

Original article

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ASYMPTOMATIC AND SYMPTOMATIC CATHETER-ASSOCIATED URINARY TRACT INFECTIONS
AFTER UROLOGICAL SURGERY: CLINICAL AND MICROBIOLOGICAL DIFFERENCES

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Nosocomial urinary tract infections (NIUT) are common complications in the postoperative care of urological patients. It is estimated that 70–80% of all NIUT are catheter-associated, which gives these infections particular epidemiological and clinical relevance. They may present as catheter-associated asymptomatic bacteriuria (CA-ASB) or symptomatic catheter-associated urinary infection (sCA-UTI). The aim of this retrospective study was the comparison of clinical, laboratory, and microbiological characteristics of patients with CA-ASB and sCA-UTI in the early postoperative period after urological surgical interventions. A total of 130 patients treated at the Clinic of Urology, University Clinical Center Niš, from June 2024 to August 2025, were analyzed. Patients were divided into two groups according to the presence of systemic inflammatory response syndrome (SIRS). Postoperative leukocyte and CRP levels were significantly higher in

the symptomatic group ($p < 0.001$). In sCA-UTI, the most frequent isolates were *Klebsiella* spp. and *Escherichia coli*, while *Enterococcus faecalis* predominated in CA-ASB. Statistically significant differences between groups were observed for *Klebsiella* spp. ($p < 0.001$), *E. faecalis* ($p < 0.001$), and *Pseudomonas* spp. ($p = 0.016$). The median MAR index was higher in the sCA-UTI group (0.75 vs. 0.66; $p < 0.001$). Our findings indicate that sCA-UTI are characterized by a stronger inflammatory response and more frequent isolation of virulent and resistant strains, while CA-ASB more often reflect colonization. Differentiating between these two entities is essential for rational antibiotic use, resistance control and optimization of postoperative care.

Keywords: catheter-associated urinary tract infection; asymptomatic bacteriuria; postoperative infections; antimicrobial resistance

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ASIMPTOMATSKE I SIMPTOMATSKE KATETER-ASOCIRANE URINARNE INFEKCIJE NAKON
UROLOŠKIH OPERACIJA: KLINIČKE I MIKROBIOLOŠKE RAZLIKE

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Nozokomijalne urinarne infekcije (NIUT) česte su komplikacije u postoperativnoj nezi uroloških pacijenata. Procene pokazuju da je 70–80% svih NIUT povezano sa urinarnim kateterom, što ovim infekcijama daje poseban epidemiološki i klinički značaj. One se mogu manifestovati kao kateter-asocirana asimptomatska bakteriurija (CA-ASB) ili kateter-asocirana simptomatska urinarna infekcija (sCA-UTI). Cilj ove retrospektivne studije bio je poređenje kliničkih, laboratorijskih i mikrobioloških karakteristika pacijenata sa CA-ASB i sCA-UTI u ranom postoperativnom periodu nakon uroloških hirurških intervencija. Analizirano je 130 pacijenata lečenih na Klinici za urologiju UKC Niš u periodu od juna 2024. do avgusta 2025. godine. Pacijenti su podeljeni u dve grupe na osnovu prisustva znakova sistemskog inflamatornog odgovora (SIRS). Rezultati su pokazali da su postoperativne vrednosti leukocita i CRP-a bile značajno više u

simptomatskoj grupi ($p < 0,001$). U sCA-UTI najčešće su izolovane *Klebsiella* spp. i *Escherichia coli*, dok je kod CA-ASB dominirao *Enterococcus faecalis*. Razlike između grupa bile su statistički značajne za *Klebsiella* spp. ($p < 0,001$), *E. faecalis* ($p < 0,001$) i *Pseudomonas* spp. ($p = 0,016$). Medijana MAR indeksa bila je viša kod sCA-UTI (0,75 vs. 0,66; $p < 0,001$). Naši nalazi ukazuju da sCA-UTI karakterišu jači inflamatorni odgovor i češća izolacija virulentnih i rezistentnih sojeva, dok CA-ASB češće odražavaju kolonizaciju. Diferencijacija ova dva entiteta od ključnog je značaja za racionalnu upotrebu antibiotika, kontrolu rezistencije i optimizaciju postoperativne nege.

Ključne reči: kateter-asocirane urinarne infekcije; asimptomatska bakteriurija; postoperativne infekcije; antimikrobna rezistencija

Introduction

Nosocomial urinary tract infection (NIUT) is defined as an infection that develops ≥ 48 hours after hospital admission, which was neither in the incubation period nor clinically manifest at the time of admission (1). It represents a serious problem in the postoperative care of urological patients, as it leads to prolonged hospitalization, increased treatment costs, and potential complications (2). According to data from the European Centre for Disease Prevention and Control, nosocomial infections affect approximately 6.5% of hospitalized patients, with urinary tract infections accounting for about one-fifth of all cases, underscoring their considerable epidemiological importance (3). Among patients with NIUT, 70–80% are catheter-associated infections (CA-UTI) (4). Two clinical presentations are distinguished in CA-UTI: catheter-associated asymptomatic bacteriuria (CA-ASB) and symptomatic catheter-associated urinary tract infection (sCA-UTI), depending on the presence of systemic inflammatory response syndrome (SIRS). This distinction has a direct impact on the choice of therapeutic approach, including the duration and type of antimicrobial therapy. Accurate differentiation between these two entities enables more rational use of antibiotics, prevents unnecessary treatment of patients with asymptomatic bacteriuria, and contributes to limiting the spread of multidrug-resistant strains in the hospital environment (5). The aim of this retrospective study was to compare the clinical, laboratory, and microbiological characteristics of patients with CA-ASB and sCA-UTI in the early postoperative period (EPP) following urological surgical interventions, as well as to determine differences in the degree of antibiotic resistance between these two groups.

Materials and Methods

A retrospective study was conducted at the Clinic of Urology, University Clinical Center (UCC) in Niš. Medical records of 130 patients hospitalized for urological surgical interventions between June 2024 and August 2025 were analyzed. The study included patients of both sexes, older than 18 years, who had a sterile urine culture at admission and from whom a urinary pathogen was isolated in the early postoperative period (EPP). The EPP was defined as the period from the end of surgery until the end of the first postoperative week. All patients were catheterized postoperatively.

For each patient, the following data were collected: sex, age, Charlson Comorbidity Index (CCI), urine culture (UC) results with pathogen identification, leukocyte count (WBC) and C-reactive protein (CRP) measured at admission and during the EPP, as well as the multiple antibiotic

resistance (MAR) index of the isolated microorganism. The degree of comorbidity was assessed using the CCI, a validated prognostic score developed by Mary Charlson and colleagues in 1987, designed to quantify comorbidity burden. The index includes 19 chronic conditions, each assigned a weighted score (1 to 6) depending on its impact on mortality. The total sum provides a comorbidity score, with higher values indicating increased mortality risk and poorer clinical outcome (6).

Laboratory parameters and urine cultures included in the analysis were sampled on the same day to ensure temporal consistency of the data. Review of medical records was performed to exclude the presence of postoperative surgical complications or other conditions (e.g., autoimmune or inflammatory diseases) that could have influenced the elevation of inflammatory markers.

Based on the presence of systemic inflammatory response syndrome (SIRS), patients were divided into two groups: CA-ASB (without SIRS) and sCA-UTI (with SIRS), which were then compared. The presence of SIRS was assessed according to established criteria: the condition was defined if at least two of the following were present — body temperature $> 38\text{ }^{\circ}\text{C}$ or $< 36\text{ }^{\circ}\text{C}$, heart rate $> 90/\text{min}$, respiratory rate $> 20/\text{min}$ or partial pressure of CO_2 (PaCO_2) $< 32\text{ mmHg}$, leukocyte count $> 12 \times 10^9/\text{L}$ or $< 4 \times 10^9/\text{L}$, or more than 10% immature neutrophil forms (7).

The mean MAR index was calculated separately for each patient group, and additionally for each isolated microorganism. The MAR index was defined as the ratio of the number of antibiotics to which a given isolate was resistant to the total number of antibiotics tested (8), with values greater than 0.2 indicating multidrug resistance (9).

Statistical analysis was performed using IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean (M) \pm standard deviation (SD) or as median (Mdn) with interquartile range (IQR), depending on distribution. Comparisons between groups were made using Student's t-test or Mann-Whitney U test, and categorical variables were analyzed with the χ^2 test or Fisher's exact test. Statistical significance was defined as $p < 0.05$.

The study was conducted in accordance with the Declaration of Helsinki, with full respect for patient privacy and confidentiality.

Results

Out of a total of 130 patients analyzed in the study, 65 had CA-ASB and 65 had sCA-UTI. In the asymptomatic group, there were 47 men (72.3%) and 18 women (27.7%), while the symptomatic group included 51 men (78.5%) and 14 women (21.5%). The mean age of patients in the asymptomatic group was 67 (56–74) years, compared with 67 (58–70) years in the symptomatic group. The mean CCI value in the asymptomatic group was 3.7 (1.4–4.9), while in the symptomatic group it was 4.4 (3.2–4.9). There were no significant differences between the two groups in terms of sex distribution, age, or mean CCI values ($p > 0.05$) (Table 1).

Table 1. Baseline characteristics of patients with CA-UTI (sex, age, CCI) and p-values for group comparison

	CA-ASB (n=65)	sCA-UTI (n=65)	p- value
Sex [Male/Female]	47/18 (72.3%/27.7%)	51/14 (78.5%/21.5%)	0.54
Age [Year]^a	67 (56–74)	67 (58–70)	0.29
CCI^a	3.7 (1.4–4.9)	4.4 (3.2–4.9)	0.12

^aData are presented as median (interquartile range)

CCI- Charlson Comorbidity Index

At admission, WBC counts were comparable between groups (CA-ASB: $7.3 \times 10^9/L$, IQR 6.5–9.0; sCA-UTI: $7.1 \times 10^9/L$, IQR 6.2–8.9; $p = 0.916$). During the early postoperative period (EPP), WBC remained stable in the asymptomatic group, while it increased significantly in the symptomatic group ($p < 0.001$), resulting in higher postoperative values in sCA-UTI ($9.1 \times 10^9/L$, IQR 8.0–11.7) compared with CA-ASB ($8.3 \times 10^9/L$, IQR 6.7–9.1; $p < 0.001$). CRP levels were already higher in symptomatic patients at admission (3.7 mg/L, IQR 2.2–6.8 vs. 3.2 mg/L, IQR 2.3–4.0; $p < 0.001$) and increased markedly in both groups postoperatively ($p < 0.001$ each), reaching substantially higher values in sCA-UTI (91.0 mg/L, IQR 53.0–145.0) compared with CA-ASB (34.0 mg/L, IQR 9.3–56.0; $p < 0.001$). (Figure 1, Figure 2)

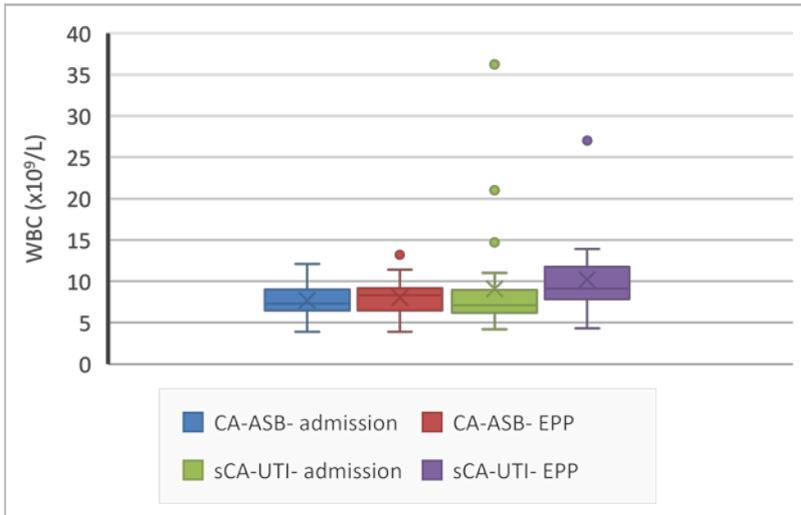


Figure 1. WBC levels at admission and EPP - Within groups: Admission vs EPP in CA-ASB ($p=0.317$), in sCA-UTI ($p < 0.001$); Between groups: Admission (CA-ASB vs sCA-UTI, $p = 0.916$), EPP (CA-ASB vs sCA-UTI, $p < 0.001$)

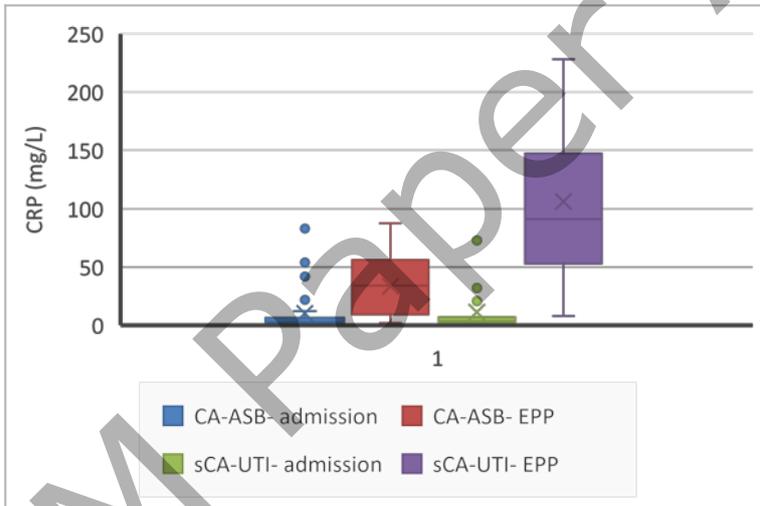


Figure 2. CRP levels at admission and EPP - Within groups: Admission vs EPP in CA-ASB ($p < 0.001$), in sCA-UTI ($p < 0.001$); Between groups: Admission (CA-ASB vs sCA-UTI, $p < 0.001$), EPP (CA-ASB vs sCA-UTI, $p < 0.001$)

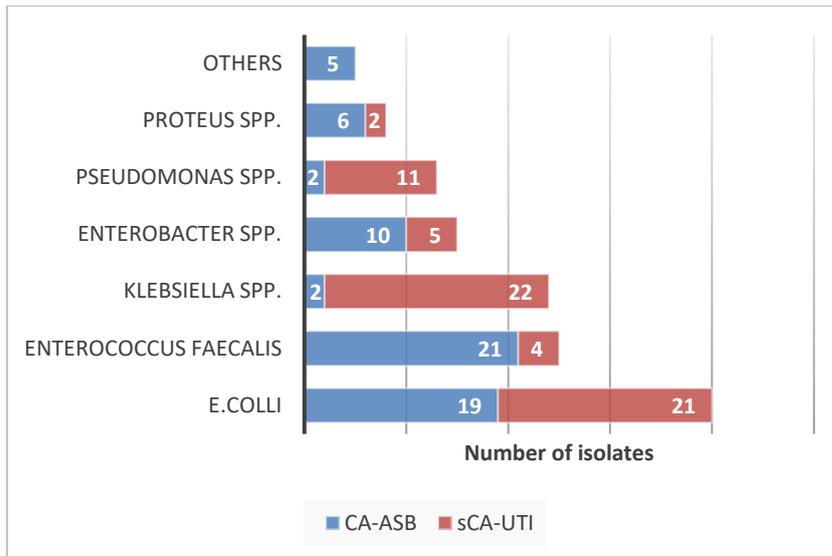


Figure 3. Distribution of bacterial isolates in CA-ASB and sCA-UTI (significant for *Klebsiella* spp., $p < 0.001$; *E. faecalis*, $p < 0.001$; *Pseudomonas* spp., $p = 0.016$)

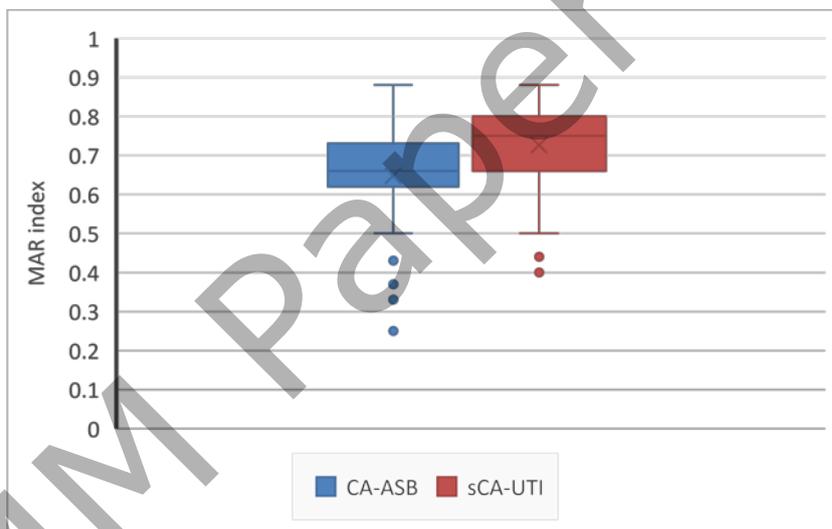


Figure 4. Overall MAR index values in CA-ASB and sCA-UTI (higher in sCA-UTI, $p < 0.001$)

Figure 3 illustrates the distribution of CA-UTI pathogens. In the asymptomatic group, *Enterococcus faecalis* predominated (32.3%), followed by *Escherichia coli* (29.2%) and *Enterobacter* spp. (15.4%), while *Proteus* spp. (9.2%), *Klebsiella* spp. (3.1%), and *Pseudomonas* spp. (3.1%) were less frequently isolated. Other rare isolates, including *Morganella morganii* and

Providencia spp., were detected only sporadically in the asymptomatic group and were not included in the distribution analysis due to their low frequency. In the symptomatic group, the most common isolates were *Klebsiella* spp. (33.8%) and *Escherichia coli* (32.3%), followed by *Pseudomonas* spp. (16.9%), *Enterobacter* spp. (7.7%), *Enterococcus faecalis* (6.2%), and *Proteus* spp. (3.1%). Statistically significant differences between groups were observed for *Klebsiella* spp. (more frequent in the symptomatic group, $p < 0.001$) and *Enterococcus faecalis* (more frequent in the asymptomatic group, $p < 0.001$). *Pseudomonas* spp. was also more frequent in the symptomatic group ($p = 0.016$), while no significant differences were observed for *Escherichia coli*, *Enterobacter* spp., or *Proteus* spp. ($p > 0.05$).

The median MAR index was significantly higher in the symptomatic group compared with the asymptomatic group (0.75; IQR 0.66–0.80 vs. 0.66; IQR 0.62–0.73; $p < 0.001$). The comparison is presented in Figure 4. Table 2 presents the median and IQR values of the MAR index for the most frequently isolated species (*E. coli*, *Enterobacter* spp., *E. faecalis*, and *Pseudomonas* spp.). A significantly higher MAR index was observed in symptomatic patients infected with *E. faecalis* ($p = 0.002$). *E. coli*, *Enterobacter* spp., *Klebsiella* spp. and *Pseudomonas* spp. showed a tendency toward higher MAR indices in the symptomatic group, but the differences did not reach statistical significance. Other species (*Proteus* spp., *Morganella morganii*, and *Providencia* spp.) were excluded from the table due to the low number of isolates in one or both groups.

Table 2. MAR index of the most frequent bacterial isolates in CA-UTI

Bacterial isolates	CA-ASB - MAR	sCA-UTI - MAR	p-value
<i>E. coli</i>^a	0.73 (0.58–0.91)	0.80 (0.72–0.85)	0.168
<i>Enterobacter</i> spp.^a	0.70 (0.66–0.73)	0.80 (0.66–0.8)	0.39
<i>E. faecalis</i>^a	0.62 (0.58–0.66)	0.81 (0.75–0.87)	0.002
<i>Pseudomonas</i> spp.^a	0.50 (0.50–0.50)	0.58 (0.49–0.66)	0.082
<i>Klebsiella</i> spp.^a	0.62 (0.66–0.8)	0.75 (0.66–0.8)	0.149

^aData are presented as median (interquartile range)

For some species (e.g., *Klebsiella* spp., *Pseudomonas* spp. and *E. faecalis*), the number of isolates in one group was small; therefore, results should be interpreted with caution. Other less

frequent species (*Proteus spp.*, *Morganella spp.*, *Providencia spp.*) were excluded from the table due to the low number of isolates in one or both groups, which precluded meaningful statistical comparisons.

Discussion

Our study demonstrated clear differences between patients with CA-ASB and sCA-UTI, primarily in terms of inflammatory response and microbiological profile. Demographic characteristics (sex, age) and CCI in our study did not show statistically significant differences between groups, suggesting that these factors alone do not have a decisive influence on the development of clinical symptomatology of infection, which is consistent with other studies involving larger patient cohorts (10, 11).

In contrast, inflammatory parameters showed a significant postoperative increase in both groups, but this increase was more pronounced among symptomatic patients. This finding supports the role of CRP and WBC not only as diagnostic but also as prognostic markers of infection severity (12, 13). In patients with asymptomatic bacteriuria, elevated inflammatory parameters may be attributable to the postoperative inflammatory response to surgical trauma (PIRS), making it more difficult to distinguish infection from colonization. Therefore, combining laboratory parameters with clinical presentation remains essential for deciding on antimicrobial therapy and avoiding unnecessary antibiotic use (14).

Our study also revealed marked differences in the distribution of isolated microorganisms between the two patient groups. This distribution suggests that the pathogenic potential and virulence of microorganisms may play a key role in the development of clinical symptoms. *Klebsiella spp.* possesses numerous virulence and resistance mechanisms (biofilm formation, capsular polysaccharides, siderophores), enabling it to provoke a stronger inflammatory response and clinically manifest infection. In contrast, *Enterococcus faecalis*, although often persisting in the urinary tract, generally behaves as an opportunistic pathogen with lower virulence, explaining its predominance in asymptomatic cases (15, 16).

Although multiple factors such as duration of catheterization, length of hospitalization, and prior antibiotic exposure are known to influence the course of infection (17–19), the focus of our study was on the microbiological profile of isolated pathogens and their resistance patterns. Unlike

previous studies that were mainly directed toward specific procedures and general risk factors (20, 21), our work enabled direct comparison of CA-ASB and sCA-UTI in the EPP following different urological operations. This complements existing literature and emphasizes the role of pathogen profile and resistance (22) as key determinants of clinical presentation.

Analysis of the MAR index demonstrated that multidrug resistance was more pronounced in symptomatic infections. The most striking finding was observed for *Enterococcus faecalis*, which exhibited a significantly higher MAR index among symptomatic patients. This suggests that more resistant *E. faecalis* strains are more likely to cause clinically manifest infections, whereas less resistant strains tend to remain within asymptomatic colonization. Thus, antimicrobial resistance, alongside virulence factors, appears to be a decisive determinant of infection presentation (23). For *E. coli*, *Pseudomonas* spp., *Klebsiella* spp., and *Enterobacter* spp., a tendency toward higher MAR indices was noted in symptomatic patients, but these differences did not reach statistical significance. This lack of significance may be attributed to the limited number of isolates in one of the groups, yet the trend remains clinically relevant as it indicates that symptomatic infections are more often associated with resistant strains (24, 25).

The isolation of *Morganella morganii* and *Providencia* spp. exclusively in the asymptomatic group suggests their opportunistic nature and limited pathogenic potential in CA-UTI. While usually colonizers of the urinary tract, they may under certain conditions become relevant nosocomial pathogens (26, 27).

Our findings clearly confirm the clinical and therapeutic significance of distinguishing CA-ASB and sCA-UTI. While symptomatic patients require prompt and targeted antimicrobial therapy, the priority in asymptomatic cases is to avoid unnecessary antibiotic administration, thereby reducing selective pressure and preserving the efficacy of available agents. Furthermore, the higher MAR index observed in symptomatic patients indicates that multidrug resistance may contribute to more severe clinical presentation, prolonged infection duration, and poorer response to empirical therapy, underscoring the importance of timely microbiological diagnostics and targeted antibiotic treatment.

Limitations of the Study

This study has several limitations that should be considered when interpreting the results. Its retrospective design carries the risk of incomplete or inaccurate data in medical records and

precludes establishing causal relationships between observed parameters and clinical outcomes. The sample size was relatively small and derived from a single tertiary care center, which limits the generalizability of the findings to a broader population. Additionally, not all potentially relevant risk factors were analyzed, including prior antibiotic exposure, duration of catheterization, type of urological surgical procedure, and individual comorbidities, which may further influence the occurrence and severity of CA-UTI. For these reasons, our results should be confirmed in future studies with larger cohorts and a prospective design.

Conclusion

Our study showed that symptomatic nosocomial urinary tract infections after urological surgery differ from asymptomatic cases by exhibiting a more pronounced inflammatory response, more frequent isolation of virulent pathogens such as *Klebsiella* spp. and *E. coli*, and a higher MAR index. In contrast, asymptomatic infections were more often associated with colonization by less virulent microorganisms, particularly *Enterococcus faecalis*. These findings highlight the crucial importance of differentiating between CA-ASB and sCA-UTI in clinical practice: while symptomatic infections require prompt and targeted antibiotic therapy, asymptomatic cases should prioritize avoiding unnecessary treatment, thus preserving antibiotic efficacy and reducing selective pressure for resistance development. Future studies with larger patient samples and prospective design are warranted to further elucidate the relationship between microbiological characteristics, host factors, and clinical course of these infections.

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