



Original Article

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 one of the most common bacterial infections in children and an important cause of pediatric morbidity. Delayed diagnosis and inappropriate treatment may result in renal scarring, hypertension, and chronic kidney disease. Increasing antimicrobial resistance among uropathogens has further complicated the management of pediatric UTIs.

Objectives: To evaluate the clinical profile, bacteriological spectrum, antibiotic sensitivity pattern, and clinical outcome of urinary tract infection in children.

Methods: This hospital-based cross-sectional study was conducted in the Department of Pediatrics, at a tertiary care hospital in Kota, Rajasthan, from October 2024 to April 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* 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. *Escherichia 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. UTIs may involve the lower urinary tract, including cystitis and urethritis, or the upper urinary tract, resulting in pyelonephritis.^[1-4]

Paediatric 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.^[2,5-8] Early diagnosis and appropriate antimicrobial therapy therefore play a crucial role in preventing long-term complications.^[2,3,9]

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.^[1-4]

Escherichia coli remains the most common causative organism and accounts for the majority of paediatric UTIs.^[2,6,10,11] Other important pathogens include *Klebsiella* species, *Proteus* species, *Pseudomonas aeruginosa*, *Enterococcus* species, and *Acinetobacter* species.^[10-12] The predominance of *E. coli* is attributed to virulence factors such as fimbriae and adhesins that facilitate attachment to uroepithelial cells.^[6] Urinary tract infection is a common pediatric illness worldwide and accounts for a substantial proportion of febrile illnesses in infants and young children. Studies have shown that approximately 6–8% of febrile children presenting to healthcare facilities may have UTI.^[3,10,13] Delayed diagnosis and treatment can result in significant renal morbidity.^[2,7,8]

The clinical presentation of paediatric 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.^[1-4,10,11] Due to these variable presentations, clinicians must maintain a high index of suspicion, particularly in children with unexplained fever.^[3,9,13]

Over recent decades, antimicrobial resistance among uropathogens has emerged as a major challenge in the management of urinary tract infections.^[6,14-17] Increasing resistance to commonly prescribed antibiotics such as ampicillin, cephalosporins, and fluoroquinolones has significantly limited empirical treatment options.^[12,14-17,20] Consequently, institution-specific antibiogram data are essential for selecting appropriate empirical therapy and implementing antimicrobial stewardship practices.^[2,14-17]

Despite the high burden of paediatric 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.

The American Academy of Pediatrics and other international guidelines recommend urine culture as the gold standard for diagnosis of urinary tract infection. These guidelines also emphasize the importance of appropriate urine collection methods and culture-guided antibiotic therapy.^[3,9,18] 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.^[10,11,19] Other common symptoms include abdominal pain, dysuria, urgency, vomiting, and frequency of micturition.^[10,11,19] 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.^[5,18,21]

Overall, available literature highlights the need for regular surveillance studies to monitor changing antimicrobial susceptibility patterns and to formulate region-specific treatment guidelines.^[14-17]

OBJECTIVES

To evaluate the clinical profile, bacteriological spectrum, antibiotic sensitivity pattern, and clinical outcome of urinary tract infection in children.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based cross-sectional study was conducted in the Department of Pediatrics at J.K. Lon Mother and Child Hospital, Government Medical College, Kota, Rajasthan, from October 2024 to April 2026 after obtaining approval from the Institutional Ethics Committee.

Study Population: 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 having culture-confirmed urinary tract infection with colony count >105 CFU/mL, admitted to the pediatric ward were included in the study.

Exclusion Criteria: Children below 6 months or above 18 years of age, having fungal urinary isolates.

Sample Size: Sample size to estimate a simple proportion (apparent prevalence):

• Estimated Proportion incidence of Culture positive Urinary Tract Infection in 6 months to 18 years paediatric age cases	0.111 (11.10%)
• Desired precision of estimate [Error 7%]	0.07
• Confidence level	95
• Population size	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.

Sample Collection: Urine samples were collected under aseptic precautions using clean-catch midstream urine in toilet-trained children; pediatric urine collection bags in non-toilet-trained children; and catheterized samples in selected infants or children with urinary retention.

Sample Processing: Urine specimens were processed using semi-quantitative culture techniques. Samples were inoculated on 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 colony growth exceeding 105 CFU/mL. Organisms were identified based on colony morphology, Gram staining, and standard biochemical tests.

Antibiotic Sensitivity Testing: Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines according to the organism-specific antimicrobial panel routinely used in the Department of Microbiology.

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.

Ethical consideration: The study was approved by the Institutional Ethics Committee of Government Medical College, Kota (IEC Approval No. F.3 (Acad/Ethical Clearance/Batch2023/2025/05)). Written informed consent was obtained from the parents or legally authorized guardians of all study participants prior to enrolment. Assent was obtained from older children, wherever applicable.

RESULTS

A total of 83 culture-positive pediatric patients with urinary tract infection were included in the present study. 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. 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. *Escherichia 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.

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 Amoxycylav, Ciprofloxacin, and third-generation cephalosporins. Nitrite positivity was observed in 22 (26.5%) patients, while urinary casts were present in 13 (15.7%) cases. Ultrasonography was normal in 55 (66.3%) patients, whereas cystitis-related inflammatory changes were observed in 13 (15.7%) cases. *E. coli* demonstrated maximum sensitivity to Fosfomycin (89.3%), Nitrofurantoin (84%), and Imipenem (80%). Complete sensitivity was observed to Imipenem, whereas high resistance was noted against fluoroquinolones and cephalosporins, in cases of *Klebsiella* isolates. All 83 cases recovered after treatment.

Table 1: 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	6.0

Flank pain	9	10.8
Urticaria	10	12.0
Fever	71	85.5

Table 2: 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 3: Antibiotic sensitivity pattern of urinary isolates

Antibiotic	Tested (n)	Sensitive (%)	Resistant (%)
Amoxyclav	69	11.6	88.4
Piperacillin	65	44.6	55.4
Cefotaxime	37	18.9	81.1
Cefixime	27	22.2	77.8
Cefuroxime	26	23.1	76.9
Cefpodoxime	27	11.1	88.9
Cefoperazone	62	54.8	43.5
Ceftriaxone	53	34.0	64.2
Norfloxacin	63	25.4	74.6
Ofloxacin	11	36.4	63.6
Levofloxacin	18	16.7	83.3
Ciprofloxacin	65	13.8	86.2
Fosfomycin	44	81.8	18.2
Amikacin	68	54.4	45.6
Gentamicin	37	45.9	54.1
Cotrimoxazole	66	31.8	68.2
Nitrofurantoin	75	80.0	20.0
Imipenem	42	85.7	14.3
Meropenem	39	59.0	41.0
Netilmicin	16	62.5	31.2

Table 4: 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 5: 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 6: Antibiotic sensitivity profile of E. coli isolates

Antibiotic	Sensitivity (%)	Denominator
Fosfomycin	89.3	28
Nitrofurantoin	84.0	51
Imipenem	80.0	26
Ciprofloxacin	15.0	41
Ceftriaxone	34.2	39

Table 7: Antibiotic sensitivity profile of Klebsiella isolates

Antibiotic	Sensitivity (%)	Denominator
Imipenem	100	8
Nitrofurantoin	75.0	16
Fosfomycin	72.7	11
Ciprofloxacin	0	15
Amoxicillin	0	15

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.^[1-3]

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.^[19] and Ahirwar et al.^[15] Female predominance beyond infancy is mainly attributed to anatomical factors such as shorter urethral length and proximity of the urethral opening to the perineum.^[1-4]

Fever was the most common presenting symptom, followed by abdominal pain and increased frequency of micturition. Similar observations were reported by Mandal et al.^[11] These findings indicate that urinary tract infection should always be considered in febrile children without an obvious source of infection.^[3,9,13]

Escherichia coli was the predominant organism isolated in the present study, accounting for isolated in 56 (67.5%; 95% CI: 56.8%–76.7%) cases, followed by *Klebsiella* species. Similar findings have been documented in previous Indian and international studies.^[2,10,11,19] The predominance of *E. coli* is attributed to virulence factors such as adhesins and fimbriae that facilitate colonization of the urinary tract.^[3,9,13]

A significant finding of the present study was the increasing antimicrobial resistance among urinary isolates. High resistance was observed against Amoxyclav (88.4%), fluoroquinolones, (for ciprofloxacin 86.2%) and cephalosporins. Similar resistance trends have been reported by Gupta et al.^[10], Ghadage et al.^[12], and Ahirwar et al.^[15] Increasing antimicrobial resistance among pediatric uropathogens has become a major therapeutic challenge worldwide.^[14,16,17] 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 Mandal et al.^[11] and Mahajan et al.^[19] The preserved sensitivity of Nitrofurantoin may be related to its limited systemic use.^[2,17] The antimicrobial resistance pattern observed in the present study is comparable to reports from other pediatric populations. Yüksel et al.^[20] 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.^[14,15,17,20]

Ultrasonography was normal (66.3%) in the majority of patients, while inflammatory changes suggestive of cystitis (15.7%) 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.^[4,5,18] Infections caused by Gram-negative organisms such as *Escherichia coli* and *Klebsiella* species were more frequently associated with inflammatory changes on ultrasonography. These organisms possess virulence factors that facilitate adherence to the uroepithelium and promote inflammatory responses within the urinary tract.^[6]

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.^[18,21] Therefore, normal ultrasonographic findings in our patients do not exclude the possibility of renal parenchymal injury or cortical scarring.^[7,18] 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.^[7,8,21] 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.^[2,3,5,18]

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.^[2,3,9,17,18]

CONCLUSION

Urinary tract infection remains a significant cause of morbidity in children. Female children were more commonly affected, and fever was the predominant presenting symptom. *Escherichia coli* was the most common uropathogen isolated. High resistance was observed against commonly prescribed antibiotics such as cephalosporins and fluoroquinolones, whereas nitrofurantoin, fosfomycin, and imipenem demonstrated good in vitro susceptibility. These findings highlight the importance of early recognition, urine culture, and culture-guided antibiotic therapy in the management of pediatric urinary tract infections. Periodic monitoring of local antimicrobial susceptibility patterns and rational antibiotic use are essential to support appropriate empirical antibiotic selection and antimicrobial stewardship. Further prospective studies are needed to evaluate their impact on long-term clinical outcomes and the prevention of complications.

The present study has certain limitations. Antimicrobial susceptibility testing was performed according to the routine laboratory protocol; therefore, ESBL production was not routinely evaluated and could not be analyzed. Although all enrolled children had a favorable in-hospital outcome, only short-term clinical outcomes during hospitalization were assessed. Furthermore, ultrasonography was the only imaging modality used, and DMSA renal scintigraphy or VCUG were not performed. Future prospective studies incorporating ESBL detection, advanced imaging modalities, and long-term follow-up are warranted.

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