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ORIGINAL ARTICLE

# Causative Organisms and Their Antimicrobial Sensitivity Pattern of Urinary Tract Infection in Chronic Kidney Disease Patients

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## Abstract

***Background:*** *Chronic kidney disease (CKD) is a significant public health issue, particularly in developing countries. Irrespective of gender urinary tract infections (UTIs) are common among CKD patients due to the presence of various risk factors.*

***Objective:*** *To examine the types of organisms and their antimicrobial sensitivity patterns in urinary tract infections among patients with chronic kidney disease.*

***Methods:*** *This observational study was conducted in the Department of Nephrology Bangladesh Medical University (BMU) for approximately 18 months following approval of the protocol by the Institutional Review Board (IRB). All patients were older than 18 years & they were selected based on selection criteria. Detailed medical histories were taken, physical examinations were performed, and routine laboratory results were noted. Blood and urine samples for culture and sensitivity were collected as per protocol. Culture and sensitivity of urine was investigated in the Department of Microbiology, BMU.*

***Results:*** *In the context of urinary tract infection (UTI) risk factors, there is a clear predominance of middle-aged and older adults, particularly those aged 51–70 years. Gender differences in infection prevalence were noted, with E. coli and Klebsiella more common in men, while Staphylococcus aureus was more prevalent in women. A significant proportion of patients 53 (48.3%) belong to stage 3 CKD followed by 48 (43.6%) patients in stage 4 CKD and 9 (8.1%) patients in stage 5 CKD. E. coli was the most common (68.1%) pathogen followed by Klebsiella (13.6%) and Staphylococcus aureus (7.4%). Antibiotic resistance patterns showed that E. coli had high sensitivity to Nitrofurantoin, Meropenem, and Gentamicin but lower sensitivity to Ciprofloxacin and Ceftriaxone. Klebsiella and other pathogens exhibited variable antibiotic sensitivities.*

***Conclusion:*** *Urinary tract infection (UTI) in CKD is predominant among middle-aged and older adults. Escherichia coli (E. coli) was the most common pathogen identified, followed by Klebsiella and Staphylococcus aureus. E. coli demonstrated high sensitivity to Nitrofurantoin, Meropenem, and Gentamicin, but showed lower sensitivity to Ciprofloxacin and Ceftriaxone.*

***Keywords:*** *Antimicrobial Sensitivity Pattern, Causative Organisms, Chronic kidney disease (CKD), Urinary Tract Infection (UTI)*

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## Introduction

Chronic kidney disease (CKD) is a significant public health issue in the 21st century, associated with higher morbidity and mortality compared to individuals without CKD. In Bangladesh, the prevalence of CKD is 22.48%[1], exceeding the global average. CKD is a known risk factor for urinary tract infections (UTIs), primarily due to metabolic abnormalities that disrupt the body's primary defense mechanisms. CKD complications include weakened immunity, anemia, malnutrition, inflammation, vitamin deficiencies, and a decline in quality of life[2]. Moreover, patients undergoing long-term hemodialysis are more susceptible to infections like UTIs due to impaired immunity[3].

Urinary tract infection (UTI) is a term applied to a variety of clinical conditions ranging from asymptomatic occurrence of bacteria in the urine to severe kidney infection with resultant sepsis[4] and presents microbial colonization of urine and infections of the lower and upper urinary tract[5]. UTI can be either asymptomatic or symptomatic, characterized by a wide spectrum of symptoms ranging from mild irritative voiding to bacteremia, sepsis, shock or even death. In specific patient groups, urosepsis may show high mortality rates of 25% to 60%[6].

Urinary tract infection (UTI) is caused by the invasion of harmful microbes into the urinary tract. It is one of the most common infections occurring both in the community and in healthcare settings, affecting around 150 million people worldwide each year[7]. Most UTIs are caused by bacteria, with prevalence rates ranging from 21.8% to 31.3%[7]. The incidence of urinary tract infections (UTIs) is higher in individuals with chronic kidney disease (CKD) due to structural and functional abnormalities[8].

Bacteria identified from urine of patients with urinary tract infection (UTI) usually stem from the normal flora of the gut, vagina and per urethral region[9] which may arise more often in women than men because of the shortness of female urethra, and in a patient exposed to urinary catheters and/or bacteria on contaminated urological instruments, during sexual intercourse, and fluid which may enter into the genitourinary area without previous host colonization[9].

Antibiotic resistance is a growing global challenge in infection treatment. Organisms from Latin America exhibit the highest levels of resistance, followed by those from the Asia-Pacific region and European countries, while resistance is lowest in Canada.[10] In Bangladesh, more than 50% of *Enterobacteriaceae* strains causing urinary tract infections, both community-onset and healthcare-associated, showed resistance to third-generation cephalosporins[11].

Some bacteria are virulent and capable of acquiring multidrug resistance to antimicrobials. For example, *Escherichia coli* (*E. coli*) is Gram-negative bacteria which can generate large spectrum of beta-lactam enzymes making them resistant to most beta-lactam antibiotics[12]. Multi-Drug Resistant (MDR) results in great clinical problems because of limited therapeutic options[13].

The high resistance rates among these organisms to most antibiotics, except carbapenems, highlight the overuse of antibiotics in recent decades. Multi-drug-resistant strains of *E. coli* are particularly common. Rates of antimicrobial resistance varies according to geographic locations and they are directly proportional to the use and misuse of antimicrobials, posing a threat to public health[14].

Various uro-pathogens have been identified based on clinical settings and risk factors, with *E. coli* being the most common cause of UTIs, followed by *Klebsiella pneumoniae* as the second most prevalent[15]. A multicenter study on bacteremia UTIs conducted in Korea reported that *E. coli* and *K. pneumoniae* accounted for 71.8% of healthcare-associated UTIs and 89.9% of community-onset UTIs[16].

It's critical for CKD patients to make an early diagnosis of urinary tract infection (UTI). Identifying the organisms causes UTIs among CKD patients and select the sensitive antibiotics is essential to ensuring appropriate therapy. In this background, the current study was aimed to investigate the types of microorganisms and their patterns of antibiotic sensitivity in urinary tract infections among individuals with chronic renal disease.

## Methodology

A cross sectional observational study was conducted at Department of Nephrology, Bangladesh Medical University (BMU). Dhaka, Bangladesh. Total 110 patients with CKD were studied over a period of 18 months. After getting IRB approval, patients were recruited from the indoor and outdoor of Department of Nephrology of Bangladesh Medical University (BMU). Inclusion criteria comprised CKD patients aged above 18 years with confirmed UTI diagnoses, while those excluded were patients on empirical antibiotic treatment, renal allograft recipients, and those on maintenance hemodialysis (MHD). Patients were fully informed about the procedure

using their own language properly, taking adequate time. Then, written consent was taken for the study. CKD patients were diagnosed and put into different stages of CKD according to KDIGO 2024 criteria. Among those patients who had ≥10 Pus cells/HPF in unspun urine sample were selected in this study. Detailed history was taken from all the respondents using a semi structured questionnaire and a check list were filled up collecting data from the patients. Clinical examination of the patients was also done and recorded. Proper instruction of urine collection method in their own language was provided before the collection of urine for culture and sensitivity analysis.

**Identification of Organisms**

In the laboratory, from the urine sample about 5µl of urine was inoculated in the chromogenic media by 2mm in diameter platinum wire loop at 45R" angle. After 24 hours of incubation at 37!, family of different bacteria were identified by colony morphology on chromogenic media. The chromogen X-glucosidase is cleaved by beta glucosidase enzyme, which is produced by *Enterococci* resulting blue colony. The chromogen red-galactosidase is cleaved by beta galactosidase enzyme, which is produced by *E. coli* resulting burgundy/pink colony. Cleavage of both chromogen by coliform group resulting purple colony. *Proteus* and *Pseudomonas* produce brown and fluoresce colonies. *Staphylococcus* aureus produce white/creamy colonies.

**Antimicrobial Susceptibility Test**

Disk diffusion method (according to CLSI 2019 disk diffusion break point criteria) was used for antimicrobial susceptibility testing of the isolated organism by Kirby-Bauer method using Mueller-Hinton agar and commercially available antibiotic disc. The dried surface of Mueller-Hinton agar plate was inoculated by streaking the swab over the entire sterile agar surface. Predetermined antimicrobial disks were dispensed on to the surface of the inoculated agar plate. Antibiotic discs of ceftriaxone (30 µg), ceftazidime (30 µg), cotrimoxazole (1.25/23.75 µg), ciprofloxacin (5 µg), gentamycin (10 µg), amikacin (30 µg), netilmicin (30 µg), imipenem (10 µg), meropenem (10 µg), linezolid(10 µg), nitrofurantoin (30 µg), colistin (10 µg), tigecycline (15 µg) were used. The plates were inverted and placed in an incubator set to 37ºC for another 16- 18 hours. The disc content and zone of inhibition were used as recommended by the Clinical Laboratory Standards Institute guideline[17]. In case of colistin and polymyxin B zone of inhibition was used per laboratory procedure because such guideline is absent in CLSI guideline. The antimicrobial discs were used according to the standard antibiotic panel for specific sample and isolated organisms. Zone of inhibition was fixed on basis of bacteria isolated in the urinary sample.

**Data Analysis**

The collected data were checked, verified and then entered into the computer. The analysis was carried out with the help of Statistical Package for Social Science (SPSS) version 26 for Windows. For descriptive statistics frequency with percentage and mean with standard deviation were used as appropriate.

## Results and observation

The total study population were 110, among them 60 (54.5%) were male and 50 (45.5%) were female. The highest representation was seen in the 51–60 years age group with 30 (27.2%), followed by the 61–70 years group with 21 (19.0%) and those aged 71 years and above at 20 (18.1%). The least represented group was d"20 years, with only 2 (1.8%). The mean age of the study population was 54.71 ± 16.05 years, with a range spanning from 18 to 90 years (Table- 1).

**Table- I**

*Distribution of study population according to age (N=110)*

| Age (year) | Frequency (n) | Percentage (%) |
|---|---|---|
| Age groups | | |
| ≤20 | 02 | 1.8 |
| 21 – 30 | 08 | 7.2 |
| 31 – 40 | 11 | 10.0 |
| 41 – 50 | 18 | 16.3 |
| 51 – 60 | 30 | 27.2 |
| 61 – 70 | 21 | 19.0 |
| >70 | 20 | 18.1 |
| Mean±SD | 54.71±16.05 | |
| Minimum-maximum | 18 – 90 | |
| Gender | | |
| Male | 60 | 54.5 |
| Female | 50 | 45.5 |

*E. coli* was the most common pathogen, causing 75 (68.2%) infections- 43 (71.7%) in males and 32 (64.0%) in females. Klebsiella accounted for 15 (13.6%) cases-9 (15.0%) in males and 6 (12.0%) in females. *Staphylococcus aureus* was more common in females (5 of 8 cases), while

Pseudomonas affected both sexes equally (3 cases in each gender). Acinetobacter and Enterococcus each caused 3 (2.7%) infections, with both more frequent in females (Table-II).

**Table-II**

*Frequency of isolated organisms in CKD patients with UTI according to gender (N=110)*

| Isolated organisms | Total (n=110) | Male (n=60) | Female (n=50) |
|---|---|---|---|
| *E. Coli* | 75 (68.2) | 43 (71.7) | 32 (64.0) |
| *Klebsiella* | 15 (13.6) | 9 (15.0) | 6 (12.0) |
| *Staph. aureus* | 8 (7.3) | 3 (5.0) | 5 (10.0) |
| *Pseudomonas* | 6 (5.5) | 3 (5.0) | 3 (6.0) |
| *Acinetobacter* | 3 (2.7) | 1 (1.7) | 2 (4.0) |
| *Enterococcus* | 3 (2.7) | 1 (1.7) | 2 (4.0) |

Among the study patients, a significant proportion of patients 53 (48.3%) belong to stage 3 CKD, followed by 48 (43.6%) at stage 4 and 9 (8.1%) in stage 5 (Figure- 1).

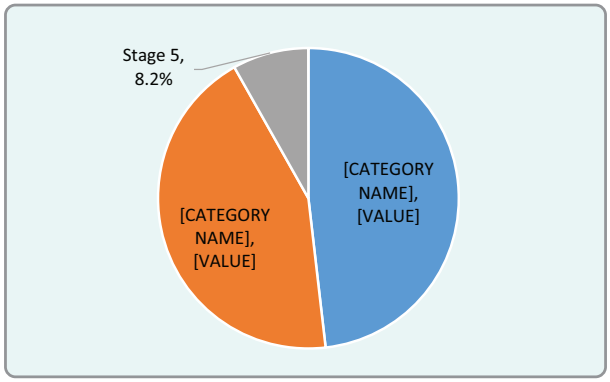


**Figure 1:** *Pie chart showing frequency of UTI according to CKD stages*

*E. coli* was the most common organism in stage 3 & 4 CKD, accounting for 41 & 31 cases respectively. *Klebsiella* were most frequent in stage 4 followed by stage 5 CKD, accounting for 09 and 04 cases respectively. Similarly, *Pseudomonas* was mostly found in stage 4, accounting for 5 cases. Staph. aureus was most prevalent in stage 3, accounting for 6 out of 9 cases. The 3 cases of *Enterococcus* were found in stage 3 CKD. *Acinetobacter* were distributed in stage 3 and 4, accounting for 1 and 2 cases respectively (Table-III).

**Table-III**

*Different organisms causing UTI according to CKD (N=110)*

| Isolated organisms | Total (n=110) | Stage 3 (n=53) | Stage 4 (n=48) | Stage 4 (n=9) |
|---|---|---|---|---|
| *E. Coli* | 75 (68.2) | 41 (37.3) | 31 (51.7) | 3 (6.0) |
| *Klebsiella* | 15 (13.6) | 2 (1.8) | 9 (15.0) | 4 (8.0) |
| *Staph. aureus* | 8 (7.3) | 6 (5.5) | 1 (1.7) | 1 (2.0) |
| *Pseudomonas* | 6 (5.5) | 0 (0.0) | 5 (8.3) | 1 (2.0) |
| *Acinetobacter* | 3 (2.7) | 3 (2.7) | 0 (0.0) | 0 (0.0) |
| *Enterococcus* | 3 (2.7) | 1 (0.9) | 2 (3.3) | 0 (0.0) |

Digit in parentheses indicate corresponding percentage

Regarding the causes of CKD; diabetic kidney disease (DKD) being the most prevalent cause accounting for 53 (48.2%). Glomerulonephritis (GN) was the second most common cause, observed in 23 (20.9%) patients, followed by hypertension (HTN), in 12 (10.9%) patients. Obstructive nephropathy (ON) accounted for 11 (10.0%) cases. Autosomal dominant polycystic kidney disease (ADPKD) and unknown causes were identified in 4 (3.6%) patients each, while chronic pyelonephritis (CPN) was the least common cause, found in 3 (2.7%) cases (Table- 4).

**Table-IV**

*Distribution of the study population according to underlying cause of CKD (N=110)*

| Underlying causes of CKD | Frequency (n) | Percentage (%) |
|---|---|---|
| DKD | 53 | 48.2 |
| GN | 23 | 20.9 |
| HTN | 12 | 10.9 |
| ON | 11 | 10.0 |
| ADPKD | 04 | 3.6 |
| Unknown | 04 | 3.6 |
| CPN | 03 | 2.7 |

Data expressed as frequency and percentage.

*E. coli* showed high sensitivity to Nitrofurantoin (72.8%), Meropenem (70%), and Gentamicin (55.7%), while demonstrating lower sensitivity to Ciprofloxacin (27.1%) and Ceftriaxone (25.7%). *Klebsiella* exhibited the highest sensitivity to Colistin (86.7%) and moderate sensitivity to Gentamicin (46.7%) and Meropenem (53.3%), but was resistant to Aztreonam and Linezolid. *Pseudomonas* was moderately sensitive to most antibiotics, including Ciprofloxacin, Ceftazidime and Amikacin (all at 50%), but was resistant to Co-trimoxazole. *Acinetobacter* showed complete resistance to Ceftazidime, Aztreonam, Mecillinam and Amikacin but had 100% sensitivity to Ciprofloxacin, Co-trimoxazole, Gentamicin, Meropenem, and Nitrofurantoin (Table- V).

**Table-V**

*Antibiotic sensitivity pattern of gram-negative organisms*

| Organisms | *E. coli* | *Klebsiella* | *Pseudomonas* | *Acinetobacter* |
|---|---|---|---|---|
| Antibiotics | | | | |
| Amikacin (%) | 50 | 40 | 50 | R |
| Aztreonam (%) | 18.6 | R | 16.7 | R |
| Ceftazidime (%) | 27.1 | 13.3 | 50 | R |
| Ceftriaxone (%) | 25.7 | R | 50 | 66.6 |
| Ciprofloxacin (%) | 27.1 | 10 | 50 | 100 |
| Colistin (%) | 42.8 | 86.7 | 50 | 66.6 |
| Co-trim (%) | 27.1 | 13.3 | R | 100 |
| Gentamicin (%) | 55.7 | 46.7 | 50 | 100 |
| Linezolid (%) | 7.1 | R | 33.4 | 66.6 |
| Mecillinam (%) | 20 | 13.3 | 50 | R |
| Meropenem (%) | 70 | 53.3 | 50 | 100 |
| Netilmicin (%) | 41.4 | 20 | 50 | 66.6 |
| Nitrofurantoin (%) | 72.8 | 26.7 | 50 | 100 |
| Tigecycline (%) | 22.8 | 40 | 50 | 100 |
| Vancomycin (%) | 4.2 | 13.3 | 33.4 | 33.4 |

It was observed that *Staphylococcus aureus* and *Enterococcus* exhibit varied sensitivity to different antibiotics. Both organisms showed a 100% sensitivity to Vancomycin, Gentamicin, and Meropenem. *Enterococcus* displayed complete resistance to Netilmicin, in contrast to *Staphylococcus aureus*, which showed a moderate 62.5% sensitivity. Colistin also demonstrated a significant disparity, with *Enterococcus* being 100% sensitive compared to only 50% for *Staphylococcus aureus*. Ciprofloxacin and Ceftriaxone exhibited lower effectiveness against both organisms (Table-VI).

**Table-VI**

*Antibiotic sensitivity pattern of gram-positive organisms*

| Organisms Antibiotics | *Staph. aureus* | *Enterococcus* |
|---|---|---|
| Amikacin (%) | 50 | 66.6 |
| Aztreonam (%) | 37.5 | 33.4 |
| Ceftazidime (%) | 25 | R |
| Ceftriaxone (%) | R | 33.4 |
| Ciprofloxacin (%) | 25 | 66.6 |
| Colistin (%) | 50 | 100 |
| Co-trim (%) | 62.5 | 100 |
| Gentamicin (%) | 100 | 100 |
| Linezolid (%) | 75 | 100 |
| Mecillinam (%) | 25 | 33.4 |
| Meropenem (%) | 100 | 100 |
| Netilmicin (%) | 62.5 | R |
| Nitrofurantoin (%) | 75 | 66.6 |
| Tigecycline (%) | 100 | 100 |
| Vancomycin (%) | 100 | 100 |

## Discussion

A total of 110 patients diagnosed with CKD and with culture-proven UTIs were included in the study. The age distribution of chronic kidney disease (CKD) patients reveals a predominance of middle-aged and older adults affected by urinary tract infections (UTIs). This finding is comparable to those of Cristea et al.[18], who reported a higher prevalence of UTIs in CKD patients aged 56–75 years, accounting for over 60% of cases. The data suggests that age plays a crucial role in UTI risk, likely due to factors such as immune senescence and comorbidities, particularly diabetes, which were also observed in the study by Dimitrijevic et al.[19] Younger age groups, such as 31–40 years (10.0%) and 21–30 years (7.2%), had significantly lower representation, aligning with the lower incidence of UTIs in younger populations noted by Zhou Y et al. [20]

The distribution of organisms responsible for urinary tract infections (UTIs) in chronic kidney disease (CKD) patients highlights the predominance of *E. coli*, found in 68.1% of cases. This is consistent with global findings, where *E. coli* is the leading cause of both community-acquired and hospital-acquired UTIs.[18,21] However, *Klebsiella pneumoniae* was identified as the second most common organism in the present study, accounting for 13.6% of cases, similar to Cristea et al.[18], who found *Klebsiella* in 32.60% of UTI cases in CKD patients. The presence of *Staphylococcus aureus* (7.4%) and *Pseudomonas* (5.4%) adds complexity to UTI management, as these pathogens are associated with more severe, complicated infections

and increased resistance, which aligns with the multidrug resistance patterns indicated in previous studies[18, 22-23]. Others studies, such as Dimitrijevic et al.[19], reinforce that *E. coli* remains the dominant pathogen in UTIs among CKD patients, although resistance to common antibiotics is growing. Shankar et al. similarly reported *E. coli* as the leading cause of UTIs in CKD patients, followed by *Klebsiella* and *Pseudomonas*[20]. The predominance of gram-negative bacteria, such as *E. coli* and *Klebsiella pneumoniae*, suggests the need for targeted antimicrobial therapy to prevent UTI complications in CKD patients. These studies underscore the importance of targeting *E. coli* in UTI treatment strategies while also considering resistance patterns in less frequent pathogens.

In analyzing the distribution of pathogens causing urinary tract infections (UTIs) by sex, *Escherichia coli* remains the most prevalent, contributing to 57.3% of infections in males and 42.7% in females. This aligns with a couple of previous studies which report *E. coli* as the leading cause of UTIs globally[18, 20, 21]. *Klebsiella pneumoniae* is the second most common pathogen, representing 60.0% of cases in males and 40.0% in females. This pattern is also supported by studies emphasizing the importance of multidrug-resistant *Klebsiella* in CKD patients.[18, 22, 23] In contrast, *Staphylococcus aureus* is more prevalent in females, accounting for 62.5% of infections, which differs from the typical UTI pathogen profile seen in other studies[24]. The equal distribution of *Pseudomonas* infections between sexes further highlights its role in complicated UTIs, particularly in immunocompromised CKD patients.

The distribution of pathogens in CKD stages among patients with urinary tract infections (UTIs) in this study highlights that *Escherichia coli* (*E. coli*), *Klebsiella*, and *Pseudomonas* are notably prevalent in advanced CKD stages. This pattern aligns with global data indicating a heightened risk of infections by Gram-negative bacteria, especially in advanced CKD stages due to weakened immunity[25]. In contrast, some studies indicate lower *Pseudomonas* prevalence compared to *Staph. aureus* in moderate CKD stages, differing slightly from the present study's findings where *Pseudomonas* dominated in stage 4 CKD cases[26]. Moreover, the unique presence of *Enterococcus* and *Acinetobacter* in this study adds to existing literature by highlighting pathogen diversity in CKD-related UTIs[27].

The findings underscore a significant risk of urinary tract infections (UTI) as chronic kidney disease (CKD) progresses, particularly in stages 3 and 4, with 48.3% of patients in stage 3 and 43.6% in stage 4 experiencing UTIs. This pattern is consistent with evidence suggesting increased UTI susceptibility as kidney function deteriorates, potentially due to compromised immune responses in advanced CKD stages[25].

Diabetic kidney disease (DKD) is the most prevalent cause of chronic kidney disease (CKD), comprising 48.2% of the cases, with glomerulonephritis (GN) and hypertension (HTN) following as other significant contributors. This distribution aligns with real-world studies, such as a study by Liu et al.[28], which reported DKD as the leading cause of CKD, accounting for 50% of the cases. Similarly, studies have demonstrated that GN contributes to approximately 20% of CKD cases, reinforcing its position as a common underlying cause[29]. Hypertension, responsible for 10.9% of CKD cases in the current findings, is also frequently cited as a risk factor, as noted by Lee et al.[30], who found it to account for 12% of cases. However, the present study highlights obstructive nephropathy (ON) as contributing to 10% of CKD cases, which contrasts with global data suggesting a lower prevalence of ON in CKD populations, such as 6% reported by Brown et al[31]. Additionally, while autosomal dominant polycystic kidney disease (ADPKD) and unknown causes are less frequently observed, other studies like that of Johnson et al.[32] have shown similar trends, with ADPKD constituting only a small proportion of CKD etiologies.

The antibiotic sensitivity patterns for gram-negative organisms isolated from CKD patients with UTIs reflect significant trends in antimicrobial resistance, which is an increasing concern globally. *E coli*, a common uropathogen, exhibited high sensitivity to Nitrofurantoin (72.8%), Meropenem (70%), and Gentamicin (55.7%), which is consistent with findings in several related studies[33,34]. However, the declining sensitivity to Ciprofloxacin (27.1%) and Ceftriaxone (25.7%) is alarming. These antibiotics were once the cornerstone of UTI treatment but are now witnessing reduced efficacy due to growing resistance[35]. *Klebsiella* showed high sensitivity to Colistin (86.7%), making it a valuable option for treatment, as also indicated by Gandia et al.[36]. *Pseudomonas*, known for its resistance, showed moderate sensitivity to Ciprofloxacin, Ceftazidime, and Amikacin, similar to the findings in the study by Navaneethan et al.[37] *Acinetobacter* demonstrated a unique sensitivity profile, being resistant to several commonly used antibiotics such as Colistin and Tigecycline. This pattern is supported by one previous study[32].

The antibiotic sensitivity patterns of gram-positive organisms in CKD patients with UTIs highlight the importance of tailoring treatments based on pathogen-specific profiles. Both *Staphylococcus aureus* and *Enterococcus* displayed 100% sensitivity to Vancomycin, Gentamicin, and Meropenem, suggesting these antibiotics as reliable choices for severe infections in CKD patients. These findings are consistent with recent studies that underscore the effectiveness of Vancomycin in treating multidrug-resistant gram-positive infections[35]. Similarly, Gentamicin continues to be a mainstay in treating severe infections, particularly in CKD patients, as it maintains efficacy despite renal impairment[38].

Given the rising antibiotic resistance patterns, particularly in CKD populations, a more judicious use of antibiotics combined with regular surveillance of microbial resistance is crucial to preventing further spread of MDR organisms. The development of new antimicrobials and the use of combination therapies should also be explored to effectively address resistant infections. Global health authorities continue to stress the importance of antibiotic stewardship programs to combat the misuse of antibiotics, which remains the leading cause of the rapid rise in antibiotic-resistant bacteria[39].

## Conclusion

Urinary tract infection (UTI) in CKD is predominant among middle-aged and older adults. The most prevalent pathogen found was *Escherichia coli* (*E. coli*), which accounted for 68.1% of the cases, followed by Klebsiella (13.6%) and Staphylococcus aureus (7.4%). E. coli was very sensitive to Nitrofurantoin, Meropenem, and Gentamicin, but less sensitive to Ciprofloxacin and Ceftriaxone. The antibiotic sensitivity of Klebsiella and other bacteria differed greatly.

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