

SPECTRUM OF UROPATHOGENS IN PEDIATRIC URINARY TRACT INFECTIONS AND THEIR AGE-WISE DISTRIBUTION

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ABSTRACT

Background: Urinary tract infection (UTI) is one of the most common bacterial infections in children and is associated with significant morbidity, recurrent infections, renal scarring, and long-term renal complications if inadequately treated. Understanding the spectrum of uropathogens and their antimicrobial susceptibility patterns is essential for effective management and empirical antibiotic selection. **Aim:** To study the spectrum of uropathogens causing urinary tract infections in children and their age-wise distribution. **Objectives:** To identify the various uropathogens isolated from urine cultures of pediatric patients with UTI, determine their age-wise distribution, and assess the antimicrobial susceptibility pattern of the isolated organisms. **Materials and Methods:** A hospital-based prospective observational study was conducted among 102 children aged 1 month to 14 years diagnosed with culture-positive urinary tract infection. Demographic, clinical, microbiological, and antimicrobial susceptibility data were collected using a structured proforma. Urine samples were processed using standard microbiological techniques, and antibiotic susceptibility testing was performed according to CLSI guidelines. Data were analyzed using SPSS software, with $p < 0.05$ considered statistically significant. **Results:** Among the 102 children studied, the majority belonged to the 1–5 years age group (55.9%), followed by children older than 5 years (22.5%) and infants younger than 1 year (21.6%). Males constituted 61.8% of cases. Lower UTIs (62.7%) were more common than upper UTIs (37.3%). *E. coli* was the predominant uropathogen, isolated in 45.1% of cases, while carbapenem-resistant *E. coli* accounted for 11.8% and *Klebsiella pneumoniae* for 17.6% of cases. No significant association was observed between age group and type of uropathogen ($p = 0.185$). Antimicrobial resistance was highest for ampicillin (96.7%), ceftriaxone (86.7%), and ciprofloxacin (80.0%). Amikacin demonstrated the highest sensitivity (71.1%) among Gram-negative isolates. **Conclusion:** *E. coli* remains the principal pathogen causing pediatric urinary tract infections across all age groups. High resistance rates to commonly used antibiotics highlight the need for culture-guided therapy and periodic surveillance of local antimicrobial susceptibility patterns. Amikacin remains an effective therapeutic option for many pediatric UTIs.

INTRODUCTION

Urinary tract infection (UTI) is one of the most common bacterial infections encountered in pediatric practice and represents a significant cause of morbidity among children worldwide. UTIs account for a substantial proportion of outpatient visits, emergency consultations, and hospital admissions in the pediatric age group. Early diagnosis and prompt treatment are essential because untreated or recurrent infections may result in serious complications such as renal scarring, hypertension, impaired renal function,

and end-stage renal disease. The burden of UTI is particularly high in infants and young children because clinical manifestations are often nonspecific, making diagnosis challenging and potentially delaying treatment.^[1]

The epidemiology of pediatric UTI varies according to age and sex. During infancy, UTIs are more common in males, especially uncircumcised infants and those with congenital urinary tract anomalies. However, after infancy, females become increasingly susceptible due to their shorter urethra and proximity of the urethral opening to the perianal region,

facilitating bacterial colonization and ascent into the urinary tract. Approximately 8% of children experience at least one episode of UTI during childhood, and recurrence rates may reach 30% within the first year after the initial infection. These observations emphasize the importance of understanding the microbial spectrum and associated risk factors in different pediatric age groups.^[2]

The majority of pediatric UTIs are caused by Gram-negative bacteria originating from the gastrointestinal tract. *Escherichia coli* remains the predominant pathogen responsible for nearly 70–90% of infections. Other commonly isolated organisms include *Klebsiella* species, *Proteus* species, *Enterobacter* species, *Pseudomonas aeruginosa*, and *Enterococcus* species. The distribution of these pathogens may vary according to age, gender, hospitalization status, underlying urinary tract abnormalities, and geographical region. Knowledge of age-wise pathogen distribution is clinically important because the prevalence of specific organisms and their resistance patterns may differ significantly between infants, preschool children, and older children.^[3]

In recent years, antimicrobial resistance among uropathogens has emerged as a major public health concern. Widespread and often inappropriate use of antibiotics has contributed to increasing resistance against commonly prescribed antimicrobial agents. Several studies have reported growing resistance among uropathogens to cephalosporins, fluoroquinolones, and cotrimoxazole, thereby limiting treatment options. Consequently, empirical therapy based solely on historical susceptibility patterns may no longer be adequate. Continuous surveillance of local uropathogen profiles and antimicrobial susceptibility patterns is essential for developing effective treatment guidelines and optimizing patient outcomes.^[4]

Aim

To study the spectrum of uropathogens causing urinary tract infections in children and their age-wise distribution.

Objectives

To identify the various uropathogens isolated from urine cultures of pediatric patients with urinary tract infection.

To determine the age-wise distribution of different uropathogens among children with urinary tract infection.

To assess the antimicrobial susceptibility pattern of the isolated uropathogens.

MATERIALS AND METHODS

Source of Data

Data were collected from pediatric patients aged 1 month to 14 years who attended the Pediatric Outpatient Department (OPD) or were admitted to the Pediatric wards of the tertiary care teaching hospital with clinically suspected urinary tract

infection and positive urine culture during the study period.

Study Design

Hospital-based prospective observational study.

Study Location

The study was conducted in the Department of Pediatrics in collaboration with the Department of Microbiology at a tertiary care teaching hospital.

Study Duration

The study was conducted over a period of 12 months.

Sample Size

A total of **102 children** diagnosed with urinary tract infection were included in the study.

Inclusion Criteria

1. Children aged 1 month to 14 years.
2. Patients presenting with symptoms suggestive of urinary tract infection.
3. Patients with significant growth of a single organism on urine culture.
4. Parents/guardians who provided informed written consent.

Exclusion Criteria

1. Children who had received antibiotics within 48–72 hours prior to urine sample collection.
2. Patients with contaminated urine culture samples.
3. Children whose parents/guardians refused consent.
4. Patients with incomplete clinical or laboratory records.

Procedure and Methodology

After obtaining approval from the Institutional Ethics Committee and written informed consent from parents/guardians, eligible children were enrolled consecutively. Detailed demographic information, clinical history, presenting symptoms, duration of illness, associated risk factors, and physical examination findings were recorded using a predesigned and pretested proforma.

Urine samples were collected using age-appropriate sterile techniques. Midstream clean-catch urine samples were obtained from toilet-trained children, whereas catheterization or sterile urine collection methods were used in younger children when required. Samples were transported immediately to the microbiology laboratory for analysis.

Children diagnosed with UTI based on significant bacteriuria were evaluated further. Information regarding age, gender, clinical presentation, type of UTI (upper or lower), imaging findings, and isolated microorganisms was documented. Uropathogens isolated from urine cultures were categorized and analyzed according to age groups.

Sample Processing

Urine specimens were subjected to routine microscopic examination and culture. Culture was performed on standard media such as Blood Agar and MacConkey Agar using calibrated loop techniques. Samples were incubated aerobically at 37°C for 24–48 hours.

A culture yielding significant growth of a single organism was considered positive. Identification of

bacterial isolates was carried out using standard microbiological methods including colony morphology, Gram staining, and biochemical tests. Antibiotic susceptibility testing was performed by the Kirby–Bauer disc diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

Statistical Methods

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 25.0.

- Categorical variables were expressed as frequencies and percentages.
- Continuous variables were presented as mean \pm standard deviation (SD).
- Association between age groups and isolated uropathogens was assessed using Chi-square test or Fisher's exact test whenever appropriate.

- A p-value <0.05 was considered statistically significant.
- Results were presented using tables, bar diagrams, and pie charts.

Data Collection

Data collection was performed using a structured case record proforma. Information recorded included:

- Demographic details (age, sex)
 - Presenting symptoms and signs
 - Clinical diagnosis
 - Risk factors for UTI
 - Urinalysis findings
 - Urine culture results
 - Identified uropathogens
 - Antibiotic susceptibility pattern
 - Radiological investigations, if performed
- All collected data were verified for completeness and accuracy before statistical analysis.

RESULTS

Table 1: Spectrum of Uropathogens Causing UTI in Children and Age-wise Distribution

Variable	n (%)	95% CI	Test value	P value
Age <1 year	22 (21.6)	14.7–30.5	$\chi^2=24.29$	<0.001
Age 1–5 years	57 (55.9)	46.2–65.1		
Age >5 years	23 (22.5)	15.5–31.6		
Male	63 (61.8)	52.1–70.6	$\chi^2=5.65$	0.017
Female	39 (38.2)	29.4–47.9		
Upper UTI	38 (37.3)	28.5–46.9	$\chi^2=6.62$	0.010
Lower UTI	64 (62.7)	53.1–71.5		
E. coli including CRE	58 (56.9)	47.2–66.1	$\chi^2=313.37$	<0.001
Klebsiella spp.	19 (18.6)	12.2–27.3		
Other organisms	25 (24.5)	17.2–33.7		

A total of 102 children with culture-proven urinary tract infection were included in the study. The majority of patients belonged to the 1–5 years age group, accounting for 57 (55.9%) cases (95% CI: 46.2–65.1), followed by children older than 5 years comprising 23 (22.5%) cases (95% CI: 15.5–31.6), while infants younger than 1 year constituted 22 (21.6%) cases (95% CI: 14.7–30.5). The age distribution showed a statistically significant difference ($\chi^2=24.29$, $p<0.001$), indicating that UTIs were most prevalent among preschool-aged children. Males predominated the study population with 63 (61.8%) cases (95% CI: 52.1–70.6), whereas females accounted for 39 (38.2%) cases (95% CI: 29.4–47.9), and this gender difference was statistically significant ($\chi^2=5.65$, $p=0.017$). Regarding the clinical

classification of infection, lower urinary tract infections were more common, occurring in 64 (62.7%) children (95% CI: 53.1–71.5), compared to upper urinary tract infections in 38 (37.3%) children (95% CI: 28.5–46.9), with a significant difference between the two groups ($\chi^2=6.62$, $p=0.010$). Analysis of the microbial spectrum revealed that E. coli, including carbapenem-resistant E. coli (CRE), was the predominant pathogen isolated in 58 (56.9%) cases (95% CI: 47.2–66.1), followed by Klebsiella species in 19 (18.6%) cases (95% CI: 12.2–27.3), while other organisms collectively accounted for 25 (24.5%) cases (95% CI: 17.2–33.7). The predominance of E. coli was highly significant statistically ($\chi^2=313.37$, $p<0.001$), confirming its major role in pediatric UTIs.

Table 2: Various Uropathogens Isolated from Urine Culture

Organism isolated	n (%)	95% CI	Test value	P value
E. coli	46 (45.1)	35.8–54.8	$\chi^2=313.37$	<0.001
E. coli (CRE)	12 (11.8)	6.8–19.4		
Klebsiella pneumoniae	18 (17.6)	11.4–26.2		
Enterococcus species	4 (3.9)	1.5–9.7		
Enterococcus faecalis	3 (2.9)	1.0–8.3		
Non-fermenting GNB	3 (2.9)	1.0–8.3		
Pseudomonas aeruginosa	3 (2.9)	1.0–8.3		
Candida tropicalis	2 (2.0)	0.5–6.9		
Enterobacter cloacae	2 (2.0)	0.5–6.9		
Proteus mirabilis	2 (2.0)	0.5–6.9		

Proteus vulgaris	2 (2.0)	0.5–6.9		
CONS	1 (1.0)	0.2–5.3		
Enterobacter aerogenes	1 (1.0)	0.2–5.3		
Klebsiella oxytoca	1 (1.0)	0.2–5.3		
Staph. aureus (MRSA)	1 (1.0)	0.2–5.3		
Streptococcus species	1 (1.0)	0.2–5.3		

Microbiological analysis of urine cultures demonstrated a diverse spectrum of uropathogens among pediatric patients with urinary tract infection. *E. coli* was the most frequently isolated organism, identified in 46 (45.1%) cases (95% CI: 35.8–54.8), followed by *Klebsiella pneumoniae* in 18 (17.6%) cases (95% CI: 11.4–26.2). Carbapenem-resistant *E. coli* (CRE) represented a notable proportion of isolates, accounting for 12 (11.8%) cases (95% CI: 6.8–19.4). *Enterococcus* species were isolated in 4 (3.9%) cases (95% CI: 1.5–9.7), while *Enterococcus faecalis*, non-fermenting Gram-negative bacilli, and *Pseudomonas aeruginosa* each accounted for 3 (2.9%) cases (95% CI: 1.0–8.3). *Candida tropicalis*,

Enterobacter cloacae, *Proteus mirabilis*, and *Proteus vulgaris* were isolated in 2 (2.0%) cases each (95% CI: 0.5–6.9). Less commonly encountered pathogens included coagulase-negative Staphylococci (CONS), *Enterobacter aerogenes*, *Klebsiella oxytoca*, methicillin-resistant *Staphylococcus aureus* (MRSA), and *Streptococcus species*, each isolated from a single patient (1.0%; 95% CI: 0.2–5.3). The overall distribution of organisms demonstrated a highly significant predominance of *E. coli* and related Enterobacterales ($\chi^2=313.37$, $p<0.001$), highlighting their major contribution to pediatric urinary tract infections.

Table 3: Age-wise Distribution of Different Uropathogens

Organism	<1 year n (%)	1–5 years n (%)	>5 years n (%)	Total n (%)	Test value	P value
<i>Candida tropicalis</i>	0 (0.0)	1 (1.8)	1 (4.3)	2 (2.0)	$\chi^2=36.743$	0.185
CONS	0 (0.0)	1 (1.8)	0 (0.0)	1 (1.0)		
<i>E. coli</i>	8 (36.4)	32 (56.1)	6 (26.1)	46 (45.1)		
<i>E. coli</i> (CRE)	3 (13.6)	6 (10.5)	3 (13.0)	12 (11.8)		
<i>Enterobacter aerogenes</i>	0 (0.0)	0 (0.0)	1 (4.3)	1 (1.0)		
<i>Enterobacter cloacae</i>	1 (4.5)	1 (1.8)	0 (0.0)	2 (2.0)		
<i>Enterococcus faecalis</i>	1 (4.5)	0 (0.0)	2 (8.7)	3 (2.9)		
<i>Enterococcus species</i>	2 (9.1)	1 (1.8)	1 (4.3)	4 (3.9)		
<i>Klebsiella oxytoca</i>	1 (4.5)	0 (0.0)	0 (0.0)	1 (1.0)		
<i>Klebsiella pneumoniae</i>	6 (27.3)	8 (14.0)	4 (17.4)	18 (17.6)		
Non-fermenting GNB	0 (0.0)	2 (3.5)	1 (4.3)	3 (2.9)		
<i>Proteus mirabilis</i>	0 (0.0)	2 (3.5)	0 (0.0)	2 (2.0)		
<i>Proteus vulgaris</i>	0 (0.0)	2 (3.5)	0 (0.0)	2 (2.0)		
<i>Pseudomonas aeruginosa</i>	0 (0.0)	1 (1.8)	2 (8.7)	3 (2.9)		
Staph. aureus (MRSA)	0 (0.0)	0 (0.0)	1 (4.3)	1 (1.0)		
<i>Streptococcus species</i>	0 (0.0)	0 (0.0)	1 (4.3)	1 (1.0)		

The age-wise analysis of isolated uropathogens revealed variations in the distribution of organisms across different pediatric age groups. *E. coli* remained the predominant pathogen in all age categories, accounting for 8 (36.4%) cases among infants younger than 1 year, 32 (56.1%) cases among children aged 1–5 years, and 6 (26.1%) cases among those older than 5 years. Similarly, *Klebsiella pneumoniae* was observed across all age groups, with the highest frequency among children aged 1–5 years (14.0%). Carbapenem-resistant *E. coli* (CRE) isolates were relatively evenly distributed, comprising 13.6%, 10.5%, and 13.0% of isolates in the respective

age groups. Certain organisms exhibited age-specific trends; *Enterococcus faecalis*, *Pseudomonas aeruginosa*, MRSA, *Streptococcus species*, and *Enterobacter aerogenes* were predominantly identified in children older than 5 years, whereas *Klebsiella oxytoca* and *Enterobacter cloacae* were more commonly encountered in infants. *Proteus mirabilis* and *Proteus vulgaris* were isolated exclusively in the 1–5 years age group. Despite these apparent variations, statistical analysis demonstrated no significant association between age group and the type of uropathogen isolated ($\chi^2=36.743$, $p=0.185$).

Table 4: Antimicrobial Resistance Pattern among Gram-negative Uropathogens

Antibiotic	Resistant n (%)	Sensitive n (%)	95% CI for resistance	Test value	P value
Amikacin	26 (28.9)	64 (71.1)	20.5–39.0	$\chi^2=141.98$	<0.001
Ampicillin	87 (96.7)	3 (3.3)	90.7–98.9		
Ceftriaxone	78 (86.7)	12 (13.3)	78.1–92.2		
Ciprofloxacin	72 (80.0)	18 (20.0)	70.6–87.0		
Cotrimoxazole	61 (67.8)	29 (32.2)	57.6–76.5		
Gentamicin	40 (44.4)	50 (55.6)	34.6–54.7		
Nitrofurantoin	47 (52.2)	43 (47.8)	42.0–62.2		
Piperacillin-tazobactam	55 (61.1)	35 (38.9)	50.8–70.5		
Meropenem	56 (62.2)	34 (37.8)	51.9–71.5		

Assessment of antimicrobial susceptibility patterns among Gram-negative uropathogens revealed substantial resistance to several commonly used antibiotics. Ampicillin exhibited the highest resistance rate, with 87 (96.7%) isolates resistant and only 3 (3.3%) sensitive (95% CI: 90.7–98.9). High resistance was also observed against ceftriaxone, affecting 78 (86.7%) isolates (95% CI: 78.1–92.2), and ciprofloxacin, with 72 (80.0%) resistant isolates (95% CI: 70.6–87.0). Resistance to cotrimoxazole was identified in 61 (67.8%) isolates (95% CI: 57.6–76.5), while piperacillin-tazobactam and meropenem showed resistance rates of 61.1% and 62.2%, respectively. Moderate resistance was noted against nitrofurantoin (52.2%) and gentamicin (44.4%). Among all tested antibiotics, amikacin demonstrated the highest effectiveness, with only 26 (28.9%) resistant isolates and 64 (71.1%) sensitive isolates (95% CI: 20.5–39.0). The overall variation in resistance and susceptibility patterns among the tested antibiotics was highly statistically significant ($\chi^2=141.98$, $p<0.001$).

DISCUSSION

In the present study, the highest proportion of pediatric UTI cases was observed in the 1–5 years age group 57 (55.9%), followed by children >5 years 23 (22.5%) and infants <1 year 22 (21.6%). This age distribution was statistically significant ($\chi^2=24.29$, $p<0.001$), suggesting that preschool children were most commonly affected. Similar observations were reported by Shaikh et al. (2008),^[1] who noted that UTI prevalence varies with age and is common in younger children due to immature bladder habits, toilet training issues, and nonspecific clinical presentation. Bitsori et al. (2012),^[2] also reported a higher burden of UTI among younger children, particularly those below 5 years. In the present study, males constituted 63 (61.8%) cases, while females accounted for 39 (38.2%), showing a significant male predominance ($p=0.017$). This finding differs from studies by Taneja et al. (2010),^[3] and Marcus et al. (2005)^[4], where female predominance was noted, especially beyond infancy. However, male predominance in younger pediatric cohorts has been reported by Kanellopoulos et al. (2006),^[5] particularly in infants and children with underlying urinary tract abnormalities. Lower UTI was more common 64 (62.7%) than upper UTI 38 (37.3%), which was statistically significant ($p=0.010$). Comparable findings were noted by Edlin et al. (2013),^[6] who reported cystitis and lower tract symptoms as frequent presentations among culture-positive pediatric UTI cases.

The microbiological profile in the present study showed that *E. coli* including CRE was the predominant pathogen, isolated in 58 (56.9%) cases, followed by *Klebsiella* spp. in 19 (18.6%) and other organisms in 25 (24.5%) cases. The predominance of *E. coli* was highly significant ($\chi^2=313.37$, $p<0.001$).

Individually, *E. coli* was isolated in 46 (45.1%) cases, *E. coli* CRE in 12 (11.8%), and *Klebsiella pneumoniae* in 18 (17.6%). This pattern is consistent with several previous studies. Shaikh et al. (2008),^[1] Marcus et al. (2005)^[4], and Edlin et al. (2013),^[6] reported *E. coli* as the leading uropathogen in children, usually accounting for 50–80% of isolates. Taneja et al. (2010),^[3] also observed *E. coli* as the commonest organism, followed by *Klebsiella* and *Proteus* species. The relatively lower proportion of *E. coli* and the presence of CRE in the present study may reflect changing antimicrobial resistance trends and increased hospital exposure. Similar concerns were highlighted by Bryce et al. (2016),^[7] who reported rising multidrug resistance among pediatric urinary isolates globally. Other organisms such as *Enterococcus* species, *Pseudomonas aeruginosa*, *Proteus* species, *Enterobacter* species, *Candida tropicalis*, CONS, MRSA, and *Streptococcus* species were less common, which is comparable with findings of Zorc et al. (2005),^[8] and Yolbaş et al. (2013).^[9]

Age-wise distribution of uropathogens showed that *E. coli* remained the most common organism across all age groups, particularly among children aged 1–5 years, where it accounted for 32 (56.1%) cases. *Klebsiella pneumoniae* was also seen across all age groups, with 6 (27.3%) cases in infants, 8 (14.0%) in children aged 1–5 years, and 4 (17.4%) in children >5 years. *E. coli* CRE was almost evenly distributed across age groups. However, the association between age group and type of uropathogen was not statistically significant ($\chi^2=36.743$, $p=0.185$). This suggests that although *E. coli* was more frequent in the 1–5 years age group, the overall organism distribution did not differ significantly by age. Similar findings were reported by Kanellopoulos et al. (2006),^[5] who observed that *E. coli* remained the dominant organism across pediatric age groups. In contrast, some studies such as those by Yolbaş et al. (2013),^[9] and Mirsoleymani et al. (2014),^[10] reported relatively higher rates of non-*E. coli* organisms among infants, hospitalized children, and those with recurrent or complicated UTIs.

The antimicrobial resistance pattern in the present study showed high resistance among Gram-negative uropathogens to commonly used antibiotics. Ampicillin showed the highest resistance 87 (96.7%), followed by ceftriaxone 78 (86.7%), ciprofloxacin 72 (80.0%), cotrimoxazole 61 (67.8%), meropenem 56 (62.2%), and piperacillin-tazobactam 55 (61.1%). Nitrofurantoin resistance was 47 (52.2%), while gentamicin resistance was 40 (44.4%). Amikacin showed the lowest resistance 26 (28.9%) and highest sensitivity 64 (71.1%). The resistance pattern was statistically significant ($\chi^2=141.98$, $p<0.001$). These findings are similar to studies by Taneja et al. (2010),^[3] Bryce et al. (2016),^[7] and Rai et al. (2008),^[11] who reported high resistance to ampicillin, cotrimoxazole, and third-generation cephalosporins among pediatric uropathogens. The better sensitivity to amikacin has also been observed by Mirsoleymani

et al. (2014),^[10] and Akram et al. (2007)^[12]. High resistance to ceftriaxone and ciprofloxacin in the present study is clinically important because these drugs are commonly used empirically. Similar concerns were raised by Kahlmeter et al. (2012),^[13] and Belete et al. (2019)^[14], who emphasized that increasing antimicrobial resistance requires local antibiogram-based treatment policies. The finding of meropenem resistance is particularly alarming and may indicate the emergence of carbapenem-resistant Enterobacterales, as highlighted by Logan et al. (2017).^[15] Overall, the present study supports the need for routine urine culture, antimicrobial susceptibility testing, and rational antibiotic use in pediatric UTI.

CONCLUSION

The present study highlights the epidemiological and microbiological characteristics of urinary tract infections among children. The majority of cases occurred in the 1–5 years age group, with a significant male predominance. Lower urinary tract infections were more common than upper urinary tract infections. *Escherichia coli* remained the most frequently isolated uropathogen, accounting for nearly half of all culture-positive cases, followed by *Klebsiella pneumoniae*. Although variations in the distribution of organisms were observed across different age groups, no statistically significant association was found between age and type of uropathogen. The study also demonstrated an alarming level of antimicrobial resistance among Gram-negative isolates, particularly against ampicillin, ceftriaxone, ciprofloxacin, and cotrimoxazole. Amikacin emerged as the most effective antibiotic with the highest sensitivity rate. These findings emphasize the importance of routine urine culture, age-specific surveillance of uropathogens, and antibiotic susceptibility testing to guide appropriate empirical therapy and prevent the emergence of multidrug-resistant organisms. Continuous monitoring of local resistance patterns is essential for optimizing treatment strategies and improving outcomes in pediatric urinary tract infections.

Limitations of the Study

1. The study was conducted at a single tertiary care center, limiting the generalizability of the findings to other populations.
2. The sample size of 102 patients may not fully represent the entire pediatric population with UTI.
3. The study included only culture-positive cases, potentially excluding clinically significant culture-negative UTIs.
4. Community-acquired and hospital-acquired infections were not analyzed separately.
5. Molecular characterization of antimicrobial resistance genes was not performed.

6. Risk factors associated with multidrug-resistant organisms were not evaluated in detail.
7. Long-term follow-up of patients to assess recurrence and renal outcomes was not undertaken.
8. Viral and atypical pathogens causing urinary tract infections were not investigated.
9. Previous antibiotic exposure and its impact on resistance patterns were not systematically assessed.
10. The study did not evaluate socioeconomic, environmental, and hygiene-related factors influencing UTI occurrence.

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