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Effectiveness of nursing instructions on reducing urinary tract infections in critically ill patients

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Abstract
Background: Urinary tract infections (UTIs) are the most common healthcare-associated infections (HAIs), resulting in significant morbidity among hospitalized patients.
Objective: Evaluate the effectiveness of applying nursing instructions (NI) on reducing UTIs in critically ill patients (CIPs).
Sample: A purposive sample of 60 patients of both sexes connected with indwelling urinary catheters (IUC).
Tools: Two tools were used;
First Tool: Patient Health Assessment (PHA) includes
First Part: Demographic Data (DD)
Second Part: Medical Data (MD).
The second Tool: The Urinary Tract Infection Assessment Checklist (UTIAC), includes
First Part: Urinary Tract Infection Manifestation (UTIM)
Second Part: Laboratory Criteria (LC).
Results: The intervention group (IG) had a lower incidence of UTI (10.0%) compared to the control group (CG) (46.66%), with a significant p-value of 0.001.
Conclusion: Nursing instructions helped reduce the incidence of UTIs and improve patient outcomes.
Recommendation: Designing standardized nursing protocol regarding the insertion, care, and removal of urinary catheters to upgrade nurses' knowledge and practice, and further research studies are needed on larger study samples.

Keywords: Effectiveness, nursing instructions, urinary tract infections, critically ill patient

Introduction

Healthcare associated infections (HCAIs) are significant health issues due to their strong correlation with elevated morbidity and mortality rates, extended hospitalization periods, and escalated treatment expenses. These infections are categorized as ward-acquired or intensive care unit (ICU) acquired infections (AI). In developing countries, the incidence of infections acquired in the intensive care unit (ICUAI) is considerably greater compared to developed countries. As per the World Health Organization (WHO), the incidence rate of Intensive Care Unit-Acquired Infections (ICUAI) is 2-3 times greater in developing nations compared to developed nations [1].

Urinary tract infections are common infections that occur when bacteria, typically originating from the skin or rectum, invade the urethra **[2].** Bacteria predominantly cause urinary tract infections (UTIs). Cystitis is the predominant urinary tract infection (UTI), although infection can manifest in different areas of the urinary tract, leading to pyelonephritis, urethritis, and prostatitis [3].

A urinary tract infection is characterized by the proliferation of a substantial quantity of microorganisms from a single species in the urine, accompanied by symptoms and a colony count exceeding 105 per milliliter of a single species in a clean urine sample collected mid-stream [4]. Risk factors of UTIs include female gender because their urethras are shorter and closer to the rectum, increased age, previous UTI, severe illness, obesity, inappropriate use of a urinary catheter (UC), and structural problems in the urinary tract, such as enlarged prostate [2]. Nurses are essential in preventing and managing UTIs; they are responsible for UC placement, daily catheter management, urine specimen collection, and removal of the

UC. Nurses play a vital role in diagnosing UTI as they are often the first to notice a clinical change or technical problem [5].

Significance of the Study

Urinary tract infections affect patients' physical, emotional, and social well-being. The complications of UTIs include bladder dysfunction (BD), urethral narrowing in men due to recurrent infections, permanent kidney damage, and sepsis [6]. Urinary tract infection (UTI) has a global annual incidence of over 150 million cases. Several studies indicate that healthcare-associated urinary tract infections (UTIs) vary between 1.4% and 3.3% in different countries [7]. Urinary tract infection (UTI) is the second most prevalent healthcare-associated infection (HAI) in critically ill patients (CIPs) [1].

Subjects and Methods

1. Aim of the study

The present study aimed to evaluate the effectiveness of NI in reducing UTIs in CIPs.

2. Research Hypothesis

H_1: The IG who received NI will have reduced UTI among the IG compared with the CG.

3. Research Design

A quasi-experimental (QE) research design was utilized in the current study.

4. Setting

The current study was conducted at the traumatic intensive care unit (TICU), affiliated to the Emergency Hospital (EH), which belongs to the Minia University Hospital (MUH) in Minia City (MC), Egypt.

5. Subjects

A purposive sample of 60 adult patients who connected with UC was divided equally into two groups (intervention and control), with 30 in each one.

5.1. Inclusion criteria

All CIPs aged 18 to 60 years with a UC.

5.2. Exclusion criteria

Patients who were not willing to participate had a UTI or any other systemic infection (SI), were immuno-compromised, and had chronic diseases such as diabetes mellitus (DM) and hypertension.

5.3 Sample Size

The sample size was estimated by using the (Mohapatra & Chamola, 2020) formula, which is computed as ($n = z^2 \times p (1- p) / d^2$). Where n = sample size, Z= Z statistic for a confidence level, P= expected prevalence or proportion (in proportion of one; if 20%, P= 0.02 and d= precision (in proportion of one; if 5%, d= 0.05).

$N= (1.96)^2 \times 0.04 (1-0.04) / (0.05)^2 = 60$ patients.

6. Study Duration

Data collection started from February 2020 to May 2021.

7. Tools of Data Collection

The researcher developed two tools that were used in the current study. They were established after an extensive literature review and revised for validity.

7.1 First Tool: Patient Health Assessment (PHA)

7.1.1 First Part: Demographic Data (DD): Such as age, sex, level of education, marital status, and residence.

7.1.2 Second Part: Medical Data (MD): It included the date of admission, medical diagnosis, and type of medication.

7.2 Second Tool: Urinary Tract Infection Assessment Checklist (UTIAC)

This tool was adapted from (CDC 2020) and is utilized to evaluate UTI. It included:

7.2.1 First Part: Urinary Tract Infection Manifestation (UTIM): included during daily inspection of the external genitalia as redness, cloudy urine, foul-smelling urine, and fever > 38 °C.

7.2.2 Second Part: Laboratory Criteria (LC): positive urine culture (PUC) of bacterial count $\geq 10^5$ /ml with no more than two species of microorganisms, pyuria (pus cells $\geq$ 3/ml in urine).

7.3 Tools validity

The developed study tools were submitted to a jury of five experts specializing in Medical-Surgical Nursing (MSN) and Critical Care Nursing (CCN) Specialty to test their content validity and clarity of items. All jury members agreed that the current study tools were valid and relevant to the aim of the study.

7.4 Tools reliability

Reliability was ascertained statistically using the Alpha Cronbach test to ensure the reliability of the study tools. The reliability of the PHA and UTIAC were (0.77 and 0.89) respectively.

8. Pilot Study

A pilot study was conducted on 10% (n = 6) of the total sample of patients admitted to the previously mentioned ICU, meeting inclusion criteria to test the applicability, clarity, and objectivity of the study tools and estimate the time required to fulfill it.

9. Ethical considerations

Official permission to conduct the study was obtained from the ethical committee of research (REC), NF, and MU, and second permission was obtained from the director of the traumatic ICU for approval to gather data for research. Written informed consent from patients was obtained to participate in the study after explaining the study's aim, purpose, procedure, and nature. It had the right to refuse to participate or withdraw from the study independently without any rationale and ensured that data collection was used only for the study.

10. Study Procedure

10.1 Preparatory Phase

The researcher carried out the present study after formal authorization was achieved. Tools were prepared through reviewing the current and relevant related literature and theoretical knowledge of the various related aspects using

textbooks, and articles, and it ended by carrying out the pilot study.

10.2 Implementation Phase

The investigator conducted the current study individually for each patient connected with UC. Collected data started from the (CG) and then from the (IG), using two tools. Obtain patient's demographic and medical data from patient files and their relatives using PHA (Tool I) for enrolled patients on the first day. The implementation time for this tool was 30-35 minutes. The CG was provided with routine ICU nursing care (NC) for urinary catheter insertion (UCI) and maintenance by the in-unit nursing staff, from patient admission to discharge. The IG received the CDC NI for the prevention of UTI by the investigator. The NI includes handwashing before and after UCI, set up a sterile field, using sterile gloves, drapes, sponges, and maintaining a strict aseptic technique throughout the actual UC insertion procedure, securing the UC to prevent urethral irritation, positioning drainage bag below the bladder, and check system for closed connections and no obstruction.

10.3 Evaluation Phase

Patients were evaluated for UTI presence by using UTIAC (Tool II). UTI manifestation and urine samples were obtained two times on the third and sixth day of the study for bacteriological examination. The executed implementation time for this tool was 30-35 minutes.

11. Operational Definition

According to the CDC, nursing instructions regarding the prevention of UTI should prepare the patient before, during, and care for the urinary catheter drainage system (UCDS) after the UCI.

12. Limitations of the Study

The finding is less amenable to generalization because the sample was selected from one geographical area in Egypt. Limited national studies have been conducted regarding the correlation between the application of nursing instructions for UC and the prevention of UTI.

13. Statistical Analysis of Data

Data was coded and transferred into a specially designed format, fed to the computer, and analyzed. A statistical package for social science (SPSS) version (22) was used to analyze the data.

Results

Table 1: Frequency distribution of the studied patients regarding their demographic data (n=60)

Demographic Data	Intervention Group (n=30)		Control Group (n=30)		χ^2	P-Value
	No.	%	No.	%		
Age (Years)						
18-28	12	40.0%	10	33.33%	4.726	0.188 NS
29-39	10	33.33%	9	30.0%		
40-49	2	6.67%	8	26.67%		
50-60	6	20.0%	3	10.0%		
Mean ± SD	33.70±13.21		35.53±11.49			
Gender						
Male	25	83.33%	27	90.0%	<0.0001	0.706 NS
Female	5	16.67%	3	10.0%		
Residence						
Urban	4	13.33%	4	13.33%	<0.0001	1.000 NS
Rural	26	86.67%	26	86.67%		
Level of Education						
Illiterate	1	3.33%	0	0.0%	1.411	0.703 NS
Read and Write	2	6.67%	2	6.67%		
Diploma	20	66.67%	21	70.0%		
Bachelor	7	23.33%	7	23.33%		
Marital Status						
Single	12	40.0%	10	33.33%	0.287	0.592 NS
Married	18	60.0%	20	66.67%		

NS: Not Significant

Table (1) Shows that slightly more than one-third of the intervention group were within the age group of (18–28) years. Also, the table revealed that more than half of the intervention and control groups were male (83.33%, 90.0%), respectively. In regard to marital status, (60.0% 66.67%) of the intervention and control groups were married, and the majority of the studied groups came from rural areas. Concerning the level of education, it was revealed that diploma-degree patients formed the highest percentage among the studied groups, about two-thirds of them. Lastly, the intervention and control groups had no statistically significant differences according to their DD.

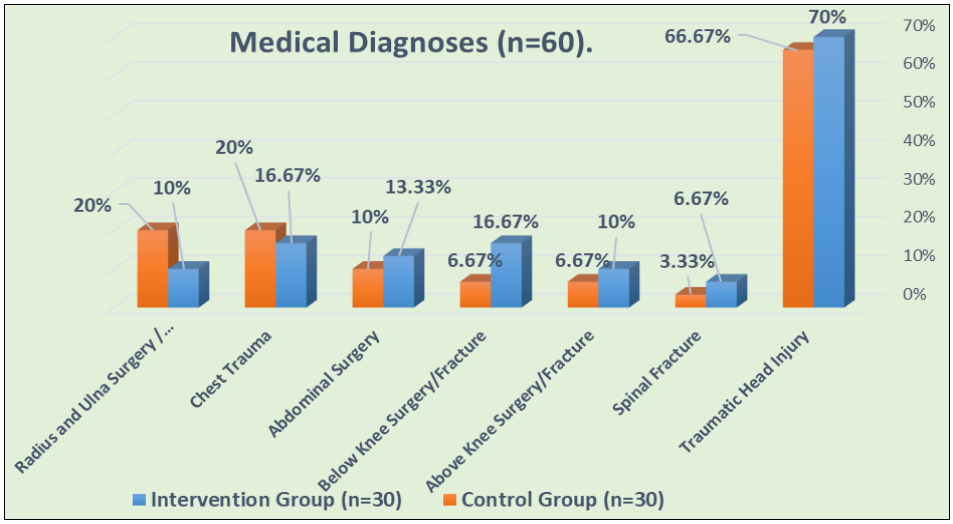

Fig 1: Frequency distribution of the studied patients regarding their medical diagnosis (n=60).

Figure (1) Revealed that 70% of the IG, compared with 66.67% of the CG, had a traumatic head injury.

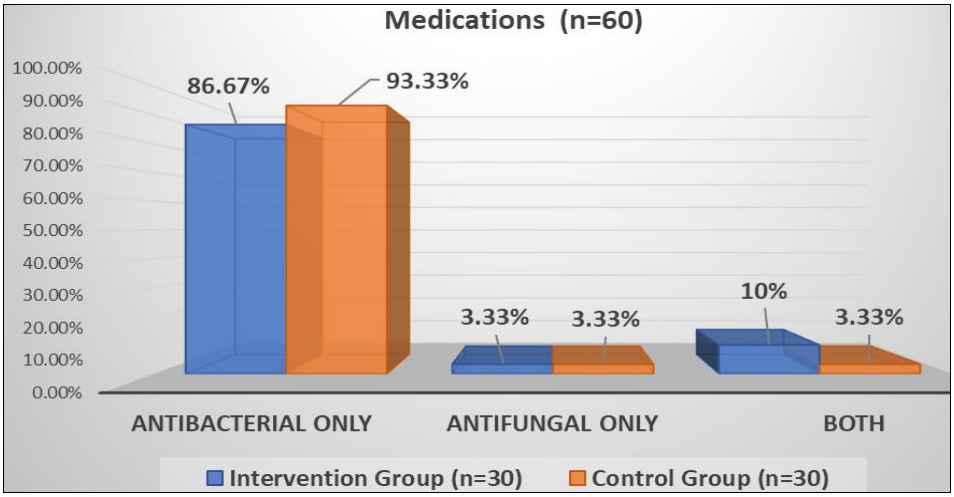

Fig 2: Frequency distribution of the studied patients according to medication (n=60).

Figure (2): Revealed that regarding medication administration, 86.67% of the IG compared with 93.33% of the CG received antibacterial medication only.

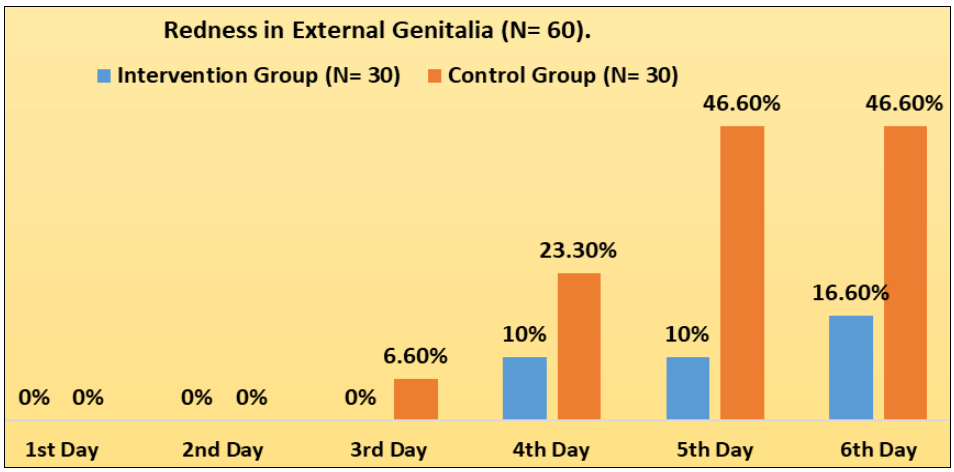

Fig 3: Distribution of the studied patients regarding manifestation of redness in external genitalia over six days (n=60)

Figure (3) Illustrates that the percentage of external genitalia redness stayed steady among IG at the 4th and 5th days, documented by 10%, and increased to 16.60% at the sixth day. While it started to appear on the 3rd day among CG and increased on the 4th, it stayed steady on the 5th and 6th days, as documented by (6.60%, 23.30%, 46.60%, and 46.60%), respectively.

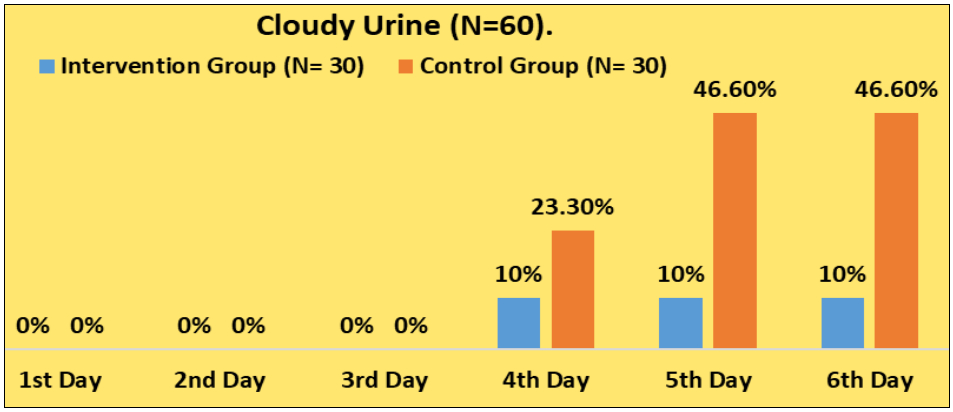

Fig 4: Distribution of the studied patients regarding manifestation of cloudy urine over six days (n=60)

Figure (4): Illustrates that the percentage of cloudy urine was pronouncedly increased, starting on the fourth day and continuing until the sixth day. It was noted that the cloudy urine percentage among IG became constant at the 4th, 5th, and 6th days, documented by 10%. The percentage of cloudy urine increase among CG at the 4th, 5th, and 6th days was documented by (23.30%, 46.60%, and 46.60%), respectively.

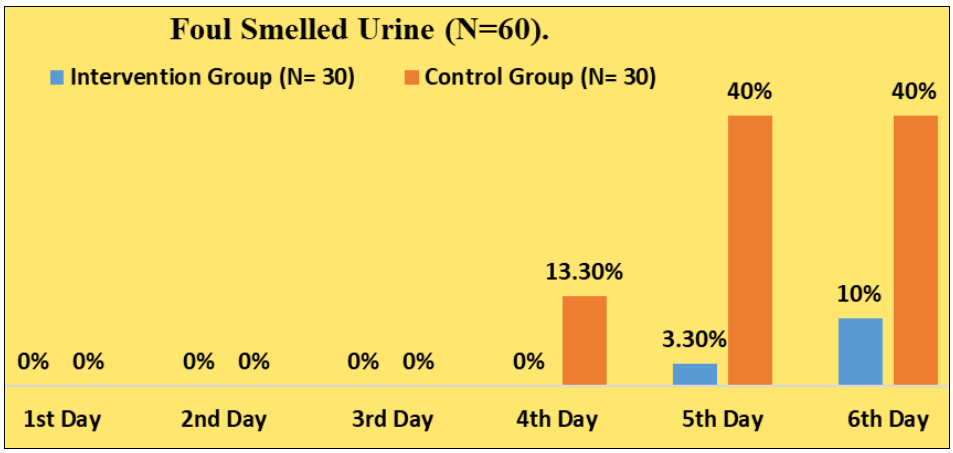

Fig 5: Distribution of the studied patients regarding manifestation of foul smelled urine over six days (n=60).

Figure (5) Illustrates that the percentage of foul-smelling urine was zero percent among the IG, compared with 13.30% of the CG having foul-smelling urine on the 4th day. The percentage of foul-smelling urine increased among IG at the 5th and 6th days, as documented by (3.30% and 10%, respectively). While it increased and stayed steady among CG at the 5th and 6th days, as documented by (40%).

Table 2: Comparison between intervention and control groups regarding the UTI criteria on the 3rd and 6th Days (n= 60):

UTI	Third Day		Sixth Day	
	Intervention Group (n=30)	Control Group (n=30)	Intervention Group (n=30)	Control Group (n=30)
	N (%)	N (%)	N (%)	N (%)
Fever > 38 °C				
Yes	2(6.66%)	15(50%)	6(20.0%)	21(70%)
No	28(93.34%)	15(50%)	24(80%)	9(30%)
χ^2	15.244		15.901	
P - Value	<0.001 **		<0.001**	
Positive Urine Culture (PUC)				
Yes	2(6.66%)	4(13.34%)	3(10.0%)	14(46.66%)
No	28(93.34%)	26(86.66%)	27(90%)	16(53.34%)
χ^2	5.831		10.569	
P - Value	0.016*		0.001**	
Pyuria				
Yes	0(0.0%)	11(36.66%)	1(3.34%)	14(46.66%)
No	30(100%)	19(63.34%)	29(96.66%)	16(53.34%)
χ^2	17. 740		17.26	
P - Value	<0.001**		< 0.001**	

*Statistically Significant Difference (P Value < 0.05). (CFU): Colony-Forming Units
** High Statistically Significant Difference (P Value < 0.01)

Table (2) shows that 20% of the IG and 70.00% of the CG had a fever. Also, 10.0% of the IG, compared with 46.66% of the CG, had (PUC). It can also be seen that 3.34% of the IG compared with 46.66% of the CG had pyuria, with a statistically significant difference (SSD) at the sixth day.

Table 3: Relation between UTI Criteria and Medical Data among Intervention and Control Groups (n= 60).

Medical Data	UTI Criteria											
	Fever				Positive Urine Culture				Pyuria			
	Intervention Group (n=30)		Control Group (n=30)		Intervention Group (n=30)		Control Group (n=30)		Intervention Group (n=30)		Control Group (n=30)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Diagnosis (Multiple Response), n=Intervention & control												
Traumatic Head Injury, n=21&20	6 (28.57)	15 (71.43)	14 (70.0)	6 (30.0)	3 (14.28)	18 (85.72)	10 (50.0)	10 (50.0)	1 (4.76)	20 (95.24)	10 (50.0)	10 (50.0)
Abdominal Surgery, n=4 & 3	1 (25.0)	3 (75.0)	3 (100)	0 (0.0)	0 (0.0)	4 (100)	2 (66.67)	1 (33.33)	0 (0.0)	4 (100)	2 (66.67)	1 (33.33)
Chest Trauma, n=5 & 6	0 (0.0)	5 (100)	5 (83.33)	1 (16.67)	0 (0.0)	5 (100)	4 (66.67)	2 (33.33)	0 (0.0)	5 (100)	4 (66.67)	2 (33.33)
Above Knee Surgery/Fracture, n=3 & 2	0 (0.0)	3 (100)	1 (50.0)	1 (50.0)	0 (0.0)	3 (100)	1 (50.0)	1 (50.0)	0 (0.0)	3 (100)	1 (50.0)	1 (50.0)
Below Knee, Surgery/Fracture, n=5 & 2	1 (20.0)	4 (80.0)	1 (50.0)	1 (50.0)	0 (0.0)	5 (100)	0 (0.0)	2 (100)	0 (0.0)	5 (100)	0 (0.0)	2 (100)
Spinal Fracture, n=2 & 1	0 (0.0)	2 (100)	1 (100)	0 (0.0)	0 (0.0)	2 (100)	0 (0.0)	1 (100)	0 (0.0)	2 (100)	0 (0.0)	1 (100)
Radius & Ulna Surgery / Fracture, n=3 & 6	1 (33.33)	2 (66.67)	3 (50.0)	3 (50.0)	1(33.33)	2 (66.67)	3 (50.0)	3 (50.0)	1 (33.33)	2 (66.67)	3 (50.0)	3 (50.0)
χ^2	6.526		4.752		5.900		4.832		10.515		4.832	
P – Value	0.480 NS		0.690 NS		0.552 NS		0.689 NS		0.161 NS		0.680 NS	
Medication												
Antibacterial	5 (16.67)	21 (70.0)	20 (60.67)	8 (26.67)	3 (10.0)	23 (76.67)	14 (46.67)	14 (46.67)	1 (3.33)	25 (83.34)	14 (46.67)	14 (46.67)
Antifungal	0 (0.0)	1 (3.33)	1 (3.33)	0 (0.0)	0 (0.0)	1 (3.33)	0 (0.0)	1 (3.33)	0 (0.0)	1 (3.33)	0 (0.0)	1 (3.33)
Both	1 (3.33)	2 (6.67)	0 (0.0)	1 (3.33)	0 (0.0)	3 (10.0)	0 (0.0)	1 (3.33)	0 (0.0)	3 (10.0)	0 (0.0)	1 (3.33)
χ^2	0.593		2.789		0.513		1.875		0.159		1.875	
P – Value	0.743	NS	0.248	NS	0.774	NS	0.392	NS	0.924	NS	0.392	NS

Table (3): Demonstrated that there were no statistically significant relations between UTI criteria and MD.

Discussion

Healthcare associated urinary tract infections (HA-UTIs) account for about 20–30% of all HAI; UTIs are a major burden for the healthcare system and are associated with prolonged hospital stay, increased morbidity, mortality, and costs [9].

Nurses are the key healthcare professionals responsible for UCI and care and adhere to all applicable standards, protocols, and guidelines to achieve the desired patient outcomes. The evidence indicates that factors such as the availability of resources and the presence of guidelines in the health facility positively impact the knowledge and practice of nurses in the prevention of UTIs [10].

Regarding age, the current study shows that more than one-third of the IG was in the youngest age group. The present study finding contradicted (Alshehri 2023) [11], revealing that about one-third of the studied patients were in the oldest age groups. Also, contrary to the findings of (Chandna, Pandey, and Maheshwari, 2022) [12], they concluded that the majority of the study population belonged to the oldest age groups.

As regards gender, the present study found that the majority of the IG was males. The present study finding contradicted (Omer *et al*., 2020) [13], who revealed that a minority of the patients were male. In addition, the study by (Chandna, Pandey, and Maheshwari, 2022) [12] reported that more than one-third of the population was male.

The present study results revealed that the majority of the IG belonged to rural areas. The investigator's perspective is that most of the Governorates in Upper Egypt are made up of villages. Also, it may have poor healthcare facilities. The present finding was consistent with (Hak *et al*., 2022) [14], who revealed slightly more than half of the patients in the study group belonged to rural areas.

Concerning educational level, it has been noticed that two-thirds of IG had diploma degrees. The investigator's perspective is that the diploma level of education is widely recognized among low-income people and some of Egypt's rural culture does not allow individuals to complete their educational level. The present study finding was consistent with (Hak *et al*., 2022) [14], who revealed that less than half of the study group had secondary and university education.

The present study results revealed that about two-thirds of IG were married. The investigator's perspective is that most of the people in rural areas of Upper Egypt tend to marry in early adulthood, and other single patients could be in urban areas or aged less than 20 years. The present study finding was consistent with (Alhabdan *et al*., 2023) [15], who revealed the majority of the participants were married. The present study finding contradicted (Hak *et al*., 2022) [14], who indicated that one-third of the study group were married.

As regards the cause of ICU admission, the current study revealed that two-thirds of the IG had head trauma. There was no SSD between the intervention and control groups by their distribution of the diseases. The investigator's perspective is that the study setting was traumatic, as data were collected from a traumatic ICU where patients were admitted with different modes of trauma, such as road traffic accidents (RTA) and falling from heights (FFH).

The current study result is consistent with (Pajerski, Harlan, Ren, & Tuite, 2022) [16], who said that one-third of the intervention group the reason behind their ICU admission was head trauma. Also, the current study results in the same line with (Perrin *et al*., 2021) [17], who revealed that the most common diagnosis in the case group was subarachnoid hemorrhage (SAH).

Regarding the number of patients who had specific manifestations such as redness in external genitalia, cloudy urine, and foul-smelling urine, it pronouncedly increased over the six days, reaching up to one-tenth in the IG. The investigator's perspective is that this might be due to the fact that adherence to NI regarding UTIs would greatly cut the road against infection.

The present finding is consistent with Ismail *et al*. [18] found that about one-quarter of the studied ICU patients manifested cloudy urine. A contrary finding by (Zaiton,

Relloso, and Medinah, 2019) [19] indicated that the symptoms of UTIs generally are nonspecific.

Regarding fever, the study result reported that only a fifth of the IG on the sixth day of follow-up were suffering from fever. From the investigator's point of view, this finding might be logically accepted due to adherence to NI regarding the prevention of UTIs. The present finding is in the context of (Mohd *et al*., 2022) [20], who reported that fever was in less than one-quarter of the studied patients and that there was a positive association between the fever and the presence of UTIs.

The present study results revealed that the majority of the IG experienced a negative urine culture of ≥105 CFU/mL on the sixth day. This finding was consistent with (Kranz *et al*., 2020) [20], who revealed that the UTI rate was markedly lower in the IG. Furthermore, the current study was supported by (Tyson *et al*., 2020) [21], who reported that catheter utilization and UTI rates decreased significantly with adopting a multimodal UTI prevention strategy.

Concerning MD, the current findings indicate no significant relationship exists between medication type, medical diagnosis as MD, and the presence of UTI criteria in both studied groups.

The present study results revealed that for the majority of the studied groups who had UTIs, the reasons behind ICU admission were attributed to traumatic head injuries. The current study results are consistent with those of Sultan *et al*. (2022) [22], who indicated that head trauma was the most common reason for ICU admission for both groups, which means that head trauma is a risk factor for UTI occurrence. These results were supported by (Pajerski *et al*., 2022) [15], who showed that patients with traumatic brain injury were at increased risk of developing a UTI.

Conclusion

The current study illustrated a reduced incidence of UTIs among the IG who received NI compared with the CG.

Recommendations

The designed brochure includes instructions regarding how to avoid the incidence of UTIs. Replication of the present finding on a larger sample size to generalize the findings

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Conflict of Interest: None.

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