

Comparative Clinical and Microbiological Profile of Non-Escherichia Coli Uropathogens Versus Escherichia Coli in Pediatric Community-Acquired Urinary Tract Infections

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Abstract

Objective

To compare the clinical characteristics, antimicrobial susceptibility patterns, multidrug resistance (MDR), extended-spectrum β -lactamase (ESBL) production, and empirical antibiotic discordance between *Escherichia coli* and non-*E. coli* community-acquired urinary tract infections (UTIs) in children.

Methods

This prospective observational study included children aged 0–12 years with symptomatic, culture-confirmed community-acquired UTI presenting to a tertiary-care pediatric centre in New Delhi between November 2020 and August 2022. Participants were classified according to the isolated pathogen as *E. coli* or non-*E. coli*. Demographic and clinical characteristics, antimicrobial susceptibility, ESBL/MDR status, empirical antibiotic use, and treatment modification were recorded. The primary outcome was empirical antibiotic discordance, defined as resistance of the isolated pathogen to the initially administered empirical antibiotic.

Results

Among 64 culture-positive UTI episodes, 51 (79.7%) were caused by *E. coli* and 13 (20.3%) by non-*E. coli* organisms. Recurrent UTI was more frequent in non-*E. coli* infections than *E. coli* infections (46.2% vs. 31.4%). Among 57 episodes receiving empirical antibiotics, discordance occurred in 13 (22.8%), being more frequent with non-*E. coli* than *E. coli* infections (41.7% vs. 17.8%). High resistance was observed to cefixime and ceftriaxone, whereas nitrofurantoin, fosfomycin and amikacin retained higher activity. ESBL production was detected in 21/42 (50.0%) tested isolates.

Conclusions

Non-*E. coli* organisms accounted for approximately one-fifth of community-acquired pediatric UTIs and were associated with greater empirical antibiotic discordance. Local susceptibility data and timely culture-directed therapy are important for appropriate empirical antibiotic selection.

Keywords: Antimicrobial resistance; *Escherichia coli*; Pediatrics; Urinary tract infection; Uropathogens;

Introduction

Urinary tract infections (UTIs) represent one of the most common acute bacterial infections in the paediatric population, contributing significantly to emergency department visits, hospital admissions, and potential long-term renal parenchymal scarring. Globally, *Escherichia coli* is recognized as the predominant uropathogen, accounting for approximately 65% to 90% of community-acquired paediatric UTIs(1)(2)

However, a substantial proportion of paediatric UTIs are caused by non-*Escherichia coli* uropathogens, including Gram-negative bacilli such as *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus* species, and *Enterobacter* species(3) . International studies from tertiary centers in Saudi Arabia, Israel, and Europe report non-*E. coli* aetiologies in 24% to 40% of paediatric UTIs. These studies highlight that non-*E. coli* infections are not merely microbiological variations, but are significantly associated with specific patient profiles, including male gender, younger age, prior exposure to broad-spectrum antibiotics, recurrent infections(3,4,5).

In the Indian clinical scenario, managing paediatric UTIs is further complicated by widespread antimicrobial pressure, high background rates of community-acquired multidrug-resistant (MDR) organisms, and a notable

prevalence of extended-spectrum beta-lactamase (ESBL) production(6)(7)

While broad-spectrum empirical therapy is often initiated for febrile or symptomatic children while awaiting culture results, non-E. coli organisms may demonstrate distinct antimicrobial susceptibility patterns and, in some cases, require broader or pathogen-specific antimicrobial therapy. Empirical antibiotic discordance may result in delayed initiation of effective therapy and may adversely affect clinical outcomes.(8,9)

Despite these clinical implications, there are limited prospective data from North India directly comparing the clinical profiles, diagnostic markers, antimicrobial resistance patterns, and empirical treatment discordance between E. coli and non-E. coli uropathogens in children presenting with community-acquired UTIs.

This study aimed to compare the clinical, microbiological, and treatment patterns of E. coli versus non-E. coli UTIs in children. Objectives were to: (i) To compare the proportion of empirical antibiotic discordance between E. coli and non-E. coli community-acquired UTI in children. (ii) To compare demographic and clinical characteristics, antimicrobial susceptibility patterns, ESBL/MDR prevalence, and treatment modification between the two groups.

Methods

Study Design and Setting

This prospective observational study was conducted in the Department of Pediatrics (Centre for Child Health) at Dr. B.L. Kapur Memorial Hospital, New Delhi, India. The study period spanned two years, from November 2020 to August 2022.

Sample Size Calculation

The sample size was estimated a priori based on a previously reported difference in prior antibiotic exposure between E. coli and non-E. coli UTI (9.5% versus 30.0%), with a two-sided α of 0.05, 80% power and an anticipated allocation ratio of 4:1. (10) (11). The estimated sample size was approximately 173 participants. During the predefined study period, 64 eligible culture-positive episodes meeting the study criteria were available and constituted the final analytical cohort. The study was therefore analysed as a comparative observational study, and estimates were interpreted with consideration of the limited sample size, particularly for the non-E. coli group.

Participant Selection

The study population consisted of children aged 0 to 12 years presenting with clinical signs and symptoms suggestive of a urinary tract infection who had a laboratory-confirmed, culture-positive urine specimen. The final analytical cohort comprised 64 UTI episodes, including 51 episodes caused by E. coli and 13 caused by non-E. coli uropathogens. Non-E. coli isolates included Klebsiella spp., Pseudomonas aeruginosa, Enterococcus spp., and Proteus species. If a child experienced multiple UTI episodes during the study period, only one episode was selected for inclusion in the final analysis according to a predefined, documented method. Consequently, each child contributed a single, independent observation to the dataset.

- **Inclusion Criteria:** All paediatric patients (0–12 years) managed either in the outpatient department (OPD) or admitted to paediatric wards/PICU with symptomatic, culture-proven community-acquired UTI during the study interval.
- **Exclusion Criteria:** We excluded patients with catheter-associated UTIs, critical neonatal illness requiring continuous intensive support, or active antibiotic use at the time of initial sampling. Children with major structural or functional urinary tract anomalies—such as neurogenic bladder, posterior urethral valves, pelvi-ureteric junction obstruction, or a history of urological surgery—were also excluded to isolate purely community-acquired profiles.

Definitions

- **Community-Acquired UTI:** Defined as an infection manifesting in the community setting or within 48 hours

of hospital admission, provided it was not incubating at the time of admission. (12)

- **Prior Antibiotic Exposure:** Defined as receipt of any systemic antibiotic within 30 days preceding clinical presentation.
- **Recurrent UTI:** Defined as ≥ 2 episodes of upper UTI/pyelonephritis, or 1 episode of upper UTI plus ≥ 1 episode of lower UTI/cystitis, or ≥ 3 episodes of lower UTI/cystitis.(13)
- **Grouping Strategy:** Isolates were categorized into two analytical groups: the E. coli Group (n=51) and the non-E. coli Group (n=13; comprising Klebsiella, Pseudomonas, Enterococcus, and Proteus species).

Data Collection and Microbiological Processing

Detailed demographic and clinical data, including documented histories of recurrent UTIs, recent antibiotic exposures, urinalysis parameters (pyuria, leukocyte esterase, nitrite), and imaging findings (USG, MCUG, DMSA), were systematically recorded.

Urine specimens were obtained via mid-stream clean-catch or sterile urethral catheterization. Samples were inoculated on CLED agar plates. Bacterial identification, antimicrobial susceptibility profiling (MIC values), and screening for extended-spectrum beta-lactamase (ESBL) production were executed using the automated VITEK-2 analyser system. Multi-drug resistance (MDR) was defined as in-vitro non-susceptibility to at least one agent across three or more distinct antimicrobial classes. (14)

Empirical Antibiotic Prescribing and Discordance Evaluation

Initial empirical antimicrobial choices (oral vs. parenteral) and treatment settings (outpatient vs. inpatient) were tracked prospectively. Empirical antibiotic discordance (inappropriate coverage) was defined as initial empirical treatment with an antimicrobial agent to which the isolated uropathogen demonstrated in-vitro resistance on subsequent sensitivity reporting. Treatment modifications and total duration of therapy were recorded.

Statistical Analysis

Data were analysed using EPI Info™ version 7.2.2.2 (CDC, Atlanta, GA). Continuous variables (e.g., age, fever duration, treatment duration) were expressed as means with standard deviations or medians with ranges, and compared between groups using independent-sample t-tests or Mann-Whitney U tests based on distribution normality. Categorical variables and proportional differences (e.g., gender, symptom prevalence, ESBL positivity, empirical discordance) were evaluated using the Chi-square test, Fisher's exact test, with a two-sided p-value of <0.05 considered statistically significant.

Ethical Considerations

The study protocol, data collection instruments, and consent proformas were formally approved by the Institutional Ethics Committee (IEC) of Dr. B.L. Kapur Memorial Hospital, New Delhi. Guardians/parents of all participating children were provided a thorough explanation of the study objectives, procedural steps, and potential risks in their preferred language (Hindi or English). Patient confidentiality was strictly maintained using anonymized unique participant identifiers. Formally signed, written informed consent was obtained from the parents or legal guardians prior to study enrolment.

Results

A total of 64 paediatric community-acquired UTI episodes were included in the final study analysis (E. coli: n=51; non-E. coli: n=13). The overall mean age was 3.4 ± 3.0 years. Children aged 1–5 years represented the predominant group (56.3%). Females accounted for 65.6% of overall episodes, with female-to-male ratio of 1.9:1. [Table 1] Prior history of recurrent UTI was documented in 22 children (34.4%), with a higher frequency observed in non-E. coli infections compared to E. coli (46.2% vs. 31.4%). Fever was the primary presenting symptom (68.8%), followed

by dysuria/crying on micturition (43.8%), abdominal pain (14.1%), and vomiting (10.9%). Outpatient (OPD) care was utilized for 71.9% of episodes, whereas 28.1% required hospitalization.

Table 1: Demographic and Clinical Comparison (E. coli vs. Non-E. coli) [N=64]

	10 (19.6%)	3 (23.1%)	13 (20.3%)
	29 (56.9%)	7 (53.8%)	36 (56.3%)
	12 (23.5%)	3 (23.1%)	15 (23.4%)
	17 (33.3%)	5 (38.5%)	22 (34.4%)
	34 (66.7%)	8 (61.5%)	42 (65.6%)
	1: 2.0	1: 1.6	1: 1.9
	16 (31.4%)	6 (46.2%)	22 (34.4%)
	35 (68.6%)	9 (69.2%)	44 (68.8%)
	22 (43.1%)	6 (46.2%)	28 (43.8%)
	7 (13.7%)	2 (15.4%)	9 (14.1%)
	6 (11.8%)	1 (7.7%)	7 (10.9%)
	4 (7.8%)	1 (7.7%)	5 (7.8%)
	37 (72.5%)	9 (69.2%)	46 (71.9%)
	14 (27.5%)	4 (30.8%)	18 (28.1%)

***Multiple response**

Gram-negative bacilli caused 96.0% of UTIs. Escherichia coli was isolated in 51 episodes, followed by Klebsiella spp., Pseudomonas aeruginosa, Enterococcus spp., and Proteus spp.

Antimicrobial susceptibility testing demonstrated substantial resistance to several commonly used oral agents in both groups. Among E. coli isolates, resistance was highest to cefixime (79.2%) and ampicillin (76.7%). In non-E. coli isolates, resistance was particularly high to cefixime (92.3%), ampicillin (84.6%). Conversely, high susceptibility was observed to fosfomycin (99% in E. coli; 92.3% in non-E. coli), amikacin (99.0% and 92.3%, respectively), and meropenem (97.1% and 92.3%, respectively). [Table 2]

Table 2: Antimicrobial Susceptibility Profile Across Uropathogens [N=64]

	8 (15.6)	39 (76.7)	2 (15.4)	11 (84.6)
	31 (62.0)	14 (28.5)	7 (53.8)	5 (38.5)
	6 (12.5)	40 (79.2)	1 (7.7)	12 (92.3)

	24 (47.3)	27 (52.7)	2 (15.4)	11 (84.6)
	44 (86.2)	4 (7.0)	9 (69.2)	3 (23.1)
	50 (98.0)	1 (2.0)	12 (92.3)	1 (7.7)
	15 (29.0)	32 (63.0)	8 (61.5)	5 (38.5)
	19 (37.0)	30 (58.0)	10 (76.9)	3 (23.1)
	17 (34.0)	34 (66.2)	2 (15.4)	11 (84.6)
	35 (69.4)	15 (29.0)	9 (69.2)	4 (30.8)
	43 (85.7)	6 (12.2)	11 (84.6)	2 (15.4)
	50 (98.0)	1 (2.0)	12 (92.3)	1 (7.7)
	44 (86.4)	6 (11.9)	8 (61.5)	5 (38.5)
	41 (81.2)	8 (16.0)	10 (76.9)	2 (15.4)
	50 (97.1)	1 (2.9)	12 (92.3)	1 (7.7)

S: susceptible; R: resistant. Percentages are based on the number of isolates tested for each antimicrobial; intermediate/non-susceptible results, where applicable, are not displayed. Denominators may therefore vary between antimicrobial agents.

Phenotypic ESBL data were evaluated in 42 tested isolates. Among the 42 isolates tested for phenotypic ESBL production, 21 (50.0%) were ESBL positive. Within the E. coli group tested, 50% were ESBL-positive. ESBL positivity showed a higher rate in children with a history of prior UTI (57.1%) compared to those without (47.7%), though this was not statistically significant. [Table 3]

Table 3: Stratification of Extended-Spectrum Beta-Lactamase (ESBL) Status [N=64]

				0.43 *
	19 (50%)	19 (50%)	38 (100%)	
	2 (50.0%)	2 (50.0%)	4 (100%)	
				0.32
	8 (57.1%)	6 (42.9%)	14 (100%)	
	13 (46.4%)	15 (53.6%)	28 (100%)	

* Fisher's exact test was used for contingency tables with expected cell counts <5

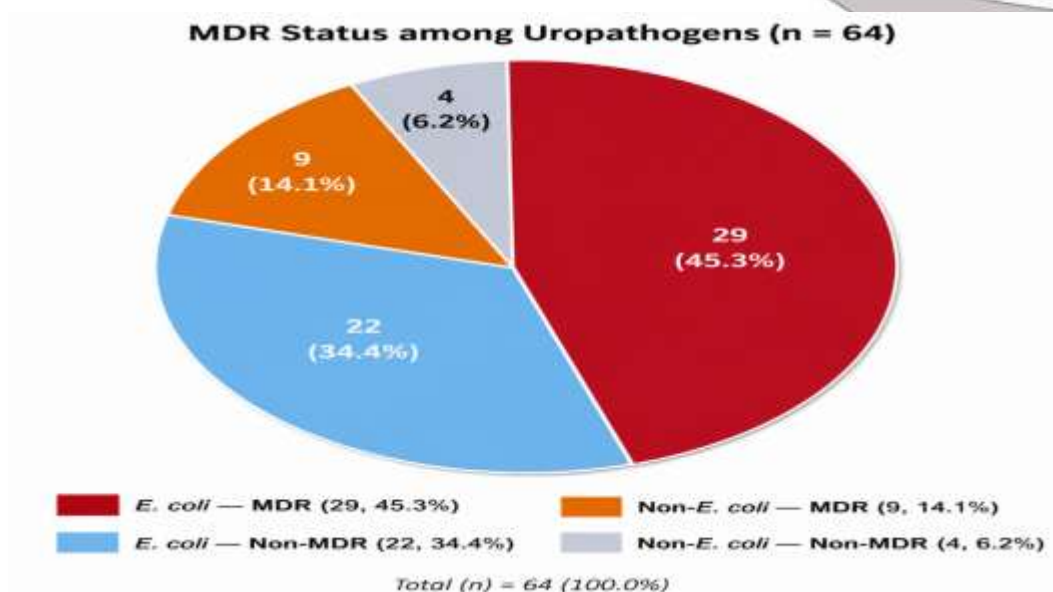


Figure 1: Pie- Chart Showing Distribution of Multidrug Resistance (MDR) across *Escherichia coli* and non-*Escherichia coli* Uropathogens in Pediatric Community-Acquired UTIs.

Empirical antimicrobial therapy was initiated before availability of urine culture results in 57 of 64 (89.1%) UTI episodes, including 45 (88.2%) *E. coli* and 12 (92.3%) non-*E. coli* infections. Oral cefixime was the most frequently prescribed empirical agent, accounting for 50.9% empirically treated episodes, followed by amoxicillin–clavulanate (19.3%) and ceftriaxone (14.0%). Among empirically treated episodes, therapy was concordant with the final susceptibility profile in 44/57 (77.2%) episodes and discordant in 13/57 (22.8%). [Table 4]

Table 4. Empirical Antibiotic Use and Discordance Among Empirically Treated UTI Episodes

	45 (88.2%)	12 (92.3%)	57 (89.1%)
	6 (11.8%)	1 (7.7%)	7 (10.9%)
	n=45	n=12	n=57
	23 (51.1%)	6 (50.0%)	29 (50.9%)
	9 (20.0%)	2 (16.7%)	11 (19.3%)
	6 (13.3%)	2 (16.7%)	8 (14.0%)
	3 (6.7%)	1 (8.3%)	4 (7.0%)
	4 (8.9%)	1 (8.3%)	5 (8.8%)

	37 (82.2%)	7 (58.3%)	44 (77.2%)
	8 (17.8%)	5 (41.7%)	13 (22.8%)
	8 (17.8%)	5 (41.7%)	13 (22.8%)

DISCUSSION

This prospective study illustrates the current bacteriologic spectrum, clinical characteristic, and antimicrobial resistance patterns in community-acquired paediatric UTIs at an urban tertiary centre in New Delhi, specifically comparing *Escherichia coli* and non-*Escherichia coli* uropathogens. Our findings reveal a significant burden of multidrug-resistant (MDR) and extended-spectrum beta-lactamase (ESBL)-producing pathogens in children presenting from the community, along with a significantly higher rate of empirical treatment discordance among non-*E. coli* infections.

The overall mean age of our cohort was 3.4 ± 3.0 years, with the 1–5-year age group constituted the largest age category (56.3%, $n=36$). Our findings are highly consistent with a study by Ganesh et al. (2019) in a similar South Asian tertiary care setting, which reported that 90% of pediatric UTI cases occurred in children under 5 years, with a heavy concentration in the 2–5 years age range(15). We observed an overall female predominance (65.6%, $n=42$), which is well-documented due to anatomical factors such as a shorter urethra. Non-*E. coli* UTIs showed a higher representation among males (38.5%) compared to *E. coli* UTIs (33.3%). In international studies by Marcus et al. (2005) (10) (57.1% male in non-*E. coli* vs. 35.2% in *E. coli*) and Al Nafeesah et al. (2022)(5), male sex was identified as a strong independent predictor of non-*E. coli* UTIs, largely driven by a higher baseline incidence of congenital anomalies and uncircumcised status in early infancy.

We noted a clear clinical trend where children with a history of recurrent UTIs had higher rates of non-*E. coli* infections (46.2%) compared to *E. coli* infections (31.4%; $p=0.32$), as well as higher rates of ESBL positivity (54.5% vs. 47.7%). Although these trends did not reach independent statistical significance due to sample size constraints, it may reflect the influence of previous antimicrobial exposure and recurrent infection, although the present study was not designed to establish causality. This aligns closely with Marcus et al. (2005)(10), who reported that antibiotic therapy within the preceding month was over three times more common in Non-*E. coli* UTIs (30.0% vs. 9.5%), and Al Nafeesah et al. (2022)(5), who observed prior antibiotic exposure in 44.9% of Non-*E. coli* cases vs. 24.8% of *E. coli* cases ($p=0.011$). As highlighted by Mahony et al. (2020)(16), previous antibiotic exposure may contribute to selection of resistant uropathogens; however, the present study was not designed to establish this mechanism.

Escherichia coli was the predominant isolate (79.7%, $n=51$), followed by *Klebsiella* spp. (7.8%), *Pseudomonas aeruginosa* (6.0%), *Enterococcus* spp. (4.0%), and *Proteus* spp. (1.0%). This pathogen distribution is consistent with global benchmarks outlined by Mahony et al. (2020)(16) and regional South Asian data from Ganesh et al. (2019)(15) and Shrestha et al. (2019)(17), where *E. coli* consistently accounts for 60%–80% of all pediatric community isolates. The 50.0% ESBL positivity among tested isolates indicates a substantial burden of phenotypic ESBL production in this tertiary-care cohort.

Several commonly used oral agents showed high rates of in-vitro resistance in this cohort. High resistance was observed across both cohorts for oral Cefixime (77.7% overall; 79.2% in *E. coli*), Ampicillin (78.4%), Cotrimoxazole (56.2%), Ciprofloxacin (57.5%), and parenteral Ceftriaxone (68.0%). Similarly high rates of third-generation cephalosporin resistance were observed in studies by Pouladfar G et al. (2017)(18) and Ghosh et al. (2018)(20). In

contrast, oral Nitrofurantoin (9.8% resistance) and Fosfomycin (2.8%) retained high in-vitro activity, while parenteral Amikacin (3.5%), Meropenem (4.8%), Cefoperazone-Sulbactam (10.0%), and Piperacillin-Tazobactam (15.0%) exhibited minimal resistance.

Overall empirical discordance reached 22.8% (n=13/57) among empirically treated children. Notably, empirical discordance was more than twice as frequent in non-E. coli UTIs (41.7%, n=5/12) as in E. coli UTIs (17.8%, n=8/45) (Table 4). This matches findings by Marcus et al. (2005)(16), who reported a 10-fold higher rate of inappropriate empirical therapy in non-E. coli UTIs (18.6% vs. 1.9%). The observed susceptibility pattern supports the use of local antibiograms when selecting empirical therapy and emphasizes the importance of culture-directed modification once antimicrobial susceptibility results become available.

Limitations

This study has limitations. First, it was conducted at a single tertiary care hospital, which may reflect a higher baseline resistance burden due to referral bias. Second, the sample size for non-E. coli subgroups (e.g., Enterococcus, Proteus) was relatively small, limiting detailed subgroup statistical comparisons. Third, molecular characterization of ESBL genes (e.g., blaTEM, blaCTX-M) was not performed.

Conclusion

Non-E. coli uropathogens cause approximately one-fifth of community-acquired paediatric UTIs in our setting and are associated with a significantly higher rate of empirical treatment discordance. A considerable burden of antimicrobial resistance and phenotypic ESBL production was also observed among the isolates tested. These findings highlight the importance of local antimicrobial susceptibility surveillance and timely urine culture with susceptibility testing in children with suspected UTI. Empirical treatment should be guided by local antibiograms and clinical severity, with prompt modification to culture-directed therapy when susceptibility results become available.

What this Study Adds:

- Non-E. coli organisms accounted for approximately one-fifth of community-acquired paediatric UTIs and had a higher proportion of empirical antibiotic discordance than E. coli infections.
- High antimicrobial resistance and phenotypic ESBL production were observed, supporting the importance of local susceptibility surveillance and timely culture-directed antibiotic modification.

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