Ad-din Medical Journal
July 2026, 4(2):23-29

Original article

Antibiotic Susceptibility Pattern of Major Uropathogens in a Private Medical College Hospital in Khulna, Bangladesh

Received: 28.02.2026 Accepted: 09.04.2026

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Abstract

Background: Urinary tract infections (UTIs) lie among the most prevalent bacterial infections worldwide, fueling extensive antibiotic use in both community and hospital settings. The increasing pattern of antimicrobial resistance (AMR) in uropathogens has critically diminished the effectiveness of empirical therapy, particularly in low and middle-income countries such as Bangladesh. ***Objectives:*** The study was conducted to investigate antibiotic susceptibility pattern of major uropathogens in a private medical college hospital. ***Methodology:*** This prospective cross-sectional study was conducted between March and November 2025 at the Department of Microbiology, Gazi Medical College Hospital, Khulna, Bangladesh. A total of 228 midstream urine specimens from patients with suspected UTIs underwent standard microbiological processing. Isolates were identified using conventional culture and biochemical methods, with antimicrobial susceptibility determined by the Kirby–Bauer disk diffusion technique on Mueller-Hinton agar, interpreted per CLSI 2023 guidelines. ***Results:*** Significant bacterial growth was observed in 143 samples (62.7%). Gram-negative organisms predominated, led by Escherichia coli (30.7%) and Klebsiella spp. (13.6%), while Gram-positives included Enterococcus spp. (7.02%) and Staphylococcus aureus (5.26%). Gram-negative isolates exhibited alarming resistance to second- and third-generation cephalosporins (e.g., cefuroxime, ceftriaxone), amoxicillin-clavulanate, and trimethoprim-sulfamethoxazole. Amikacin retained strong activity against E. coli (89.7% susceptible), and colistin showed near-complete efficacy (94–100%) against both major Gram-negatives. Meropenem susceptibility was relatively preserved, yet emerging resistance reached 16% in E. coli and 32% in Klebsiella. Among S. aureus, 33.3% displayed cefoxitin resistance, suggesting probable MRSA; linezolid and vancomycin remained highly effective. ***Conclusion:*** This study reveals a considerable burden of multidrug-resistant uropathogens in Khulna, characterized by widespread resistance to widely used beta-lactams and cephalosporins. These findings indicate an urgent need for sustained local AMR surveillance, evidence-based empirical prescribing, and boosting antimicrobial stewardship to protect therapeutic options amid escalating resistance threats.

Keywords: UTI, Uropathogen, Antibiotic, Susceptibility, Resistance.

How to cite this article:Zaber M, Al Amin AMM, Khan NM, Akhtar S, Sen S, Hossain N, Sarker A. Antibiotic Susceptibility Pattern of Major Uropathogens in a Private Medical College Hospital in Khulna, Bangladesh. Ad-din Med J. 2026 Jul;4(2)::23-29

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Introduction:

Urinary tract infections (UTIs) are the most common bacterial infections affecting all age groups and sexes, with a high incidence in women due to certain physiological and anatomical factors. UTIs occur worldwide in both community and hospital settings, with approximately 150 million new cases each year.[1,2] UTIs impose a remarkable burden on global healthcare with increased morbidity, high antibiotic consumption, significantly elevated healthcare costs, and serve as a leading cause of both out- and inpatient antibiotic prescriptions throughout the world.[3,4] UTIs are principally caused by Gram-negative bacteria, mainly Escherichia coli, which contributes 70–90% of community-acquired infections, followed by Klebsiella pneumoniae, Proteus spp., and Pseudomonas aeruginosa. Gram-positive organisms like Enterococcus and Staphylococcus spp. are also responsible in particular patient populations.[5–7]

Rapid diagnosis and initiation of proper antibiotic therapy are key to preventing complications such as pyelonephritis, renal scarring, septicemia, and recurrent infections.[6] However, the outcome of empirical treatment has been highly compromised by the prompt emergence of antimicrobial resistance (AMR) among uropathogens.[8–10] Resistance to commonly used antibiotics—including fluoroquinolones, trimethoprim-sulfamethoxazole, and third-generation cephalosporins—have risen over the past few decades, leading to higher rates of treatment failure and increased healthcare expenditure.[11–13] Multidrug-resistant (MDR) and extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae have more limited treatment options, leading to the use of carbapenems or other reserve antimicrobial options.[14,15] The scenario of antimicrobial resistance (AMR) is very alarming in many low- and middle-income Southeast Asian countries, including Bangladesh, where unrestricted access to antimicrobials, overprescribing of empirical therapies, self-medication, and insufficient laboratory facilities contribute to the accelerated increase of resistance rates.[16,17] Studies from different tertiary care hospitals across Bangladesh have documented significant resistance rates among urinary pathogens. Several studies reported alarmingly high resistance of E. coli and K. pneumoniae to ciprofloxacin, ceftriaxone, amoxicillin-clavulanate, and cotrimoxazole.[18–21] Detection of ESBL-producing strains and multidrug resistance (MDR) organisms has been increasingly observed in both inpatient and outpatient settings.[20,22] Moreover, AMR patterns vary considerably between countries, different geographic locations, and institutions, highlighting the necessity for local surveillance data to construct a hospital-specific antibiogram to guide empirical therapy.[21,23]

Divisional town-Khulna, situated in the southern corner of Bangladesh, has a diverse population with various healthcare needs. However, very scanty data are available for this region on the antibiotic susceptibility patterns of bacterial uropathogens. Understanding local susceptibility patterns is essential for prescribing empirical therapy, reducing therapeutic failures, and restricting the spread of resistant strains. Thus, this study was conducted to fill the existing information gap by investigating the prevalence and AMR pattern of uropathogens isolated from patients having UTIs in a privately funded medical college hospital in Khulna. The findings are expected to contribute to evidence-based therapeutic guidelines, support antimicrobial stewardship, and strengthen infection control strategies to reduce the burden of AMR.

Materials and methods

This was a prospective cross-sectional study conducted at the Department of Microbiology and Clinical Microbiology Laboratory of Gazi Medical College Hospital, Khulna, during the period of March 2025 to November 2025. Clinically suspected 265 UTI cases irrespective of age and sex, referred from outpatient and different inpatient departments of the hospital with a requisition for urine culture and sensitivity test, were included in the study.

Clean-catch midstream urine samples (MSU) (4-5 ml) were collected in a sterile disposable leakproof container from all the enrolled suspected UTI cases and transported immediately to the laboratory. Urine culture was done by semi-quantitative method on MacConkey agar, Nutrient agar, and Chromogenic agar media by using calibrated loops and incubated aerobically for 24 hours at 37°C.[24,25] Routine microscopic examination of all urine samples was done for counting pus cells. If no colony appeared after 24 hours of incubation, those culture plates were further incubated for 48 hours. Bacterial isolates were identified and confirmed by using standard microbiological and biochemical tests like Gram staining, examining colony morphology on culture media, motility, indole urease test, citrate utilization test, observing biochemical changes in TSI media, catalase, coagulase, and oxidase test.[25]

Antimicrobial susceptibility testing was performed on Mueller-Hinton agar using the disk diffusion Kirby-Bauer technique according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Antibiotics were interpreted as sensitive or resistant on the basis of the zone of inhibition of bacterial growth. Interpretation of zone diameters was performed according to CLSI 2023 guidelines (M100-S33). Resistance to the cefoxitin disk (30 µg) was interpreted as indicative of methicillin-resistant Staphylococcus aureus (MRSA), with a zone diameter of ≤21 mm classified as resistant. Due to variation in antibiotic disc availability and organism-specific testing protocols, not all isolates were tested against every antimicrobial agent.

Ethical approval was obtained from the Institutional Review Board of Gazi Medical College. Written informed consent was obtained from all participants.

Due to disc availability, not every isolate was tested against every antibiotic, which could cause variation in the interpretation of susceptibility. Finally, the lack of molecular information on resistance mechanisms limited our comprehension of the genetic underpinnings of observed patterns.

Result:

A total of 228 urine samples were analyzed for culture and sensitivity during the study period, of which 143 (62.7%) had positive culture results. Among the gram-negative bacilli, the predominant isolate was the Escherichia coli (n=70, 30.7%), followed by Klebsiella spp. (n=31, 13.6%). Among the gram-positive bacteria, the most frequently identified organism was Enterococci (n=16, 7.02%) and Staphylococcus aureus (n=12,5.26%) (Fig 1).

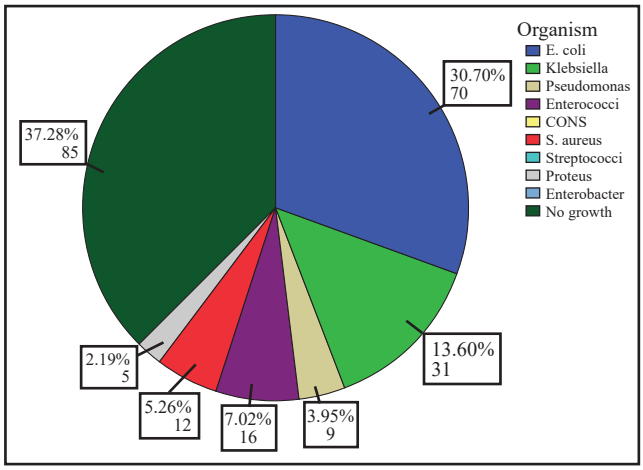

Fig 1: Distribution of Uropathogens Isolated in the Study

Susceptibility testing was successful for all but two E. coli isolates and one S. aureus isolate. These three isolates were excluded from AST analysis because they did not yield sufficient growth for reliable testing on Mueller-Hinton agar.

Table 1 shows the susceptibility patterns of Gram-negative organisms (E. coli, Klebsiella). A total of 68 (68.7%) Escherichia coli (excluding 2 isolates that couldn't produce reliable growth on Mueller-Hinton agar) and 31 (31.3%) Klebsiella spp isolates were analyzed. The antimicrobial susceptibility pattern showed high resistance to third-generation cephalosporins in both organisms. Among E. coli isolates, resistance was highest to cefuroxime (91.2%), co-amoxiclav (86.8%), ceftriaxone (80.9%), and co-trimoxazole (88.2%). Klebsiella spp. also demonstrated high resistance to co-amoxiclav (96.8%), ceftazidime (90.3%), cefuroxime (87.1%), and doxycycline (83.9%).

Aminoglycosides showed comparatively better sensitivity among E. coli, particularly amikacin (89.7%) and gentamicin (73.5%), whereas Klebsiella spp. showed moderate sensitivity to amikacin (54.8%) but high resistance to gentamicin (74.2%). Carbapenem (meropenem) retained good activity against E. coli (83.8% sensitivity) and Klebsiella spp. (67.7% sensitivity). Although emerging resistance was noted (16.2% and 32.3%, respectively).

Fluoroquinolones (ciprofloxacin and levofloxacin) demonstrated moderate sensitivity in both organisms (approximately 58%). Piperacillin-tazobactam showed good activity against Klebsiella spp. (83.9%) and moderate activity against E. coli (60.3%). Colistin remained highly effective, with 94.1% sensitivity in E. coli and 100% sensitivity in Klebsiella spp. Overall, multidrug resistance was prominently observed among both isolates, particularly against commonly used cephalosporins and beta-lactam antibiotics.

Table 2 shows the susceptibility patterns of Gram-positive bacteria (S. aureus, Enterococcus). A total of 28 Gram-positive isolates were obtained in primary culture. However, antimicrobial susceptibility testing was performed on 27 isolates, as one isolate failed to produce reliable growth on Mueller-Hinton agar. Among the tested isolates, 12 (44.4%) were Staphylococcus aureus and 15 (55.6%) were Enterococci. The antimicrobial susceptibility pattern demonstrated considerable resistance to beta-lactam antibiotics among both organisms. High resistance to ceftriaxone was observed in Enterococci (93.3%) and S. aureus (83.3%). Similarly, resistance to cefepime was high in both Enterococci (73.3%) and S. aureus (75.0%).

Clindamycin showed moderate sensitivity in S. aureus (33.3%) but no sensitivity in Enterococci. Cloxacillin resistance was notable in S. aureus (58.3%), while Enterococci demonstrated complete resistance among tested isolates. Cefoxitin resistance in S. aureus (33.3%) indicates the presence of methicillin-resistant strains (MRSA).

With linezolid sensitivity of 91.7% in S. aureus and 80.0% in Enterococci, and vancomycin sensitivity of 66.7% and 53.3%, respectively, both drugs maintained strong action against both species. Amikacin showed good action against Enterococci (73.3%) and S. aureus (83.3% sensitivity). Overall, there was clear evidence of multidrug resistance, especially to beta-lactam and cephalosporin drugs.

Table 1: Antibiotic Sensitivity and Resistance Patterns of E. coli and Klebsiella spp.

Antibiotic	E. coli Sensitive n (%)	E. coli Resistant n (%)	E. coli Total Tested(n)	Klebsiella Sensitive n (%)	Klebsiella Resistant n (%)	Klebsiella Total Tested (n)
Cefuroxime	6 (8.8%)	62 (91.2%)	**68**	4 (12.9%)	27 (87.1%)	**31**
Ceftazidime	18 (26.5%)	50 (73.5%)	**68**	3 (9.7%)	28 (90.3%)	**31**
Ceftriaxone	13 (19.1%)	55 (80.9%)	**68**	4 (12.9%)	17 (54.8%)	**21**
Cefepime	35 (51.5%)	33 (48.5%)	**68**	15 (48.4%)	16 (51.6%)	**31**
Amikacin	61 (89.7%)	6 (8.8%)	**67**	17 (54.8%)	14 (45.2%)	**31**
Gentamicin	50 (73.5%)	18 (26.5%)	**68**	8 (25.8%)	23 (74.2%)	**31**
Co-amoxiclav	1 (1.5%)	59 (86.8%)	**60**	0 (0.0%)	30 (96.8%)	**30**
Ciprofloxacin	40 (58.8%)	28 (41.2%)	**68**	18 (58.1%)	13 (41.9%)	**31**
Levofloxacin	40 (58.8%)	28 (41.2%)	**68**	18 (58.1%)	13 (41.9%)	**31**
Azithromycin	4 (5.9%)	31 (45.6%)	**35**	0 (0.0%)	10 (32.3%)	**10**
Colistin	64 (94.1%)	4 (5.9%)	**68**	31 (100%)	0	**31**
Co- trimoxazole	6 (8.8%)	60 (88.2%)	**66**	4 (12.9%)	25 (80.6%)	**29**
Tigecycline	32 (47.1%)	18 (26.5%)	**50**	9 (29.0%)	9 (29.0%)	**18**
Doxycycline	18 (26.5%)	48 (70.6%)	**66**	3 (9.7%)	26 (83.9%)	**29**
Meropenem	57 (83.8%)	11 (16.2%)	**68**	21 (67.7%)	10 (32.3%)	**31**
Nitrofurantoin	34 (50.0%)	18 (26.5%)	**52**	11 (35.5%)	16 (51.6%)	**27**
Piperacillin-Tazobactam	41 (60.3%)	10 (14.7%)	**51**	26 (83.9%)	4 (12.9%)	**30**

Note: The total number of isolates tested varied by antibiotic due to the availability of discs and clinical relevance. Sensitivity and resistance percentages were calculated using the number of isolates tested for each antibiotic as the denominator. Isolates not subjected to testing were excluded from analysis.

Table 2: Antibiotic Sensitivity and Resistance Patterns of S. aureus and Enterococci

Antibiotic	S. aureus Sensitive n (%)	S. aureus Resistant n (%)	S. aureus Total Tested(n)	Enterococci Sensitive n (%)	Enterococci Resistant n (%)	Enterococci Total Tested (n)
Clindamycin	4 (33.3%)	4 (33.3%)	**8**	0 (0.0%)	2 (13.3%)	**2**
Linezolid	11 (91.7%)	1 (8.3%)	**12**	13 (86.7%)	2 (13.3%)	**15**
Cloxacillin	2 (16.7%)	7 (58.3%)	**9**	0 (0.0%)	5 (33.3%)	**5**
Cefoxitin	5 (41.7%)	4 (33.3%)	**9**	1 (6.7%)	7 (46.7%)	**8**
Vancomycin	8 (66.7%)	—	**8**	8 (53.3%)	—	**8**
Amikacin	10 (83.3%)	2 (16.7%)	**12**	11 (73.3%)	4 (26.7%)	**15**
Cefepime	3 (25.0%)	9 (75.0%)	**12**	4 (26.7%)	11 (73.3%)	**15**
Ceftriaxone	2 (16.7%)	10(83.3%)	**12**	0 (0.0%)	14 (93.3%)	**14**
Cefuroxime	3 (25.0%)	9 (75.0%)	**12**	3 (20.0%)	12 (80.0%)	**15**

Note: Percentages calculated within the organism. Isolates marked as 'Not tested' were excluded from calculation. The total number of isolates tested varied by antibiotic due to the availability of discs and clinical relevance. Sensitivity and resistance percentages were calculated using the number of isolates tested for each antibiotic as the denominator. Isolates not subjected to testing were excluded from analysis.

Discussion

Urinary tract infections (UTIs) continue to be among the most prevalent bacterial infections globally, affecting individuals of all ages. The pattern of antimicrobial resistance (AMR) varies significantly across regions, healthcare settings, and patient populations. In a tertiary care hospital in Khulna, Bangladesh, the current study investigated the association between isolated bacterial infections and their antibiotic susceptibility profiles, highlighting significant regional resistance developments.
In this study, Gram-negative bacilli were the predominant uropathogens, with E. coli (67.6%) and Klebsiella spp. (8.23%) together accounting for 75.83%. A total of 143 positive cultures were identified among 228 urine samples. These results are consistent with regional trends where UTIs are dominated by E. coli and Klebsiella, which frequently account for over 70% of isolates in Bangladeshi hospitals.[26] Our data contradict a report by Haque et al., which revealed E. coli as the most frequent uropathogen at 59.3%.[27] Gram-positive bacteria, such as S. aureus (12.49%), were less common but notable, consistent with reports from Dhaka centers showing S. aureus and Enterococcus in 13.7% and 11.29% of cases, respectively.[28],[29]

The culture positivity rate of 62.7% in this study is relatively high, likely reflecting the inclusion of hospitalized and complex cases. Similar inpatient studies report positivity rates ranging from 50% to 70%, often associated with factors such as indwelling urinary catheters, prior antibiotic therapy, and the presence of extended-spectrum beta-lactamase (ESBL)-producing organisms.[30] National AMR surveillance data also support these findings, showing that in hospital-based samples, positive culture rates were two to three times higher than in outpatient samples, largely due to the predominance of resistant strains in inpatient settings.[31]

A notable observation in this study is the high resistance to second- and third-generation cephalosporins; E. coli showed 91.2% resistance to cefuroxime and 80.9% to ceftriaxone, while Klebsiella spp. reached 96.8% resistance to co-amoxiclav. While colistin performed exceptionally well (94.1–100% sensitive), amikacin and other aminoglycosides emerged as superior alternatives (89.7% sensitive for E. coli, 54.8% sensitive for Klebsiella); meropenem maintained moderate activity despite a 16–32% resistance rate. Such exceptionally high cephalosporin resistance is alarming but not unexpected; the overuse of broad-spectrum cephalosporins, facilitated by their easy availability in community and hospital settings, is well documented in South Asia.[32] The extensive empirical use of cephalosporins and fluoroquinolones in Bangladeshi outpatient and inpatient settings may potentially contribute to these high resistance rates. These patterns are consistent with findings from Bangladesh, where cephalosporin resistance in Klebsiella and E. coli frequently exceeds 70–90%, indicating widespread multidrug-resistant (MDR) strains and ESBL production.[33],[34],[35] Meropenem, a carbapenem, [L1] showed comparatively higher susceptibility among Gram-negative isolates in our cohort, with 83.8% sensitivity in E. coli and 67.7% in Klebsiella spp.[36] The relatively lower meropenem susceptibility in Klebsiella spp. compared to E. coli is consistent with increasing reports of carbapenem-resistant Klebsiella in South Asia.[37] However, the finding that a significant minority of isolates were resistant to meropenem is concerning and may indicate emerging carbapenem resistance, warranting further molecular investigation.

Among 27 Gram-positive isolates, S. aureus and Enterococcus showed high beta-lactam resistance, including 83.3% ceftriaxone resistance in S. aureus and 93.3% in Enterococcus. The detection of cefoxitin resistance in 33.3% of Staphylococcus aureus isolates suggests the presence of methicillin-resistant Staphylococcus aureus (MRSA) in our study population. Cefoxitin disk diffusion is recommended by the CLSI as a reliable phenotypic surrogate marker for methicillin resistance in S. aureus. Although molecular confirmation of the mecA or mecC gene was not performed in this study, phenotypic resistance to cefoxitin strongly indicates probable MRSA strains. The observed MRSA rate is comparable to previous hospital-based studies in Bangladesh, where MRSA prevalence has ranged between 25% and 45% among clinical isolates. These findings indicate that MRSA is not limited to bloodstream or wound infections but may also contribute to urinary tract infections in hospitalized patients.[38],[39] The presence of probable MRSA has significant therapeutic implications, as beta-lactam antibiotics, including penicillins and most cephalosporins, become ineffective against these strains. In our study, high resistance to ceftriaxone (83.3%) and cefepime (75.0%) among S. aureus isolates further supports this concern.

Although vancomycin exhibited moderate action and linezolid showed high susceptibility in this trial, dependency on these backup medicines raises treatment costs and may accelerate the development of resistance. Linezolid (80.0–91.7% sensitive) was reliable, and amikacin susceptibility was 73.0–83.0%, which is consistent with a similar study in Dhaka.[28] Vancomycin showed 53.0–67.0% susceptibility; however, since it was not tested against the remaining isolates, the absolute resistance rate could not be confirmed, though the lack of observed resistance suggests high susceptibility.[29] These findings indicate that glycopeptides serve as crucial resources against rising MDR. Aligning with South Asian trends, the resistance rate of cephalosporins in this study exceeded 70%.[40]

In this investigation, multidrug resistance—especially to

cephalosporins and beta-lactam agents—emerged as a predominant trend. This makes empirical treatment options in this tertiary care context considerably more difficult. This observation demands national calls for strengthened antimicrobial stewardship programs.[26],[35] The development of carbapenem resistance (16–32%) is concerning and jeopardizes the effectiveness of last-line treatments, even though amikacin, colistin, linezolid, and vancomycin remain useful therapeutic choices. This growing resistance issue is further exacerbated by community-level factors, such as the over-the-counter availability of antibiotics and improper prescription practices.[28]

Overall, the findings underscore the urgent need for consistent local surveillance, regular revision of empirical treatment guidelines, and effective implementation of antibiotic stewardship policies. Strengthening infection prevention measures and regulating antibiotic use at both the hospital and community levels are critical to mitigating the growing AMR burden in tertiary hospitals across Bangladesh.[41]

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