Biomedicine Advances

Biomed adv 2026;3(3):117-122
doi:10.34172/bma.73
https://biomedad.ae

Original Article

Distribution of Pathogens and Antimicrobial Resistance in Catheter-Associated Urinary Tract Infections in Hospitalized Patients in a Tertiary General Hospital in Tehran, Iran, 2024-2025

Mahboobeh Nazarpoor[1], Seyedeh Esmat Hosseini[2], Soheil Rahmani Fard[1], Sara Saeedifar[1], Neda Shafiei[3], Shirin Manshouri[4], Sobhan Mehdeipour[1], Sara Minaeian[1*]

[1]Antimicrobial Resistance Research Center, Institute of Immunology and Infectious Diseases, Iran University of Medical Sciences, Tehran, Iran
[2]School of Nursing and Midwifery, Iran University of Medical Sciences, Tehran, Iran
[3]Control infection of Rasool Akram Hospital, Iran University of Medical Sciences, Tehran, Iran
[4]Cardiovascular Research Center, Rajaie Cardiovascular Institute, Tehran, Iran

***Corresponding Author:** Sara Minaeian, Email: sara.minaeian@gmail.com

Summary

Introduction: Nosocomial urinary tract infections (UTIs), particularly catheter-associated urinary tract infections (CAUTIs), remain as one of the most common complications of hospitalization. Recent evidence suggests a shift in pathogen profiles, including a growing contribution of fungal organisms, alongside increasing prevalence of antimicrobial resistance among bacterial isolates.

Methods: We conducted a retrospective cross-sectional study over one year (March 2024–February 2025) in a tertiary hospital in western Tehran. Symptomatic CAUTI cases with positive urine culture ≥ 48 hours after admission were included. Demographic and clinical data, ward distribution, microbiological findings, time-to-infection measures, and in-hospital outcome were extracted from medical records and the hospital information system.

Results: Most cases were identified in intensive care units and the mortality rate of the CAUTI population was 41.9% (113/270). The dominant pathogen was *Candida* spp. (53%, 143/270). Second most frequently isolated organisms were *Klebsiella* spp. (18.5%, 50/270), followed by *E. coli* (13.3%, 36/270), and *Enterococcus* spp. (9.25%, 25/270). Analyses of antimicrobial susceptibility showed high resistance rates among *Klebsiella* spp. and *E. coli isolates*, particularly to cephalosporins and fluoroquinolones, as well as notable carbapenem resistance.

Conclusion: These findings highlight the importance of monitoring catheter-associated urinary tract infection in hospitalized patients and appropriate antibiotic prescribing based on antibiogram results. Additionally, it is necessary to study the antibiogram test for *Candida* spp. because it was the predominant pathogen in this hospital.

keywords: Urinary tract infections, Urinary catheters, Intensive care units, Drug resistance, Microbial

Received: May 13, 2026, **Revised:** June 14, 2026, **Accepted:** July 2, 2026, **ePublished:** July 20, 2026

Introduction

Healthcare-associated infections (Healthcare-Associated Infections; HAIs) remain a major global public health challenge and continue to threaten patient safety by increasing complications, prolonging hospital stays, and imposing substantial treatment-related costs. [1] Among these infections, urinary tract infections (Urinary Tract Infections; UTIs) are among the most common microbial infections in humans. Notably, in hospitalized patients—particularly older adults and individuals with immunosuppression or exposure to invasive devices—the burden of disease and the risk of adverse outcomes are considerably higher. [2]

Catheter-associated urinary tract infection (CAUTI) is one of the most important forms of hospital-acquired UTI and is associated with prolonged length of hospital stay, which in turn increases healthcare costs, and, in some cases, bacteremia, sepsis, and mortality. [3]

According to the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) criteria, CAUTI is defined as a symptomatic urinary tract infection (SUTI) in a patient who, on the date of infection, has had an indwelling urinary catheter in place for more than two consecutive days in the same location of care. [4] Catheterization provides a direct route for pathogen entry and promotes colonization and biofilm formation on the catheter surface, thereby impairing natural urinary defenses and increasing infection risk. [5,6] Therefore, timely diagnosis and intervention are essential to prevent complications such as cystitis, pyelonephritis, bacteremia, and urosepsis. [7]

Pathogenetically, many UTIs begin with urethral contamination followed by microbial ascent to the bladder, adhesion, replication, and persistence through biofilm

formation, a process that may be intensified by catheter use. [8] Although E. coli is generally the most common etiologic agent of UTI, pathogen distribution varies according to demographic and clinical factors, including age, sex, and catheterization, and may lead to bloodstream infection and severe outcomes in certain patients. [9]

While most CAUTI pathogens are bacterial, *Candida* species, particularly *Candida albicans*, have increasingly been recognized as important non-bacterial contributors to catheter-associated urinary infections. [10] However, despite global concerns regarding changing urinary pathogen profiles and the growing role of fungal agents, coherent data on epidemiology, clinical outcomes, and pathogen-specific mortality in Iranian referral hospitals remain limited. Furthermore, recent studies point to an interesting finding that shows an increased prevalence of fungal-associated CAUTIs that demonstrates an evolving field. [11-13]

Therefore, this one-year retrospective study aimed to characterize the epidemiology and distribution of microorganisms and determine clinical outcomes, including length of stay and mortality stratified by pathogen type and ward of admission, among patients with CAUTIs in a teaching–treatment center.

Methods

Study Design and Setting

This retrospective, descriptive cross-sectional study evaluated the epidemiology and in-hospital outcomes of CAUTIs over a one-year period (March 2024 to February 2025) in a teaching hospital in western Tehran, Iran. The study protocol was approved by the Ethics Committee of Iran University of Medical Sciences (IR.IUMS.REC.1402.059).

Study Population

Data were extracted from medical records and the hospital information system (HIS) using a structured checklist. Urine culture and available antimicrobial susceptibility data were obtained from the final laboratory reports available in the HIS. CAUTI cases were identified from the hospital infection surveillance records. All included patients had been previously classified and recorded as CAUTI cases according to the hospital surveillance system based on CDC/NHSN criteria. No polymicrobial urine cultures were recorded in the final dataset available for analysis; therefore, all included cases were classified according to a single reported organism. As the study relied on routinely collected hospital data, detailed information regarding urine sampling procedures, culture methods, colony count thresholds, culture media, and organism identification techniques was not available to the investigators. Collected variables included age, sex, admitting ward, organism identified in urine culture, time from admission to infection onset (days), time from urinary catheter insertion to infection onset (days), total length of stay, and in-hospital outcome (discharge with recovery/partial recovery vs death). In-hospital mortality was recorded as death during the same hospital admission, regardless of the underlying cause. The available dataset did not include information on whether death was directly attributable to CAUTI. Cases were included if (i) clinical signs and symptoms of UTI were documented and (ii) urine culture was positive ≥ 48 hours after admission. Records with missing key information (e.g., unclear final in-hospital outcome or length of stay) were excluded. After applying these criteria, 270 patients were included.

All included patients underwent urinary catheterization; however, catheter-to-infection time was unavailable for 21 patients, and analyses involving this variable were performed using available cases (n = 249).

Antimicrobial Susceptibility Testing

Extracted data included inhibition zone test results of commonly used antibiotics— ciprofloxacin (5 µg), cefotaxime (30 µg), cefepime (30 µg), cefazolin (30 µg), amikacin (30 µg), gentamicin (10 µg), imipenem (10 µg), piperacillin–tazobactam (100/10 µg), nitrofurantoin (300 µg), colistin (10 µg), vancomycin (30 µg), and linezolid (30 µg)—and were summarized as drug-class levels. *Enterococcus* isolates were reported separately due to their Gram-positive nature and different resistance patterns. An isolate was defined as multidrug-resistant (MDR) if it was non-susceptible to at least one antimicrobial agent in three or more antimicrobial categories. [14]

Statistical Analysis

Statistical analyses were performed using SPSS software (version 26; IBM Corp., Armonk, NY, USA). Continuous variables, including length of hospital stay, time from hospital admission to infection onset, and time from device insertion to infection, were expressed as mean ± standard deviation (SD).

Differences in these continuous variables among pathogen groups were evaluated using one-way analysis of variance (ANOVA). When a statistically significant overall difference was observed, post hoc pairwise comparisons were conducted using Tukey's test.

A P-value < 0.05 was considered as statistically significant.

Results

Demographic and Clinical Characteristics

A total of 270 patients with CAUTI were included. The study population showed a nearly balanced sex distribution and an older age profile, and most cases were identified in ICU settings. 50.4% (136) of patients were male and 49.6% (134) of them were female. The Mean ± SD age of participants in this study was 66.3 ± 15.7yr old (ranging from 5-97 yr old) (Table 1). *Candida* spp. was the predominant isolate (53%, 143/270), followed by *Klebsiella* spp. (18.5%, 50/270), *E. coli* (13.3%, 36/270), and *Enterococcus* spp. (9.25%, 25/270).

Candida spp. predominated across ICU settings, whereas non-ICU wards demonstrated a more heterogeneous

Table 1. Demographic and clinical characteristics of the study population

Characteristics	Categories	Number	%
Length of stay (days)	<7	20	7.4
	7–14	61	22.6
	15–30	104	38.5
	≥31	85	31.5
Age group (years)	0–19	3	1.1
	20–39	16	5.9
	40–59	48	17.7
	60–79	154	57.1
	≥80	49	18.2
Sex	Male	136	50.4
	Female	134	49.6
Site of admission (ward)	Surgical ICU	67	24.8
	Medical ICU	51	18.9
	General ICU	36	13.3
	Other wards	116	43.0
Admission → infection (days)	1–5	75	27.8
	6–10	51	18.9
	11–20	76	28.1
	≥21	68	25.2
Catheter → infection (days) N = 249	0–3	59	23.7
	4–9	65	26.1
	10–18	67	26.9
	≥19	58	23.3
Outcome	Partial recovery	157	58.1
	Death	113	41.9

pathogen profile. The catheter insertion to infection times were varied among the patients with a mean and standard deviation of 13.80 ± 14.19. Furthermore, the mortality rate of the study population was 41.9% (113/270).

All pertinent information regarding the study population is provided in Table 1.

Antimicrobial Resistance Patterns of Common Bacterial Uropathogens

Antimicrobial susceptibility results for the most frequent bacterial pathogens are summarized at drug class level (Table 2). Overall, in this study, high resistance rates were observed across several commonly used drug classes among *Klebsiella* spp. and *E. coli*. with particularly elevated resistance to cephalosporins and fluoroquinolones. Resistance to carbapenems was also notable in *Klebsiella* spp. and *E. coli*. The *Enterococcus* spp. isolates was most resistant to fluoroquinolones and glycopeptides.

Furthermore, the prevalence of multidrug-resistant (MDR) strains was evaluated. Significant proportions of MDR isolates were identified, particularly among *Klebsiella* spp. and *E. coli*.

Pathogen-Based Comparisons

There was a statistically significant difference in length of hospital stay across pathogen groups. Post-hoc comparisons showed that infections caused by *Candida* spp. and *Klebsiella* spp. were associated with longer hospital stays compared with *E. coli*, while no other pairwise differences reached significance.

Pathogen type also significantly affected the interval between hospital admission and infection. Infections due to *E. coli* occurred earlier than those caused by *Candida* spp. and *Klebsiella*, with no other significant group differences.

Similarly, the interval between device insertion and subsequent infection varied significantly among pathogens. *E. coli* infections developed earlier than those associated with *Candida* spp. and *Klebsiella*, and no additional comparisons were statistically significant. (Table 3).

Discussion

What stood out most in our dataset was how often *Candida* spp. appeared: it accounted for more than half of all isolates (143/270). After Candida, the organisms we observed most frequently were *Klebsiella* spp. (50/270), *E. coli* (36/270), and *Enterococcus* spp. (25/270). The increased presence of *Candida* spp. has also been reported in some recent CAUTI studies. In a Palestinian critical care study, *Candida* spp. were isolated in 75% of CAUTI cases, with non-albicans *Candida* accounting for most fungal isolates. Notably, patients who developed CAUTI had higher in-hospital mortality than those without CAUTI, suggesting that fungal-predominant CAUTI may be clinically relevant in critically ill catheterized patients. [11] That said, the picture is not uniform across settings. In the study by Sleziak et al., *Klebsiella pneumoniae* was the leading CAUTI pathogen, while *Candida* spp. ranked second, accounting for 18.5% of all identified etiological agents. [13] In the study by Reyes-Martinez et al., *E. coli* ranked first, followed by fungi, which accounted for 29.2% of all identified isolates. Among the fungal isolates, *Candida* species were predominant, with *Candida* albicans being the most frequent species, followed by *Candida glabrata* and *Candida tropicalis*. [12] These observations support the growing evidence that *Candida* spp. should not be regarded merely as incidental urinary findings in catheterized hospitalized patients, particularly when describing the etiological profile of CAUTI.

When we set our findings next to a multicenter report from Istanbul by Kucukates et al, the bacterial profile looks broadly comparable, but the *Candida* spp. proportion is dramatically different—about 53% in our study versus 7.53% in the Istanbul study. Also, although resistant organisms such as A. baumannii and P. aeruginosa were more prominent in the Istanbul study, they made up only a small fraction of isolates in our data (1.1% and 4.1%, respectively). [15] Differences in ICU case-mix, antibiotic exposure, catheterization practices, and each hospital's "microbial ecology" could all contribute to such a gap. Interestingly, our distribution is closer to an Ethiopian ICU report, where yeasts accounted for roughly 43% of infections. [7]

Table 2. Antimicrobial resistance patterns of common uropathogens by drug class among CAUTI patients

A. Gram-negative isolates			
Organism	**Drug class**	**Tested number**	**Resistance (%)**
***Kelebsiella* spp. (N = 50)**	Cephalosporins	44	92.3
	β-lactam/β-lactamase inhibitors	22	86.4
	Carbapenems	28	64.3
	Aminoglycosides	43	78.2
	Fluoroquinolones	35	91.4
	Polymyxins (Colistin)	46	32.6
	Total MDR	44/50 88%	
***E. coli* (N = 36)**	Cephalosporins	35	72.4
	β-lactam/β-lactamase inhibitors	18	61.1
	Carbapenems	24	41.7
	Aminoglycosides	35	62.6
	Fluoroquinolones	32	93.8
	Nitrofurantoin	35	0.0
	Polymyxins (Colistin)	36	5.6
	Total MDR	17/36 47.2%	
B. **Gram-positive isolates**			
Organism	**Drug class**	**Tested number**	**Resistance (%)**
***Enterococcus* spp. (N = 25)**	Fluoroquinolones	19	100.0
	Nitrofurantoin	23	8.7
	Glycopeptides	25	84.0
	Oxazolidinones	25	16.0
	Total MDR	4/25 16%	

For each organism, N indicates the total number of isolates recovered in this study. At the class level, an isolate was considered resistant if it was resistant to ≥ 1 agent in that class. Resistance (%) was calculated among tested isolates.

Table 3. Pathogen-based comparisons of clinical/hospital factors

Pathogen	**Length of hospital stay (days) Mean ± SD**	**Admission to infection (days) Mean ± SD**	**Device insertion to infection (days) Mean ± SD**
Candida spp.	30.38 ± 20.88	17.63 ± 14.62	15.73 ± 14.38
Klebsiella spp.	30.04 ± 18.73	16.58 ± 16.06	15.28 ± 16.23
E. coli	15.78 ± 9.10	7.00 ± 4.41	5.71 ± 4.68
ANOVA (Tukey Post hoc)	*P = 0.004*	*P = 0.001*	*P = 0.008*

The antibiogram adds an important second layer to this picture. Even though *Candida* spp. dominates our isolates, resistance among the common bacterial pathogens remains a real issue. Resistance to widely used AB classes such as cephalosporins and fluoroquinolones was high. Moreover, there was a notable resistance to carbapenems among Enterobacterales. Other ICU-focused studies point in the same direction. In Ethiopia, Bizuayehu et al. reported MDR in 65.8% of bacterial pathogens and very high resistance to third-generation cephalosporins such as ceftriaxone and cefotaxime, while amikacin and carbapenems performed comparatively better. [7] In the study by Rabi/Abu-Taha et al., MDR bacteria were identified among CAUTI cases, and ESBL-producing organisms were highlighted among the prominent MDR patterns; prior broad-spectrum exposure was also discussed as a potential source of selective pressure. [11]

This underscores the need to regularly review local prescribing policies, minimize unnecessary catheterization, and strengthen antimicrobial stewardship practices.

In our study, infection tended to appear relatively soon after catheter placement: the mean time to infection onset was 15.2 days from admission and about 13.8 days after device insertion. Recent work suggests that up to 95% of UTIs in ICU settings are catheter-derived, with catheter duration being the key risk factor [16]. Not surprisingly, hospital stays were also long in our population (mean 27.7 days), and ICU-based reports consistently link CAUTI with prolonged hospitalization, greater morbidity, and a higher risk of adverse in-hospital outcomes in critically ill patients. [17]

Finally, we observed differences in in-hospital outcomes across pathogen groups. Cases with *Candida* spp. had the

highest in-hospital mortality rate (57.6%), whereas the corresponding rate for *E. coli* was much lower (13.9%). At the same time, CAUTI may not have been the direct cause of death in every case, and outcome can also reflect comorbidities, baseline severity, and concurrent infections. Therefore, the observed association between *Candida* spp. and higher in-hospital mortality in this study should not be interpreted as evidence of a causal relationship.

From a biological standpoint, Candida's ability to form biofilms on indwelling urinary catheters offers one plausible explanation for persistence and reduced treatment responsiveness in catheterized patients. [18]

To achieve a more comprehensive picture of the etiological spectrum, complementary microbiological testing, including the determination of antifungal susceptibility profiles, should be considered for future studies. This is particularly important given the potential for healthcare-associated fungal urinary tract infections in hospitalized patients and the need for targeted therapies, which can significantly contribute to advancing management strategies and improving clinical outcomes. This study has some limitations related to the retrospective use of routine laboratory data. Since only the final laboratory reports recorded in the HIS were available, we could not evaluate details of urine specimen collection, culture methodology, colony count criteria, culture media, organism identification procedures, or antifungal susceptibility data. This limitation should be considered when interpreting the pathogen distribution observed in this study, particularly the high proportion of *Candida* spp., as potential sampling- or laboratory-related influences could not be assessed.

In addition, information on several potentially important clinical factors, including underlying diseases, immunosuppression status, and severity of illness, was not available in the dataset. Therefore, the potential influence of these factors on clinical outcomes could not be evaluated.

Moreover, the available data only indicated whether patients died during hospitalization and did not include the specific cause of death. Therefore, we could not determine whether deaths were directly attributable to CAUTI.

Conclusion

CAUTIs in the study hospital were concentrated in ICU wards, where *Candida* spp. made up a large share of isolates. The short time between catheter placement and infection onset—alongside prolonged hospital stays—suggests that stricter catheter related guidelines regarding their use, maintenance and duration matter. At the same time, the antibiotic resistance patterns observed among bacterial isolates highlight the need to strengthen antimicrobial stewardship and regularly review local prescribing policies. Taken together, these findings argue for a practical focus on infection prevention in high-risk ICUs, with attention to both fungal and bacterial urinary pathogens.

Acknowledgments

The authors used the ChatGPT language model (OpenAI, San Francisco, CA, USA) to assist with English language editing and grammar during manuscript preparation. All content was reviewed and approved by the authors.

Artificial Intelligence Use Disclosure

ChatGPT (OpenAI; GPT-5.5 Thinking) was used only to support grammar checking, language editing, and readability improvement during manuscript preparation. It was not used to design the study, analyze data, interpret results, develop conclusions, or generate/modify figures. The authors reviewed and edited the AI-assisted text and take full responsibility for the final manuscript.

Authors' Contribution

Conceptualization: Sara Minaeian, Mahboobeh Nazarpoor
Data curation: Seyedeh Esmat Hosseini, Sara Saeedifar, Neda Shafiei, Shirin Manshouri, Sobhan Mehdeipour
Methodology: Sara Minaeian, Mahboobeh Nazarpoor
Supervision: Sara Minaeian
Writing-original draft: Mahboobeh Nazarpoor
Writing-review & editing: Sara Minaeian

Competing Interests

The authors declare no conflicts of interest.

Ethical Approval

The study protocol was approved by the Ethics Committee of Iran University of Medical Sciences (IR.IUMS.REC.1402.059).

Funding

This study was funded by the Vice-Chancellery for Research and Technology of Iran University of Medical Sciences, Tehran, Iran.

References

1. Raoofi S, Pashazadeh Kan F, Rafiei S, Hosseinipalangi Z, Noorani Mejareh Z, Khani S, et al. Global prevalence of nosocomial infection: a systematic review and meta-analysis. PLoS One 2023;18(1):e0274248. doi:10.1371/journal.pone.0274248
2. Flores-Mireles A, Hreha TN, Hunstad DA. Pathophysiology, treatment, and prevention of catheter-associated urinary tract infection. Top Spinal Cord Inj Rehabil 2019;25(3):228-40. doi:10.1310/sci2503-228
3. Fasugba O, Cheng AC, Gregory V, Graves N, Koerner J, Collignon P, et al. Chlorhexidine for meatal cleaning in reducing catheter-associated urinary tract infections: a multicentre stepped-wedge randomised controlled trial. Lancet Infect Dis 2019;19(6):611-9. doi:10.1016/s1473-3099(18)30736-9
4. Centers for Disease Control and Prevention (CDC). National Healthcare Safety Network (NHSN) Patient Safety Component Manual: Chapter 7—Urinary Tract Infection (UTI) Event. Atlanta, GA: CDC; 2026. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/7psccautiurrent.pdf. Accessed May 24, 2026.
5. Shmoury AH, Hanna W, Zakhour J, Zahreddine NK, Kanj SS. Epidemiology and microbiology of catheter-associated urinary tract infections: a 14-year surveillance study at a tertiary care center in Lebanon. J Infect Public Health 2024;17(5):825-32. doi:10.1016/j.jiph.2024.03.022
6. Venkataraman R, Yadav U. Catheter-associated urinary tract infection: an overview. J Basic Clin Physiol Pharmacol 2023;34(1):5-10. doi:10.1515/jbcpp-2022-0152
7. Bizuayehu H, Bitew A, Abdeta A, Ebrahim S. Catheter-associated urinary tract infections in adult intensive care units at a selected tertiary hospital, Addis Ababa, Ethiopia. PLoS One 2022;17(3):e0265102. doi:10.1371/journal.pone.0265102
8. Werneburg GT. Catheter-associated urinary tract infections:

current challenges and future prospects. Res Rep Urol 2022;14:109-33. doi:10.2147/rru.S273663
9. Choi MH, Kim D, Park Y, Jeong SH. Impact of urinary tract infection-causative microorganisms on the progression to bloodstream infection: a propensity score-matched analysis. J Infect 2022;85(5):513-8. doi:10.1016/j.jinf.2022.08.039
10. La Bella AA, Santiago-Tirado FH, Flores-Mireles AL. *Candida auris* is emerging as a prevalent urinary pathogen. PLoS Pathog 2025;21(5):e1013138. doi:10.1371/journal.ppat.1013138
11. Rabi R, Enaya A, Jomaa DM, Dweekat MZ, Raddad S, Saqfalhait ZT, et al. Catheter-associated urinary tract infections in critical care: understanding incidence, risk factors, and pathogenic causes in Palestine. PLoS One 2024;19(8):e0309755. doi:10.1371/journal.pone.0309755
12. Reyes-Martinez P, Sierra-Diaz E, Ortiz-Lazareno PC, Garcia-Gutierrez M, Ramírez-de-Arellano A, Sandoval-Pinto E, et al. Microbiological profile and epidemiological perspective on urinary tract infections (UTIs) in a tertiary medical center in Western Mexico. Front Microbiol 2026;17:1734551. doi:10.3389/fmicb.2026.1734551
13. Sleziak J, Błażejewska M, Duszyńska W. Catheter-associated urinary tract infections in the intensive care unit during and after the COVID- 19 pandemic. BMC Infect Dis 2025;25(1):595. doi:10.1186/s12879-025-10996-2
14. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect 2012;18(3):268-81. doi:10.1111/j.1469-0691.2011.03570.x
15. Kucukates E, Karatas A, Alacam S. Intensive care units-acquired urinary tract infections: a 5-year multicenter retrospective study in Istanbul. J Infect Dev Ctries 2026;20(1):52-61. doi:10.3855/jidc.20690
16. Yajun L, Xuan Z, Juan T, Rui T, Zuyan X, Bingbing Z, et al. Risk factors for catheter-associated urinary tract infection in an intensive care unit: a matched case-control study. BMC Infect Dis 2025;25(1):617. doi:10.1186/s12879-025-10839-0
17. Rubi H, Mudey G, Kunjalwar R. Catheter-associated urinary tract infection (CAUTI). Cureus 2022;14(10):e30385. doi:10.7759/cureus.30385
18. Singh Y, Karicheri R, Nath D. The burden of catheter associated urinary tract infection by *Candida albicans* and non-*albicans* with emphasis on biofilm formation and antifungal sensitivity pattern. Int J Health Sci 2022;6(S2):2356-63. doi:10.53730/ijhs.v6nS2.5544