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Original Article

Paediatrics Section

Clinicomicrobiological Profile, Antibiotic Resistance Trends and Radiological Association in Paediatric Urinary Tract Infections: A Prospective Observational Study

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ABSTRACT

Introduction: Urinary Tract Infection (UTI) is a common bacterial infection in children, with a varied clinical presentation that often leads to diagnostic challenges. Delayed diagnosis and inappropriate treatment in India can result in complications such as renal scarring and hypertension. The rising antimicrobial resistance in Haryana, India, among uropathogens necessitates continuous monitoring of the clinicomicrobiological profile and antibiotic susceptibility patterns.

Aim: To analyse the clinical presentation, microbiological profile, and antibiotic susceptibility patterns in paediatric UTI cases, emphasising the role of imaging in diagnosis.

Materials and Methods: The present prospective observational study was conducted at the Department of Paediatrics, SGT Medical College, Haryana, India, over 12 months. A total of 120 children (aged 1 month to 18 years) with laboratory confirmed UTI were included. Clinical history, urine analysis, urine culture with sensitivity testing, and imaging studies were performed. Statistical analysis was done using Statistical Package for Social Sciences (SPSS) software.

Results: Out of 120 children, 69 were male and 51 were female. UTI was more common in males under five years, whereas females had a higher prevalence after five years (p=0.012). *Escherichia coli* were the most common uropathogen (40.7%), followed by *Klebsiella* and *Staphylococcus aureus*. High resistance to third generation cephalosporins was noted, while amikacin and gentamycin showed high sensitivity. Radiological abnormalities were present in 91.6% of cases, with cystitis and hydronephrosis as the most common findings.

Conclusion: This study found that fever was the most common clinical presentation of paediatric UTIs. *E.coli* was the predominant pathogen isolated, with high resistance to ampicillin and ceftriaxone, while showing good sensitivity to amikacin and nitrofurantoin. Early imaging, particularly ultrasound, proved valuable in detecting structural abnormalities in a significant number of cases. These findings underscore the importance of tailored empirical therapy based on local resistance patterns and support the routine use of imaging in evaluating paediatric UTIs.

Keywords: Antibacterial agents, Bacterial infections, Drug resistance, Microbial organism, Ultrasonography

INTRODUCTION

The UTIs are a major cause of morbidity in children, affecting both genders but with a higher incidence in females beyond infancy [1,2]. These infections rank among the most frequent bacterial infections in children and are a significant cause of hospital visits. UTIs can present with diverse symptoms, ranging from non specific febrile illness in neonates to more classical symptoms such as dysuria, changes in urgency and frequency in older children. The potential for renal damage and long-term complications, including hypertension and chronic kidney disease, highlights the importance of early and accurate diagnosis [3,4].

Paediatric UTI are often overlooked or misdiagnosed due to their varied presentation. In neonates and infants, symptoms may include fever, irritability, vomiting, and poor feeding, whereas older children often exhibit dysuria, abdominal pain, frequency, and urgency. The risk factors for UTI include Vesicoureteral Reflux (VUR), congenital urinary tract anomalies, constipation, and inadequate perineal hygiene [5]. Left untreated, UTIs can result in renal scarring, which is a precursor to chronic kidney disease.

The increasing prevalence of antimicrobial resistance in uropathogens has become a growing concern worldwide. Empirical treatment regimens often fail due to the emergence of multidrug-resistant strains, necessitating continuous monitoring of local bacterial profiles and resistance patterns [6]. The frequent use of broad-spectrum antibiotics has contributed to the rise of Extended-Spectrum Beta-Lactamase (ESBL)-producing bacteria, which complicates treatment options. Therefore, targeted antibiotic therapy based on susceptibility testing is critical for effective management [7].

Imaging studies, particularly ultrasonography, are valuable tools in identifying structural abnormalities that predispose children to recurrent UTI. Additional investigations such as Voiding Cystourethrography (VCUG) and Dimercaptosuccinic Acid (DMSA) scans are recommended in recurrent or complicated cases to assess renal involvement and reflux status [8]. Given the potential long-term consequences of recurrent infections, preventive measures such as hydration, hygiene education, and prophylactic antibiotics for high-risk cases should be emphasised.

Several studies have reported on the microbial etiology and resistance patterns in paediatric UTI; however, most are limited by small sample sizes, focus primarily on single centers, or lack integration of clinical presentation and imaging findings [9,10]. Additionally, with the dynamic nature of antimicrobial resistance, periodic evaluation of local bacterial profiles and their susceptibility patterns is crucial. There remains a paucity of comprehensive regional data that concurrently analyse clinical symptoms, microbiological profiles, antibiotic resistance trends, and imaging correlations in paediatric UTIs. This study aimed to address that gap by providing an integrated analysis of these parameters, offering updated evidence to guide clinical decision making and improve diagnostic and therapeutic strategies in the paediatric population.

MATERIALS AND METHODS

The present hospital-based prospective observational study was conducted in the Department of Paediatrics at SGT Hospital, a tertiary care teaching hospital in Gurugram, Haryana, India. The study was carried out over a period of 12 months, from June 2023 to June 2024. Ethical clearance was obtained from the Institutional Ethics Committee (IEC/FMHS/MD/S/2022-44).

Inclusion and Exclusion criteria: Children aged one month to 12 years presenting with symptoms suggestive of UTI and confirmed by positive urine culture or positive urine microscopy were included in the study [11]. Patients who had received antibiotics in the 48 hours prior to urine collection, those with known congenital urogenital anomalies, or incomplete medical records were excluded.

Sample size calculation: The sample size was estimated based on the formula for cross-sectional studies, Considering 95% confidence level (Z=1.96) with estimated prevalence of UTI as 8% from previous studies and absolute precision of 5% (d=0.05) [12,13]. A minimum sample size of 125 was required. However, 126 children who met the inclusion criteria during the study period were included.

Study Procedure

Detailed clinical history and examination findings were recorded for each child. Urine samples were collected using clean-catch midstream methods or catheterisation, depending on age and co-operation. Clean-catch midstream samples were obtained from children >5 years, while catheterisation were used in infants and selected one to five year olds. Samples were sent for routine microscopy, culture, and sensitivity testing. Isolated organisms were identified using standard microbiological techniques, and antimicrobial susceptibility was determined by the Kirby-Bauer disk diffusion method according to CLSI guidelines [14]. Positive cases had undergone abdominal ultrasound within three days using standard bladder-filling protocols. The parameters studied included clinical symptoms, uropathogens isolated, their antimicrobial resistance patterns, and imaging findings.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS version 26. Descriptive statistics such as mean, median, standard deviation, and proportions were used to summarise the data. Cross-tabulations were prepared, and associations between categorical variables were tested using the Chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 126 children fulfilled the inclusion criteria out of which two children were on antibiotics, one child refused to be included in the study and three children had undergone surgery for urinary tract. Thus, from 126 children, 120 were taken for the study.

Out of 120 children 69 were male and 51 were female. UTI was most common in male children falling in age group < one year and 1-4 years. After five years UTI was more prevalent in the female children which was statistically significant (p=0.012) [Table/Fig-1].

Among the 120 children evaluated, dysuria was the most common presenting symptom, followed by fever, haematuria, abdominal pain, and vomiting. Although the Confidence Interval (CI) appears narrow and inverted, the high Odds Ratio (OR) suggests a strong association between UTI and febrile presentation. Dribbling and poor urinary stream were more prevalent in males than females. Notably, all male children with UTI exhibited either dribbling or poor stream, underscoring the diagnostic relevance of these symptoms in boys [Table/Fig-2].

Age group	Male (n)	%	Female (n)	%
<1 year	11	15.9	4	7.8
1-4 years	17	24.6	9	17.6
5-9 years	16	23.2	13	25.5
10-14 years	20	29.0	22	43.1
15-18 years	5	7.2	3	5.9
Total	69	100	51	100

[Table/Fig-1]: Age and gender wise distribution of study participants (N=120).

Clinical features	Male	%	Female	%
Fever	38	57.5	28	42.4
Abdominal pain	29	54.7	24	45.3
Vomiting	23	57.5	17	42.5
Dysuria	41	56.9	31	43.1
Hematuria	32	59.3	22	40.7
Dribbling	8	100	0	0
Poor stream	31	100	0	0

[Table/Fig-2]: Distribution of participants according to their gender and clinical profile (N=120).

Dysuria, vomiting, and haematuria were commonly observed in both sexes, whereas fever and abdominal pain were more frequently reported in males. These findings supported symptom-based screening for UTI, particularly in younger male children with urinary symptoms.

Among 120 children, 59 (49.2%) showed significant bacterial growth. Bacteriuria was more common in males 38 (55.1%) than females 21 (41.2%). Males had 1.27 times higher odds of culture positivity (OR=1.267; 95% CI=0.928-1.730), though not statistically significant (p=0.187), highlighting a possible higher UTI burden in male children [Table/Fig-3].

Culture	Male	%	Female	%
Positive	38	55.1	21	41.2
Negative	31	44.9	30	58.8
Total	69	100	51	100

[Table/Fig-3]: Gender wise distribution of participants according to culture test (N=120).

A total of 24 (40.7%) children had *E. coli* growth, compared to eleven members of the group, five members of the *Proteus* species group, two members in *Pseudomonas* group, one *E. fecalis*, two Acinetobacter, two Citrobacter, and four Coagulase Negative Staphylococci (CoNS). [Table/Fig-4] describes gender wise distribution of the study participants according to significant growth of bacteria. The most prevalent organism grown in both male and female youngsters was *E. coli*. Only male children were found to have *Proteus*, whereas only female children were found to have *Pseudomonas aeruginosa*, *Enterococcus faecalis*, and *Acinetobacter*.

Organism	Male	%	Female	%
Escheria coli	14	36.8	10	47.6
Klebsiella	9	23.7	2	9.5
Staphylococcus aureus	6	15.8	2	9.5
CoNS	3	7.9	1	4.8
Proteus	5	13.2	0	0
Pseudomonas aeruginosa	0	0	2	9.5
Enterococcus fecalis	0	0	1	4.8
Acinetobacter	0	0	2	9.5
Citrobacter	1	2.6	1	4.8
Total	38	100	21	100

[Table/Fig-4]: Distribution of participants according to gender and bacteriological growth.

[Table/Fig-5] describes distribution of the study participants according to culture and antibiotic sensitivity pattern. The most frequent pathogen that caused UTI was *E. Coli*, which was 66.6% responsive to amikacin (χ^2=176.344, DF=18, $p<0.05$). High significance of senility against antibiotic spectrum was seen among *Proteus*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Acinetobacter* and *Citrobacter*.

Radiological investigations revealed abnormalities in 91.6% of USG cases, with cystitis (41.8%) being the most common. VUR was detected in 12.7% of children who then underwent Micturating cysto-urethrogram. Early identification of such abnormalities is critical for initiating prophylactic treatment and preventing renal damage which corresponded by Guney D et al., in his study [22]. Similar studies by Kayak D et al., and Yang S et al., have also stressed the importance of imaging in first UTI episodes [23,24].

Organism	Sensitivity pattern	Number (n)	Percent (%)	Chi-square (χ^2)	p-value
Escheria coli	Amikacin+Gentamycin	16	66.66	176.3	0.001
Klebsiella	Gentamycin+Meropenam	5	45.45	178.36	0.001
Staphylococcus aureus	Nitrofuratoin+Vancomycin	5	62.5	138.2	<0.001
CoNS	Vancomycin	3	75	201.1	0.002
Proteus	Amikacin+Gentamycin	4	80	186.2	0.001
Pseudomonas aeruginosa	Imipenam	1	50	152.6	0.001
Enterococcus fecalis	Ampicillin	1	100	236	<0.001
Acinetobacter	Taxim+Pitaz	1	50	173.5	0.001
Citrobacter	Meropenam	2	100	197.7	<0.001

[Table/Fig-5]: Distribution of participants according to culture and sensitivity pattern.

A total of 110 out of 120 children had radiological abnormalities in ultrasonogram. Vesico Ureteric Reflux (VUR) was found in 13 children. Majority of children were diagnosed with cystitis i.e., 41.8% followed by Hydroureteronephrosis which was 20%. Among those diagnosed with cystitis, majority of children i.e., 34.8% (16) were of 10-14 years. Cystitis was most common in children <1 year. Hydroureteronephrosis and VUR was seen maximum in 1-4 years of children i.e., 30.4% and 17.4%, respectively [Table/Fig-6].

The findings of this study supported the need for targeted education of caregivers regarding symptom recognition, hygiene, and medication adherence. Healthcare providers should use local resistance data to guide empirical treatment and apply selective imaging to identify children at risk for complications.

	Age (years)											
	<1		1-4		5-9		10-14		15-18		Total	
Diagnosis	n	%	n	%	n	%	n	%	n	%	n	%
Cystitis	6	46.2	8	34.8	13	46.4	16	41.0	3	42.9	46	41.8
Hydroureteronephrosis	2	15.4	7	30.4	5	17.9	7	17.9	1	14.3	22	20
PUJ obstruction	1	7.7	2	8.7	4	14.3	2	5.1	0	0	9	8.2
Posterior urethral valve	1	7.7	1	4.3	1	3.6	2	5.1	0	0	5	4.5
Vesico Ureteric Reflux (VUR)	0	0	4	17.4	3	10.7	6	15.4	1	14.3	14	12.7
Calculus	1	7.7	0	0	0	0	4	10.3	2	28.6	7	6.4
Pyelonephritis	2	15.4	1	4.3	2	7.1	2	5.1	0	0	7	6.4
Total	13	100	23	100	28	100	39	100	7	100	110	100

[Table/Fig-6]: Age wise distribution of participants according radiological profile.
PUJ: Pelvi-ureteritic junction

DISCUSSION

This study evaluated 120 children with UTIs. UTI was most common in male children upto five years. After five years UTI was more prevalent among female children. Dysuria was the most common presenting symptom (60%), followed by fever (55%) and haematuria (45%) and abdominal pain (44.2%). The findings collaborated with many studies related to prevalence among gender, age and non specific symptoms while fever was seen most common in UTI [15]. These nonspecific symptoms stress the importance of considering UTI in febrile infants without a clear source [16].

Escherichia coli was the most commonly isolated organism (20%), which aligned with previous literature, though the rates in this study was lower than in studies by Giri A et al., and Al Nafeesah A et al., which reported *E. coli* prevalence above 70% [17,18]. This difference could be due to geographical variation and rising resistance among non-E.coli pathogens, underscoring the need for regular local antibiogram surveillance. The sensitivity and resistance pattern of organism has been evolving and need to change the empirical therapy which is similar to other studies [19,20]. The increasing prevalence of antibiotic resistance underscores the necessity for judicious antibiotic use and region-specific antibiogram-based empirical therapy [21]. The findings suggested that amikacin and gentamycin remain viable options for initial treatment, particularly in hospitalised patients.

Limitation(s)

This study was conducted at a single tertiary care center, which may limit the generalisability of the findings to broader paediatric populations. The relatively small sample size might not capture the full spectrum of epidemiological patterns seen across different regions. Additionally, there is potential for diagnostic errors in interpretation of ultrasonography, which may influence the reported prevalence of structural abnormalities like VUR and renal scarring. Microbiological testing methods and culture sensitivities may vary, possibly affecting the accuracy of pathogen identification. Furthermore, unmeasured confounding factors such as prior antibiotic use, underlying co-morbidities, or variations in clinical practice could have influenced the observed antibiotic resistance patterns.

CONCLUSION(S)

Paediatric UTIs remain a significant health concern, with E.coli as the leading pathogen. The observed change in antibiotic sensitivity pattern underscores the need for region-specific empirical treatment protocols and continuous surveillance of local resistance patterns. Ultrasonography proved valuable in identifying anatomical abnormalities predisposing children to recurrent infections, reinforcing its role in initial evaluations. To enhance clinical outcomes, it is imperative to strengthen antibiotic stewardship programs, promote early and targeted imaging, and tailor empirical therapy using updated local antibiograms. Clinicians should also educate caregivers on early symptom recognition and adherence to treatment. Future research should focus on large-scale, multicenter studies to validate these findings and support the development of standardised national guidelines for diagnosis, management, and prevention of paediatric UTIs.

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REFERENCES

[1] Kumar V, Singh RKN, Verma PK, Bhat NK, Shrivastava Y, Yhoshu E, et al. Clinico-microbiological profile and clinical predictor of urinary tract infection in children: A single-center study from Himalayan foothills. Cureus. 2023;15(1):e33289.
[2] Shabani Y, Sadeghi H, Yousefichaijan P, Shabani D, Rafiee F. Prevalence of risk factors of urinary tract infections in infants and children in Arak, Iran: A cross-sectional study. Nephro-Urol Mon. 2022;15(1):e131333.
[3] Brandström P, Hansson S. Urinary tract infection in children. Pediatr Clin North Am. 2022;69(6):1099-114. Doi: 10.1016/j.pcl.2022.07.003.
[4] Hari P, Meena J, Kumar M, Sinha A, Thergaonkar RW, Iyengar A, et al. Evidence-based clinical practice guideline for management of urinary tract infection and primary vesicoureteric reflux. Pediatr Nephrol. 2024;39(5):1639-68.
[5] Sharma S. Urinary tract infection in children: Preventing the havoc in India. Int J Community Med Public Health. 2022;9(1):528-30.
[6] Samancı S, Çelik M, Köşker M. Antibiotic resistance in childhood urinary tract infections: A single-center experience. Turk Pediatri Ars. 2020;55(4):386-92.
[7] Fan N, Chen H, Chen C, Ou L, Lin T, Tsai M, et al. Rise of community-onset urinary tract infection caused by extended-spectrum β-lactamase-producing Escherichia coli in children. J Microbiol Immunol Infect. 2014;47(5):399-405.
[8] Ahmad I, Niazi AB, Razzaque J, Ikram M, Munir M, Andrabi WI. Clinical spectrum and radiological evaluation of urinary tract infections in children. Pak J Med Health Sci. 2023;18(11):172-74.
[9] Wang J, He L, Sha J, Zhu H, Huang L, Zhu X, et al. Etiology and antimicrobial resistance patterns in pediatric urinary tract infection. Pediatr Int. 2018;60(5):418-22.
[10] Bitew A, Zena N, Abdeta A. Bacterial and fungal profile, antibiotic susceptibility patterns of bacterial pathogens and associated risk factors of urinary tract infection among symptomatic pediatrics patients attending st. paul's hospital millennium medical college: A cross-sectional study. Infect Drug Resist. 2022;15:1613-24. Available from: https://doi.org/10.2147/IDR.S358153.
[11] Ansari MS, Shekar PA, Singh C, Joshi SS. The Urological Society of India Guidelines for the management of pediatric urinary tract infection (Executive Summary). Indian J Urol. 2021;37(1):10-12. Doi: 10.4103/iju.IJU_568_20. PMID: 33850350; PMCID: PMC8033226.
[12] Leung AK, Wong AH, Leung AA, Hon KL. Urinary tract infection in children Recent Pat Inflamm Allergy Drug Discov. 2019;13:02-18.
[13] Saikh N, Morone NE, Bost JE, Farrell MH. Prevalence of urinary tract infection in childhood: A meta-analysis. Pediatr Infect Dis J. 2008;27:302-08.
[14] Humphries R, Bobenchik AM, Hindler JA, Schuetz AN. Overview of changes to the clinical and laboratory standards institute performance standards for antimicrobial susceptibility testing, M100, 31st Edition. J Clin Microbiol. 2021;59(12):e0021321. Doi: 10.1128/jcm.00213-21. Available from: https://doi.org/10.1128/jcm.00213-21
[15] Daniel M, Szymanik-Grzelak H, Sierdziński J, Podsiadły E, Kowalewska-Młot M, Pańczyk-Tomaszewska M. Epidemiology and risk factors of UTIs in children—a single-center observation. JPM. 2023;13(1):138.
[16] Boon HA, Van den Bruel A, Struyf T, Gillemot A, Bullens D, Verbakel JY. Clinical features for the diagnosis of pediatric urinary tract infections: Systematic review and meta-analysis. Ann Fam Med. 2021;19(5):437-46.
[17] Giri A, Kafle R, Singh GK, Niraula N. Prevalence of E. Coli in urinary tract infection of children aged 1-15 years in a medical college of eastern Nepal. JNMA J Nepal Med Assoc. 2020;58(221):11-14.
[18] Al Nafeesah A, Al Fakeeh K, Chishti S, Hameed T. *E. coli* versus non-*E. coli* urinary tract infections in children: A study from a large tertiary care center in Saudi Arabia. Int J Pediatr Adolesc Med. 2021;9(1):46-48.
[19] Mohapatra S, Panigrahy R, Tak V, Shwetha JV, Sneha KC, Chaudhuri S, et al. Prevalence and resistance pattern of uropathogens from community settings of different regions: An experience from India. Access Microbiol. 2022;4(2):000321.
[20] Rajni E, Goyal K, Sharma R. A guide to empirical management of urinary tract infection in outpatient setting in a tertiary care institute: A study from Western India. J Postgrad Med. 2025;71(1):15-19. Doi: 10.4103/jpgm.jpgm_602_24.
[21] Chandrasekar K, Saju SJ, Zechariah BH, John JA, Sadagoban GK, Arun KP. Drug utilization evaluation of aminoglycosides, gentamicin and amikacin: A retrospective study in pediatric patients at secondary care public hospital. Research Journal of Pharmacy and Technology. 2021;14(3):1247-50.
[22] Güney D, Demirtaş G, Bostancı SA, Tiryaki HT. Is there any difference in the predictive findings for vur in different age groups? Evaluation of VCUG and USG examinations in 539 children with febrile urinary tract infection. Hamidiye Med J. 2021;2(2):57-63.
[23] Kayak D, Tekin M, Konca C. Ultrasonography results in first urinary tract infection during childhood: Which age group should be screened? Indian J Pediatr. 2023;90(7):671-76.
[24] Yang S, Gill PJ, Anwar MR, Nurse K, Mahood Q, Borkhoff CM, et al. Kidney ultrasonography after first febrile urinary tract infection in children. JAMA Pediatr. 2023;177(8):764.

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