AN INTERVENTIONAL STUDY TO IMPROVE THE EMERGENCY DEPARTMENT CATHETER ASSOCIATED URINARY TRACT INFECTION: EVIDENCE FROM A TERTIARY CENTER

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Abstract

Background: The Emergency Department (ED) is the major entry point for patients admitted into the hospital. The continued use of urinary catheters from the ED is identified as a risk for patients to develop catheter associated urinary tract infection (CAUTI).

Objective: This study aimed firstly to identify the prevalence of ED-related CAUTI in our centre, University Malaya Medical Centre and the appropriateness of catheter use among all the cases. Secondly, to assess the impact of a urinary catheter care bundle E-learning training module on the rates of CAUTI and appropriate use of urinary catheter.

Method: A pre-post intervention study was conducted between June 2017 and April 2019. A retrospective analysis was conducted to assess the changes in infection rate before and after the training module. The urinary care bundle E learning tutorial module was developed, and all ED staff were trained using this module from September 2018 to November 2018. Outcome measures were the prevalence rate of ED-related CAUTI, the rate of appropriateness indication in urinary catheter insertion and the association between patient's characteristic and the rate of appropriateness in urinary catheterization.

Result: The CAUTI rates were significantly dropped from 17.04 per 1000 device days in pre-intervention period to 7.4 in post-intervention period (p=0.03).

Conclusion: An online training module on urinary catheter bundle effectively reduced CAUTIs but not improve the appropriate use of urinary catheter. Therefore, further study is needed to improve the rate of appropriateness in urinary catheter insertion.

Keywords: Catheter Associated Urinary Tract Infection (CAUTI), E-learning, Emergency Department (ED)

Introduction

Healthcare associated infections (HAIs) are the most frequent adverse event in current health-care delivery worldwide. Estimated up to 722,000 HAIs incidence in U.S. acute care hospital happened in 2011 and 75,000 patients with HAIs died during their hospitalization (1). HAIs not only caused prolong hospital stay, but also increased microorganism resistance toward antimicrobials and contribute to the additional financial burden to health systems (2).

Catheter associated urinary tract infections (CAUTI) is among the most common HAIs (3). For the past 50 years, there has been a drastic increase in the use of urinary catheters, despite the increased risk of bacterial colonization, chronic infection, septicaemia and the possibility of causing damage to the bladder and urethra

(4). In the National Healthcare Safety Network (NHSN) 2011 surveillance report, 45-79% of patients in adult critical care units had an indwelling catheter (5). Based on Centers for Disease Control and Prevention (CDC) Hospital Acquired Infection prevalence survey 2011, 93,300 urinary tract infections were estimated to have occurred in US acute care hospitals and 75% of the infections are from urinary catheter (6). CAUTI was the most prevalent hospital acquired infection among the US hospitals, and up to 65-70% of these cases are preventable (7).

Study shows Emergency Department (ED) has gradually become a major entry point for patients to be admitted into hospital (8). Within 24 hours of admission, 91% of the urinary catheters were from ED (9) and 64.5% of them were potentially avoidable (10). Prolonged catheterization for more than seven days is a risk for patient to develop CAUTI (11). Therefore, to reduce the rate of CAUTI, many centres have implemented different interventions such as: criteria for appropriate placement of urinary catheter, daily review of the necessity of urinary catheter and removal of urinary catheter before day seven. The result of these interventions has shown significantly reduce the rate of CAUTI (12, 13).

University Malaya Medical Center (UMMC) is a tertiary Klang Valley teaching centre with 1275-bed, receiving 4.5 million patients per annum. Yearly, the ED receives more than 120,000 visits, where 10% of the visiting patients were admitted via the ED. Currently, there is no available data on the prevalence of CAUTI in UMMC. Urinary catheters are often inserted in the ED for multiple reasons including acute urinary retention, for the measurement of urine output of critically ill patients and patients involved in trauma. The continued use of urinary catheters in the wards might become a risk for patients to develop CAUTI.

Therefore, the aim of this study was firstly to determine the prevalence rates of ED-related CAUTI and inappropriate insertion of urinary catheters in the Emergency Department. Secondly, to assess the impact of a urinary catheter care bundle E-learning training module on the rates of CAUTI and appropriate use of urinary catheter.

Methodology

Study setting

This study was conducted in the ED in UMMC. This ED has adopted a 3-tier triage system to allocate patient to different locations, such as: critical, semi-critical and non-critical zone, based on the severity of the patient's presentation. All patients are attended by the frontliner, which are the emergency physicians, medical officers, house officers, nurses, and medical assistance during their shift. Emergency Department is operating based on 3 shift systems: morning shift (8 am-3 pm); afternoon shift (3 pm-10 pm) and night shift (10 pm-8 am). The numbers of staffs in ED are equally distributed in each shift and zone.

Study design

This is an interventional study over 2 year-period. Intervention was carried out after baseline prevalence of ED-related CAUTI rate was identified. Post-intervention assessment was done straight after the intervention period with the aim to reduce prevalence of ED-related CAUTI.

Data collection

Through the electronic medical record (EMR), the pre-interventional and post-interventional ED-related CAUTIs were retrospectively identified based on all the positive urine culture samples taken during the study period which obtained from the microbiology lab (Figure 1).

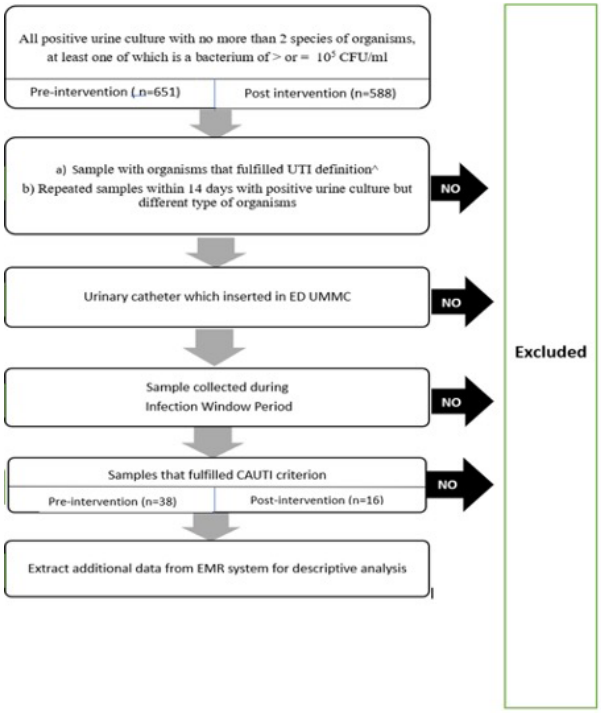

Figure 1: Overview of data collection process

Pre-intervention

The pre-intervention period was from January 2017 to March 2017. Baseline prevalence rate on ED-related CAUTI was identified without informing the participants.

Demographic data

Once ED-related CAUTIs are identified, patient's case note will be reviewed via EMR. Patient's characteristic are well recorded in the EMR. Age, gender, ethnicity and premorbid will be identified. Patient's presenting triage location, place where catheter is inserted, shift when patient's arrived ED and personnel who ordered catheterization will also be documented in patient's case note during their admission.

Etiological agents of CAUTI

In this study, all organisms that grow from the urine culture will be considered as a positive growth. However to prevent the overestimation of CAUTI rates, *Candida* species, yeast, mold, dimorphic fungi or parasites were excluded in this study. It is due to positive urine cultures with those organisms usually do not provide clinical benefit (14) and the true urinary tract infections that caused by them are rare (15).

Positive urine culture with more than 2 species of organisms in a single urine culture will be excluded in this study to reduce the possibility of contamination of the specimen. If the urine sample contained of 2 organisms of same genus but different species will consider as 2 organisms and if both organisms are same but different antimicrobial susceptibilities will consider as 1 organism. "Mixed flora" which means at least 2 organisms are present in the urine cultures will be excluded.

Personnel involved

All ED staffs including medical officers, house officers, nurses and medical assistants who work in UMMC Emergency Department, were trained using this module over 3 months period (from September 2018 to November 2018).

Intervention

In this study, we use an E-learning training module via Schoology® as an online teaching platform. The available hospital urinary catheter care bundle guideline and NHSN guidelines were used for this training. In the week prior to the implementation of this intervention, information session about this study was provided for all participants. Participants were asked to sign up Schoology® online account. No payment was needed and declaration of no conflict of interest was done during the sessions.

E- Bundle training

This module mainly emphasised on the importance of following the appropriate indication of urinary catheter insertion and alternatives to indwelling catheterization including; intermittent catheterization, external catheters, and suprapubic catheters based on HICPAC guideline (16) (Supplementary data 1 & 2). The proper steps and technique of catheter insertion were demonstrated via video teaching. Urinary catheter insertion checklist also attached in the module (Appendix A). The videos were separately prepared by our nursing school, the principal college of health sciences (COHES) and UMMC urology department.

Pre-test and post-test assessments are included in this module. Participants are required to complete this E-training module once they sign in. At the end of this module, they will be rewarded with an online certificate. In view of this is a pilot study, therefore, it is a once- off course.

Post intervention

The post-intervention was from December 2018 to February 2019. The data collection process is same as pre-intervention.

Definition used during this study

The definition of catheter associated urinary tract infection is based on the NHSN guideline (Appendix B) (17), whereby both symptomatic CAUTI and catheter associated asymptomatic bacteraemia urinary tract infection (ABUTI) were included. Based on this guideline, patient diagnosed with CAUTI must have an indwelling urinary catheter for more than 2 days or the date of event falls on the first day after urinary catheter was removed. For symptomatic CAUTI, patient must have at least 1 sign or symptoms such as fever, suprapubic tenderness, costovertebral angle pain, dysuria and urinary urgency. Whereas, for catheter associated ABUTI, patient does not have any sign or symptom of UTI but the blood specimen and urine specimen must have at least 1 same bacterium or meets laboratory confirmed bloodstream infection criterion 2, where the organisms identified in the blood is not related to an infection at another site and the culture is identified from two or more blood specimens collected on separate occasions (18). Both urine cultures must not have more than 2 organisms identified and at least 1 of which is a bacterium of ≥ 105 CFU/ml and happened during the Infection Window Period. All uncommon uropathogen such as *Candida* species, yeast, mold, dimorphic fungi or parasites will be excluded.

The date of event is defined as the day when patient was diagnosed as CAUTI within the 7-day of Infection Window Period, where the Infection Window Period can be the date of first positive diagnostic test or first documented localized sign or symptom of UTI. In this study, ED-related CAUTI is defined as all CAUTI occurring in patients catheterized from ED in UMMC (17).

ED-related CAUTI per 1000 urinary catheter days were calculated by measuring each identified incident through the pre and post intervention divided by the number of catheter days for each study period, and then multiplying the result by 1000. Catheter utilization ratios for each period were calculated by dividing the number of catheter-days by the total number of patient-days. The proportion of unnecessary catheter days was calculated by dividing the total number of unnecessary catheter days by the total number of catheter-days between both periods.

Inclusion criteria

1. Patient aged 12 and above; because urinary catheter is not commonly used in children and the appropriateness guidelines address to adult, we only limit our analysis to patients with age greater than 12 years.
2. Positive urine cultures of all inpatients with or without signs and symptoms in UMMC hospital.

3. Patient who had an indwelling catheter for > 48 hour and all elements of the UTI criterion (Appendix C) and must occur during the infection window period.
4. Patient who received urinary catheter in ED.
5. Patients who diagnosed as CAUTI.

Exclusion criteria

1. Culture show organism not from the common uropathogen group.
2. The following excluded organisms cannot be used to meet the UTI definition (Appendix C):
   - *Candida* species or yeast not otherwise specified
   - Mold
   - Dimorphic fungi or
   - Parasites
3. Positive urine culture with more than 2 species of organisms.
4. Patients with diagnosis of UTI upon admission.
5. Patients who have indwelling urinary catheter from home.
6. All catheterizations with missing data or IUC duration less than 48 hours were deleted from the analysis.

Outcome measure

The primary outcome measure of this study was the rate of ED-related CAUTIs. The secondary outcome was the number of cases among all the ED-related CAUTIs which did not have a proper indication for urinary catheter insertion; and the third outcome was to assess the impact of this intervention.

Statistical analysis

Descriptive statistics were used to characterize the population into groups. Pearson Chi squared test was used to calculate p values for differences between proportion of gender, age, ethnicity, patient's comorbidity, triage location and shift when patient arrived. The prevalence of ED-related CAUTI rate, catheter utilization ratio and unnecessary catheter utilization percentage between the pre and post groups were compared using Fisher's exact test. For our analysis of inappropriate insertion of urinary catheters, we have performed a univariate analysis to summarize patients' demographic, clinical, and microbiologic characteristics. All statistical analysis was performed using IBM SPSS statistical package version 23.

Result

Primary outcome: the prevalence rate of ED-related CAUTIs

Data shows the total number of positive urine cultures in UMMC is 651 during the pre-intervention period. Out from 651, 38 were diagnosed having ED-related CAUTI. The baseline of the prevalence rate of ED–related CAUTI in this centre is 17.04 per 1000 device days in pre-intervention period.

Secondary outcome: the number of cases among all the ED-related CAUTIs which did not have a proper indication for urinary catheter insertion

During pre-intervention, out of 38 patients who diagnosed ED-related CAUTI, 10 patients were not having proper indication for urinary catheter insertion.

Third outcome: to assess the impact of the intervention

With the baseline prevalence of ED-related CAUTI and rate of inappropriateness indication in urinary catheter insertion, post intervention data was collected for comparison. The characteristics of patients audited in the pre-intervention and post-intervention period were demonstrated in Table 1. Both groups had similar age, gender, ethnicity, comorbidity, triage location, shift when patient presented to ED and person who order urinary catheter insertion. During post intervention period, the number of positive urine culture was 588, 16 of them were ED-related CAUTI. The CAUTI rates dropped significantly from 17.04 per 1000 device days in pre-intervention period to 7.4 in post-intervention period (p=0.03). Although the rate of ED-related CAUTI reduced significantly, the urinary catheter utilization ratio and the compliance of appropriate usage of urinary catheter have not statistically decrease after the intervention. These results are detailed in Table 2. The most common inappropriate indications for urinary catheters were measuring urine output in hemodynamically stable patients (50%). In Table 3, by the univariate logistic regression analysis, those who triage to semi-critical zone were 30 (95% CI, 5.510-163.347; p< 0.001) times as likely to be catheterize without appropriate indication.

Table 1: Patient's characteristics in pre-intervention and post-intervention period

	Pre-intervention, n=38 (%)	Post-intervention, n=16 (%)	P value
Age			
< 60 years old	15 (39.5)	6 (37.5)	0.892
≥ 60 years old	23 (60.5)	10 (62.5)	
Gender			
Female	17 (44.7)	6 (37.5)	0.623
Male	21 (55.3)	10 (62.5)	

Table 1: Patient's characteristics in pre-intervention and post-intervention period (continued)

	Pre-intervention, n=38 (%)	Post-intervention, n=16 (%)	P value
Ethnicity			
Malay	7 (18.4)	6 (37.5)	
Chinese	12 (31.6)	8 (50)	0.072
Indian	14 (36.8)	1 (6.3)	
Others	5 (13.2)	1 (6.3)	
Premorbid			
DM	17 (44.7)	2 (12.5)	0.24
HIV	0 (0)	0 (0)	UTC
Active / history of cancer	6 (15.8)	3 (18.8)	0.79
On immunosuppressant drug	0 (0)	1 (6.3)	0.12
Triage where catheter is inserted in ED			
Non-critical	1 (2.6)	0 (0.0)	0.743
Semi-critical	14 (36.8)	7 (43.8)	
Critical	23 (60.5)	9 (56.3)	
Shift when patients arrived ED			
AM	19 (50)	7 (43.7)	0.566
PM	14 (36.8)	5 (31.2)	
ON	5 (13.2)	4 (25)	
Personnel who ordered catheterization			
House officer	1 (2.6)	0 (0)	0.712
Medical officer	26 (68.4)	9 (56.25)	
Specialist	1 (2.6)	0 (0)	
Not recorded	10 (26.3)	7 (43.75)	

DM, Diabetes Mellitus; HIV, Human Immunodeficiency Virus; AM, Morning Shift (8 am – 3 pm); PM, Afternoon Shift (3 pm – 10 pm); ON, Night Shift (10 pm – 8 am); UTC, Unable to count

Table 2: Rates of ED-related CAUTI and the rate of appropriateness in urinary catheterization before and after implementation of a urinary catheter care bundle

	Pre-intervention (n= 651)	Post-intervention (n= 588)	P value
Catheter days	2230	2160	
Patient days	26136	25211	
Catheter utilization ratio	0.085	0.085	0.1991
ED-related CAUTI rate-incident CAUTI per 1000 catheter days (%)	17.04	7.4	0.03
ED-related CAUTI rate with inappropriate indication for catheterization % (n)	26.31 (10)	37.5 (6)	0.411

Table 3: Factors that associated with the risk of inappropriateness in urinary catheter insertion

	Appropriateness, n (%)	Inappropriateness, n (%)	OR (95% CI)	P value
Gender				0.911
Female	16 (42.1)	7 (43.8)	1.06 (0.329- 3.477)	
Male	22 (57.9)	9 (56.3)	1	
Age				
< 60 years old	15 (39.5)	6 (37.5)	0.92 (0.276-3.064)	0.892
≥ 60 years old	23 (60.5)	10 (62.5)	1	
Ethnicity				
Malay	11 (28.9)	2 (12.5)	1	0.133
Chinese	12 (31.6)	8 (50.0)	3.667 (0.636-21.147)	
Indian	9 (23.7)	6 (37.5)	3.667 (0.590-22.783)	
Others	6 (15.8)	0 (0.0)	UTC	
Triage location				
Non-critical	1 (2.6)	0 (0.0)	UTC	<0.001
Semi-critical	7 (18.4)	14 (87.5)	30.0 (5.510-163.347)	
Critical	30 (78.9)	2 (12.5)	1	
Personnel who ordered urinary catheter insertion				
House officer	1	0	1	0.712
Medical officer	26	9	559292688.5	
Specialist	1	0	UTC	
Shifts				
AM	15 (39.5)	11 (68.8)	1	0.125
PM	15 (39.5)	4 (25.0)	5.867 (0.637-53.999)	
ON	8 (21.1)	1 (6.3)	2.133 (0.203-22.444)	
Post-intervention				
Training status				
Untrained	4 (57.1)	2 (40.0)	0.5 (0.049-5.154)	0.558
Trained	3 (42.9)	3 (60.0)	1	

AM, Morning Shift (8 am – 3 pm); PM, Afternoon Shift (3 pm – 10 pm); ON, Night Shift (10 pm – 8 am); UTC, Unable to count

Epidemiology of ED-related CAUTI

There were 54 ED-related CAUTI events from this total population of patients with IUCs and without missing data. The median days for patients to develop ED-related CAUTI during pre-intervention phase is 11 days (interquartile range: 3-27) and post intervention phase is 24 days (interquartile range: 11-45).

There were no statistically significant differences identified in the median duration of developing CAUTI in term of age, gender and comorbidity (Table 4). The results indicate that female, diabetes patient and patients who are aged 60 and above were prone to develop CAUTI earlier.

Table 4: Median duration to develop CAUTI in each category

	Median (IQR)	P value
Gender		
Female	7 (2-40)	0.072
Male	15 (9-33)	
Age		
< 60 years old	14 (6-41)	0.315
≥ 60 years old	11 (3-31)	
Comorbidity DM		
Yes	11 (3-26)	0.26
No	14	
Active/ history of cancer		
Yes	12 (2.5 16.5)	0.569
No	14	

DM, Diabetes Mellitus

Microbiology of ED-related CAUTI

The majority of CAUTIs were caused by *E. coli* (n= 12, 22%), *Enterococcus faecalis* (n=8, 18%), *Pseudomonas aeruginosa* (n=7, 13%). Multiple drug resistant organisms (MDRO) were found in 18% of ED-related CAUTI cases between both periods. Number of MDRO cases did reduce during post intervention, but it was not found to be statistically significant (Table 5). Organisms that classified as MDRO are *Acinetobacter baumanii, Pseudomonas aeruginosa* and *Klebsiella pneumoniae.* In this study, no factor was found to be significantly associated with the incident of MDRO (Table 6).

Table 5: Changes in number of patients who developed MDRO between pre- and post-intervention phase

	MDRO	Non MDRO	OR (95% CI)	P value
Pre-intervention	14 (36.8%)	24 (63.2%)	1	0.07
Post-intervention	4 (25%)	12 (75%)	0.571 (0.154- 2.117)	

MDRO, Multiple drug resistant organisms

Table 6: Association of factors with the risk of MDRO

	MDRO	No MDRO	OR (95% CI)	P value
Gender				
Female	7	16	0.749 (0.232-2.418)	0.697
Male	11	20	1	
Age				
< 60 years old	6	15	0.669(0.202-2.222)	0.554
≥ 60 years old	12	21	1	
Ethnicity				
Malay	3	10	1	0.363
Chinese	5	15	1.032 (0.189-5.643)	
Indian	7	8	3.36 (0.617- 18.294)	
Others	3	3	3.798 (0.462-31.194)	

Table 6: Association of factors with the risk of MDRO (continued)

	MDRO	No MDRO	OR (95% CI)	P value
Comorbidity DM				
Yes	7	12	1.119 (0.326-3.843)	0.687
No	11	24	1	
Active/ history of cancer				
Yes	3	6	2.288 (0.388-13.502)	1.0
No	15	30	1	
Patient on immunosuppressive drug				
Yes	0	1	UTC	0.475
No	18	35	1	
Triage Location				
Non-critical	1	0	UTC	0.357
Semi-critical	7	14	1.100 (0.340-3.564)	
Critical	10	22	1	

MDRO, Multiple drug resistant organisms; DM, Diabetes Mellitus; UTC, Unable to count

Discussion

This study addressed the need of intervention over the prevalence of ED- related CAUTI and the appropriateness in urinary catheter insertion in this centre. Aligning with the emphasis on improving patient safety and care, this study will evaluate the effectiveness of E-training module to reduce ED-related CAUTI rate and incidents of inappropriate usage of urinary catheter. The end goal objective is the prevention of ED-related CAUTI which lead to better patient outcome.

By using this online training module, the ED-related CAUTI rate significantly reduced post intervention. Many studies have shown the impact of evidence-based intervention on reduced rates of CAUTI in different settings (19). For example, Meddings *et al.,* have successfully reduced 53% of CAUTI rate by using a reminder or stop order for urinary catheter placement based on HICPAC urinary catheter indication list (20). Most of the studies were conducted by using face to face teaching. However, this current study has shown that using an online training module can also reduce the ED-related CAUTI rate.

In this study, the rate of inappropriate use of urinary catheter and the catheter utilization rate remained the same after the intervention despite the rate of ED-related CAUTI dropped significantly. This finding corresponds to the study done by Davis and colleagues in the paediatric population, whereby the catheter utilization rate remained at 0.12 before and after implementation with a 50% reduction in infection rate (21). There was another study which emphasised on nursing education to decrease CAUTI also failed to improve the catheter utilization rate despite dropped in CAUTI rate (22). However, other studies had shown a linear reduction between the rates of CAUTI and urinary catheter utilization (23-26). Various studies have shown the significant association between the reduction

in catheter utilization rate and the increase in compliance to appropriate use of urinary catheter (22, 27).

There may be various reasons for this. Based on CDC guidelines, the risk for patient to develop CAUTI are multifactorial. The rate of ED-related CAUTI, are not only influenced by reduction of inappropriate catheterization, but also the technique of urinary catheter insertion, the days of indwelling catheter as well as continuously maintaining unobstructed urine flow during admission (17). In this study, not only educate all ED staff with the knowledge on appropriate indications of urinary catheter insertion, but also trained the staff on the proper technique of catheterization and catheter care. Therefore, the rate of ED-related CAUTI reduction may be due to improvement technique of catheter insertion and maintenance. This study is a pilot study and it is a one-off course for all staffs. Knowledge and skill retention might deteriorate over the months. Therefore, continuous reassessment might be needed in the future to reduce the rate.

In Fakih *et al.,* study, ED catheterization patient's mean age was 63.4 ± 22.0 years and those without an indication, the mean age was 71.3± 18.8 years (28). Holroyd-Leduc *et al.,* found that one third of the hospitalized patients aged of 85 years or older received urinary catheter were unnecessary (29). In this study, the mean age of those who catheterized was 60.50±19.96 years old and the mean age of those without appropriate indication was 64.38±19.986 years old. There was a study showed, the most common reason that lead to inappropriate urinary catheter insertion among older patients are convenience of care and urine specimen collection. Elder patients who presented with chronic constipation, cognitive impairment, ADL dependent were likely to undergo inappropriate urinary catheterisation. In their study also pointed out some of the nurses may request a physician order for a urinary catheter in order to reduce their toileting workload (30). This may find in our department as well.

Elderly patients have higher incidence of HAIs when compared to younger patients. A study showed the age of more than 90 years old were independent risk factors for CAUTI and the chances of receiving urinary catheter are much higher in older age (31). In our study, patients who aged 60 and above, developed CAUTI 3 days earlier than those who are below 60. However, it is not statistically significant. Otherwise, study did not show the significant association between age and inappropriate catheterization.

Triage location is found to have strong association with the inappropriate catheter insertion rate. Patient who triage to semi critical zone were more likely to be prescribed urinary catheter without proper indication by their treating doctor. The explanation for this could be, UMMC emergency department have adopted a 3 tier triage system based on the severity of the patient's presentation. Patient who triaged to the semi critical and critical zone, are often critically ill or at increased risk for deterioration and require interventions. Based on Gould *et al.*, critically ill patients who require urinary catheterization are those who are hemodynamically unstable, patients who are on neuromuscular blockade and those with desaturation during exertion or position change (16). Most of the critically ill patients who fulfil the above criteria will be triage to critical zone and therefore would have been catheterized appropriately. However, since there is no similar definition for semi critical patients, the patients who were triaged to the semi critical zone were probably more likely to be catheterized inappropriately. However, in our study, we did not ascertain the actual reason of inappropriate catheterization.

Based on the epidemiology of patients, the median duration for female to develop CAUTI is 2 times earlier than male patient (7 days vs 14 days, (IQR 2-40)). Many studies showed female and age are the independent risks for patients to develop CAUTI (32-34). It might due to short urethra in female. A study conducted in a single centre ICU, has shown the patients with diabetes were 4.55 ($p< 0.001$) times higher risk than those who without (35). The greater comorbidities were found to have significant association with the inappropriate urinary catheterization (36). This study found similar results for those with diabetes and cancer have developed CAUTI in a shorter time when compare with those who are not.

CAUTI incidence is significantly related to the physicians' perception on practicing CAUTI prevention which includes the knowledge on the risk factors which contribute to CAUTI and the frequency of training on proper catheterization (37). The number of CAUTI incident with inappropriate use of urinary catheter among emergency physician, medical officers and house officers were analysed in this study. In theory, emergency physicians and medical officers should have more awareness on CAUTI prevention when compares to house officers. However in this study, most of the urinary catheters were ordered by the medical officers. Thus, we were unable to associate the correlation between seniority and the risk of inappropriate insertion of urinary catheter.

Out of five inappropriate insertion of urinary catheter insertions during post intervention phase, 2 are inserted by other department, which consider as untrained personnel. There was no statistical significant difference among trained and untrained staff in appropriateness catheterization. It might due to our study sample size was small.

Male gender and presence of indwelling urinary catheter have been found to be predictors of developing multidrug-resistant gram-negative bacteria (38). Most likely due to small sample size, this study did not find any factor which is significantly associated with the incident of multidrug-resistant organism. As much as 50% of nosocomial acquired UTIs which included catheter associated urinary tract infection are caused by *E.coli* (39). Similarly in this study, most of the catheter associated urinary tract infections are caused by *E.coli* as well.

Strengths

This intervention study was done via online platform, exploring the potential of E-learning in reducing the rate

of infection. The participants are not required to gather in one place to complete the module, this provide the flexibility for participants especially for those who working in shift system. Additionally, during this COVID pandemic period, this method can become a good tool for centres to educate their staffs.

Limitations

Unfortunately, this study has several limitations. Firstly, the reduction of ED-related CAUTI in this study, maybe affected by other factors such as other clinical parameters that would not be able to assess due to it is a retrospective study; however, to our knowledge, there was no change in the hospital protocol on urinary catheter care or compliance in hand hygiene and environmental and equipment cleaning. During the pre-intervention phase, some cases with missing data were excluded. However, in the post-intervention phase, due to the re-enforcement on important of proper documentation, data for all cases that diagnosed ED-related CAUTI events were able to be retrieved. Second, this is a single centre, the finding might not be generalized to other hospitals. Third, due to the small sample size, this study was unable to show any significant impact from patient's demographic and clinical on the rate of inappropriate catheterization. Fourthly, this study is a one-off course may result with lesser impact.

Conclusion

Patients who presents to the emergency department have a significant risk to be catheterize inappropriately and develop CAUTI later in the ward. There was a significant reduction in ED-related CAUTIs after introduction of a CAUTI care bundle E-learning training module for the ED staff.

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Ethics approval

This study has received ethics approval from UMMC Medical Research Ethics Committee (MREC) ID NO: 2017109-5666.

Informed consent

Verbal informed consent was taken from all the participants.

Competing interest

Authors declare no conflict of interest in this study.

References

1. Centers for Disease Control and Prevention. HAI Prevalence Survey. 2014. Available at: http://www.cdc.gov/hai/surveillance/. Accessed 18 April 2014.
2. World Health Organization. Health care-associated infections fact sheet. 2015. Available at: https://www.who.int/gpsc/country_work/gpsc_ccisc_fact_sheet_en.pdf. Accessed 10 December 2015.
3. Saint S. Clinical and economic consequences of nosocomial catheter-related bacteriuria. Am J Infect Control. 2000;28(1):68-75.
4. Lo E, Nicolle LE, Coffin SE, Gould C, Maragakis LL, Meddings J, *et al.* Strategies to prevent catheter-associated urinary tract infections in acute care hospitals: 2014 Update. Infect Control Hosp Epidemiol. 2014;35(5):464–79.
5. Dudeck MA, Horan TC, Peterson KD, Allen-Bridson K, Morrell G, Pollock DA, *et al.* National Healthcare Safety Network (NHSN) Report: Data summary for 2010, device-associated module. Am J Infect Control. 2011;39(10):798–816.
6. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, *et al.* Emerging infections program healthcare-associated infections and antimicrobial use prevalence survey team: Multistate point-prevalence survey of health care-associated infections. N Engl J Med. 2014;370(13):1198–208.
7. Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. Infect Control Hosp Epidemiol. 2011;32(2):101–14.
8. Schuur JD, Venkatesh AK. The growing role of emergency departments in hospital admissions. N Engl J Med. 2012: 367(5): 391–3.
9. Munasinghe RL, Yazdani H, Siddique M, Hafeez W. Appropriateness of use of indwelling urinary catheters in patients admitted to the medical service. Infect Control Hosp Epidemiol. 2001;22(10):647-9.
10. Schuur JD, Chambers JG, Hou PC. Urinary catheter use and appropriateness in U.S. emergency departments, 1995-2010. Acad Emerg Med. 2014;21(3):292-300.
11. Shapiro M, Simchen E, Izraeli S, Sacks TG. A multivariate analysis of risk factors for acquiring bacteriuria in patients with indwelling urinary catheters for longer than 24 hours. Infect Cont. 1984; 5(11):525–32.
12. Kanj SS, Zahreddine N, Rosenthal VD, Alamuddin L, Kanafani Z, Molaeb B. Impact of a multidimensional infection control approach on catheter-associated urinary tract infection rates in an adult intensive care

unit in Lebanon: International Nosocomial Infection Control Consortium (INICC) findings. Int J Infect Dis. 2013;17(9):e686-90.
13. Leblebicioglu H, Ersoz G, Rosenthal VD, Nevzat-Yalcin A, Akan ÖA, Sirmatel F, *et al.* Impact of a multidimensional infection control approach on catheter-associated urinary tract infection rates in adult intensive care units in 10 cities of Turkey: International Nosocomial Infection Control Consortium findings (INICC). Am J Infect Control. 2013;41(10):885–91.
14. Sobel JD, Kauffman CA, McKinsey D, Zervos M, Vazquez JA, Karchmer AW, *et al.* Candiduria: a randomized, double-blind study of treatment with fluconazole and placebo: National Institute of Allergy and Infectious Diseases (NIAID) Mycoses Study Group. Clin Infect Dis. 2000;30(1):19-24.
15. Kauffman CA, Vazquez JA, Sobel JD, Gallis HA, McKinsey DS, Karchmer AW, *et al.* Prospective multicenter surveillance study of funguria in hospitalized patients. Clin Infect Dis. 2000;30(1):14-8.
16. Gould CV, Umscheid CA, Agarwal RK, Kuntz G, Pegues DA. Guideline for prevention of catheter-associated urinary tract infections 2009. Infect Control Hosp Epidemiol. 2010;31(4):319-26.
17. Centers for Disease Control and Prevention. Urinary tract infection (catheter-associated urinary tract infection [CAUTI] and non-catheter-associated urinary tract infection [UTI]) and other urinary system infection [USI]) events. 2015. Available at: http://www.cdc. gov/nhsn/PDFs/pscManual/7pscCAUTIcurrent. Accessed 15 Nov 2021.
18. Centers for Disease Control and Prevention. Bloodstream infection event (central line-associated bloodstream infection and non-central line-associated bloodstream infection). 2017. Available at: https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf. Accessed 15 Nov 2021.
19. Taha H, Raji SJ, Khallaf A, Abu Hija S, Mathew R, Rashed H, *et al.* Improving catheter associated urinary tract infection rates in the medical units. BMJ Qual Improv Rep. 2017;6(1):u209593.
20. Meddings J, Rogers MAM, Krein SL, Fakih MG, Olmsted RN, Saint S. Reducing unnecessary urinary Catheter use and other strategies to prevent catheter-associated urinary tract infection: An integrative review. BMJ Qual Saf. 2014;23(4):277-89.
21. Davis KF, Colebaugh AM, Eithun BL, Klieger SB, Meredith DJ, Plachter N, *et al*. Reducing catheter-associated urinary tract infections: A quality-improvement initiative. Pediatrics. 2014;134(3):e857–64.
22. Gordon PR. The effects of nursing education on decreasing catheter associated urinary tract infection rates. ScholarWorks. 2015. Available at: http://scholarworks.waldenu.edu/dissertations. Accessed 4 April 2019.
23. Titsworth WL, Hester J, Correia T, Reed R, Williams M, Guin P, *et al*. Reduction of catheter-associated urinary tract infections among patients in a neurological intensive care unit: a single institution's success. J Neurosurg. 2012;116(4):911-20.
24. Fakih MG, Watson SR, Greene MT, Kennedy EH, Olmsted RN, Krein SL, *et al*. Reducing inappropriate urinary catheter use: A statewide effort. Arch Intern Med. 2012;172(3):255-60.
25. Moss M, Koll B, Tanafranca A, Barnett B, Amato-Hayes M, Williamson L, *et al*. Reduction in CAUTI and urinary catheter utilization rates on a medical unit and a respiratory step down Unit. Open Forum Infect Dis. 2015;2(1):288.
26. Bunch M. Sustained reduction of Catheter Associated Urinary Tract Infection (CAUTI) rate in a Long-Term Acute Care Setting (LTAC). Am J Infect Control. 2018;46(6):S75-6.
27. Blondal K, Ingadottir B. Einarsdottir H, Bergs D, Steingrimsdottir I, Steindorsdottir S, *et al.* The effect of a short educational intervention on the use of urinary catheters: A prospective cohort study. Int J Qual Health Care. 2016;28(6):742-8.
28. Fakih MG, Shemes SP, Pena ME, Dyc N, Rey JE, Szpunar SM, *et al.* Urinary catheters in the emergency department: Very elderly women are at high risk for unnecessary utilization. Am J Infect Control. 2010;38(9):683-8.
29. Holroyd-Leduc JM, Sands LP, Counsell SR, Palmer RM, Kresevic DM, Landefeld CS. Risk factors for indwelling urinary catheterization among older hospitalized patients without a specific medical indication for catheterization. J Patient Saf. 2005;1(4):201–7.
30. Hu FW, Chang CM, Tsai CH, Chen CH. Exploring initial inappropriate use of urinary catheters among hospitalised older patients in Taiwan. J Clin Nurs. 2015;24(11-12):1656-65.
31. Avci M, Ozgenc O, Coskuner SA, Olut AI. Hospital acquired infections (HAI) in the elderly: Comparison with the younger patients. Arch Gerontol Geriatr. 2012;54(1):247-50.
32. Lee JH, Kim SW, Yoon BII, Ha US, Sohn DW, Cho YH. Factors that affect nosocomial catheter-associated urinary tract infection in intensive care units: 2-year experience at a single center. Korean J Urol. 2013;54(1):59-65.
33. Raffaele G, Bianco A, Aiello M, Pavia M. Appropriateness of use of indwelling urinary tract catheters in hospitalized patients in Italy. Infect Control Hosp Epidemiol. 2008;29(3):279-81.
34. Vincitorio D, Barbadoro P, Pennacchietti L, Pellegrini I, David S, Ponzio E, *et al*. Risk factors for catheter-associated urinary tract infection in Italian elderly. Am J Infect Control. 2014;42(8):898-901.
35. Gillen JR, Isbell JM, Michaels AD, Lau CL, Sawyer RG. Risk factors for urinary tract infections in cardiac surgical patients. Surg Infect. 2015;16(5): 504–8.
36. Daniels KR, Lee GC, Frei CR. Trends in catheter-associated urinary tract infections among a national cohort of hospitalized adults, 2001-2010. Am J Infect Control. 2014;42(1):17-22.

37. Mbi Feh MKN. Physicians' perceptions and practice regarding the prevention of catheter-associated urinary tract infections in the ICU. Thesis. US: Walden University. 2015.
38. Gomila A, Shaw E, Carratalà J, Leibovici L, Tebé C, Wiegand I, *et al.* Predictive factors for multidrug-resistant gram-negative bacteria among hospitalised patients with complicated urinary tract infections. Antimicrob Resist Infect Control. 2018;7(111):1-11.
39. Kucheria R, Dasgupta P, Sacks SH, Khan MS, Sheerin MS. Urinary tract infections: New insights into a common problem. Postgrad Med J. 2005;81(952):83–6.

Appendix A: Urinary catheter insertion checklist

Long-Term Care: Indwelling Urinary Catheter Insertion Checklist

Resident Name (print) _____ Med Rec# _____Unit _____Date/Time _____
Inserting Clinician (print) _____ Signature _____
Technique Reviewer*, if applicable (print) _____ Signature _____

I. BEFORE CATHETER INSERTION	✔	COMMENTS
1. Confirm order, to include catheter and balloon size; use the smallest effective catheter size.		
2. Assemble and verify supplies. Consider bringing a second catheter to use if the first one is accidentally contaminated.		
3. Identify the resident, per facility policy. Explain the procedure, its necessity, and its potential complications to the resident and/or family.		
4. Ensure privacy and good lighting.		
5. Position the resident correctly for the procedure; consider using an assistant to help resident stay in position and decrease potential contamination of sterile catheter.		
6. Perform hand hygiene, don clean gloves, and cleanse the perineal area with a washcloth, skin cleanser, and warm water, moving from front to back.		
7. Remove gloves and perform hand hygiene.		

II. DURING INSERTION	✔	COMMENTS
1. Open the sterile catheterization kit on a clean bedside table, using sterile technique. Ensure all supplies are conveniently positioned.		
2. Put on sterile gloves and drape the resident.		
3. Prepare the antiseptic solution; ensure the resident is not allergic to iodine. Apply sterile lubricant to the catheter tip. Consider attaching catheter to drainage system now, if not already attached, and ensure the drainage bag emptying port is clamped.		
4. With nondominant hand, identify meatus, and be prepared to keep this hand in this position until after the urine is flowing.		
5. With dominant (sterile) hand, clean the meatus opening with the antiseptic solution, moving from top to bottom. Use a new wipe/swab each time. Allow the antiseptic to dry.		
6. With the dominant (sterile) hand, insert the catheter slowly into the urethra until there is a return of urine. Then advance the catheter 2-3 inches more. (Do not force the catheter through the urethra). Leave the catheter in the vagina, if accidentally inserted, until after the new sterile urinary catheter is inserted into the bladder.		
7. Hold the catheter with the nondominant hand; use the dominant hand to fully inflate the catheter balloon with the entire volume of supplied sterile water in the prefilled syringe.		
8. Gently pull on catheter after balloon inflation to feel resistance.		

III. AFTER INSERTION	✔	COMMENTS
1. Remove used equipment and dispose of used supplies in trash per facility policy. Place syringe in sharps container. If a bladder scanner was used, wipe it with appropriate disinfectant cleaner before storing for use with the next resident.		
2. Secure catheter to the resident's leg with securement device. Remove gloves and perform hand hygiene		
3. Cover the resident with linens and assist to a comfortable position.		
4. Ensure the tubing in not kinked and the drainage bag is below the level of the bladder. Place a cover over the drainage bag to maintain resident dignity.		
5. Perform hand hygiene.		
6. Document— Type and size of catheter and balloon Amount of fluid inserted in the balloon How the resident tolerated the procedure Amount of urine obtained and its characteristics Name of person performing the insertion and the date it was completed.		
7. Label a urine collection container with a resident identifier and date.		

Appendix B: Definitions based on NHSN surveillance

Present on Admission (POA)	It is the day of admission to an inpatient location, the 2 days before admission, and the calendar day after admission.
Date of event (DOE)	It is the day when the first element used to meet the UTI infection criterion happened for the first time within the 7-day Infection Window Period.
Infection Window Period	It is a date of first positive diagnostic test that is used as an element of the site- specific criterion OR In the absence of a diagnostic test, use the date of the first documented localized sign or symptom that is used as an element of the site-specific criterion
Repeat Infection Timeframe (RIT)	The RIT is a 14-day timeframe during which no new infections of the same type are reported. The RIT applies to POA. The date of event is Day 1 of the 14-day RIT. If criteria for the same type of infection are met and the date of event is within the 14-day RIT, a new event is not identified or reported.
Indwelling catheter	A drainage tube that is inserted into the urinary bladder through the urethra, is left in place, and is connected to a drainage bag (including leg bags). These devices are also called Foley catheters. Condom or straight in-and-out catheters are not included nor are nephrostomy tubes, ileoconduits, or suprapubic catheters unless a Foley catheter is also present. Indwelling urethral catheters that are used for intermittent or continuous irrigation are included in CAUTI surveillance.
Urinary tract infection	Urinary tract infections (UTI) are defined using Symptomatic Urinary Tract Infection (SUTI) criteria, Asymptomatic Bacteremic UTI (ABUTI), or Urinary System Infection (USI) criteria
Catheter-associated UTI (CAUTI):	A UTI where an indwelling urinary catheter was in place for >2 calendar days on the date of event, with day of device placement being Day 1, AND an indwelling urinary catheter was in place on the date of event or the day before. If an indwelling urinary catheter was in place for > 2 calendar days and then removed, the date of event for the UTI must be the day of discontinuation or the next day for the UTI to be catheter-associated

Appendix C: UTI criterion based on CDC/ NHSN Surveillance

Criterion	**Urinary Tract Infection (UTI)** **Symptomatic UTI (SUTI)** **Must meet at least one of the following criteria**
SUTI 1a Catheter-associated Urinary Tract Infection (CAUTI)	Patient must meet 1, 2, and 3 below: 1. Patient had an indwelling urinary catheter that had been in place for > 2 days on the date of event (day of device placement = Day 1) AND was either: • Present for any portion of the calendar day on the date of event, OR • Removed the day before the date of event 2. Patient has at least one of the following signs or symptoms: • fever (>38.0°C) • suprapubic tenderness * • costovertebral angle pain or tenderness * • urinary urgency ** • urinary frequency ** • dysuria ** 3. Patient has a urine culture with no more than two species of organisms identified, at least one of which is a bacterium of $\geq 10^5$ CFU/ml (See Comments). All elements of the UTI criterion must occur during the Infection Window Period (See Definition Chapter 2 Identifying HAIs in NHSN). *With no other recognized cause (see Comments) **These symptoms cannot be used when catheter is in place. An indwelling urinary catheter in place could cause patient complaints of “frequency” “urgency” or “dysuria”. Note: Fever is a non-specific symptom of infection and cannot be excluded from UTI determination because it is clinically deemed due to another recognized cause

Appendix C: UTI criterion based on CDC/ NHSN Surveillance (continued)

Criterion	Urinary Tract Infection (UTI) Symptomatic UTI (SUTI) Must meet at least one of the following criteria
SUTI 1b Non-Catheter-associated Urinary Tract Infection (Non-CAUTI)	Patient must meet 1, 2, and 3 below: 1. One of the following is true: Patient has/had an indwelling urinary catheter, but it has/had not been in place >2 calendar days on the date of event OR Patient did not have a urinary catheter in place on the date of event nor the day before the date of event 2. Patient has at least one of the following signs or symptoms: • fever (>38°C) in a patient that is ≤ 65 years of age • suprapubic tenderness * • costovertebral angle pain or tenderness * • urinary frequency ** • urinary urgency ** • dysuria ** 3. Patient has a urine culture with no more than two species of organisms identified, at least one of which is a bacterium of $\geq 10^5$ CFU/ml. (See Comments) All elements of the SUTI criterion must occur during the Infection Window Period *With no other recognized cause (see Comments) **These symptoms cannot be used when catheter is in place. An indwelling urinary catheter in place could cause patient complaints of "frequency" "urgency" or "dysuria". Note: Fever is a non-specific symptom of infection and cannot be excluded from UTI determination because it is clinically deemed due to another recognized cause.
Asymptomatic Bacteremic Urinary Tract Infection (ABUTI)	Patient must meet 1, 2, and 3 below: 1. Patient with* or without an indwelling urinary catheter has no signs or symptoms of SUTI 1 or 2 according to age (Note: Patients > 65 years of age with a non-catheter-associated ABUTI may have a fever and still meet the ABUTI criterion) 2. Patient has a urine culture with no more than two species of organisms identified, at least one of which is a bacterium of $\geq 10^5$ CFU/ml (see Comment section below) 3. Patient has organism identified** from blood specimen with at least one matching bacterium to the bacterium identified in the urine specimen, or meets LCBI criterion 2 (without fever) and matching common commensal(s) in the urine. All elements of the ABUTI criterion must occur during the Infection Window Period. *Patient had an indwelling urinary catheter in place for >2 calendar days on the date of event, with day of device placement being Day 1, and catheter was in place on the date of event or the day before.

Appendix C: UTI criterion based on CDC/ NHSN Surveillance (continued)

Criterion	Urinary Tract Infection (UTI) Symptomatic UTI (SUTI) Must meet at least one of the following criteria
	** Organisms identified by a culture or non-culture based microbiologic testing method which is performed for purposes of clinical diagnosis or treatment (e.g., not Active Surveillance Culture/Testing (ASC/AST)
Comments	"Mixed flora" is not available in the pathogen list within NSHN. Therefore, it cannot be reported as a pathogen to meet the NHSN UTI criteria. Additionally, "mixed flora" represent at least two species of organisms. Therefore, an additional organism recovered from the same culture would represent >2 species of microorganisms. Such a specimen also cannot be used to meet the UTI criteria. The following excluded organisms cannot be used to meet the UTI definition: • Candida species or yeast not otherwise specified • mold • dimorphic fungi or • parasites An acceptable urine specimen may include these organisms as long as one bacterium of greater than or equal to 100,000 CFU/ml is also present. Additionally, these non-bacterial organisms identified from blood cannot be deemed secondary to a UTI since they are excluded as organisms in the UTI definition.

Supplementary Data 1: Examples of appropriate and inappropriate use of indwelling catheter

A. Examples of Appropriate Indications for Indwelling Urethral Catheter use based on CDC Guideline "Prevention of Catheter- Associated Urinary Tract Infections" (Gould et .al, n.d.)

- Patient has acute urinary retention or bladder outlet obstruction.
- Need for accurate measurements of urinary output in critically ill patients.
- Critically ill patients are defined as:
- Hemodynamic instability (requiring pressors, shock)
- Neuromuscular blockade (ventilated)
- Deoxygenation with exertion or position change (i.e. acute respiratory compromised and /or acute decompensated CHF)
- Perioperative use for selected surgical procedures:
- Patients undergoing urologic surgery or other surgery on contiguous structures of the

- genitourinary tract.
- Anticipated prolonged duration of surgery (catheters inserted for this reason should be removed in PACU).
- Patients anticipated to receive large-volume infusions or diuretics during surgery.
- Need for intraoperative monitoring of urinary output.
- To assist in healing of open sacral or perineal wounds in incontinent patients.
- Patient requires prolonged immobilization (e.g., potentially unstable thoracic or lumbar spine, multiple traumatic injuries such as pelvic fractures).
- To improve comfort for end of life care if needed.

B. Examples of Inappropriate Uses of Indwelling Catheters

1) As a substitute for nursing care of the patient or resident with incontinence.

2) As a means of obtaining urine for culture or other diagnostic tests when the patient can voluntarily void.

For prolonged postoperative duration without appropriate indications (e.g., structural repair of urethra or contiguous structures, prolonged effect of epidural anaesthesia, etc.).

Supplementary Data 2: Aseptic Urine Specimen Collection based on HICPAC recommendation (16)

1. If a small volume of fresh urine is needed for examination (i.e., urinalysis or culture), aspirate the urine from the needleless sampling port with a sterile syringe/cannula adapter after cleansing the port with a disinfectant. (Category IB)
2. Obtain large volumes of urine for special analyses (not culture) aseptically from the drainage bag. (Category IB) Spatial Separation of Catheterized Patients.