Research Article

Prevalence and causative pathogens of catheter associated urinary tract infections and compliance of healthcare workers on preventive strategies in selected intensive care units at a tertiary care centre

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Abstract

Introduction: Catheter associated urinary tract infection (CAUTI) is a common cause of healthcare associated infections worldwide. Surveillance on compliance rate of CAUTI prevention strategies would be important for the improvement of patient care quality.

Objectives: Assess the prevalence and causative pathogens of catheter associated urinary tract infections and compliance of healthcare workers on preventive strategies in selected intensive care units (ICU) at a tertiary care centre.

Methods: A descriptive cross-sectional study was conducted in the selected intensive care units (medical ICU and neurology ICU) at National Hospital, Sri Lanka (NHSL) from December 2021 to March 2022. Catheterised patients who stayed >48 hours in the ICU (n=146) were included in the study. Urine samples were collected according to the National Healthcare Safety Network (NHSN) criteria, United States of America (USA). Urine specimens were processed according to the standard operating procedures (SOP) and identification of the pathogens and antibiotic sensitivity were performed using an automated identification system (BD Phoenix^{TM}).

Results: The average CAUTI rate for the study period was 7.3 per 1000 urethral catheter (UC) days and UC utilisation rate was 0.95. With improving compliance rate for UC prevention strategies, a reduction in CAUTI rate was observed from 7.9 to 1.8 per 1000 UC days. There was a statistically significant association with compliance for CAUTI prevention strategies (all or none method) with the reported CAUTI rate (p= 0.03). Common pathogens isolated in the patients with CAUTI were *Escherichia coli* (25%) and *Enterococcus faecium* (25%). Among Gram-negative pathogens, 75% were multi-drug resistant (MDR).

Conclusion: Improving the compliance rate for UC associated infection prevention strategies will have positive impact in reducing the CAUTI rate.

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Introduction

Seventy to eighty percent of healthcare associated urinary tract infections (UTI) are caused by instrumentation of the urinary tract.[1] Catheter associated urinary tract infection (CAUTI) is associated with increased morbidity, mortality, healthcare cost and length of hospital stay.[2]

Several studies have shown that a significant percentage of hospital inpatients are catheterised during their hospital stay.[1] Several international guidelines have emphasised the importance of implementing strategies to prevent CAUTI and surveillance of CAUTI.[1,2] There is no well-organised national surveillance system to monitor CAUTI rates in Sri Lanka, though it is considered a main component of infection prevention and control (IPC). The main objectives of this study were to assess the prevalence and causative pathogens of CAUTI, and compliance of healthcare workers on preventive strategies in two selected intensive care units (ICU) at a tertiary care centre.

Methods

The study was conducted during a four-month period from 25/11/2021 to 24/03/2022 at the medical intensive care unit (MICU), neurology intensive care unit (NICU) and microbiology laboratory, National Hospital, Sri Lanka.

Patients admitted to the ICUs requiring catheterisation or admitted with a urethral catheter in situ and stayed in the ICU for >48 hours were enrolled in the study. Urine specimens were collected from patients enrolled in the study according to National Healthcare Safety Network (NHSN) criteria, United States of America (USA).[3] Specimen collection was done according to guidelines in the Laboratory Manual, 2nd edition, Sri Lanka College of Microbiologists, 2011.[4]

A urine sample was collected 48 hours after insertion of the urethral catheter. Urine was collected adhering to the case definition of CAUTI or as a part of a septic screen.

The compliance of health care workers to the urethral catheter bundle care checklist was observed by the principal investigator during daily rounds in MICU and NICU.

CAUTI was defined according to the NHSN criteria as the presence of 1,2 and 3 as given below.[3]

1. Patient has an indwelling urinary catheter which has been in situ for more than two consecutive days in an inpatient location on the date of event
2. Patients have at least one of the following signs or symptoms (fever>38 °C, suprapubic tenderness, costovertebral angle pain or tenderness, urgency, frequency, dysuria)
3. Urine culture with not more than 2 species of organisms isolated, at least one bacterium with $\geq 10^5$ CFU/ml

Patient related data were collected from the patient's records, or from patients and/or relatives using a pre-tested observer administered questionnaire. Samples were processed according to the SOP (Laboratory Manual in Microbiology 2011 (2nd edition).[4] Species identification and antibiotic sensitivity test were performed using the BD Phoenix™ automated identification system. Antibiotic sensitivity was interpreted according to the Clinical and Laboratory Standards Institute (CLSI) M 100 32nd edition.[5] Frequencies and means were used for descriptive analysis of data. Chi-square test was used to find the relationship between two categorical data.

Urethral catheter bundle care compliance was assessed according to the Institute for Healthcare Improvement (IHI) guidelines on 'How to guide: Prevent catheter associated urinary tract infections' by using 'all or none' approach.[6] Catheter utilisation ratio was calculated by the number of urethral catheter days dividing by number of patient days according to the NHSN (USA) criteria.[3] Multi drug resistance (MDR) is defined in this study as acquired resistance to one agent in three or more antimicrobial categories.[7]

Results

During the 4-month study period, 146 patients were enrolled in the study of whom 16 (10.9%) were diagnosed as CAUTI.

Table 1: Patient demographics, co-morbidities, clinical features and microbiological data

Data of Study Population	
Age (years)	Median 53.5 (SD 18.4)
Male	85 (58.2%)
Female	61 (41.8%)
Duration of catheterisation (days)	Median 3 (Inter quartile range (IQR)=3-7)
Co-morbidities in diagnosed patients with CAUTI	
Diabetes mellitus	6/16 (38%)
Hypertension	5/16 (31%)
Clinical features	
Fever	15/16 (94%)
Dysuria	2/16 (12.5%)
Suprapubic tenderness	1/16 (6.3%)
Urgency	0
Frequency	0
Costovertebral angle pain/tenderness	0
Pyuria	
Presence of pyuria	75/146 (51%)
No pyuria	71/146 (49%)
Pathogens isolated	
Escherichia coli	4/16 (25%)
Enterococcus faecium	4/16 (25%)
Pseudomonas aeruginosa	3/16 (25%)
Klebsiella pneumonia	2/16 (12.5%)
Acinetobacter baumanni /calcoaceticus	2/16 (12.5%)
Enterobacter cloacae	1/16 (6.2%)

Median age of the study population was 53.5, the commonest co-morbidity was diabetes mellitus and 16/146 (10.9%) were diagnosed as CAUTI (Table 1). Pyuria was found in 75 patients, including the 16 patients with CAUTI. Of the remaining 59 patients who had pyuria, 58 had no growth and 1 patient had growth $<10^5$/ml.

The four *E.coli* isolates were resistant to ampicillin and amoxicillin-clavulanate. Two *K. pneumoniae* and two *A. baumanni /calcoaceticus* complex isolates were multi drug resistant (MDR). All 12 Gram negative isolates were sensitive to colistin. Eight of the 12 Gram negative isolates in our study were carbapenem resistant (Table 2).

All four isolates of *Enterococcus faecium* were resistant to ampicillin and all were sensitive to vancomycin, teicoplanin and linezolid.

Table 2- Antibiotic sensitivity of Gram-negative pathogens

	No of isolates	Ampicillin	Amocycillin/ Clavulanate	Cefotaxime/ Ceftriaxone	Ceftazidime	Ciprofloxacin	Gentamicin	Amikacin	Co-trimoxazole	Piperacillin tazobactam	Meropenem	Colistin
E.coli	4	0	0	1	1	1	3	3	1	2	2	4
K. pneumoniae	2	NA	0	0	0	0	0	1	0	0	0	2
E.cloacae	1	NA	NA	1	1	1	1	1	1	1	1	1
P. aeruginosa	3	NA	NA	NA	1	2	2	2	NA	2	1	3
A. baumanni/ calcoaceticus complex	2	NA	NA	0	0	0	0	0	1	0	0	2

NA – Not applicable

Table 3- Compliance with each prevention strategy

	Prevention strategy	n	Compliance	%
1	The urethral catheter is being used for an appropriate indication	146	146	100
2	The correct size of the urethral catheter is used		142	97.3
3	Insertion date is documented		146	100
4	Hand hygiene is performed before & after procedure and sterile gloves worn during the procedure		146	100
5	Urethral catheter has been continuously connected	459	459	100
6	The seal between the urethral catheter and collecting tube is intact		459	100
7	The urethral catheter is secured to the patient		243	52.9
8	The urethral catheter tubing is unobstructed and not twisted, kinked or looped		455	99.1
9	Daily meatal hygiene is performed by healthcare staff		459	100
10	Empty urethral catheter bag often, as a separate procedure, into the clean container without touching it with the urethral catheter bag		247	53.8

Overall compliance for urethral catheter associated UTI prevention strategies was 81.5% (all or none method). Compliance for the emptying urethral catheter bag as a separate procedure into the clean container without touching it with the urethral catheter bag was low (53.8%) (Table 3).

Table 4- CAUTI rate and UC utilisation ratio

Month	CAUTI n	UC days n	Patient days n	CAUTI rate	UC utilisation ratio
December	4	504	552	7.9	0.91
January	7	556	582	12.5	0.96
February	4	579	601	6.9	0.96
March	1	540	565	1.9	0.95

CAUTI rate in December 2021 and March 2022 were 7.9 and 1.9 per 1000 UC days respectively (Table 4)

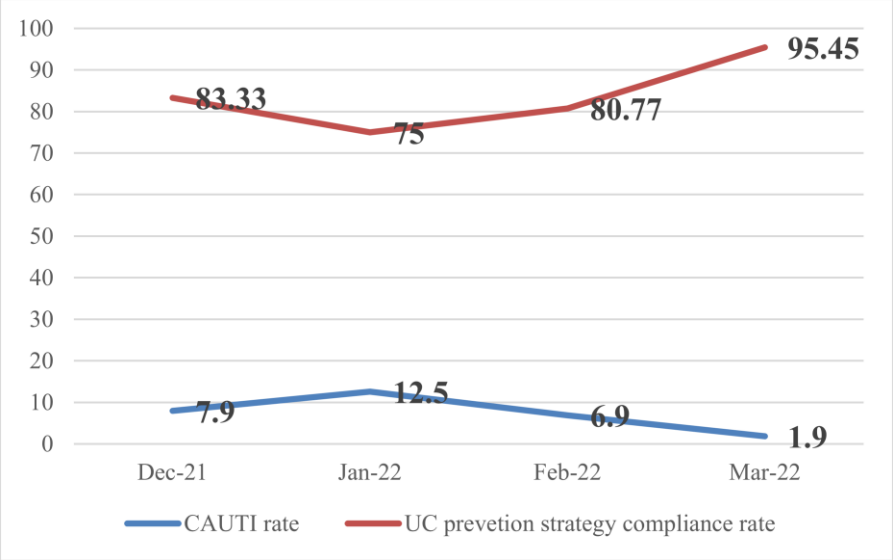

Figure 1: The association between compliance to UC prevention strategies with CAUTI rate

Figure 1 demonstrates increase in CAUTI rates with reduction of compliance to urethral catheter prevention strategies. As shown in Figure 1, with improved compliance in March 2022, the CAUTI rate was reduced to 1.8 per 1000 urethral catheter days. The association between compliance of healthcare workers to UC preventive strategies and reported CAUTI is statistically significant (*p* 0.03) (CI-2.08-4.30, chi-square test).

Discussion

Study of CAUTI and compliance of healthcare workers to prevention strategies for CAUTI is helpful for quality improvement in hospitals as well as an output indicator of healthcare associated infections (HCAI) according to the National Health Strategic Master Plan 2016-2025 (curative services).[8] In our study, 15 of 16 patients (94%) with CAUTI had fever as the commonest clinical feature. In a study done in the United States of America (USA) on patients who were diagnosed as CAUTI, analysis of clinical features showed that only 16.7% had fever.[9] Fever can be a non - specific symptom of infections other than CAUTI.

Pyuria was observed in 75 of 146 specimens (51%) from study participants. According to a study done in India, presence of the UC causes bladder inflammation and pyuria could be present without CAUTI.[10] Therefore, pyuria in a patient with indwelling UC does not necessarily indicate infection. This was evident in the present study where although pyuria was present in 75 of the

146 urine samples (51%), only 16 of the 146 (10.9%) had CAUTI. An Indian study reported urine culture positivity in 35 of 50 participants (70%) of whom 25 (50%) were asymptomatic.[11] Six of the 146 (4.1%) urine samples in the current study represented asymptomatic bacteriuria.

In our study, 12 of 16 isolates (75%) were Gram negative bacteria and 4 (25%) were Gram-positive bacteria. Four of the 12 Gram negative bacteria were *Escherichia coli*. All Gram-positive bacteria were identified as *Enterococcus faecium*. According to studies done in the United Kingdom (UK), India and data reported in NHSN network (USA) from 2018 to 2021, *E. coli* is the commonest pathogen in CAUTI.[1,11,12] However, in the present study, 4 of the 16 isolates were *E. faecium*. Although this could be due to low number, it could also reflect the antibiotic policy of the ICUs where 3rd generation cephalosporins are used as first line empirical antibiotics.

Of the 12 Gram negative bacteria, 8 (66.6%) were multidrug resistant. All the Gram-negative bacteria isolated in the study were resistant to ampicillin and amoxicillin-clavulanate. Among the four *E.coli* , only one was sensitive to third generation cephalosporins, highlighting the importance of routine testing for extended spectrum β-lactamases (ESBL) production. Carbapenem resistance was seen in 4 of the 7 Enterobacterales. Testing for carbapenemase should be included in future studies.

Ciprofloxacin resistance was found in 3 of the 4 *E.coli* and both *K. pneumoniae* isolates. All 12 Gram negative isolates were sensitive to colistin. According to the NHSN data (2018-2021), carbapenem resistance was detected in 1.8% Enterobacterales and 44.8% of *Acinetobacter* sp. and extended spectrum cephalosporin resistance in 21.5% of Enterobacterales.[12] Carbapenemase production was detected in 10 of 120 strains using the modified Hodge test in a Sri Lankan study (2017) indicating higher levels of resistance than shown in the NHSN data.

Lower compliances were reported for securing the UC to the patient (52.9%) and emptying the UC bag separately (53.8%). Compliance for the proper securement of the UC was also low (51.1%) in a study done in Hong Kong, which was consistent with our present study.[14] Urethral catheter checklist adherence was 45% prior to a supervision programme done in tertiary care hospital in India and increased to 65% after the programme.[15] Even without intervention in our study, a rising trend of compliance for UC prevention strategies was observed. In our study, CAUTI rate increased to 12.6 per 1000 UC days during the first 2 months and then reduced to 1.9 per 1000 UC days in the last month of the study. The average CAUTI rate was 7.3 per 1000 UC days during the study period. UC utilisation ratio was above 0.90 for all months and average UC utilisation ratio 0.95.in our present study. The association between compliance of healthcare workers to UC preventive strategies and reported CAUTI was statistically significant (*p* value -0.03) in our study The Society for Healthcare Epidemiology of America (SHEA) 2022 update indicated compliance to catheter care bundle and catheter utilisation as measures of performance/ process for the evaluation of CAUTI quality improvement programme.[16] In a study done in India, during pre-implementation phase of CAUTI care bundle, the CAUTI rate was 10.7 per 1000 UC days and after implementation of the care bundle, the CAUTI rate dropped to 4.5 per 1000 UC days.[17]

A study done in a tertiary care hospital in the southern province of Sri Lanka showed a CAUTI rate of 3.1 per 1000 UC days which was lower than our present study.[18] CAUTI rate of 9 per 1000 UC days and UC utilisation ratio of 1.0 was reported in a study done in the ICUs and HDUs at

NHSL in 2011.[19] The catheter associated UTI rate of the above study was in line with our study. The average urethral catheter utilisation ratio in our study was 0.95 and that value was somewhat less than the value in a previous study done at NHSL in 2011.

Most of the studies available were interventional studies and assessed the pre-implementation and post-implementation CAUTI rates to assess the impact of UC prevention strategies. In our study the CAUTI rate was assessed throughout the period without implementing a prevention programme. Even though our study was not an interventional study, awareness of the healthcare workers about the study could have made an impact similar to an interventional study. That may result in a possible bias of the CAUTI rate in the two ICUs at NHSL.

Conclusion

Most of the pathogens causing CAUTI were identified as MDR pathogens which highlights the need for well-organised antibiotic stewardship programmes and IPC activities. With the improvement of compliance with UC prevention strategies, reduction in CAUTI rate was observed in the current study. Since this study was of short duration (4 months) the sample size was limited. The percentage of negative cultures was high which affects the statistical significance of the study. Further studies with larger sample size are needed to provide data to support implementation of strategies to prevent CAUTI and improve surveillance of CAUTI. Improving the compliance rate for UC associated infection prevention strategies would have a positive impact in the reduction of the CAUTI rate.

Declarations

Conflict of interest: There are no conflicts of interest
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Author contributions:
J. A. L. U. Kumara- Principal investigator of the research and writing the manuscript,
C. G. U. A. Patabendige- Supervisor of the research and reviewing the manuscript

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