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Evaluation of Catheter-Associated Urinary Tract Infection Rates in Surgical and Medical Intensive Care Units at a Tertiary Care Center: A Surveillance Study From North India

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Abstract

Introduction: Healthcare-associated infections (HAIs) are a major cause of morbidity and mortality among hospitalized patients, with catheter-associated urinary tract infections (CAUTIs) being one of the most prevalent infections in intensive care unit (ICU) settings. The primary objective of this study was to determine the incidence rate of CAUTI among catheterized patients at a tertiary care hospital within the Etawah district through surveillance.

Materials and methods: The present study was conducted over one year (January-December 2024) in the surgical ICU (SICU) and 10 months (March-December 2024) in the medical ICU (MICU) by infection control team members. CAUTI case framing was conducted as per standard guidelines. CAUTI, healthcare-associated urinary tract infection (HA-UTI) rates, and device utilization ratio (DUR) were calculated using patient-related surveillance case sheets. Pearson's correlation coefficients were calculated. Additionally, the demographic and microbiological profile of CAUTI cases was also assessed.

Results: CAUTI rates in the present study ranged between 0 and 15 (overall being 5.7) per thousand urinary catheter days in SICU and 0 and 6.76 (overall being 1.6) per thousand urinary catheter days in MICU, which is quite comparable with other studies from India and abroad. Similarly, the highest HA-UTI rate was found to be 14.9 in SICU and 6.6 in MICU. In the SICU, CAUTI and HA-UTI rates showed fluctuations over 2024, with peaks in June (CAUTI 15.0, HA-UTI 14.9) and lows in March, April, September, and December. MICU rates were generally lower, with minor peaks in August (CAUTI 6.76, HA-UTI 6.6). DUR ranged between 0.78 and 1.03 in SICU and 0.93 and 0.99 in MICU, respectively.

Conclusion: This study provides the first significantly relevant and practice-guiding data on CAUTI rates at a tertiary care hospital in Etawah, filling an important knowledge gap and establishing a foundation for evidence-based infection prevention strategies tailored to the local healthcare environment.

Categories: Trauma, Epidemiology/Public Health, Infectious Disease

Keywords: catheter, catheter-associated urinary tract infections (cauti), cauti, ca-uti, healthcare-associated infections, healthcare-associated infections (hais), urinary catheter, urinary tract infection, urinary tract infection, uti

Introduction

Healthcare-associated infections (HAIs) are a major cause of morbidity and mortality among hospitalized patients, with catheter-associated urinary tract infections (CAUTIs) being one of the most prevalent infections in intensive care unit (ICU) settings. CAUTI occurs when microorganisms, typically bacteria, enter the urinary tract through an indwelling urinary catheter and establish infection in any part of the urinary system, including the bladder, kidneys, ureters, and urethra. The clinical significance of CAUTI extends beyond mere infection rates, as these infections are associated with increased patient morbidity, mortality, prolonged hospital stays, and substantial healthcare costs. Studies have demonstrated that CAUTI can lead to serious complications, including prostatitis, epididymitis, cystitis, pyelonephritis, bacteremia, sepsis, and, in severe cases, death [1]. The economic burden is equally concerning, with CAUTI contributing significantly to healthcare costs. In the Indian context, CAUTI surveillance has shown varying rates across different studies and institutions. Recent multicenter surveillance data from India reported pooled CAUTI rates ranging between 2.5 and 4.5 per thousand urinary catheter days and UTI rates between 1.7 and 2.8 per thousand patient days in ICUs [2]. Individual institutional studies from India have reported CAUTI rates ranging from 1.37 to 9.4 per 1,000 catheter days, indicating significant variability in infection rates across different healthcare settings [3,4]. The implementation of effective CAUTI prevention strategies requires a thorough understanding of local epidemiology, including causative organisms. Hence, the present study aims to analyze CAUTI rates along with the microbial etiology of CAUTI cases, which will help assess the effectiveness of infection control practices and further implement preventive strategies to reduce the burden of HAIs.

How to cite this article

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Materials And Methods

The present study was conducted over one year (January–December 2024) in the surgical ICU (SICU) and 10 months (March–December 2024) in the medical ICU (MICU) by the members of the infection control team. All procedures were performed in accordance with institutional guidelines and national ethical standards. Patient confidentiality was protected throughout the study, and all data were anonymized prior to analysis. Individual informed consent was not required, as the research involved routine surveillance of hospital infection data without any new, identifiable information. Patients of all age groups and both genders were included in the study. Surveillance terminologies such as date of event (DOE), HAI, present on admission (POA), and infection window period (IWP) were taken into account during data analysis. DOE is considered the date when the first symptom appears, or the first diagnostic test becomes positive (date of sample collection, not the date of reporting), whichever is earlier. The infection was assigned as HAI if the DOE was after the first two calendar days of admission to the ICUs (medical and surgical) and was included in the study. The infection was considered POA if the DOE was on either of the first two calendar days, and such episodes were excluded from the study. IWP was considered a seven-day period ranging from the date of the first positive diagnostic test, three days before and three days after (e.g., for culture, a seven-day period included three days before the sample collection date, the sample collection date, and three days after it was considered IWP). Numerator (name, age, sex, date of admission in ICU, date of urinary catheter insertion, removal or reinsertion, date of urine collection for testing and causative organism detected, daily recording of signs and symptoms, etc.) and denominator (containing information pertinent to patient days, foley's catheter days during daily rounds) case sheets were meticulously screened. CAUTI event framing was done according to National Healthcare Safety Network (NHSN) guidelines with modification (inclusion of *Candida* as done in other Indian studies) [5,6].

CAUTI rates, healthcare-associated urinary tract infection (HA-UTI) rates, and device utilization ratio (DUR) were calculated as per the given formula:

CAUTI rate per 1,000 urinary catheter days = number of CAUTI episodes/number of urinary catheter days) × 1,000

HA-UTI rate per 1,000 patient days = number of HA-UTI episodes/number of patient days × 1,000

DUR (in case of urinary catheter use) = number of urinary catheter days divided by the number of patient days

Data/statistical analysis

All relevant clinical and laboratory data, including CAUTIs, HA-UTI, and DUR, were extracted from numerator and denominator case sheets and entered into Microsoft Excel (Microsoft 365, Version 2507, Microsoft Corp., Redmond, WA, USA). Descriptive statistics were applied to summarize study variables. Categorical variables were reported as counts and percentages. Monthly trends of CAUTI, HA-UTI, and DUR were analyzed retrospectively to assess infection patterns and device utilization. To explore associations between infection rates (CAUTI and HA-UTI) and DURs, Pearson's correlation coefficients were calculated. Correlation strength and direction were interpreted based on standard thresholds, and statistical significance was set at $p < 0.05$. All analyses were performed using Microsoft Excel (Microsoft 365, Version 2507) and R (version 4.3.1, R Foundation for Statistical Computing, Vienna, Austria).

Results

In the present study, 14 CAUTI episodes were identified over a period of one year (January–December 2024) from SICU, and nine CAUTI episodes were identified over a period of 10 months (March–December 2024) from MICU. Total patient days in SICU were 2,528, and in MICU were 5,841. Total urinary catheter days in SICU were 2,457, and in MICU were 5,606 during the study period. CAUTI and HA-UTI rates and DUR in SICU and MICU have been summarized in Table 1 and Table 2, respectively. CAUTI rates in the present study ranged between 0 and 15 per thousand urinary catheter days in SICU and 0 and 6.76 per thousand urinary catheter days in MICU. Similarly, the highest HA-UTI rate was found to be 14.9 in SICU and 6.6 in MICU. The overall CAUTI rate was 5.7 per 1,000 urinary catheter days in SICU. In the case of MICU, the overall CAUTI rate was 1.6 per 1,000 urinary catheter days. DUR ranged between 0.78 and 1.03 in SICU and 0.93 and 0.99 in MICU, respectively. Analysis of the SICU data from January to December 2024 showed variable trends in CAUTI and HA-UTI rates, with peak incidences. In the SICU, CAUTI and HA-UTI rates showed fluctuations over 2024, with peaks in June (CAUTI 15.0, HA-UTI 14.9) and lows in March, April, September, and December. MICU rates were generally lower, with minor peaks in August (CAUTI 6.76, HA-UTI 6.6) (Figure 1). DURs remained near 1.0 in both units throughout the year, indicating consistent catheter use. In Figure 2, Spearman correlation coefficients are displayed, with color intensity representing the strength and direction of correlation. Strong positive associations were observed between CAUTI and HA-UTI in both units, while DUR showed weak or negligible correlations with infections. Correlation analysis between CAUTI, hospital-acquired urinary tract infection (HAUTI), and DUR revealed distinct patterns across the two ICUs. In the SICU, a strong positive correlation was observed between CAUTI and HAUTI ($r = 0.91$). However, correlations between CAUTI and DUR ($r = 0.06$) and HAUTI and DUR ($r = 0.26$) were weak, suggesting that

DUR was not strongly associated with infection rates in this setting. In the MICU, a similar strong positive correlation was identified between CAUTI and HAUTI (r = 0.96). In contrast, both CAUTI-DUR (r = -0.03) and HAUTI-DUR (r = -0.08) showed negligible negative correlations, indicating no meaningful relationship between DUR and infection incidence. These findings highlight that CAUTI and HA-UTI were closely related in both ICUs, whereas DUR did not show a consistent influence on infection occurrence. The microbiological profile of CAUTI cases included *Enterococcus* spp., *Acinetobacter baumannii*, *Candida* spp., and *Pseudomonas aeruginosa*. Age-wise distribution of CAUTI cases suggests the highest occurrence in the age group of 41-50 years (30%), followed by 21-30 years (26 %) (as summarized in Table 3). CAUTI was detected in 10 males and 13 females; hence, the male: female ratio was found to be 0.8 (suggesting a slight preponderance in females).

Month	CAUTI rate	HA-UTI rate	DUR
Jan	14.71	14.63	1
Feb	5.29	5.29	1
Mar	0	0	0.95
Apr	0	4.95	1
May	9.13	9.13	1
June	15	14.9	1
July	9.9	9.5	0.96
Aug	4.78	4.95	1.03
Sept	0	0	1
Oct	4.4	4.4	0.99
Nov	5.1	3.98	0.78
Dec	0	0	1

TABLE 1: CAUTI and HA-UTI rates and DUR in SICU (January-December 2024)

CAUTI: catheter-associated urinary tract infection; HA-UTI: healthcare-associated urinary tract infection; DUR: device utilization ratio; SICU: surgical intensive care unit

Month	CAUTI rate	HA-UTI rate	DUR
Mar	0	0	0.99
Apr	1.83	1.78	0.97
May	0	0	0.93
June	0	0	0.95
July	1.7	3.3	0.95
Aug	6.76	6.6	0.98
Sept	0	0	0.97
Oct	3.6	3.35	0.93
Nov	1.86	1.78	0.96
Dec	0	0	0.97

TABLE 2: CAUTI, HA-UTI rates, and DUR in MICU (March-December 2024)

CAUTI: catheter-associated urinary tract infection; HA-UTI: healthcare-associated urinary tract infection; DUR: device utilization ratio; MICU: medical intensive care unit

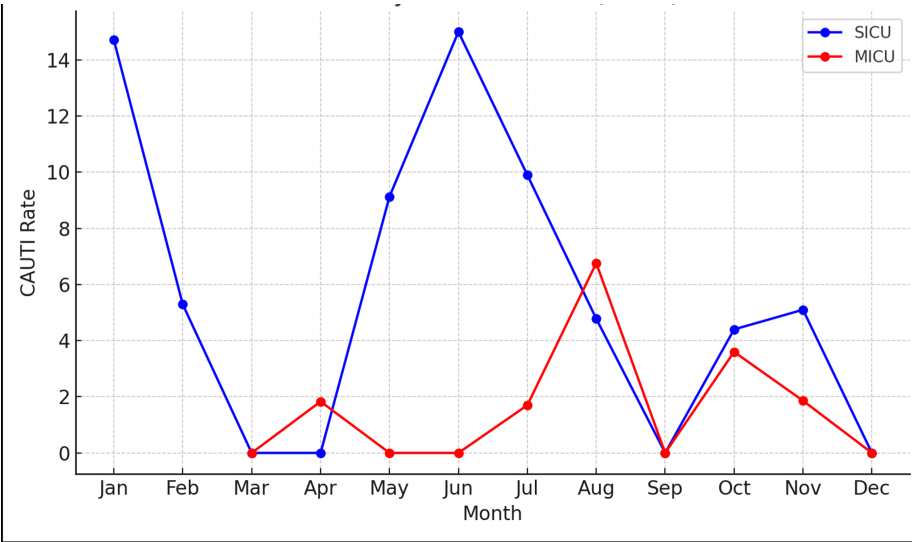


FIGURE 1: Monthly CAUTI trends (SICU vs MICU)-2024

CAUTI: catheter-associated urinary tract infection; SICU: surgical intensive care unit; MICU: medical intensive care unit

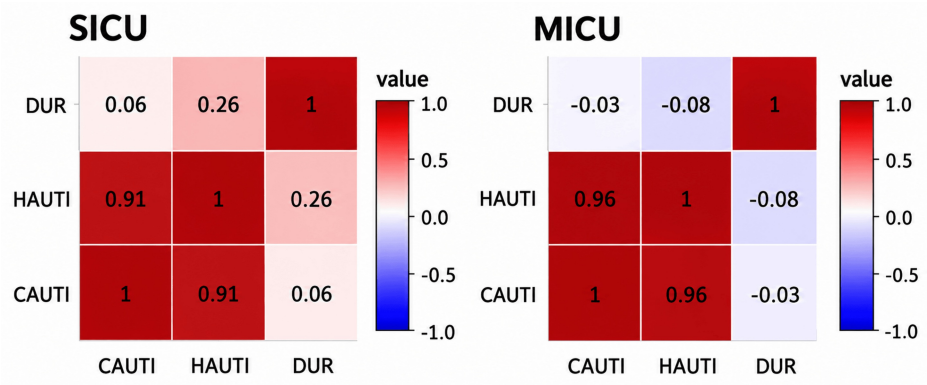


FIGURE 2: Correlation heatmaps of CAUTI and HA-UTI rates and catheter utilization ratio in SICU and MICU

CAUTI: catheter-associated urinary tract infection; HA-UTI: healthcare-associated urinary tract infection; SICU: surgical intensive care unit; MICU: medical intensive care unit; DUR: device utilization ratio

Age group (years)	Number of cases (n)	Percentage (%)
0-10	0	0.0
11-20	2	8.7
21-30	6	26.1
31-40	0	0.0
41-50	7	30.4
51-60	5	21.7
61-70	1	4.3
71-80	2	8.7
Total	23	100.0

TABLE 3: Age-wise (years) distribution (number, percentage) of CAUTI cases in ICU settings

CAUTI: catheter-associated urinary tract infection; ICU: intensive care unit

Discussion

CAUTI represents one of the most common HAIs globally, accounting for approximately 40% of all hospital-acquired infections in healthcare facilities [1]. Previous studies suggest that each HA-UTI case results in 3-5 additional hospital days and significant cost increases [7]. Keeping a check on nurse-led catheter removal protocols, care bundles, or daily device audits can significantly lower DUR and CAUTI rates. Similarly, conducting root-cause analysis during high-incidence months, tracking microbiological trends, and ensuring implementation of antimicrobial stewardship can significantly reduce CAUTI burden in ICUs. It is proven in multiple studies that women are at greater risk of developing urinary tract infections and even CAUTI than men due to anatomical factors such as a shorter urethra and colonization susceptibility (the female urethral meatus lies in close proximity to the anus and vagina, facilitating easier colonization by gut and vaginal flora) [8-10]. Forty percent to 60% of women experience at least one UTI in their lifetime, compared to only 10%-15% of men [11]. This anatomical susceptibility extends to CAUTIs when indwelling catheters provide an external pathway for bacteria in women. Our study also supported this fact, as we detected a larger number of CAUTI cases in females, with a male:female ratio of 0.8. Other risk factors include prolonged catheterization, pregnancy, poor nutritional status, fecal incontinence, immunocompromised status, and critical illness [12].

In the present study, the 41-50 years age group accounted for the highest proportion of CAUTI cases (30%), followed closely by the 21-30 years age group (26%). This notable finding among middle-aged individuals

aligns with observations from other ICU-based studies. For instance, a surveillance study from an ICU catering to tribal communities in India found the highest CAUTI incidence (33.3%) in the 41–60 years range, followed by younger adults (age $\leq$ 20 years, 26.7%) [13]. A large international cohort study across 235 ICUs in Asia reported that age significantly increased CAUTI risk [14]. While some ICU-based studies report higher CAUTI rates in older age, the clustering of cases around middle-aged groups (40–60 years) remains a recurring observation. In the present study, the overall magnitude of CAUTI rates varied from 0 to 15 (overall being 5.7) per thousand urinary catheter days in SICU and 0 to 6.76 (overall being 1.6) per thousand urinary catheter days in MICU. This indicates lower rates in MICU as compared to SICU, exhibiting better catheter care bundle practice and infection control in MICU. In the study done by Papanikolopoulou et al. from Greece, the six-year CAUTI rate was 5.27 infections per 1,000 catheter days [15]. Similarly, in our study, the overall CAUTI rate in SICU was 5.7 per 1,000 catheter days. Our MICU CAUTI rate was almost similar to the CAUTI rate reported by Bhushan et al. in similar settings (i.e., MICU) from Patna, India, and Leticia-Kriegel et al. from the United States [3,16]. On the contrary, Datta et al. from Chandigarh reported a higher CAUTI rate, i.e., 9.08/1,000 catheter days, among ICU patients in their one-year study period [17]. The organisms identified in CAUTI cases in this study—*Enterococcus* spp., *A. baumannii*, *Candida* spp., and *P. aeruginosa*—reflect a microbiological profile frequently documented in ICU-acquired urinary tract infections. Studies from ICUs have consistently identified *Acinetobacter* spp. and *P. aeruginosa* as significant contributors to CAUTI, often displaying high-level multidrug resistance (MDR) and belonging to the ESKAPE (*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *A. baumannii*, *P. aeruginosa*, and *Enterobacter* spp.) pathogen group [18]. *Enterococcus* spp. are also common in catheterized patients due to their capacity to form robust biofilms on urinary catheters [19,20]. The surveillance period of one year in the present study limits the detection of seasonal or long-term trends in CAUTI rates. Another limitation is that it is confined to one tertiary care hospital's ICUs; hence, its findings cannot be generalized.

Despite the presence of major healthcare facilities in Etawah district, systematic surveillance data on CAUTI rates remain limited, highlighting the need for comprehensive observational studies for establishing baseline infection rates, monitoring trends over time, and evaluating the effectiveness of infection control interventions. This study can fill an important knowledge gap, showing the true CAUTI rates at ICUs of a tertiary care hospital in Etawah, establishing a foundation for evidence-based infection prevention strategies tailored to the local healthcare environment. With this information, hospitals can take better steps to prevent CAUTIs—such as improving hygiene during urinary catheter use, ensuring the catheter is properly secured at all times after placement and the drainage bag is always above the floor and below the bladder level, reviewing whether catheters are really needed, and ascertaining early removal when possible.

Conclusions

This study provides the first significantly relevant and practice-guiding data on CAUTI rates at a tertiary care hospital within the Etawah district. By monitoring catheterized patients and systematically analyzing surveillance case sheets in ICUs, our study has established baseline CAUTI incidence rates for the local healthcare setting. Hand hygiene practices exert a sustained and potent impact on infection control, significantly lowering CAUTI incidence.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Uneza Husain, Dharmendra P. Singh

Acquisition, analysis, or interpretation of data: Uneza Husain, Rajesh K. Verma

Drafting of the manuscript: Uneza Husain, Dharmendra P. Singh

Critical review of the manuscript for important intellectual content: Uneza Husain, Rajesh K. Verma

Supervision: Uneza Husain

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the

submitted work.

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