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Bacteriological Profile of Urinary Tract Infection in Patients with Nephrolithiasis and their Antibiotic Susceptibility Profile Attending a Tertiary Care Hospital in North India

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ABSTRACT

Background: Nephrolithiasis is a common urological condition often associated with urinary tract infections (UTIs). Identifying the bacteriological profile and antibiotic resistance patterns in such patients is essential for effective management and prevention of recurrence. To determine the bacteriological profile of urine in patients with nephrolithiasis and assess the antibiotic susceptibility patterns of the isolated organisms.

Methods: This cross-sectional observational study included 200 patients with nephrolithiasis at a tertiary care hospital. Midstream urine samples were collected aseptically and cultured using standard microbiological techniques. Isolated organisms were identified, and antibiotic susceptibility testing was performed using the Kirby-Bauer disc diffusion method in accordance with CLSI guidelines. Demographic data and other characteristics were also documented.

Results: Out of 200 patients, 136 (68%) showed significant bacteriuria. *Escherichia coli* was the most common isolate (44.1%), followed by *Enterococcus* spp. (23.5%) and *Pseudomonas* spp. (15.4%). *E. coli* showed high sensitivity to nitrofurantoin (96%) and amikacin (90%) but low sensitivity to ciprofloxacin (23%). *Enterococcus* spp. exhibited good sensitivity to vancomycin (95%) and linezolid (93%) but high resistance to fluoroquinolones. *Pseudomonas* spp. demonstrated high susceptibility to imipenem (89%) and piperacillin-tazobactam (80%).

Conclusion: Urinary tract infections are common among patients with nephrolithiasis, with *E. coli* being the predominant pathogen. Increasing resistance to commonly used antibiotics underscores the need for routine urine culture and sensitivity testing. Culture-based therapy and antibiotic stewardship are vital to improving outcomes in these patients.

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Introduction

Nephrolithiasis is a common urological condition that affects millions of individuals worldwide, with a rising trend seen particularly in the Indian subcontinent due to dietary habits, dehydration, and genetic predispositions (1). Urolithiasis is one of the most common problems for which a patient visits the urology outpatient department, and its prevalence ranges from 7% to 13% in North America, 5%-9% in Europe, and 1%-5% in Asia (2, 3). The presence of infection in the urinary tract has long been implicated in stone formation, particularly in the case of struvite stones, which are typically associated with urease-producing organisms like *Proteus* and *Klebsiella* (4, 5). However, there is a growing body of evidence suggesting that non-urease-producing organisms such as *Escherichia coli* may also play a significant role in lithogenesis, although the exact mechanisms remain to be elucidated (6). This raises the critical question: does infection precede stone formation, or do stones provide a nidus for subsequent infection? (7).

Understanding the bacteriological profile in nephrolithiasis is essential because stones can act as a "tombstone" for bacteria, harboring persistent infection and complicating management strategies (8). Complicated UTIs—defined by factors such as the presence of urinary stones, indwelling catheters, or urinary tract abnormalities—often lead to recurrent infections that are polymicrobial and resistant to multiple drug classes (9, 10). The most frequently isolated uropathogen remains *E. coli*, accounting for upto 65%-90% of UTIs across both community and hospital settings, followed by *Klebsiella pneumoniae*, *Enterococcus faecalis*, *Pseudomonas* spp., and *Staphylococcus* spp. (11). In a study from a tertiary hospital in Nepal, *E. coli* was isolated in 67% of culture-positive nephrolithiasis cases, followed by *Klebsiella* in 27% and *Pseudomonas* in 6% (6). Likewise, Rao and Rao reported *E. coli* and Coagulase-negative *Staphylococcus* as the most common organisms found in renal stones (23.5% and 26.5%, respectively) (12). The rising prevalence of multidrug-resistant (MDR) uropathogens is an alarming trend. A study conducted in North India found *E. coli* to be 76.7% resistant to ciprofloxacin and 82.2% resistant to levofloxacin, with higher sensitivity retained only to nitrofurantoin and aminoglycosides (93.3% and 90%, respectively). Similarly, *Enterococcus faecalis* demonstrated high resistance to fluoroquinolones but retained good sensitivity to vancomycin and linezolid (95.7% and 93.6%) (13).

Regarding the abovementioned explanations, the objectives of this study were to analyze the bacteriological profile of urine in patients with nephrolithiasisand to determine the antibiotic susceptibility patterns of the isolated organisms.

Materials and Methods

This observational cross-sectional study was conducted over a period of 12 months in the Departments of Microbiology at a tertiary care teaching hospital. The study included patients diagnosed with nephrolithiasis based on clinical evidence (ultrasound, X-ray KUB, or CT scan), who were either symptomatic or undergoing evaluation for urinary tract infection.

A total of 200 patients were enrolled. The sample size was calculated based on an expected prevalence of urinary tract infection in nephrolithiasis of 50%, a 95% confidence interval, and a margin of error of 7%, using the formula:

$$n = \frac{Z^2 \times p \times (1-p)}{e^2} = \frac{(1.96)^2 \times 0.5 \times 0.5}{0.07^2} \approx 196$$

Thus, 200 patients were included to account for possible dropouts and incomplete data. Midstream urine samples were collected under strict aseptic precautions prior to initiation of any antibiotic therapy. The samples were immediately transported to the microbiology laboratory for culture and sensitivity testing. Stone-related data,

including side (left, right, bilateral), number, and clinical association (e.g., bladder stone, recurrent stone formation), were documented based on radiological imaging and surgical findings. In cases where surgical removal of stones was performed (e.g., via ureteroscopy or PCNL), stone composition was noted where available, although biochemical analysis of stones was not within the scope of this study. Antibiotic susceptibility testing of isolated organisms was carried out using the Kirby-Bauer disc diffusion method in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines. The antibiotics tested included amikacin, gentamicin, ciprofloxacin, nitrofurantoin, ceftriaxone, piperacillin-tazobactam, imipenem, meropenem, and linezolid, depending on the organism isolated.

While inclusion criteria were; patients ≥18 years of age, clinicaly confirmed nephrolithiasis, availability of urine culture and sensitivity report. exclusion criteria were; patients with recent antibiotic use (within 7 days), known cases of chronic kidney disease (Stage 4 or above), incomplete clinical or microbiological data.

Ethical clearance for the study was obtained from the Institutional Ethics Committee. The collected data were entered into Microsoft Excel and analyzed using descriptive statistical methods to evaluate the frequency and antibiotic resistance pattern of isolated organisms in patients with nephrolithiasis.

Results

A total of 200 patients diagnosed with nephrolithiasis were included in the study, of which 136 patients (68%) had positive urine cultures, while 64 patients (32%) showed no growth on culture (Table 1).

The demographic analysis revealed a male predominance, with 120 males (60%) and 80 females (40%). The majority of the study participants were in the age group of 20-40 years (40%), followed by 41–60 years (35%). Patients above 60 years constituted 20% of the cohort, while only 5% were below 20 years of age (Table 2).

In terms of occupation, the largest group comprised farmers (25%), followed by housewives (20%), businesspersons (15%), laborers (10%), and others including unemployed individuals and students (30%). This demographic distribution reflects the diverse population attending the tertiary care center for nephrolithiasis-related evaluation and management (Table 2).

Among the 136 culture-positive urine samples from patients with nephrolithiasis, *Escherichia coli* was the most frequently isolated organism, accounting for 44.12% of all positive cultures. This was followed by *Enterococcus* spp. with 23.53%, and *Pseudomonas* spp. with 15.44% of isolates. Other notable organisms included *Klebsiella* spp. (5.15%), MSSA (2.94%), and MRSA (2.21%). Fungal growth was noted in 2.21% of cases as yeast isolates (Table 3).

Less commonly isolated bacteria included *Proteus mirabilis* and *Citrobacter* spp., each constituting 1.47% of the positive cultures. Mixed bacterial flora and mixed unspecified organisms were observed in 0.74% of cases each. Overall, the data indicate that gram-negative organisms were predominant among culture-positive cases, with *E. coli* remaining the leading uropathogen in patients with nephrolithiasis (Table 3).

Among the tested organisms, *E. coli* exhibited high susceptibility to Nitrofurantoin (96%), Imipenem (93%), and Amikacin (90%), indicating these as the most effective agents against it. However, resistance to Ciprofloxacin was notable, with only 23% sensitivity observed. *Enterococcus* spp. showed good susceptibility to Vancomycin (95%) and Linezolid (93%), while sensitivity to Nitrofurantoin was moderate (78%). Susceptibility to Ciprofloxacin was very low at 8%, and it showed no sensitivity to aminoglycosides or carbapenems, as expected (Table 4).

Table 1. Urine culture results.

Urine Culture	Frequency	Percentage
Positive	136	68.00
No Growth	64	32.00

Table 2. Socio-Demographic details of the participants.

Parameter		Frequency	Percentage
Age in years	<20 years	10	1.67
	20–40 years	80	13.33
	41–60 years	70	11.67
	>60 years	40	6.67
Gender	Male	120	20
	Female	80	13.33
Occupation	Farmer	50	8.33
	Business	30	5
	Housewife	40	6.67
	Labourer	20	3.33
	Others	60	10

Table 3. Organisms isolated in culture-positive cases.

Organism	Frequency	Percentage
E. coli	60	44.12
Enterococcus spp	32	23.53
Pseudomonas spp	21	15.44
Klebsiella spp	7	5.15
MSSA	4	2.94
MRSA	3	2.21
Yeast	3	2.21
Proteus mirabilis	2	1.47
Citrobacter spp	2	1.47
Mixed bacterial flora	1	0.74
Mixed	1	0.74

Table 4. Transposed antibiotic susceptibility.

Antibiotic	E. coli	Enterococcus spp	Pseudomonas spp	Klebsiella spp
Amikacin (%)	90	-	85	88
Ciprofloxacin (%)	23	8	35	30
Nitrofurantoin (%)	96	78	-	82
Imipenem (%)	93	-	89	91
Piperacillin-Tazobactam (%)	69	-	80	77
Vancomycin (%)	-	95	-	-
Linezolid (%)	-	93	-	-

For *Pseudomonas* spp., Imipenem (89%) and Amikacin (85%) showed the highest efficacy, followed by Piperacillin-Tazobactam (80%). Susceptibility to Ciprofloxacin was relatively lower (35%), and resistance to Nitrofurantoin was complete. *Klebsiella* spp. isolates were most sensitive to Imipenem (91%), Amikacin (88%), and Nitrofurantoin (82%), while demonstrating moderate susceptibility to Piperacillin-Tazobactam (77%) and lower sensitivity to Ciprofloxacin (30%) (Table 4).

Overall, carbapenems (Imipenem) and aminoglycosides (Amikacin) showed consistent efficacy across gram-negative isolates, while Nitrofurantoin remained a strong oral option for *E. coli* and *Klebsiella* spp.. The resistance to fluoroquinolones like Ciprofloxacin was evident across all major organisms, reinforcing the need for local antibiogram-guided empirical therapy in nephrolithiasis-associated UTIs (Table 4).

Discussion

In the present study, 68% of patients with nephrolithiasis had positive urine cultures, a figure significantly higher than the 28.3% culture positivity reported by Rao and Rao (2024) (12) who studied renal stones directly rather than urine samples. This difference may be attributed to our use of urine cultures, which can detect bacteriuria even in the absence of stone colonization. However, both studies reinforce the association between urinary tract infections and stone disease. *Escherichia coli* emerged as the predominant isolate (44.1%) in our cohort. This finding parallels the results of Rishi et al., (2022) (13) who reported *E. coli* in 43.26% of hospitalized patients with UTIs. They further noted high *E. coli* resistance to ciprofloxacin (76.7%) and levofloxacin (82.2%), which correlates with the low fluoroquinolone sensitivity observed in our study. Similarly, *E. coli* in our cohort was highly sensitive to nitrofurantoin (96%) and amikacin (90%), closely matching the reported sensitivity of 96.7% to nitrofurantoin and 90% to amikacin as described by Rishi et al., (2022) (13).

Our findings also highlight the growing role of *Enterococcus* spp., the second most common isolate (23.5%). Rishi et al., (2022) (13) documented *Enterococcus faecalis* as the second most common organism, with a significant increase in hospitalized patients, especially those with longer hospital stays and instrumentation. They emphasized its high resistance to ciprofloxacin (91.5%) and levofloxacin (89.4%), both of which were mirrored in our findings, along

with its high susceptibility to vancomycin (95.7%) and linezolid (93.6%).

Pseudomonas spp. accounted for 15.4% of isolates in our study. This figure is higher than the 6–10% range reported in broader UTI cohorts like those in Nazir and Kanth (2024) (14) and Ranjit and Singh (2020) (15) where *Pseudomonas* was more frequent in hospitalized or catheterized patients. Our findings support Rao and Rao results who found *Pseudomonas* in 17.6% of renal stone cultures, underscoring its relevance in complicated urolithiasis (12). Regarding antibiotic susceptibility, *Pseudomonas* in our study showed high sensitivity to carbapenems (imipenem 89%) and piperacillin-tazobactam (80%), in line with Nazir and Kanth (2024) (14) who reported similar efficacy of these agents against gram-negative isolates, especially in hospitalized patients.

Notably, the antibiotic resistance profiles of gram- positive cocci were also aligned with those reported by Nazir and Kanth (2024) (14) where *Enterococcus* showed excellent sensitivity to linezolid (100%) and vancomycin (61.7%) but poor sensitivity to ciprofloxacin (13.2%). Our study confirms these findings with a slightly higher vancomycin sensitivity (95%) and similar resistance to fluoroquinolones. The demographic profile of our study, with a male predominance and peak incidence in the 20–40 year age group, was consistent with the observations made by Ranjit and Singh (2020) (15) who associated this distribution with occupational exposure, dehydration, and lifestyle patterns common among males in rural India.

Interestingly, our findings also support the view of Rao and Rao (2024) (12) who described renal stones as "tombstones for bacteria"—a notion reflecting how bacterial colonization and recurrent infections often co-exist with stone formation. These insights strengthen the hypothesis that infection may not only result from stone presence but may also precede or even initiate lithogenesis, particularly with organisms capable of forming biofilms and altering urine pH.

Conclusion

The observed resistance patterns emphasize a worrying trend of decreased sensitivity to fluoroquinolones and third-generation cephalosporins. However, high sensitivity to nitrofurantoin, aminoglycosides, carbapenems, and glycopeptides offers viable options for empirical and targeted therapy. These findings underscore the necessity of routine urine culture and sensitivity testing in all nephrolithiasis patients, especially prior to surgical intervention.Antibiotic stewardship programs and regional surveillance of resistance trends are essential to preserve the efficacy of key antimicrobials. Furthermore, the inclusion of stone cultures in future studies could provide more comprehensive insights into infection-related lithogenesis and guide more effective long-term management strategies.

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Ethics approval and consent to participate

Not applicable.

Conflict of interest

The authors declare that there are no conflicts of interest related to the content of this manuscript.

References

1. Dickson KA, Haigis MC, Raines RT. Ribonuclease inhibitor: structure and function. Prog. *Nucleic Acid Res Mol Biol* 2005; **80**:349-74.
2. Tefekli A, Cezayirli F. The history of urinary stones: In parallel with civilization. *Sci World J* 2013; **2013**:423964.
3. Sorokin I, Mamoulakis C, Miyazawa K, et al.

Epidemiology of stone disease across the world. *World J Urol*. 2017; **35**(9):1301-20.
4. Golechha S, Solanki A. Bacteriology and chemical composition of renal calculi accompanying urinary tract infection. *Indian J Urolog* 2001; **17**(2):111-7.
5. Bangash K, Shigri F, Jamal A, et al. Spectrum of renal stones composition; chemical analysis of renal stones. *Int J Patholog* 2011; **9**(2):63-6
6. Alelign T, Petros B. Kidney stone disease: an update on current concepts. *Adv Urol* 2018; **2018**:3068365.
7. Coe FL, Parks JH, Asplin JR. The pathogenesis and treatment of kidney stones. *N Engl J Med* 1992; **327**:1141-52.
8. Lande MB, Varade W, Erkan E, et al. Role of urinary supersaturation in the evaluation of children with urolithiasis. *PediatrNephrol* 2005; **20**(4):491-4.
9. Fatima A, Jan A, Akhter N, et al. Evaluation of microscopic screening methods for detection of urinary tract infection. *Int J Cur Res Rev* 2017; **9**(6):44-9.
10. Sobel JD, Donald Kaye D. Urinary tract infections. Gerald. Mandell John E. Bennett Raphael Dolin Mandell, Douglas and Bennett's Principle and Practice of Infectious diseases 8th edition. Churchill Livingstone Elsevier; 2010.p.886-913.
11. Manges AR, Natarajan P, Solberg OD, et al. The changing prevalence of drug-resistant *Escherichia coli* clonal groups in a community: evidence for community outbreaks of urinary tract infections. *Epidemiol Infect* 2006; **134**(2):425-31.
12. Rao S, Rao SS. Bacteriological profile of nephrolithiasis: A tertiary care centre experience. *J Card Dis Res* 2024; **15**(9):916-20.
13. Rishi S, Nahvi N, Wani AR, et al. Microbiology and drug resistance pattern in clinically significant isolates of urine from medical wards of a tertiary care hospital in North India. Indian J Res 2022; **11**(01):40-4.
14. Nazir A, Kanth F. Bacteriological profile and antimicrobial susceptibility pattern of patients with urinary tract infections in a tertiary care hospital. *J Res Appl Basic Med Sci* 2024; **10**(2): 110-20.
15. Ranjit S, Singh K. Bacteriological profile of urine in patients with different types of kid¬ney stones in a tertiary care hospital: a descriptive cross-sectional study. *J Nepal Med Assoc* 2020; **58**(231):871-4.