

Clinical spectrum, antibiotic sensitivity, and clinical outcome of urinary tract infection in the pediatric age group: A cross-sectional study

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Abstract

Background: Urinary tract infection (UTI) is a common pediatric bacterial infection; delayed diagnosis and antimicrobial resistance increase complications and treatment challenges. The objective of this study is to evaluate the clinical profile, bacteriological spectrum, antibiotic sensitivity patterns, and clinical outcomes of urinary tract infections in children.

Methods: This hospital-based cross-sectional study was conducted in the Department of Pediatrics, J.K. Lone Mother and Child Hospital from October 2024 to January 2026. A total of 83 children aged 6 months to 18 years with culture-confirmed UTI were included. Urine samples were collected under aseptic precautions using clean-catch midstream collection, catheterization, or urine collection bags as appropriate. Samples were processed using semi-quantitative culture techniques on CLED agar. Antibiotic susceptibility testing was performed using the Kirby–Bauer disk diffusion method according to CLSI guidelines.

Results: Among 83 culture-positive cases, females constituted 59% and males 41%. Fever (85.5%) was the most common presenting symptom, followed by abdominal pain (54.2%) and increased frequency of micturition (30.1%). *Escherichia coli* (*E. coli*) was the predominant pathogen (66.3%), followed by *Klebsiella* species (19.3%). Nitrofurantoin and Fosfomycin showed high sensitivity among oral antibiotics, whereas Fosfomycin and Imipenem demonstrated maximum sensitivity among injectable agents. High resistance was observed against Amoxycylav, Ciprofloxacin, and third-generation cephalosporins.

Conclusion: Urinary tract infection remains a major pediatric health concern with evolving antimicrobial resistance. *E. coli* continues to be the predominant uropathogen. Periodic surveillance of local antimicrobial susceptibility patterns and culture-guided therapy are essential for effective management and prevention of complications.

Keywords: urinary tract infection; pediatrics, antibiotic sensitivity; *Escherichia coli*; antimicrobial resistance

Introduction

Urinary tract infection (UTI) is among the most common bacterial infections encountered in children and represents a significant cause of morbidity in pediatric practice. It is defined by the presence of significant bacteriuria in a properly collected urine specimen associated with clinical features suggestive of infection involving any part of the urinary tract [1, 2]. UTIs may involve the lower urinary tract, including cystitis and urethritis, or the upper urinary tract, resulting in pyelonephritis.

Pediatric urinary tract infections are clinically important because recurrent or untreated infections may lead to renal parenchymal damage, renal scarring, hypertension, proteinuria, and chronic kidney disease later in life [3].

Early diagnosis and appropriate antimicrobial therapy therefore play a crucial role in preventing long-term complications.

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The incidence of UTI varies according to age and sex. During infancy, UTIs are relatively more common in boys, particularly uncircumcised male infants. Beyond infancy, girls are affected more frequently because of anatomical predisposition, including a shorter urethra and close proximity of the urethral opening to the perineum.

Escherichia coli (*E. coli*) remains the most common causative organism and accounts for the majority of pediatric UTIs. Other important pathogens include *Klebsiella* species, *Proteus* species, *Pseudomonas aeruginosa*, *Enterococcus* species, and *Acinetobacter* species. The predominance of *E. coli* is attributed to virulence factors such as fimbriae and adhesins that facilitate attachment to uroepithelial cells.

The clinical presentation of pediatric UTI is often nonspecific, especially in infants and younger children. Fever, irritability, vomiting, poor feeding, and abdominal pain are common presentations, whereas older children may present with dysuria, urgency, frequency, or flank pain [4]. Due to these variable presentations, clinicians must maintain a high index of suspicion, particularly in children with unexplained fever.

Over recent decades, antimicrobial resistance among uropathogens has emerged as a major challenge in the management of urinary tract infections. Increasing resistance to commonly prescribed antibiotics such as ampicillin, cephalosporins, and fluoroquinolones has significantly limited empirical treatment options. Consequently, institution-specific antibiogram data are essential for selecting appropriate empirical therapy and implementing antimicrobial stewardship practices.

Despite the high burden of pediatric UTI, regional data regarding microbial patterns and antibiotic susceptibility in the Hadoti region of Rajasthan remain limited. The present study was therefore undertaken to evaluate the clinical spectrum, bacteriological profile, antibiotic sensitivity pattern, and clinical outcome of urinary tract infection in children attending a tertiary care center.

Urinary tract infection is a common pediatric illness worldwide and accounts for a substantial proportion of febrile illnesses in infants and young children [5]. Studies have shown that approximately 6–8% of febrile children presenting to healthcare facilities may have UTI. Delayed diagnosis and treatment can result in significant renal morbidity.

The American Academy of Pediatrics and other international guidelines recommend urine culture as

the gold standard for diagnosis of urinary tract infection [6]. These guidelines also emphasize the importance of appropriate urine collection methods and culture-guided antibiotic therapy.

Several investigators have also studied the clinical profile of pediatric UTI. Fever has consistently been reported as the most common presenting symptom, particularly in infants and younger children. Other common symptoms include abdominal pain, dysuria, urgency, vomiting, and frequency of micturition.

Imaging studies such as ultrasonography play an important role in identifying structural abnormalities associated with recurrent infections. Vesicoureteral reflux, hydronephrosis, and obstructive uropathy are among the common abnormalities associated with recurrent pediatric UTIs.

Overall, available literature highlights the need for regular surveillance studies to monitor changing antimicrobial susceptibility patterns and to formulate region-specific treatment guidelines.

Materials and methods

This hospital-based cross-sectional study was conducted in the Department of Pediatrics at J.K. Lone Mother and Child Hospital, Government Medical College, Kota, Rajasthan, from October 2024 to January 2026 after obtaining approval from the Institutional Ethics Committee. Children aged 6 months to 18 years admitted with clinically suspected urinary tract infection and having culture-positive urine samples were included in the study.

Inclusion Criteria: Children aged 6 months to 18 years who were admitted to the pediatric ward and had a culture-confirmed urinary tract infection (UTI), defined by a urine culture showing a bacterial colony count of $>10^5$ CFU/mL, were included in the study.

Exclusion Criteria: Children younger than 6 months or older than 18 years, patients with fungal urinary isolates, and those whose parents or legally authorized guardians did not provide informed consent were excluded from the study.

The study was approved by the Institutional Ethics Committee of Government Medical College, Kota. Written informed consent was obtained from the parents or legally authorized guardians of all study participants before enrollment. Assent was obtained from older children, wherever applicable.

The sample size was calculated to estimate the apparent prevalence of culture-positive urinary tract infection among children aged 6 months to 18 years. Based on an estimated proportion of 11.10%, with a desired precision (margin of error) of 7% and a 95% confidence level, the required sample size was calculated accordingly. The population size was considered not applicable (N/A).

The calculated minimum sample size was 77 using the standard formula:

$$n = (Z^2 \times P \times [1 - P]) / e^2$$

A total of 83 culture-positive pediatric patients were ultimately included in the study.

Urine samples were collected under aseptic precautions. Clean-catch midstream urine samples were obtained from toilet-trained children, while pediatric urine collection bags were used for non-toilet-trained children. Catheterized urine samples were collected from selected infants or children with urinary retention.

Urine specimens were processed using semi-quantitative culture techniques. Samples were inoculated onto Cysteine–Lactose Electrolyte-Deficient (CLED) agar using a calibrated nichrome loop and incubated aerobically at 37°C for 24–48 hours. Significant bacteriuria was defined as bacterial growth exceeding 10^5 CFU/mL. The isolated organisms were identified based on colony morphology, Gram staining, and standard biochemical tests.

Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Antimicrobial susceptibility testing was performed according to the organism-specific antimicrobial panel routinely used in the Department of Microbiology. Consequently, not every isolate was tested against every antimicrobial agent. The number of isolates tested (denominator) for each antibiotic has therefore been reported in the respective tables.

Clinical Outcome Assessment: Clinical outcome was recorded for all enrolled patients during hospitalization as recovered, death, or left against medical advice (LAMA). Recovery was defined as clinical improvement following appropriate antimicrobial therapy and discharge from the hospital.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using descriptive statistics. Continuous variables were expressed as mean $\pm$ standard deviation, while

categorical variables were expressed as percentages and proportions.

Results

A total of 83 culture-positive pediatric patients with urinary tract infection were included in the present study. Table 1 show the sex distribution among study participants. Female children constituted the majority of cases, accounting for 49 (59%) patients, whereas males accounted for 34 (41%) patients, indicating female predominance in pediatric urinary tract infections.

Table 1: Sex distribution of patients with urinary tract infection.

Sex	Number (n)	Percentage (%)
Female	49	59
Male	34	41

Table 2 demonstrate the presenting clinical features among children with urinary tract infection. Fever was the most common presenting symptom and was observed in 71 (85.5%) patients, followed by abdominal pain in 45 (54.2%) cases. Increased frequency of micturition and dysuria were observed in 30.1% and 26.5% of patients respectively.

Table 2: Presenting symptoms of urinary tract infection in pediatric patients.

Symptom	Present (n)	Percentage (%)
Dysuria	22	26.5
Increased frequency	25	30.1
Abdominal pain	45	54.2
Hematuria	5	6
Flank pain	9	10.8
Urticaria	10	12
Fever	71	85.5

Table 3 depict the microbiological distribution of urinary isolates. *E. coli* was the predominant uropathogen isolated in 55 (66.3%) cases, followed by *Klebsiella* species in 16 (19.3%) patients. *Pseudomonas* and *Enterococcus* species each accounted for 4.8% of isolates.

Table 4 summarize the antibiotic sensitivity pattern among urinary isolates. Fosfomycin (81.8%) and Nitrofurantoin (80%) demonstrated high sensitivity among oral antibiotics, while Imipenem (85.7%) showed maximum sensitivity among injectable agents. High resistance rates were observed against Amoxycyclav, Ciprofloxacin, and third-generation cephalosporins.

Table 3: Distribution of causative organisms in urinary tract infection.

Organism	Number (n)	Percentage (%)
<i>E. coli</i>	55	66.3
<i>Klebsiella</i>	16	19.3
<i>Pseudomonas</i>	4	4.8
<i>Enterococcus</i>	4	4.8
<i>Acinetobacter</i>	2	2.4
<i>Citrobacter</i>	1	1.2
Culture-positive, organism not identified	1	1.2

Table 4: Antibiotic sensitivity pattern of urinary isolates.

Antibiotic	Sensitive (%)	Denominator	Resistant (%)
Amoxyclav	11.6	70	88.4
Cefotaxime	18.9	38	81.1
Cefixime	22.2	28	77.8
Ciprofloxacin	13.8	67	86.2
Fosfomycin	81.8	45	18.2
Nitrofurantoin	80	77	20
Imipenem	85.7	44	14.3

Table 5 demonstrates urine analysis findings among culture-positive cases. Nitrite positivity was observed in 22 (26.5%) patients, while urinary casts were present in 13 (15.7%) cases.

Table 5: Urine analysis findings among culture-positive cases.

Parameter	Positive (n)	Percentage (%)
Nitrite	22	26.5
Casts	13	15.7
Microprotein	7	8.4
RBCs	6	7.2

Table 6 demonstrate ultrasonographic findings among study participants. Ultrasonography was normal in 55 (66.3%) patients, whereas cystitis-related inflammatory changes were observed in 13 (15.7%) cases.

Table 7 present the antibiotic sensitivity profile of *E. coli* isolates. *E. coli* demonstrated maximum sensitivity to Fosfomycin (89.3%), Nitrofurantoin (84%), and Imipenem (80%).

Table 7: Antibiotic sensitivity profile of *E. coli* isolates.

Antibiotic	Sensitivity (%)	Denominator
Fosfomycin	89.3	28
Nitrofurantoin	84	51
Imipenem	80	26
Ciprofloxacin	15	41
Ceftriaxone	34.2	39

Table 6: Ultrasonographic findings among culture-positive cases.

USG Finding	Number (n)	Percentage (%)
Normal	55	66.3
Cystitis changes	13	15.7
Mild free fluid	4	4.8
Ascites + cystitis	3	3.6
Other findings	8	9.6

Table 8 show the antibiotic sensitivity pattern of *Klebsiella* isolates. Complete sensitivity was observed to Imipenem, whereas high resistance was noted against fluoroquinolones and cephalosporins.

Table 8: Antibiotic sensitivity profile of *Klebsiella* isolates.

Antibiotic	Sensitivity (%)	Denominator
Imipenem	100	8
Nitrofurantoin	75	16
Fosfomycin	72.7	11
Ciprofloxacin	0	15
Amoxicillin	0	15

Table 9: Clinical outcome of study participants.

Clinical outcome	Number (n)	Percentage (%)
Recovered	83	100
Deaths	0	0
LAMA	0	0

Discussion

Urinary tract infection is one of the most common bacterial infections in children and remains an important cause of pediatric morbidity. Delayed diagnosis and treatment may result in renal scarring, hypertension, and chronic kidney disease [1, 2].

In the present study, female children constituted 49 (59.0%; 95% CI: 48.3%–68.9%) of cases, while males

accounted for 34 (41.0%; 95% CI: 31.1%–51.7%). Similar findings were reported by Mahajan et al. [7] and Ahirwar et al. [8]. Female predominance beyond infancy is mainly attributed to anatomical factors such as shorter urethral length and proximity of the urethral opening to the perineum [2,9].

Fever was the most common presenting symptom, followed by abdominal pain and increased frequency of micturition. Similar observations were reported by Mandal et al. [10]. These findings indicate that urinary tract infection should always be considered in febrile children without an obvious source of infection [3,11].

E. coli was the predominant organism isolated in the present study, accounting for 56 cases (67.5%; 95% CI: 56.8%–76.7%), followed by *Klebsiella* species. Similar findings have been reported in previous Indian and international studies [2,7,10]. The predominance of *E. coli* may be attributed to virulence factors such as adhesins and fimbriae, which facilitate colonization of the urinary tract [12].

A significant finding of the present study was the increasing antimicrobial resistance among urinary isolates. High resistance was observed against Amoxycylav (11.6%; 95% CI: 6.0%–21.0%), fluoroquinolones, (for ciprofloxacin 13.6%; 95% CI: 7.2%–24.3%) and cephalosporins. Similar resistance trends have been reported by Ahirwar et al. [8] and Gupta et al. [13]. Increasing antimicrobial resistance among pediatric uropathogens has become a major therapeutic challenge worldwide [14,15].

Nitrofurantoin (80.3%; 95% CI: 69.9%–87.7%) and Fosfomycin (81.8%; 95% CI: 67.3%–91.0%) demonstrated relatively high sensitivity among oral antibiotics, whereas Imipenem showed excellent sensitivity against resistant isolates. Similar findings were reported by Mahajan et al. [7]. The preserved sensitivity of Nitrofurantoin may be related to its limited systemic use.

The antimicrobial resistance pattern observed in the present study is comparable to reports from other pediatric populations. Yüksel et al. [16] demonstrated that increasing resistance among common uropathogens reduces the reliability of empirical therapy and emphasized the importance of institution-specific antibiograms for guiding antibiotic selection. Our findings similarly support periodic surveillance of local susceptibility patterns to optimize empirical treatment and strengthen antimicrobial stewardship.

Ultrasonography was normal in the majority of patients, while inflammatory changes suggestive of cystitis were

observed in a smaller proportion. Similar findings have been reported in previous studies, suggesting that structural abnormalities are not universally present in pediatric urinary tract infection [9, 17]. Although ultrasonography is an important first-line imaging modality for detecting structural abnormalities of the urinary tract, its sensitivity for detecting renal cortical scarring is limited. Dimercaptosuccinic acid (DMSA) renal scintigraphy is considered the reference standard for detecting renal cortical scars following acute pyelonephritis, while voiding cystourethrography (VCUG) is indicated in selected children for the evaluation of vesicoureteral reflux. Therefore, normal ultrasonographic findings in our patients do not exclude the possibility of renal parenchymal injury or cortical scarring. Recent studies have also explored advanced imaging modalities such as magnetic resonance urography (MRU) and urinary biomarkers including pentraxin-3 for the detection of renal scarring in children with vesicoureteral reflux and acute pyelonephritis [18–20]. These techniques may improve the identification of long-term renal injury, although they were beyond the scope of the present study.

All patients in the present study had a favorable short-term in-hospital outcome and recovered following appropriate antimicrobial therapy. However, only in-hospital clinical outcomes were assessed. Long-term outcomes such as recurrence, renal scarring, renal function, and follow-up imaging were beyond the scope of this cross-sectional study and should be evaluated in future prospective studies.

Overall, the present study highlights the importance of early diagnosis, urine culture, culture-guided therapy, and periodic surveillance of local antimicrobial susceptibility patterns for effective management of pediatric urinary tract infection.

Conclusion

Urinary tract infection remains an important cause of morbidity in children, with female children more commonly affected and fever being the predominant presenting symptom. *E. coli* was the most frequently isolated uropathogen. High antimicrobial resistance was observed against commonly used cephalosporins and fluoroquinolones, whereas nitrofurantoin, fosfomycin, and imipenem demonstrated good in vitro susceptibility. These findings emphasize the importance of early recognition, urine culture, and culture-guided antibiotic therapy. Periodic surveillance of local antimicrobial susceptibility patterns and rational antibiotic use are essential for appropriate empirical treatment and antimicrobial stewardship. The study was limited by the lack of routine ESBL testing, advanced imaging,

and long-term follow-up. Future prospective studies incorporating ESBL detection, advanced imaging, and long-term follow-up are warranted.

Conflicts of interest

Authors declare no conflicts of interest.

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