

## The Application of UTI Prevention and Control Bundles on CAUTI in Ward Patient

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**Abstract**—Infections frequently develop because catheter insertion is a case of HAIs (Health Care Associated Infections) that occur as a result of non-compliant procedures and activities by healthcare providers. This research approach is a pre-post design model experiment. The sample was divided into two groups: the treatment group and the control group. Each consists of 20 respondents. An independent sample t-test was used to analyze the data to determine the impact of UTI prevention and control bundles on CAUTI in inpatients. The results showed that no bacterial growth was found in the control group who underwent urine culture examination at the beginning of the catheterization (pre-test), but bacterial growth was discovered after 72 hours (post-test), with candida albicans > 10<sup>5</sup> CFU/ml found by four respondents (20%), staphylococcus aureus 10<sup>5</sup> CFU/ml found by one respondent (5%), and Escherichia coli >10<sup>5</sup> CFU/ml found by one respondent (5%). During the pre-test and post-test, no evidence of bacterial growth was discovered in the treatment group. The findings of the independent sample t-test revealed that the prevention and control of UTI prevention and control bundles had a significant effect on CAUTI in inpatients, with a value of p = 0.000 (p < 0.05). To avoid CAUTI, a strategic approach is required, including deploying a UTI prevention and control bundle tailored to the hospital's current arrangements.

**Keywords**—UTI prevention and control bundle, CAUTI.

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### I. INTRODUCTION

The introduction of germs and their multiplicity in the urinary tract, which can be linked to health services, is known as a urinary tract infection. This refers to the process of conveying germs to patients with indwelling catheters via equipment used by health staff during the catheter insertion process and care provided while the catheter is connected [1].

Urinary tract infections caused by catheters are common hospital-acquired infections [2]. Eighty-two patients had a urinary catheter inserted in a hospital in Indonesia, and 36 patients identified microorganisms in the urine using urine culture, which was linked to a lack of urinary catheter maintenance throughout hospitalization [3]. Most CAUTI occurrences occur in hospitals, as evidenced by a study conducted at the Government Medical College and Haldwani Hospital (Nainital), where numerous CAUTI cases were discovered, and E.coli was determined to be the most common bacteria proven to be the cause[4]. Almost identical to the study showing that this bacterium is a prevalent

infection found in hospital in patients with indwelling catheters[5].

In the prevention of CAUTI, the nurse's role is critical. Several studies have revealed that most nurses have a low degree of understanding regarding CAUTI, bad attitudes toward implementing UTI prevention and control bundles, and poor practices or actions[6].

This type of UTI caused by a catheter can be avoided. Puducherry had a considerable drop in CAUTI infections based on the results of a prevalence survey conducted in a tertiary care hospital during a three-year period. This was owing to the careful application of UTI bundles, which included hand cleanliness, aseptic procedures, a closed catheter drainage system, and personal protective equipment (PPE). This demonstrates that infection prevention may be managed successfully when health care are provided while in the hospital [5]. The UTI prevention and control bundle contains this management, and it is used as a catheterization-related control to reduce catheter-related UTIs. According to the findings, sticking to the UTI Bundle implementation

helped reduce CAUTI cases from 2.7 infections per 1000 catheter insertions per day to 0 instances of UTI.

CAUTI can lead to major consequences in patients, such as cystitis, pyelonephritis, sepsis, and shock, all of which create discomfort for the patient, extend hospitalization, raise medical costs owing to increased time, medications, and treatment measures, and even result in death [7]. As a result, the researcher wanted to see if utilizing bundles could help prevent and control catheter-related infections.

## II. MATERIALS AND METHODS

The research methodology employed in this study is quantitative research.

### A. Research Flow Chart

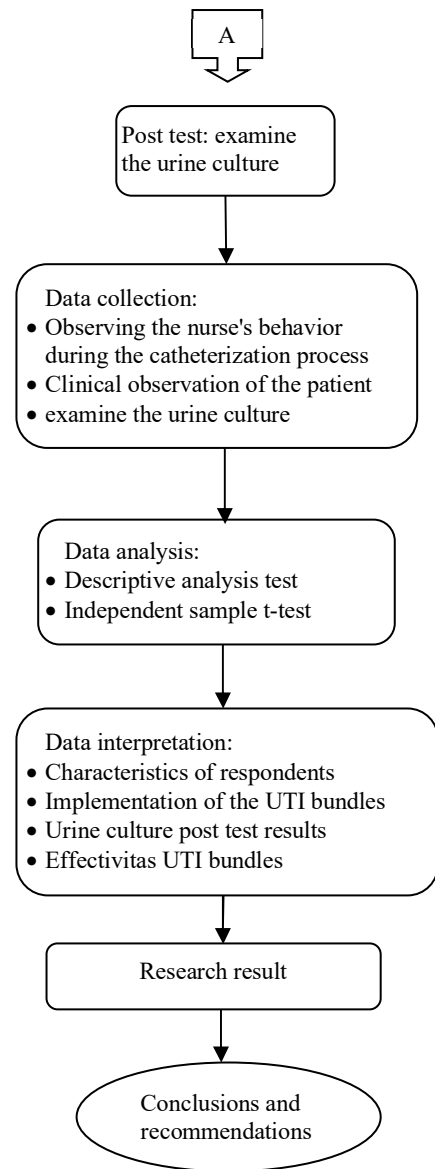
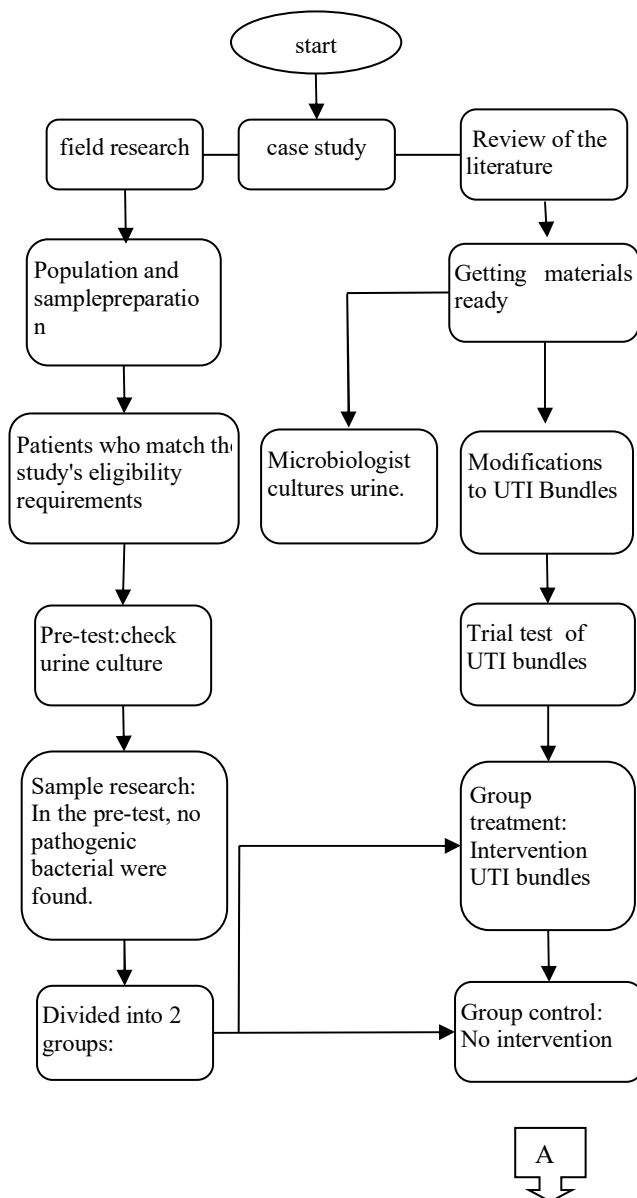


Fig. 1 Research Flow Chart

### B. Research Design

The design of this study is an experimental study that aims to identify the effectiveness of the application of UTI prevention and control bundles on CAUTI in inpatients. This study's population was all patients hospitalized at USU Hospital with indwelling catheters. The sample was selected according to the research objectives to avoid bias.

The criteria for the sample are:

- Do not suffer from diseases related to nephrology and urology,
- Patients with urinary catheters for 72 hours,
- The leukocyte value is within normal limits.

This research is experimental, and the participants are divided into two groups: the treatment and control groups. Quota determines the number of samples, with each group comprising 20 respondents. The treatment group consists of individuals who are catheterized as part of a bundle of care to prevent and control urinary tract infections. The control group consists of individuals with a catheter inserted cautiously under the hospital's guidelines.

### C. Instrument

There are two pieces to the research instrument. The first section includes a patient data questionnaire identifying the respondent's characteristics, medical history, and disease condition data. The UTI prevention and control bundles questionnaire, which serves as a checklist for implementing UTI prevention and control bundles during the study, is included in the second section. This questionnaire was adapted from Majdalawi [10] research on UTI preventive and control bundles. Specialists carried out the validity test in their domains, and the bundles were adjusted and suited to the hospital infrastructure where the research was done.

The following were the contents of the UTI bundles that were created, which were suited to the needs of the research hospital and modified from the existing theory:

- Catheter insertion, when inserting a urinary catheter, the nurse must follow the proper procedure, which includes catheter insertion, aseptic technique, hand hygiene, sterile urine catheter set, cleaning the meatus, filling the balloon according to the manufacturer's recommendations, properly securing the catheter, expert catheter insertion.
- Taking specimens, when a nurse or analyst takes a urine sample from a urinary catheter, the following procedures must be followed: hand hygiene, disinfecting the connector before taking the specimen and draining the urine, maintaining aseptic techniques, ensuring that the catheter connector does not come into contact with the outside environment, and not taking urine samples from the urine bag.
- Catheter maintenance, the catheter must be maintained with the following procedures as long as the patient is hospitalized and a urinary catheter is still attached: maintain sterility during catheter placement, keep drainage systems closed, maintain the cleanliness of hands before and after manipulating the catheter, minimize opening and closing urine catheters, empty the urine bag regularly / shift, Every patient has a urinal and is routinely cleansed, urine bag under the bladder, urine bag does not touch the floor, care of the urethra meatus, check the catheter tube as often as possible to avoid folding, make repairs if damage or leakage occurs in the catheter
- Catheter removal, patients who will have a catheter removed will undergo the following procedure: remove or replace the patient's catheter as indicated, hand hygiene, remove the liquid from the balloon first, ensure the balloon is flat, wait 30 seconds, and allow the liquid to flow according to gravity before pulling the catheter.

### D. Data collection

Data collection was carried out from May to November 2019. The data collection procedure is as follows:

- Each potential respondent receives an informed consent document that details the operation as well as patient safety and security concerns
- The researcher completed the respondent's identity questionnaire, which identifies the characteristics of the respondent, including comorbidities.

- The treatment and control group respondents had a urine sample obtained from the catheter for urine culture analysis as initial data or pre-test. This is done to guarantee that there are no germs in the urine of the research participants.
- In the control group, treatment was carried out according to hospital procedures, whereas bundles for UTI prevention and control were carried out in the treatment group.
- A catheter was likewise implanted in the therapy group, following the insertion bundle designed by the researcher. The urine catheter was then maintained, specimens were collected, and the urinary catheter was withdrawn under the care bundle.
- The researcher did not intervene during catheter insertion, catheter care while the catheter was inserted, or catheter removal in the control group.
- As long as the catheter is in place, the two groups of respondents are monitored regularly by completing the researcher-designed checklist.
- The researchers gathered urine samples from the two research groups for urine culture investigation as post-test data after the catheter had been implanted for 72 hours.

### E. Research Ethics

This research was conducted after obtaining research permission from the hospital's main director under the number 2250/UN5.4.1.1.1/KPM/2019, and it was declared not to conflict with human values and norms by the USU Faculty of Nursing's Health Research Ethics Commission under the number 1740/IV/SP/2019.

### F. Data Analysis

The data were subjected to statistical tests to obtain the study's results. In all groups, the frequency distribution of the independent variables, namely respondent characteristics, execution of bundles or protocols for prevention and control of UTI, and distribution of urine culture findings, was determined using the frequency distribution test. Meanwhile, the efficiency of UTI bundles on CAUTI incidents was investigated using an independent sample t-test with a significance level of  $p < 0.05$ . The findings of urine culture after 72 hours of observation in two research groups, the treatment, and the control groups, are compared in this test.

## III. RESULTS AND DISCUSSION

Respondent characteristics, UTI prevention and control bundles in the inpatient ward, urine culture results, and the impact of UTI prevention and control bundles on UTI incidence are all examples of the study's findings.

### A. Characteristics of Respondents

According to the findings, most of the respondents in the treatment group were in the productive age group, whereas most of the respondents in the control group were old. In both categories, the gender of the responders was evenly split between men and women. The treatment group had a majority of high school graduates (55%), while the control group had largely elementary school graduates (60%).

The respondent's occupation corresponds to their age and education level, with the majority of the treatment group working as private employees (60%) and the majority of the control group not working (75%). The study's findings are listed in the table below:

TABLE I  
FREQUENCY DISTRIBUTION OF RESPONDENT CHARACTERISTICS

Characteristics	Treatment group		Control group	
	n	%	n	%
Age				
20-30 years	3	15	1	5
31-40 years old	7	35	0	0
41-50 years old	6	30	3	15
51-60 years old	2	10	5	25
> 60 years old	2	10	11	
Gender				
Male	10	50	7	35
Female	10	50	13	65
Education				
Primary school	3	15	12	60
Junior high school	0	0	2	10
Senior High School	11	55	6	30
Lecture	6	30	0	0
Profession				
Does not work	6	30	15	75
Entrepreneur	2	10	2	10
Private employees	12	60	2	10
Government employees	0	0	1	5

Respondent characteristics in general, all respondents are under the age of 60. It means that the age group of respondents in this study is not at a higher risk of developing a urinary tract infection (UTI) due to catheter implantation. According to Medina Martha's research published in 2019, urinary tract infection cases increase with patient age, especially if the patient is above 65 years old and female since instances are more usually discovered in females than males [9], [10]. According to a study, the prevalence rate of urinary tract infections has increased in older women over 65. This occurs due to the repeated insertion of urinary catheters, a healthcare procedure that makes pathogen transmission to the urinary system easier [9]. Urinary tract infections are influenced by age, female gender, little amounts of alcohol consumed, infrequent urination, a history of diabetes mellitus, and urinary tract blockage [11], [12], [8].

#### B. UTI Prevention and Control Bundles in the Inpatient Ward

All patients in the treatment group will be treated by nurses trained to perform catheter insertion, catheter maintenance, and catheter removal according to the management provided in the UTI bundles created to meet hospital requirements. Meanwhile, the response group that did not receive therapy will be regularly seen by the same nurse. Hand hygiene was practiced 60-75% of the time, aseptic technique during insertion was practiced 35% of the time, routine urethral meatus care was practiced 25% of the time, and personal urinals were used practiced 25% of the time.

TABLE II  
FREQUENCY DISTRIBUTION OF UTI PREVENTION AND CONTROL BUNDLES IN THE INPATIENT WARD

Implementation of the Bundles	Treatment group		Control group	
	n	%	n	%
<b>Catheter insertion</b>				
Hand hygiene	20	100	15	75
Meatus hygiene	20	100	10	50
The sterile urine catheter set	20	100	0	0
Aseptic technique	20	100	7	35
Fill balloons according to manufacturer's recommendations	20	100	20	100
Fixation well	20	100	20	100
<b>Catheter care</b>				
Hand hygiene during catheter manipulation	20	100	12	60
Empty the urine bag regularly / shift	20	100	16	80
Urine bag under the bladder	20	100	20	100
The urine bag does not touch the floor	20	100	20	100
Perform urethra/shift meatus	20	100	5	25
Check the hose as often as possible not to fold (kingking)	20	100	15	75
Each patient has his own urinal and is routinely cleaned daily	20	100	5	25
<b>Removing the catheter</b>				
Hand hygiene	20	100	12	60
Remove the patient's catheter as indicated	20	100	20	100
Remove the liquid first from the balloon	20	100	20	100
Balloon is empty	20	100	20	100

In order to prevent and control catheter related UTIs, appropriate management or treatment is a viable alternative. This begins with the practice of hand cleanliness before taking action, such as catheter care and catheter removal, to prevent germ transfer from the hands to the patient's urinary system. Hand hygiene for every nursing action at a hospital can help to limit the number of infections caused by health workers' negligence. Because they have more frequent cross-contact with patients, health personnel play the most important role in spreading harmful microorganisms. Unclean hands used during catheter manipulation or catheter placement are one of the most common sources of bacterial colonization in the urinary system[13].

In this study, the behavior of maintaining hand hygiene and performing aseptic techniques was found to be lacking, as evidenced by an audit using UTI bundles, which found 7 respondents (35%) for catheter insertion measures (35%) and 12-15 respondents (60-75%) for hand washing. It is practically identical to K. M. Jones's study on nurse hand hygiene awareness and consistency, which found that only 45% of nurses know of hand hygiene, and only 36% wear gloves during urinary catheter insertion [13].

UTI is linked to genital hygiene, where individuals who do not clean their genital area on a regular basis are more likely to get urinary tract infections because germs remaining in the genital area can spread to the urinary system. In patients with indwelling catheters, genital hygiene is often overlooked and dismissed. Only 5 responders (25%) in this study were in the

control group, who exercised genital hygiene on a regular basis.

Patients can collaborate with nurses to make decisions about their urinary catheters and do something about their personal hygiene that they can do themselves. Patients may believe that urine catheterization is a personal concern because it is linked to self-image and sexuality. Thus, nurses must establish a reciprocal trusting connection with patients so that they may be open with them. In this instance, the patient should be able to check his urine, communicate his symptoms, and take an active role in maintaining the cleanliness of his genitalia in order to limit the risk of CAUTI [14].

Inserting a catheter carries a significant risk of introducing germs into the urinary tract. The Use of sterile instruments can create this, but it can also be caused by the nurse's negligence or lack of respect for sterile principles. The Use of a sterile urinary catheter set is required for the prevention and control of bundle UTIs, according to the theory. Staff may have difficulty inserting a catheter tube because the patient's bodily state is weak or the patient is less cooperative, resulting in less sterile actions during catheter insertion. Other considerations may include, for example, the patient's age or other contributing factors.

Based on the results of observations made during the study, the control group's implementation of actions related to urinary catheter placement was not carried out adequately. This is due to the fact that this hospital has not implemented the UTI prevention and control bundle. As a result, it is critical to developing a strategy that requires catheter placement to follow the UTI prevention and control bundle's principles.

### C. Urine Culture Results

Before inserting a urinary catheter, all individuals participating in this study will have their urine culture checked. The urine culture revealed that the patient had no substantial bacterial growth. Urine culture was re-examined as an indicator of urinary tract infection due to bacterial colonization 72 hours after indwelling catheter implantation in the two research groups.

The urine culture results in the treatment group showed that the patient's urine contained no significant bacterial growth. This demonstrates that using UTI bundles to prevent CAUTI is effective. While the growth of bacteria in the control group was generally *Candida albicans* > 10<sup>5</sup> CFU/ml, as many as four responders were discovered to have *Candida albicans* > 10<sup>5</sup> CFU/ml (20%). One respondent (5%) had *Escherichia coli* > 10<sup>5</sup> CFU/ml, and another (5%) had *Staphylococcus aureus* 10<sup>5</sup> CFU/ml.

The following table shows the results:

TABLE III  
URINE CULTURE RESULTS DISTRIBUTION IN THE CONTROL GROUP

No.	pre-test	post-test
1	No bacterial	No bacterial
2	No bacterial	No bacterial
3	No bacterial	No bacterial
4	No bacterial	<i>Staphylococcus aureus</i> < 10 <sup>5</sup> CFU/ml
5	No bacterial	No bacterial
6	No bacterial	<i>Candida albicans</i> > 10 <sup>5</sup> CFU/ml
7	No bacterial	No bacterial
8	No bacterial	No bacterial
9	No bacterial	<i>Candida albicans</i> > 10 <sup>5</sup> CFU/ml

No.	pre-test	post-test
10	No bacterial	No bacterial
11	No bacterial	<i>Candida albicans</i> > 10 <sup>5</sup> CFU/ml
12	No bacterial	<i>Candida albicans</i> > 10 <sup>5</sup> CFU/ml
13	No bacterial	<i>Escherichia coli</i> > 10 <sup>5</sup> CFU/ml
14	No bacterial	No bacterial
15	No bacterial	No bacterial
16	No bacterial	No bacterial
17	No bacterial	No bacterial
18	No bacterial	No bacterial
19	No bacterial	No bacterial
20	No bacterial	No bacterial

Enteropathogenesis, such as *E. coli*, *Staphylococcus aureus*, and *Klebsiella* spp., are the most prevalent bacteria that cause catheter-related UTIs [15]. Furthermore, some studies show identical results, such as the urine culture test, which revealed that gram-negative organisms accounted for 89.2 % of the bacteria, *Candida* species 5.6 %, and gram-positive organisms 5.2 %. The presence of germs greater than 10<sup>5</sup> CFU/ml is a sign of urinary tract infection [16]. The most microorganisms detected in urine culture tests in patients with urinary tract infections at RSUP DR Soetomo were *E. coli* and *K. pneumonia* [3]. According to the findings of a study including 541 UTI patients, the most common pathogens were gram-negative bacteria, specifically *E. coli* (53.5%) [17], [18].

According to the results of microbiological tests published in a study journal in 2019, the development of germs was checked twice. On the third and third day-5, bacterial growth was identified in 11 urine samples from 100 critical care unit patients. 63.6 % *Enterococcus faecalis* [19]. CAUTI cases were 3.2 per 1000 catheters/day of 330 patients sampled before the installation of bundle UTI prevention, according to the findings of a hospital study [20].

The case then improved after the intervention, in which the catheter was placed under the UTI bundle. The decrease in instances was considerable, with 1.36 cases per 1000 catheters daily. *Candida* was the most common microbe detected in this study's culture findings, followed by *E. coli* [20]. Almost identical to the findings of this study, namely the growth of *Candida*, *Staphylococcus aureus*, and *Escherichia coli* in the urine following catheter placement and urine culture.

### D. The effectiveness of UTI Prevention and Control Bundles on UTI incidence

The table below shows the results of statistical analysis tests to determine the effectiveness of UTI bundle management against CAUTI.

TABLE IV  
EFFECTIVENESS OF UTI PREVENTION AND CONTROL BUNDLES ON CAUTI IN INPATIENTS

Group	Mean	Std. Deviation	T	95% CI of the Difference		p
				Lower	Upper	
Treatment	0.00	0.000	-	-0.451	-0.049	0.000
Control	0.25	0.444	-	-0.458	-0.042	
			2.517			

The findings of the analysis utilizing the independent sample t-test revealed that UTI prevention and control bundles had a significant influence on the incidence of UTI owing to catheter insertion, with a p-value of 0.000 (p < 0.05).

This is supported by the findings of a study that examined 51 people and showed that 12 (23.5%) had urinary tract infections. This problem emerges due to nurse noncompliance with standard operating procedures (SOP) for catheter placement. Because health workers do not understand the catheterization protocol, it is important to facilitate clinicians with standard urine catheterization procedures. A consistent catheterization protocol will help patients receive safe and high-quality care in the hospital [21], [22].

Another study found that using UTI bundles helped avoid CAUTI [23], which is consistent with the findings of this one. CAUTI can be avoided by ensuring nurse compliance with UTI Bundle management or the established protocol, which includes installing a catheter according to indications to minimize its installation, using aseptic techniques when inserting a urinary catheter, maintaining a catheter during installation, and evaluating and auditing nurses while the catheter is in the patient [24], [25]. Research conducted at various hospitals reported that facilities that applied the CAUTI prevention protocol had an 83 percent drop in incidence from 2013 to 2017 [26], [27]. The knowledge, attitudes, and abilities of nurses involved in the execution of bundle management impact CAUTI prevention [28].

The collaboration of relevant care providers, including doctors, nurses, and students, is unavoidable in implementing bundle management. As a result, it is critical to strengthen communication and collaboration among healthcare professionals, particularly nursing students who directly offer nursing care to patients, to establish collaborative competency among students. This will reduce errors in catheterization treatment for patients [29].

CAUTI cases occur as a result of the catheterization process, which is not good while the patient is hospitalized. Evaluation and monitoring from leaders such as the head of the room/IPCN/quality and patient safety section, as well as improving the skills of implementing nurses and nurses' motivation, including high awareness of nurses, will support the prevention of increasing CAUTI cases. The hospital's management must improve nurses' knowledge and motivation in avoiding and identifying UTIs [30], [31].

#### IV. CONCLUSION

Based on the study's results, it can be stated that using UTI bundles in hospitals is a highly successful way of preventing and controlling urinary tract infections. Based on the study's findings, it can be stated that using UTI bundles to prevent and control urinary tract infections caused by catheter placement in inpatients at the USU Hospital is significantly beneficial. After the initial socialization, it is intended that more studies will be able to monitor and assess the application of the UTI Bundles. Because good attitudes, motivation, and behavior significantly impact a commitment to UTI bundle implementation.

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- [1] A. C. Use *et al.*, "Urinary Tract Infection (Catheter-Associated Urinary Tract Infection [CAUTI] and Non-Catheter-Associated Urinary Tract Infection [UTI]) Events Definitions :," no. January, pp. 1–18, 2022.
- [2] S. H. Ardehali, M. Sedaghatmanesh, and A. Fatemi, "The Role of Foley Catheter Coated with Gold, Silver, and Palladium in Decreasing Urinary Tract Infections in the Intensive Care Unit; a Letter to Editor," *Arch. Acad. Emerg. Med.*, vol. 7, no. 1, p. e40, 2019, doi: 10.22037/aaem.v7i1.432.
- [3] H. Hariati, D. E. Suza, and R. Tarigan, "Risk factors analysis for catheter-associated urinary tract infection in medan, Indonesia," *Open Access Maced. J. Med. Sci.*, vol. 7, no. 19, pp. 3189–3194, 2019, doi: 10.3889/oamjms.2019.798.
- [4] J. Alam, P. K. Verma, S. Kala, and V. Rawat, "Incidence and Microbiology of Catheter Associated Urinary Tract Infection in Hospitalized Patients in a Tertiary ... Incidence and Microbiology of Catheter Associated Urinary Tract Infection in Hospitalized Patients in a Tertiary Care Hospital in Kumaon R," *Int. J. Res. Rev.*, 2020.
- [5] K. Ramakrishnan, J. Venugopal, J. M. Easow, and M. Ravishankar, "Incidence, bacteriological profile and antibiotic resistance pattern of catheter associated urinary tract infections in a tertiary care hospital," *J. Pure Appl. Microbiol.*, vol. 13, no. 3, pp. 1549–1554, 2019, doi: 10.22207/JPAM.13.3.27.
- [6] S. M. Sofar and D. Y. Wazqar, "Nurses' Knowledge and Practices Toward Prevention of Catheter-Associated Urinary Tract Infection At King Abdulaziz University," *J. Heal. Med. Nurs.*, vol. Vol.4, no. Issue 1 No.4, p. pp 39-62, 2019.
- [7] A. Gomila *et al.*, "Clinical outcomes of hospitalised patients with catheter-associated urinary tract infection in countries with a high rate of multidrug-resistance: The Combacte-Magnet Rescuing study," *Antimicrob. Resist. Infect. Control*, vol. 8, no. 1, pp. 1–8, 2019, doi: 10.1186/s13756-019-0656-6.
- [8] F. Majdalawi, "Erase CAUTI: Catheter Associated Urinary Tract Infection Bundle Implementation," 2020, <http://hdl.handle.net/10755/21306>.
- [9] M. Medina and E. Castillo-Pino, "An introduction to the epidemiology and burden of urinary tract infections," *Ther. Adv. Urol.*, vol. 11, pp. 3–7, 2019, doi: 10.1177/1756287219832172.
- [10] M. Gajdács, M. Ábrók, A. Lázár, and K. Burián, "Increasing relevance of Gram-positive cocci in urinary tract infections: a 10-year analysis of their prevalence and resistance trends," *Sci. Rep.*, vol. 10, no. 1, pp. 1–11, 2020, doi: 10.1038/s41598-020-74834-y.
- [11] A. Hailay, K. Zereabruk, G. Mebrahtom, W. Aberhe, and D. Bahrey, "Magnitude and Its Associated Factors of Urinary Tract Infection among Adult Patients Attending Tigray Region Hospitals, Northern Ethiopia, 2019," *Int. J. Microbiol.*, vol. 2020, 2020, doi: 10.1155/2020/8896990.
- [12] O. Storme, J. Tirán Saucedo, A. Garcia-Mora, M. Dehesa-Dávila, and K. G. Naber, "Risk factors and predisposing conditions for urinary tract infection," *Ther. Adv. Urol.*, vol. 11, p. 175628721881438, 2019, doi: 10.1177/1756287218814382.
- [13] K. M. Jones, J. Mantey, and L. Mody, "Current Practices in Infection Prevention: A 3-year Survey of Michigan Nursing Homes' Urinary Tract Infection Prevention Strategies," *Am. J. Infect. Control*, vol. 49, no. 6, p. S7, 2021, doi: 10.1016/j.ajic.2021.04.028.
- [14] A. Waskiewicz, O. Alexis, and D. Cross, "Supporting patients with long-term catheterisation to reduce risk of catheter-associated urinary tract infection," *Br. J. Nurs.*, vol. 28, no. 9, pp. S4–S17, 2019, doi: 10.12968/bjon.2019.28.9.S4.
- [15] L. M. Weiner-Lastinger *et al.*, "Antimicrobial-resistant pathogens associated with adult healthcare-associated infections: Summary of data reported to the National Healthcare Safety Network, 2015–2017," *Infect. Control Hosp. Epidemiol.*, vol. 41, no. 1, pp. 1–18, 2020, doi: 10.1017/ice.2019.296.
- [16] I. Dadzie, E. Quansah, M. Puopelle Dakorah, V. Abiade, E. Takyi-Amuah, and R. Adusei, "The Effectiveness of Dipstick for the Detection of Urinary Tract Infection," *Can. J. Infect. Dis. Med. Microbiol.*, vol. 2019, 2019, doi: 10.1155/2019/8642628.
- [17] V. Folliero *et al.*, "Prevalence and antimicrobial susceptibility patterns of bacterial pathogens in urinary tract infections in university hospital of campania' luigi vanvitelli' between 2017 and 2018," *Antibiotics*, vol. 9, no. 5, pp. 1–9, 2020, doi: 10.3390/antibiotics9050215.
- [18] J. Quan *et al.*, "Etiology and prevalence of ESBLs in adult community-onset urinary tract infections in East China: A prospective multicenter

- study," *J. Infect.*, vol. 83, no. 2, pp. 175–181, 2021, doi: 10.1016/j.jinf.2021.06.004.
- [19] L. Rodriguez-Mañas, "Urinary tract infections in the elderly: A review of disease characteristics and current treatment options," *Drugs Context*, vol. 9, pp. 1–8, 2020, doi: 10.7573/DIC.2020-4-13.
- [20] F. Dehghanrad, Z. Nobakht-e-Ghalati, F. Zand, S. Gholamzadeh, M. Ghorbani, and V. Rosenthal, "Effect of instruction and implementation of a preventive urinary tract infection bundle on the incidence of catheter associated urinary tract infection in intensive care unit patients," *Electron. J. Gen. Med.*, vol. 16, no. 2, 2019, doi: 10.29333/ejgm/94099.
- [21] C. Davis, "Catheter-associated urinary tract infection: signs, diagnosis, prevention," *British journal of nursing*, vol. 28, no. 2, 2019.
- [22] G. H. Ahmed and G. A. Shehata, "Effect of Catheter Care Maintenance Bundle on Reducing Incidence of Urinary Tract Infection among Catheterized Patients," *American Journal of nursing Research*, vol. 8, no. 4, 477-482, June, 2020, doi: 10.12691/ajnr-8-4-8.
- [23] M. N. VC, M. M., & Anitha, "Effectiveness of Nursing Care Bundle on Prevention of Catheter Associated Urinary Tract Infection (CAUTI) among Patients with Indwelling Catheter at," *IJISET*, vol. 8, no. 5, pp. 77–83, 2021.
- [24] P. Yeung, "Quality of Long-Term Care for Older People in Residential Settings – Perceptions of Quality of Life and Care Satisfaction From Residents and Their Family Members," *Nurs. Prax. New Zeal.*, vol. 33, no. 1, pp. 28–43, 2019, doi: 10.36951/ngpxnz.2019.004.
- [25] M. Wanat *et al.*, "Optimising interventions for catheter-associated urinary tract infections (Cauti) in primary, secondary and care home settings," *Antibiotics*, vol. 9, no. 7, pp. 1–13, 2020, doi: 10.3390/antibiotics9070419.
- [26] S. G. Van Decker, N. Bosch, and J. Murphy, "Catheter-associated urinary tract infection reduction in critical care units: a bundled care model," *BMJ Open Qual.*, vol. 10, no. 4, p. e001534, 2021, doi: 10.1136/bmjopen-2021-001534.
- [27] Y. C. Yap, M. I. Zakaria, S. Ponnampalavanar, and M. K. Bador, "an Interventional Study To Improve the Emergency Department Catheter Associated Urinary Tract Infection: Evidence From a Tertiary Center," *J. Heal. Transl. Med.*, vol. 25, no. 1, pp. 44–56, 2022, doi: 10.22452/jummec.vol25no1.8.
- [28] P. Balu *et al.*, "Assessment of knowledge, attitude and practice on prevention of catheter-associated urinary tract infection (CAUTI) among health care professionals working in a tertiary care teaching hospital," *J. Pure Appl. Microbiol.*, vol. 15, no. 1, pp. 335–345, 2021, doi: 10.22207/JPAM.15.1.28.
- [29] R. E. Nurhidayah and H. Revi, "Readiness of ward for implementation inter professional education in Universitas Sumatera Utara Hospital," *Enferm. Clin.*, vol. 31, pp. 560–563, 2021, doi: 10.1016/j.enfcli.2021.04.011.
- [30] L. F. Jones *et al.*, "Development of an information leaflet and diagnostic flow chart to improve the management of urinary tract infections in older adults: A qualitative study using the Theoretical Domains Framework," *BJGP Open*, vol. 4, no. 3, pp. 1–11, 2020, doi: 10.3399/bjgpopen20X101044.
- [31] Z. Ahmadi, M. Shamsi, N. Roozbahani, and R. Moradzadeh, "The effect of educational intervention program on promoting preventive behaviors of urinary tract infection in girls: A randomized controlled trial," *BMC Pediatr.*, vol. 20, no. 1, pp. 1–10, 2020, doi: 10.1186/s12887-020-1981-x.