (5%)		
● None	16 (40%)	15 (37.5%)		
UC indication				
● Severely ill and immobility	39 (97.5%)	30 (75%)	8.538	**0.003**
● preoperative- selected surgical procedures	1 (2.5%)	10 (25%)		

CAUTIs: catheter-associated urinary tract infections bundle, **TC**: traditional care group, **UC**: urinary catheter
X^2:Chi-Square test, p-value ≤ 0.05

Table 2 Comparing the UC Insertion Bundle in Day 1 Between the Studied Groups

Insertion Bundle Steps	Groups (n=80)					
	CAUTIs		TC		Significance test	
	Done	Not Done	Done	Not Done	x^2	*p*-value
• Hand hygiene	40 (100%)	0 (0%)	27 (67.5%)	13 (32.5%)	15.522	**<0.0005**
• Catheter insertion kit with sterile gloves	33 (82.5%)	7 (17.5%)	11 (27.5%)	29 (72.5%)	24.444	**<0.0005**
• Cleansing meatus with antiseptic Solution	36 (90%)	4(10%)	16 (40%)	24 (60%)	21.978	**<0.0005**
• Cleaning supplies	40 (100%)	0 (0%)	25 (62.5%)	15(37.5%)	18.461	**<0.0005**
• Sterile lubricant	28 (70%)	12 (30%)	0 (0%)	40 (100%)	43.176	**<0.0005**
• Sterile urinary catheter attached to a drainage bag	33 (82.5%)	7 (17.5%)	17 (42.5%)	23(57.5%)	13.653	**<0.0005**
• Perform hand hygiene before and after each patient contact	40 (100%)	0 (0%)	22 (55%)	18(45%)	23.225	**<0.0005**
• Maintain an unobstructed flow	38 (95%)	2 (5%)	28 (70%)	12(30%)	8.658	**<0.0005**
• Maintain drainage bag below the level of the bladder and the floor	40 (100%)	0 (0%)	29 (72.5%)	11 (27.5%)	12.753	**<0.0005**
• Secure catheter prevent irritation of urethra	40 (100%)	0 (0%)	15(37.5%)	25(62.5%)	21.333	**<0.0005**
• Review urinary catheter necessity daily and remove catheter promptly	40 (100%)	0 (0%)	0 (0%)	40 (100%)	80.000	**<0.0005**
• Total: Median (IQR)	90.9 (90.9-90.9)		27.3 (27.3-27.3)		Z = 8.835	**<0.0005**

CAUTIs: catheter-associated urinary tract infections bundle group, **TC:** traditional care group**, Z**: Mann-Whitney U test for the total score, **IQR**: interquartile range, $\mathbf{X^{2:}}$ Chi-Square test, ***p*-value** ≤ 0.005 (significant)

Table 3 Comparing the Maintenance Bundle Between the CAUTIs Bundle and the TC Groups

Day	Groups (n=80)		Bundle steps													
			Assess daily need for catheter		Perform hand hygiene for every contact with a patient		Secure catheter in place		Perform daily meatal hygiene		Empty drainage bag		Maintain unobstructed urine flow		Ensure catheter remove or continue	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Day (1)	CAUTIs	Done	40	100	40	100	35	87.5	40	100	40	100	38	95	40	100
		Not done	0	0.0	0	0.0	5	12.5	0	0.0	0	0.0	2	5	0	0.0
	TC	Done	0	0.0	22	55	15	37.5	13	32.5	40	100	28	70	0	0.0
		Not done	40	100	18	45	25	62.5	27	67.5	0	0.0	12	30	40	100
	Significance test	x^2	80.000		23.225		21.333		40.754		-----		8.658		80.000	
		P	**<0.0005**		**<0.0005**		**<0.0005**		**<0.0005**				**0.005**		**<0.0005**	
Day (2)	CAUTIs	Done	40	100	40	100	37	92.5	40	100	40	100	33	82.5	40	100
		Not done	0	0.0	0	0.0	3	7.5	0	0.0	0	0.0	7	17.5	0	0.0
	TC	Done	0	0.0	26	65	18	45	33	82.5	40	100	19	47.5	0	0.0
		Not done	40	100	14	35	22	55	7	17.5	0	0.0	21	52.5	40	100
	Significance test	x^2	80.000		16.969		21.003		7.671		-----		10.769		80.000	
		P	**<0.0005**		**<0.0005**		**<0.0005**		**0.005**				**0.002**		**<0.0005**	
Day (3)	CAUTIs	Done	40	100	40	100	36	90	40	100	40	100	37	92.5	40	100
		Not done	0	0.0	0	0.0	4	10	0	0.0	0	0.0	3	7.5	0	0.0
	TC	Done	0	0.0	21	52.5	16	40	35	87.5	40	100	21	52.5	9	22.5
		Not done	40	100	19	47.5	24	60	5	12.5	0	0.0	19	47.5	31	77.5
	Significance test	x^2	80.000		24.918		21.978		5.333		-----		16.050		50.612	
		P	**<0.0005**		**<0.0005**		**<0.0005**		**0.02**				**<0.0005**		**<0.0005**	
Day (4)	CAUTIs	Done	40	100	40	100	38	95	40	100	40	100	34	85	40	100
		Not done	0	0.0	0	0.0	2	5	0	0.0	0	0.0	6	15	0	0.0
	TC	Done	0	0.0	23	57.5	18	45	34	85	40	100	25	62.5	13	32.5
		Not done	40	100	17	42.5	22	55	6	15	0	0.0	15	37.5	27	27.5
	Significance test	x^2	80.000		21.587		23.809		6.315		-----		5.230		40.754	
		P	**<0.0005**		**<0.0005**		**<0.0005**		**0.01**				**0.02**		**<0.0005**	

CAUTIs: catheter-associated urinary tract infections bundle group, **TC group**: traditional care group

$\boldsymbol{x^{2:}}$ Chi-Square test, P-***value*** ≤ 0.05

Table 4 Comparing the CAUTIs Rate Between the Studied Groups

CAUTI rates categories	Groups (n=80)			
	CAUTIs	TC	Significance test	
			x^2	P
• UC Installation days	242	293	22.453	**<0.0005**
• Infection documented cases	4	9		
• CAUTIs rate	16.5	30.7		

CAUTIs: catheter-associated urinary tract infections bundle group, **TC group:**: traditional care group

$x^{2:}$ Chi-Square test, ***P-value*** ≤ 0.05

5.Discussion

The current study aimed to investigate the effect of implementing the CAUTIs bundle on the prevention of HAIs among critically ill patients in ICUs. The section aims to discuss and interpret the results of this study in the light of relevant publications. Thereby, the findings of the current study are discussed in three main sections as follows:

Section I: Demographic Characteristics and Clinical Data of the Studied Groups

The findings of the study showed that more than half of the CAUTIs bundle patients, and more than two-thirds of TC patients were males. This is because men are more exposed to different modes of trauma than women due to their work and hazardous occupations.

Our results are aligned with other similar studies (Prin & Li, 2016; Podkovik et al., 2019; Guadarrama-Ortega et al., 2020) which reported that males were the predominant in their investigations. However, in Egypt, Ismail, Alshawadfy, Magrabi, and Sherief (2019) investigated factors influencing the CAUTIs rate in the ICU and reported that more than half of their sample was females. Also, Blodgett, Gardner, Blodgett, Peterson, and Pietraszak (2015) assessed the CAUTIs signs and symptoms among the hospitalized patients and illustrated that both genders were represented in equal percentages. For the cited studies, these findings may be due to the difference in the sample size and study settings.

The present study showed that 47.5% of the CAUTIs bundle group aged between 26 and 35 years old, while 42.5% of the TC group aged between 36 and 45 years old. This indicates that the CAUTIs group was younger than the TC group with no statistically significant difference between them. This may be due to the study's inclusion criteria of the age group that ranged from 18 to 45 years old to ensure that the patients were free from infections and other age-related diseases. Similarly, Selim (2018) reported that the mean age of their patients was 37.3 ±11.4 which is congruent with our findings. On the Contrary, Abdel-Hakeim and Hamza (2018) revealed that the most common age group of the studied patients was between 40 and 50 years old with a statistically significant difference between the studied groups. These discrepancies may be attributed to the inclusion criteria in each study.

Concerning the patients' medical diagnosis, head trauma was the most common reason for ICU admission in the present study for both groups with a highly statistically significant difference. This could be explained by the nature of the study setting as data were collected from a surgical ICU where patients were admitted with different modes of trauma such as road traffic accidents (RTA) and falling from heights (FFH). Additionally, Davies et al. (2018) and Prin and Li (2016) documented that head trauma was the leading cause of ICU admission. In harmony with this finding, Tyson et al. (2018) declared that most of their sample was traumatized. On the other hand, Mukakamanzi (2017) reported that the most common causes of patients' admission to the ICU were sepsis and pneumonia followed by hyperglycemia. This discrepancy may be due to the nature of the study setting in each research.

In the present study, the installation days of UC were between six and seven days in both groups. In the same line, B. Kim et al. (2017) noted that the studied patients' median duration of UC was 7 days. However, this is inconsistent with the report of Talescshian-Tabrizi et al. (2015) which illustrated that the mean catheter duration was 15.86 days in ICUs. This contradiction could be due to the prolonged length of patients' stay in the ICU in their study.

Section II: Comparing the Implementation of the CAUTIs Bundle Between the Studied Groups

The current study demonstrated that severe illness and immobility were the most frequent indications for UC insertion for patients in both groups. This is because most patients were

unconscious and connected to MV which restricted their mobility. On the other hand, many studies reported that a UC is indicated for admitted patients in ICUs for fluid monitoring and management (Al meida et al., 2020; Dehghanrad et al., 2019; Fakih et al., 2010; B. Kim et al., 2017; Knill, Maduro, & Payne, 2018; Kuriyama et al., 2017; Sampathkumar, 2017). Also, an Egyptian study conducted by Ismail et al. (2019) and an Iranian study conducted by Talescshian-Tabrizi et al. (2015) emphasized that fluid monitoring was the most mutual indication for UC insertion. Guadarrama-Ortega et al. (2020) found that urine retention and urine output control were the most frequent indications for UC insertion.

The findings of the current study showed that all nurses and physicians performed hand hygiene before UC insertion, maintained cleaning supplies, maintained drainage bag below the level of the bladder and the floor, secured catheter to prevent irritation of the urethra, and reviewed urinary catheter necessity daily correctly and completely for the CAUTIs bundle patients. However, about two-thirds of nurses and physicians performed the same steps for TC patients.

Additionally, highly statistically significant differences were noted between both groups regarding nurses' and physicians' performance of the UC insertion bundle. This is because the PI accurately followed the bundle steps for the CAUTIs bundle group to ensure the optimal quality of UC care. On the other hand, the TC group patients received catheter insertion according to the unit's protocol, and this may indicate a lack of compliance with the infection control protocol.

This finding is in the line with Ravi and Joshi (2018) who reported that the compliance of nurses to the Hospital Infection Control Committee (HICC) guidelines during UC insertion reached 100% in the intervention phase compared to 82.69% in the baseline phase with statistically significant difference between the two phases. On the contrary, an Egyptian study evaluated the incidence of CAUTIs at Alexandria University ICUs and reported health care staff's poor performance of infection control measures before and during the UC insertion (Talaat et al., 2010).

Concerning the maintenance bundle, highly statistically significant differences were noted between the two groups regarding all steps along the four days of the study except for emptying the drainage bags using a clean container. This is in agreement with Amine, Helal, and Bakr (2014) who assessed the effect of an intervention program on the prevention of CAUTIs in the ICU in an Egyptian hospital. They found that all critical care nurses performed the UC maintenance bundle steps competently after two months of the intervention phase with a highly statistically significant difference between the baseline and the intervention phases.

On the contrary, Talescshian-Tabrizi et al. (2015) delineated that critical care nurses' performance showed noncompliance with most elements of the UC maintenance care, and its drainage system such as hanging the catheter on the stand and below the level of patients bladder, washing hands after the UC bag drainage, putting on gloves during drainage process, and damaging the bags after changing it.

Section III: Comparing the CAUTIs Rate Between the Studied Groups

The current findings showed that the implementation of the CAUTIs bundle resulted in a decrease in the CAUTIs rate among the CAUTIs bundle group (16.5 per 1000) rather than the TC group (30.7 per 1000) with an approximately 50% decrease in CAUTIs rate between both groups. This is supported by the findings of the other two studies which implemented the CAUTIs bundle and reported a 50% reduction in the CAUTIs rates (Davis et al., 2014; Selim et al., 2018).

Despite the decreased CAUTIs rate in the bundle group compared to the TC group, its prevalence is still high compared to the international prevalence. This is because the study settings have some limitations such as the lack of some supplies, the high ratio of patients to nurses, and non-compliance of physicians and nurses with handwashing and gloving guidelines during UC insertion or care. In this regard, our findings are supported by several studies which were conducted in developing countries as Egyptian studies (Abdesalam, Ahmed, & Khalil, 2018; Ahmed & Shehata, 2020; Aly, Tawfeek, & Mohamed, 2016; Amine et al., 2014; Ismail et al., 2019; Selim et al., 2018; Talaat et al., 2010), Saudia studies (Abdel-Hakeim, & Hamza, 2018; Raslaan, 2012) and one Lebanese study (Kanj et al., 2013). These studies reported a high CAUTIs rate.

On the contrary, the studies were carried out in the developed countries such as the American studies (Clarke et al., 2013; Davis et al., 2018; Perrin et al., 2020; Tyson et al., 2018), European studies (Düzkaya, Bozkurt, Uysal, & Yakut, 2016; Letica-Kriegel et al., 2019), a Spainian study (Lerma et al., 2019), an Asian study (Dehghanrad et al., 2019), and another international study that

was applied in 15 developing countries (Rosenthal et al., 2012) reported low CAUTIs rate. This disagreement may be due to adherence to CAUTIs guidelines and the availability of resources in the developed countries. Another reason could be due to the type of these studies as most of them were applied on large sample size and for a long duration.

6.Conclusion and Recommendations:

The implementation of CAUTIs prevention bundles is an efficient method to reduce UTIs when caring for critically ill patients, and hence, improve patient outcomes. Therefore, health care professionals should comply with the CAUTIs bundle.

7.Limitations of the current study

- The sample was drawn from one hospital in one geographical area in Egypt that restricts the generalization of findings.
- The study sample was restricted to the age group between 18 and 45 years old.
- Our sample comprised of 80 patients, where a larger sample would have been more appreciated.
- The lubricant gel was unsterile which limits the sterilization of UC before the insertion.

8.Acknowledgment

We would like to express our gratitude to all patients who consent to take a part in this study and the health care staff for their support during the study.

9.Funding

This study research did not obtain any particular finance from any communal, commercial, or private agencies.

10.Statement of Competing Interests

The authors acknowledged no latent conflicts of interest regarding this study, authorship, and/or publication of this research.

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