

Research Paper

Clinico-bacteriological Profile, Antibiotic Resistance Pattern, in Recurrent Urinary Tract Infections In Children



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ABSTRACT

Background: Urinary tract infections (UTIs) are among the significant health concerns in children. In addition, recurrent UTIs pose a greater challenge with increasing rates of antibiotic resistance and acute kidney injury.

Objectives: To study the clinical and bacterial profiles, resistance patterns, and associated risk factors for recurrent UTIs in the pediatric population.

Methods: A prospective observational study over 18 months was conducted, during which 60 children aged 1 month to 18 years with recurrent UTIs were enrolled. Data on demographics, clinical presentation, underlying anomalies, bacterial isolates, and antibiotic susceptibility (antibiogram) and imaging results were recorded and analysed.

Results: Of 60 patients, 35(58.3%) were female, and the mean age of the studied children was 4.88 ± 3.99 years. The most common symptoms were fever in 42 patients (70%), abdominal pain in 40(66.7%), and dysuria in 25(41.7%). Congenital anomalies of the kidney and urinary tract (CAKUT) were present in 43 patients (71.7%), with vesicoureteral reflux in 27(45%) being the most prevalent. Bowel bladder dysfunction (BBD) was seen in 39(65%) enrolled patients. Urine culture grew gram-negative microorganisms in 46(76.7%); *Escherichia coli* was the most common, showing 100% sensitivity to nitrofurantoin and colistin but 100% resistance to ampicillin and cefotaxime. Gram-positive enterococci were isolated from 10/60 (16.6%) and showed 100% sensitivity to nitrofurantoin, vancomycin, and linezolid; however, they were 100% resistant to gentamicin.

Conclusions: Children with underlying CAKUT and bowel dysfunction are predisposed to recurrent UTIs. *E. coli* and Enterococci are the most common uropathogens with concerning antibiotic resistance profiles. These findings highlight the need for targeted antibiotic stewardship and early management of BBD and CAKUT to prevent recurrence.

Key Words:

Bacteria, Children, Infection, Resistance, Urinary tract

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Introduction

Recurrent urinary tract infection (UTI) in children is associated with considerable health risk and financial burden on the affected individuals and their families. Approximately

30% of children will experience at least one recurrence within 6–12 months, and 3–15% of children after the first UTI will show renal scarring [1-4]. Factors associated with recurrent UTI in infants <1 year include high-grade vesicoureteral reflux and delayed contrast clearance on Micturating cystourethrogram (MCU) [5, 6].

Besides these, other risk factors include various forms of obstructive uropathy, abnormal communications between the urinary and gastrointestinal systems, phimosis in male children, vulval synechiae in female children, bladder instability, and a history of antecedent infections [7-9].

Approximately 75% of pediatric UTIs are caused by *Escherichia coli*, which has demonstrated resistance to relapse [10, 11]. The presence of virulence factors, such as P fimbriae, the K1 capsular antigen, hemolytic factors, and cytotoxic necrotizing factors, helps *E. coli* colonize and cause UTIs. Other pathogens, such as *Klebsiella*, *Proteus*, *Pseudomonas aeruginosa*, *Enterococcus*, *Staphylococcus*, and *Streptococcus*, exhibit varied mechanisms for causing UTI [12, 13].

The use of antibiotics before the urine culture report is based on clinical findings and a positive urinalysis, to eradicate the microbe before it causes renal damage. However, while treating UTIs primarily with antimicrobials, antimicrobial resistance is emerging as a major challenge for physicians. This disturbing trend constitutes a major international public health threat where primary healthcare accounts for about 80% of all antibiotics prescribed [14, 15].

We aimed to study the clinical profile, common incriminating pathogens, risk factors, and antibiotic resistance in children with recurrent UTIs.

Materials and Methods

This prospective observational study was conducted over 18 months at the Department of Pediatrics and Pediatric Nephrology at the Government Children's Hospital, Bemina, Srinagar—a tertiary care facility in Jammu and Kashmir, India. The study population comprised all children aged 1 month to 18 years who visited the pediatric nephrology and general pediatric outpatient

departments with symptoms suggesting a UTI and who were subsequently evaluated for recurrent UTI, which was confirmed, and enrolled. All suspected patients between 1 month to 18 years, who met the inclusion criteria, were studied. Patients with HIV, congenital immune deficiencies, sickle cell disease, neurogenic bladder, paralytic syndromes, chronic renal disease, renal calculi, or central nervous system malformations were excluded. Informed consent from all participating patients or their parents/guardians was obtained, and comprehensive data were collected from each patient's history, physical examination, and investigations, and recorded in a pre-designed proforma. During evaluation, clinical observations, comprehensive urinalysis (including isolation of specific pathogens and their antimicrobial sensitivity/resistance profiles), and ultrasound of the kidneys were performed in all. MCU and dimercaptosuccinic acid (DMSA)/diethylene triamine pentaacetic acid (DTPA)/uroflowmetry were performed as per protocol. Our additional evaluations included inquiries about urinary symptoms such as frequency, hesitancy, intermittent stream, weak stream, incontinence, nocturia, dysuria, holding manoeuvres, and incomplete emptying, which were also documented and analysed. In addition to assessment for urinary retention, post-micturition dribbling, suprapubic pain, bowel and bladder diary, along with psychological evaluation, were also carried out as needed.

Antibiogram disks for nitrofurantoin, meropenem, imipenem, ertapenem, co-amoxiclav, piperacillin-tazobactam, gentamicin, amikacin, colistin, cefepime, cefixime, cefotaxime, ceftazidime, ceftriaxone, linzolid, vancomycin, levofloxacin, ciprofloxacin, cotrimoxazole, fosfomycin, amoxicillin, ampicillin, amphotericin B, and rifampicin were studied and analysed. Data were collected using the structured pro forma and entered into a Microsoft Excel spreadsheet for subsequent statistical analysis. For continuous variables, Mean \pm SD was used; for non-normal distributions or those containing outliers, results were reported as percentages.

Results

Of 60 children studied, 35(58.3%) were females, and 25(41.7%) were males; 38 patients (63.3%) were in the 1-5 years age group, with a mean age of presentation of 4.88 ± 3.99 years. The most frequently reported clinical symptoms included fever in 42 patients (70%), followed by abdominal pain in 40(66.7%) and dysuria in 25 (41.7%). Other symptoms are shown in Table 1—bowel-bladder dysfunction, affecting 39 patients (65%) is a remarkable finding.

Table 1. Clinical profile of studied patients

Variables	Patient Profile	No. (%)
Gender	Male	25(41.7)
	Female	35(58.3)
Age (y)	0-6	38(63.3)
	7-12	18(30)
	13-18	4(6.7)
Symptom	Fever	42(70)
	Pain abdomen	40(66.7)
	Dysuria	26(43.3)
	Increased urination	25(41.7)
	Vomiting	20(33.3)
Symptom	Urgency	18(30)
	Poor feeding	15(25)
	Diarrhea	9(15)
	Irritability	9(15)
	Constipation	8(13.3)
	Hematuria	5(8.3)
	Incontinence	4(6.7)
Bowel bladder dysfunction		39(65)

Antibiograms showing sensitivity and resistance are shown in [Table 2](#). *Candida* was isolated from one patient and was sensitive to amphotericin B. *Mycobacterium tuberculosis* was isolated from one patient and was sensitive to rifampicin. MCU was performed in 27 patients (45%), DMSA scans in 21(35%), and DTPA scans in 9(15%) patients. The majority of patients (n=48; 80%) were managed conservatively, while 12(20%) required surgical intervention; among those, ureterostomy was the most common procedure (33.3%), followed by fulguration. Nephrectomy was performed in one patient having chronic pyelonephritis with hypertension.

Discussion

Our study demonstrated that the most common age group was 1 month to 5 years (mean 4.88 ± 3.99), which is consistent with the findings of Shaikh et al. [\[16\]](#). A similar finding was observed by Kiros et al. [\[17\]](#) and Malla et al. [\[18\]](#), who noted that children under 10 years are

more susceptible to recurrent UTIs. Regarding gender susceptibility, our finding of higher female prevalence (1.4:1) in recurrent UTIs is consistent with Malla et al. [\[18\]](#) and Gebremariam et al. [\[19\]](#), attributing this to females having a shorter and wider urethra, its proximity to the anus, and a warm, moist environment conducive to bacterial growth. However, some studies, such as those by Elale et al. [\[20\]](#), Kiros et al. [\[17\]](#), and Winberg et al. [\[21\]](#), reported a male predominance, potentially due to a larger proportion of uncircumcised males in their cohorts.

The most common presenting symptoms were fever (70%), followed by abdominal pain (66.7%), dysuria (43.3%), and increased urine frequency (41.7%). These clinical presentations are consistent with those reported by Schlager et al. [\[22\]](#).

Table 2. Organisms, antibiotics, and resistance patterns

Antibiotic	No. (%)					
	<i>E. coli</i> (n=37)		<i>Klebsiella Pneumoniae</i> (n=7)		<i>Enterococcus Faecalis</i> (n=10)	
	S	R	S	R	S	R
NF	37(100)	0	0	7(100)	10(100)	0
LZ	NA	NA	NA	NA	10(100)	0
VAN	NA	NA	NA	NA	10(100)	0
MEM	34(91.1)	3(8.1)	5(71.4)	2(28.6)	NA	NA
IPM	32(86.5)	5(13.5)	6(85.7)	1(14.3)	NA	NA
TZP	19(51.4)	18(48.6)	2(28.6)	5(71.4)	1(10)	9(90)
GEN	16(43.2)	21(56.8)	3(42.8)	4(57.1)	0	10(100)
AMK	32(86.5)	5(13.5)	0	7(100)	2(20)	8(80)
COLS	37(100)	0	7(100)	0	NA	NA
CAZ	0	37(100)	0	7(100)	NA	NA
CRO	7(18.9)	30(81.1)	0	7(100)	NA	NA
LVX	6(16.2)	31(83.8)	2(28.6)	5(71.4)	7(70)	3(30)
SXT	0	37(100)	0	7(100)	NA	NA
FOS	6(16.2)	31(83.8)	6(85.7)	1(14.3)	NA	NA
AMP	0	37(100)	NA	NA	8(80)	2(20)
TG	NA	NA	6(85.7)	1(14.3)	NA	NA

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Abbreviations: S: Sensitive; R: Resistant; AMK: Amikacin; AMP: Ampicillin; CRO: Ceftriaxone; CAZ: Ceftazidime; COLS: Colistin; SXT: Cotrimoxazole; FOS: Fosfomycin; GEN: Gentamicin; IPM: Imipenem; LZ: Linezolid; LVX: Levofloxacin; MEM: Meropenem; NF: Nitrofurantoin; TZP: Piperacillin/tazobactam; TGC: Tigecycline; VAN: Vancomycin.

Ultrasonography revealed various abnormalities in 43 patients (71.6%) which included hydronephrosis in 25(58%), unilateral multicystic dysplastic kidneys in 8(18.6%), prominent ureters 4(9.3%), pyelonephritis in 3(6.95), and horse shoe kidney, single kidney, unilateral double moiety in one each (2.3%), which is in line with the observations made by Sinha et al. [23].

The present study showed vesicoureteral reflux (VUR) in 27 patients (45%), the commonest form of congenital anomalies of the kidney and urinary tract, similar to the observations of Sinha et al. [23] and Wils Gliam [24]. Among the 21 DMSA scans, 17 patients (81%) showed decreased uptake/renal scarring, while among the 9 DTPA scans, 4(44.4%) showed decreased estimated GFR unilaterally.

Our higher incidence of hydronephrosis compared to a previous study from the same centre by Ashraf et al. [25] might be attributed to our exclusive enrolment of recurrent UTI patients.

Besides VUR, the second most common association in recurrent UTI was bladder bowel dysfunction (BBD), observed in 39 patients (65%), which is higher than an earlier published study [26] but far lower than the study by Shaikh et al. [27].

Among gram-negative organisms, *E. coli* was the most common, accounting for 61.7% (37/60), followed by Enterococci at 16.7% (10/60) and *Klebsiella* at 11.7% (7/60). It is noteworthy that *E. coli* is consistently detected in recurrent UTIs, possibly due to its ability to evade host defences through evolving mechanisms.

These findings are consistent with earlier studies [17-20, 28, 29], which reported *E. coli* as the predominant uropathogen in children.

E. coli isolates exhibited 100% sensitivity to nitrofurantoin and colistin. High sensitivity was also observed with meropenem (91.1%), imipenem (86.5%), amikacin (86.5%), and piperacillin-tazobactam (51.4%). However, *E. coli* showed 100% resistance to cefotaxime, ceftazidime, ampicillin, and cotrimoxazole. Increased resistance was also noted for ceftriaxone (81.1%), fosfomycin (83.8%), and levofloxacin (83.8%), as shown in Table 2, findings similar to those of the study conducted by Younis et al. [30]. For *Klebsiella* species, 100% sensitivity was observed with colistin, and 85.7% sensitivity with fosfomycin, tigecycline, and imipenem. Conversely, *Klebsiella* exhibited 100% resistance to nitrofurantoin, ceftriaxone, ceftazidime, and cotrimoxazole. Other notable resistances included tazobactam (71.4%) and levofloxacin (71.4%). These findings generally align with those of Maraki et al. [31].

Among gram-positive pathogens, *Enterococcus* demonstrated 100% sensitivity to linezolid, nitrofurantoin, and vancomycin. They showed 80% sensitivity to ampicillin and 70% to levofloxacin. However, *Enterococcus* exhibited 100% resistance to gentamicin, 90% resistance to piperacillin-tazobactam, and 80% resistance to amikacin, a pattern consistent with results from Elale et al. [20], who also reported high resistance to tetracycline and erythromycin but no resistance to nitrofurantoin in *Enterococcus* species.

Conclusion

Recurrent UTIs in children are not uncommon and are often linked to underlying congenital anomalies, such as vesicoureteral reflux, pelvi-ureteric junction obstruction, and posterior urethral valve, as well as clinical conditions like bowel-bladder dysfunction. Among the causative organisms, *E. coli* and *Enterococcus* were identified as the most frequent pathogens. These isolates demonstrated high susceptibility to certain antibacterial agents, while showing resistance to many others, underscoring the challenge of effective treatment. These findings emphasize the importance of early identification and management of congenital anomalies of the kidney and urinary tract, addressing bowel-bladder dysfunction as a contributing factor; while implementing targeted antibiotic stewardship to minimize resistance and prevent recurrence.

Study limitations

The main limitations of this study are the small sample size (60 children) and its conduct at a single tertiary care center. These factors restrict the generalizability of the antibiotic resistance findings to other healthcare settings (such as primary care centers) and different geographical regions. The observational, non-comparative nature of the study prevents us from accurately determining cause-and-effect relationships and quantifying the independent effects of each risk factor. As we excluded patients with immunodeficiencies, neurogenic bladder, and chronic kidney disease to homogenize the study group, the results do not apply to the entire spectrum of children with recurrent UTI (who often have these comorbidities). The highest frequency of patients was in the age group of 1 month to 5 years, while risk factors such as BBD are more common in children older than 4-5 years, and remained unresolved, being this a descriptive study.

Study recommendations

Given the above limitations, there is a clear need for larger multicenter studies to enhance the generalizability of findings across diverse populations and healthcare settings. In addition molecular analysis of bacterial strains to better understand resistance mechanisms and epidemiological patterns along with interventional studies on bowel-bladder dysfunction (BBD) management, as this remains an under-resolved risk factor in recurrent pediatric UTIs.

Ethical Considerations

Compliance with ethical guidelines

Study was conducted after obtained ethical clearance from the Institution Ethical Committee, [Government Medical College Srinagar](#), Kashmir India. Due informed consents were taken from parents/legal guardians/absent from children whichever was applicable.

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Authors contributions

Conceptualization and study design: Parvez Ahmed and Mohd Ashraf; Methodology and data analysis: Mohd Ashraf, Mohd Suhail Lone, Sameer Ahmed Peer; Writing: Mohd Ashraf, Ashiq Nisar Andrabi, and Samiya Mushtaq.

Conflicts of interest

The authors declared no conflict of interest.

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