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A cross-sectional study of clinical and microbiological profile of urinary tract infections in children from tertiary care centre in Maharashtra

Abdul Wahab Abdul Aziz Syed[1]*, Nabeel Nayyar Mohammad[2], Zameer Haseeb Pathan[2]

[1]Assistant Professor, Department of Pediatrics, JIIUS IIMSR Jalna
[2]Junior Resident, Department of Pediatrics, JIIUS IIMSR, Jalna

Corresponding Author:
Abdul Wahab Abdul Aziz Syed, Assistant Professor, Department of Pediatrics, JIIUS IIMSR Jalna
E-MAIL: drsawahab@gmail.com

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ABSTRACT

Introduction: Urinary tract infections (UTIs) are common in children, often leading to renal damage if not promptly treated. Understanding the changing epidemiology, causative agents, and antibiotic resistance patterns is crucial for effective management. **Methods**: A cross-sectional study was conducted at a tertiary care hospital. 100 children aged 1 month to 18 years diagnosed with UTI based on symptoms, pyuria, and bacteriuria were enrolled. Data on demographics, clinical features, and antibiotic use were collected. Urine samples were cultured, and antimicrobial susceptibility testing was performed. **Results**: Infants (<1 year) showed a higher male prevalence (69.6%) compared to females (30.4%). Fever was the most common symptom (92%). Escherichia coli (E. coli) was the predominant pathogen (69%), followed by Klebsiella pneumoniae (10%) and Enterobacter spp. (6%). Antibiotic resistance was observed, with 20% sensitive to 4 or fewer antibiotics and 27% sensitive to 9-12 antibiotics. Prior urinary instrumentation, past UTI history, and recent antibiotic use were identified as risk factors for resistance. ESBL-producing organisms showed significant resistance to cephalosporins and ciprofloxacin compared to non-ESBL organisms. **Conclusions:** UTIs in children show age-specific gender variations and evolving bacterial profiles. E. coli remains the dominant pathogen, but resistance is rising. Prior interventions, past UTIs, and recent antibiotic use are associated with resistance. ESBL-producing organisms pose a particular challenge. These findings highlight the need for judicious antibiotic use and tailored management strategies based on age, bacterial profile, and resistance patterns.

KEYWORDS: Urinary tract infection, children, E. coli, antibiotic resistance, ESBL

INTRODUCTION

Urinary tract infection (UTI) is a common bacterial infection in children. Boys have a 1-3% risk and girls have a 3-10% risk of contracting a UTI before the age of 14. [1, 2]

The diagnosis of UTI is often overlooked in infants and young children due to minimal and nonspecific urinary symptoms. However, prompt evaluation and treatment are crucial to prevent renal parenchymal damage and renal scarring, which can lead to hypertension and progressive renal damage. [3]

Traditionally, Gram-negative enteric bacilli, particularly Escherichia coli and Klebsiella spp., have been the most common uropathogens. [4–6] However, other agents such as Enterococcus spp., yeasts, and Staphylococcus aureus have emerged as significant agents in recent years. [7, 8] Various host factors, including age, gender, toilet training, circumcision status, underlying anatomical or functional anomalies of the urinary tract, prior antibiotic use, past history of UTI, and use of urinary catheters, have been implicated in the changing etiology of UTI. [1, 2, 9]

The widespread and inappropriate use of antimicrobial agents has led to the development of antibiotic resistance, a major global issue in recent years. In patients with suspected UTI, antibiotic treatment is typically initiated empirically, before urine culture results are available. [10–12] Therefore, knowledge of the organisms causing UTI and their antibiotic susceptibility in a specific geographic area is essential. [13–16].

The choice and route of treatment depend on various factors, including the predominant pathogens in the patient's age group, antibacterial sensitivity patterns in the practice area, the patient's clinical status, the opportunity for close follow-up, and compliance. [17–19] However, there is a lack of recent surveillance data on the prevalence of UTI in children, causative agents, and their antibiotic sensitivity susceptibility from the western region of India. [13–16]

This study aims to identify the etiological agents, determine the antibiotic sensitivity pattern, and identify risk factors for antibiotic resistance in UTI in children from the western zone of India. This information is expected to be useful in formulating guidelines for the choice of empiric antibiotic treatment for UTIs. The objectives of this study were to Study the clinical profile and sensitivity patterns of etiological agents in children with UTI.

MATERIALS AND METHODS

Study Design*:* A cross-sectional study was conducted at a single centre, BJ Wadia Hospital for Children, a tertiary hospital in Mumbai, Maharashtra.

Study Setting and Sample Size*:* All consecutive UTI cases that met the inclusion criteria and were admitted to the indoor department of Paediatrics were enrolled in the study over a period of one year after obtaining prior consent or assent. A total of 100 cases were enrolled in the study.

Study participants*:* The study included children aged 1 month to 18 years who presented with UTIs during the study period. UTI was defined as the presence of symptoms, significant pyuria, and significant bacteriuria.

Exclusion Criteria*:*

1. Neonates were excluded from the study due to their unique etiological profile and risk factors a

2. Patients with known immunodeficiency (such as HIV or primary immunodeficiency) or those on immunosuppressive drugs were also excluded.

Data Collection*:* Data was collected through a detailed questionnaire that covered various aspects, including the mode of presentation, age, sex, community, and history of urinary infections. Emphasis was placed on identifying risk factors such as genitourinary tract anomalies, history of urethral instrumentation, past UTI history, and past antibiotic use.

Clinical Evaluation and Treatment*:* Patients with features of complicated UTIs or those aged less than 3 months were admitted for parenteral antibiotics in accordance with ISPN guidelines. The choice of antibiotics was at the discretion of the treating physician. Detailed records of investigations and treatment were maintained.

Diagnostic Procedures*:* Urine analysis and urine culture were performed using aseptic techniques for all patients upon presentation. Admitted patients also underwent complete blood count with ESR, CRP, blood culture, and serum creatinine.

Sample Collection*:* Urine samples were collected using a clean-catch midstream technique after washing the genitalia with soap and water. For certain cases, urethral catheterization was performed based on age and clinical status.

Antimicrobial Sensitivity Testing*:* Urine specimens were promptly plated within one hour of collection, and when delay was anticipated, samples were refrigerated at 4ºC for up to 24 hours. The urine samples were inoculated on Muller Hinton Agar using the Bauer-Kerby method. Antimicrobial susceptibility testing was carried out via disc diffusion, following the Clinical and Laboratory Standards Institute (CLSI) guidelines. A range of antimicrobial agents including Nitrofurantoin, Cefoperazone, Cefoperazone+Sulbactam, Piperacillin, Piperacillin+Tazobactum, Ceftriaxone, Cefepime, Ciprofloxacin, Gentamycin, Meropenem, and Colistin were tested.

Statistical Data Analysis: Qualitative data such as sex, caste, and residence were presented in numbers and percentages. Significance was assessed using Chi-square and Fischer's exact tests. Quantitative data such as age and bacterial counts were presented as mean, median, and standard deviation. Student's t-test was used to compare mean differences between the two groups. A significant difference was considered when the p-value was less than 0.05. Data analysis was conducted using Excel and Epi Info version 7.

RESULTS

Total 100 children with UTIs were enrolled in the study.

Age	Females (%)	Males (%)	Total (%)
Less than 1 year	7 (30.40%)	23 (69.6%)	30 (100%)
1 to 5 years	21 (41%)	30 (59%)	51 (100%)
More than 5 years	12 (63%)	7 (37%)	19 (100%)
Total	40 (40%)	60 (60%)	100 (100%)

χ2 =7.75, p = 0.02

Table 1: Demographic Characteristics and Age Distribution

Infants less than one year old exhibited a higher proportion of males (69.6%) compared to females (30.4%), while the 1 to 5 years age group showed a balanced distribution. In contrast, the more than 5 years age group displayed a higher prevalence of females (63%) than males (37%). A statistically significant association Is observed between age and gender (p = 0.02).Table 1

Fever was the most common complaint present in about 92 cases (92), and other complaints were dysuria (29), vomiting (23), loose motions (16), frequency of micturition (12), pain in the abdomen (12), turbid urine(10), dribbling micturition (9), and constipation (5).Figure 1

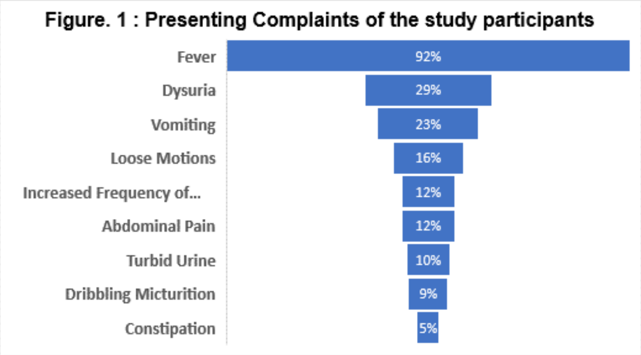

Figure 1: Presenting complaints of study participants

Organisms found on Urine Culture	Isolates
E. Coli	69
Enterobacter	6
Enterococcus fecalis	2
Klebsiella Pneumoniae	10
Pseudomonas aeruginosa	13
Total	100

Table 2: Organisms found on urine culture in the study

E coli was more prominent organism found in UTI on urine culture followed by Pseudomonas aeruginosa.Table 2

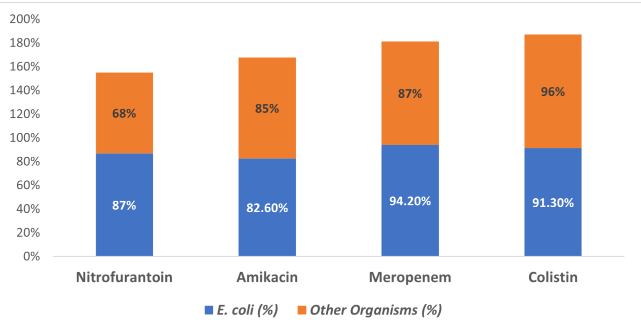

Figure 2: Antibiotic Sensitivity of Common Organisms

High efficacy of Nitrofurantoin (87), Amikacin (82.60), Meropenem (94.20), and Colistin (91.30) against E. coli. Additionally, these antibiotics demonstrated effectiveness against other organisms, with notable percentages for Nitrofurantoin (68), Amikacin (85), Meropenem (87), and Colistin (96) were observed.Figure 2

Cefoperazone, Ceftriaxone, and Cefepime demonstrated significant effectiveness against the strains tested, with susceptibility rates of 65.3, 68.0, and 40.0, respectively. Notably, Cefoperazone-sulbactam exhibited high efficacy (57.3), while Piperacillin-tazobactam and Colistin displayed relatively lower susceptibility rates (24.0 and 1.3, respectively).Table 3

The presence of GUT anomaly was associated with a higher sensitivity to 4 or fewer antibiotics (12.7) compared to cases where the anomaly was absent (37.9). Prior urinary instrumentation showed a significant impact, with cases of instrumentation having a higher sensitivity to fewer antibiotics (16.5) compared to those without instrumentation (40). Additionally, a history of urinary tract infections (UTIs) demonstrated increased sensitivity to antibiotics, with 35.1 in cases with a history of UTI compared to 11.1 in those without. Notably, antibiotic use in the last three months was associated with elevated sensitivity to antibiotics, as 31.6 of individuals with recent antibiotic use demonstrated this pattern compared to 12.9 of those without recent antibiotic use.**Table** 4

In comparing 25 ESBL organisms with 75 non-ESBL organisms, it was observed that fever resolution occurred within 3 days for the majority of non-ESBL cases (78.6), while ESBL UTIs required 5-10 days for resolution in the majority. Constitutional symptoms showed improvement within 3 days for both groups, with 80 resolutions in the ESBL group and 88 in the non-ESBL group. Notably, the resolution of pyuria took longer, with non-ESBL cases responding earlier (77 by 5 days) compared to ESBL cases (88 by >10 days).Table 5

DISCUSSION

In our study, which included 100 cases of culture-positive urinary tract infections (UTI), we observed specific age and gender distributions among the cases. Among these cases, 30% were infants (less than one year of age), 51% were aged 1 to 5 years, and 19% were above five years old. The male-female distribution indicated that males comprised 60% and females 40% of the cohort.

When comparing different age groups, we noted variations. In infants, males (69.6%) were more prone to UTI than females (30.4%). In the 1-to-5-year age group, males (59%) had a higher occurrence of UTI compared to females (41%). Conversely, in the age group above five years, there was a female predominance (67%). This difference in male and female patients according to age groups was statistically significant (p=0.02).

The mean age for males in our study was 2.2 years, while for females, it was 4.3 years. This indicated that males had a greater susceptibility for UTI than females (male to female ratio, 1.5:1) up to 5 years of age. After this age, females showed higher susceptibility. Similar, findings were observed in a study by Ramgopal G. and Kumar V. [17, 18]

Fever was the most common presenting symptom (92%). Dysuria (29%) and vomiting (23%) were the second and third most common symptoms, while other symptoms included loose motions, increased frequency of urination, abdominal pain, turbid urine, dribbling urination, and constipation. The overall findings were statistically significant suggesting a noteworthy association between age, gender, and bacterial

Antibiotics	Organisms				p-Value
	Non-ESBL		ESBL		
	Resistant	Sensitive	Resistant	Sensitive	
Cefoperazone	49 (65.3)	26 (34.7)	25 (100)	0 (0.0)	0.001
Nitrofurantoin	27 (36.0)	48 (64.0)	5 (20.0)	20 (80.0)	0.215
Cefoperazone sulbactam	43 (57.3)	32 (42.7)	24 (96.0)	1 (4.0)	0.001
Piperacillin	30 (40.0)	45 (60.0)	12 (48.0)	13 (52.0)	0.49
Piperacillin tazobactam	18 (24.0)	57 (76.0)	7 (28.0)	18 (72.0)	0.79
Ceftriaxone	51 (68.0)	24 (32.0)	25 (100)	0 (0.0)	0.001
Cefepime	30 (40.0)	45 (60.0)	23 (92.0)	2 (8.0)	0.001
Ciprofloxacin	47 (62.7)	28 (37.3)	24 (96.0)	1 (4.0)	0.001
Gentamycin	18 (24.0)	57 (76.0)	10 (40.0)	15 (60.0)	0.13
Amikacin	13 (17.3)	62 (82.7)	2 (8.0)	23 (92.0)	0.34
Meropenem	8 (10.7)	67 (89.3)	5 (20.0)	20 (80.0)	0.3
Colistin	1 (1.3)	74 (98.7)	3 (12.0)	22 (88.0)	0.47

Table 3: Antibiotic sensitivity of ESBL and Non-ESBL organisms.

Associated Risk Factors		Sensitivity Pattern			Total	p-value
		4 (or) less antibiotics	5 to 8 antibiotics	9 to 12 antibiotics		
GUT Anomaly	Absent	9 (12.7)	37 (52.1)	25 (35.2)	71 (100)	0.002
	Present	12 (37.9)	16 (55.2)	2 (6.9)	29 (100)	
Prior Urinary instrumentation	No	14 (16.5)	44 (51.8)	27 (31.8)	85 (100)	0.007
	Yes	6 (40.0)	9 (60)	0 (0)	15 (100)	
History of UTI	No	7 (11.1)	32 (50.8)	24 (38.1)	63 (100)	0.001
	Yes	13 (35.1)	21 (56.8)	3 (8.1)	37 (100)	
Antibiotic use in the last three months	No	8 (12.9)	30 (48.4)	24 (38.7)	62 (100)	0.001
	Yes	12 (31.6)	23 (60.5)	3 (7.9)	38 (100)	

Table 4: Associated Risk Factors and Antibiotic Resistance

prevalence in our study population.

In our study, Escherichia coli (E. coli) was the most common isolated organism (69%). Pseudomonas aeruginosa (13%) and Klebsiella pneumoniae (10%) were the next common, followed by Enterobacter spp. (6%) and Enterococcus faecalis (2%). Previous surgical interventions, such as urinary instrumentation, were associated with Pseudomonas-UTI risk. The study reveals a significant shift in bacterial prevalence among age groups, with E. coli being the predominant pathogen which is like the findings by Shrestha LB et al., Venugopal P et al. and Renko M. [19–21]

We assessed antibiotic sensitivity patterns for isolated organisms. Around 20% were sensitive to 4 or fewer antibiotics, 53% were sensitive to 5 to 8 antibiotics, and 27% were sensitive to 9 to 12 antibiotics. E. coli showed sensitivity to Nitrofurantoin (87%), Gentamycin (82.60%), Amikacin (94.20%), Meropenem (91.30%), and Colistin (95.70%), but Enterobacter species showed high resistance E. coli showed sensitivity to Nitrofurantoin (68%), Amikacin (85%), Meropenem (87%), and Colistin (96%), but resistance to Ceftriaxone (76%), Cefoperazone (74%), and Ciprofloxacin (71%) was noted [Table 8] [Fig. 7]. Comparable results

Resolution in days	Remission of Fever		Improvement in symptoms		Resolution of pyuria	
	ESBL	Non-ESBL	ESBL	Non-ESBL	ESBL	Non-ESBL
Within 3 days	12 (48)	59 (78.60)	20 (80)	66 (88)	0	0
4 to 5 days	9 (36)	11 (14.60)	4 (16)	6 (8)	13 (52)	58 (77.30)
6 to 10 days	4 (16)	5 (6.60)	1 (4)	3 (4)	9 (36)	15 (20)
More than 10 days	0	0	0	0	3 (12)	2 (2.70)
Total	25	75	25	75	25	75
p= value	p= 0.01		p= 0.44		p= 0.036	

Table 5: Comparisonof Response to Treatment of ESBL vs non-ESBL bacteria

were noted in a study conducted by Tiwari S et al and Nag BC et al among children diagnosed with severe acute malnutrition. [22, 23]

In our study, prior urinary instrumentation history, past UTI history, genitourinary tract anomalies, and antibiotic use in the past three months were risk factors for antibiotic resistance. These findings correlated with Albaramki JH et al and Nasser R et al. [24, 25]

Among our cases, 25 were caused by ESBL organisms. These organisms showed resistance to various antibiotics, with more resistance against Cephalosporins and ciprofloxacin compared to non-ESBL organisms. A history of prior UTI and antibiotic use within three months correlated with ESBL cases. These findings were consistent with studies of Ahmed I et al, Shaikh S et al, El Alia NA et al., Suh W et al., Rajiv Gandhi G. and Gharavi MJ et al. [26–31]

In our study group, 18% had Vesicoureteral Reflux (VUR), with 66.7% on uroprophylaxis. While the study by Hoberman et al suggested VUR-associated uroprophylaxis might lead to resistance, our study found no significant difference. Cases with VUR did not significantly correlate with ESBL organisms.

Finally, we observed resolution times for fever, symptoms, and pyuria. ESBL cases had prolonged fever resolution compared to non-ESBL cases, with other symptoms showing comparable improvements. Our study provided valuable insights into antibiotic resistance patterns, symptom resolution, and risk factors for UTIs in children.

CONCLUSIONS

UTIs in children show age-specific gender variations and evolving bacterial profiles. E. coli remains the dominant pathogen, but resistance is rising. Prior interventions, past UTIs, and recent antibiotic use are associated with resistance. ESBL-producing organisms pose a particular challenge. These findings highlight the need for judicious antibiotic use and tailored management strategies based on age, bacterial profile, and resistance patterns.

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