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Causative Organisms and Their Sensitivity Pattern of Urinary Tract Infection in Children at a Tertiary Care Hospital

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Author`s Contribution

[1,3]Substantial contributions to the conception or design of the work; or the acquisition, [2,6]Active participation in active methodology, [4] analysis, or interpretation of data for the work, [5]Drafting the work or revising it critically for important intellectual content

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ABSTRACT

Objective: To explore the causal organisms and their sensitivity patterns in UTIs among pediatric patients, with the goal of improving management and treatment techniques for pediatric urinary tract infections.

Methodology: A prospective observational design was done at department of paeds, AIMS Hospital Muzaffarabad AJK during six months of duration from June 2023 to December 2023. All the children under 12 years old, both genders with a clinical diagnosis of UTI and a confirmed positive urine culture were included. Specimens of urine have been obtained using clean-catch or catheterization methods and cultured according to established microbiological protocols. Isolated organisms have been identified and evaluated for sensitivity to antibiotics.

Results: A total of 82 paediatrics patients were study studied; with an overall mean age of 5.46±3.03 years. Girls were 67.4% and boys were 33.6%. Escherichia coli was the most common isolate (83.6%). Meropenem showed the highest sensitivity (90.2%), with Fosfomycin and Nitrofurantoin were also highly effective (82% each). Imipenem and Piperacillin were sensitive in 80.3% of cases and Amikacin was sensitive in 70.5% cases. Moderate sensitivity was observed for Ceftriaxone (50.8%), with lower rates for Vancomycin, and Cephalexin. Resistance was highest for Amoxicillin and Chloramphenicol. Bacterial isolates revealed high resistance to Amoxicillin and significant sensitivity to Fosfomycin, Nitrofurantoin, Imipenem (p<0.05), Meropenem and Piperacillin (p->0.05).

Conclusion: The predominant causative organism for urinary tract infections was observed Escherichia coli, followed by Klebsiella and Staphylococcus species. Among the tested antibiotics, Meropenem, Fosfomycin, Piperacillin, Nitrofurantoin and Amikacin observed with highest sensitivity and most resistant drugs were amoxicillin, Chloramphenicol and ciprofloxacin.

Key words: UTI, children, Organisms, Sensitivity, Resistance

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Introduction

Urinary tract infections (UTIs) are a common cause of significant illness in children, with a prevalence of 3-5% and the occurrence of UTIs varies depending on the child's gender and age.[1] It is among the most frequent types of bacterial infections in children and ranks as the second most common infectious disease after respiratory infections.[2] In children, UTIs often present with nonspecific symptoms, such as fever with no clear source of infection. This is a primary reason for initiating antibiotic treatment during emergency room visits or hospital admissions.[2] The risk factors for urinary tract infections include female gender, uncircumcised males, and anatomical abnormalities such as vesico-ureteric reflux (VUR). Other contributing factors are neurogenic

bladder, toilet training, voiding dysfunction and the obstructive uropathy. Additional risks include improper wiping technique (back to front) in girls, pinworm infestation, tight clothing, ureteral instrumentation, sexual activity and the constipation.[3,4]

The incidence and prevalence of UTIs differ across regions worldwide. In Pakistan, data on pediatric UTIs are scarce. Diagnosing a UTI relies on clinical evaluation and urine culture sensitivity, typically obtained from a clean-catch urine sample.[5] Collection such a sample is particularly challenging in young children, especially those less than four years old. Careful attention is essential during sample collection to ensure accuracy and avoid mislabeling a case as UTI before initiating empirical antibiotic treatment.[5] Several studies conducted on infants and children to identify the organisms responsible for UTIs consistently indicate that *Escherichia coli (E. coli)* is the most frequently isolated pathogen. Other common culprits include *Klebsiella* species, *Staphylococci*, *Pseudomonas*, *Enterobacter* and *Proteus mirabilis* among others.[6]

The evolving antibiotic resistance patterns of bacterial pathogens responsible for acute UTIs pose a growing challenge. The bacteria causing UTIs in children often vary by geographic region, and the misuse of antibiotics by some practitioners has led to the emergence of uncommon organisms as significant pathogens. Understanding the local distribution of urinary pathogens and their antimicrobial susceptibility is vital for selecting effective empiric treatment for children with acute UTIs.[7,8] However the regular monitoring of causative uropathogens and their resistance patterns, along with prompt diagnosis and appropriate antibiotic administration, is crucial for effective management and for preventing renal complications such as scarring, hypertension, and progressive parenchymal damage.[8] Recognizing the underestimation of this growing disease in children and the conflicting local data, this study was conducted to identify the causative organisms and their antibiotic sensitivity patterns in pediatric UTIs, with aim to enhance the management and treatment strategies for urinary tract infections in children.

Methodology

A prospective observational design was done at department of Paeds, AIMS Hospital Muzaffarabad AJK during six months of duration from June 2023 to December 2023. Study was done after taking ethical approval. All the children under 12 years old, both genders with a clinical diagnosis of UTI and a confirmed positive urine culture were included. Children aged 12 years or older, those with suspected or diagnosed infections other than UTI, children with known anatomical abnormalities, children with negative culture reports and those with a history of antibiotic use for more than 48 hours prior to urine culture were excluded. A written informed consent was taken from parents or caretakers after obtaining the aims and objective of the study. A careful urine samples collection was done to ensure the effective culture results. A clean-catch method was used in the toilet trained children, involving through cleaning the genital area and urine collection was done by a sterile container provided by laboratory. A sterile bag was used for the younger children or catheterization method was used as per requirement and in few cases suprapubic urine aspiration was done for sampling. All the collected urine samples were carefully labeled and were sent to the laboratory immediately. The culture and sensitivity test were in the laboratory to evaluate the causative organisms and their sensitivity and resistant pattern. All the information was collected by using self-made study proforma and analysis was done using SPSS version 26.

Results

Mean age was 5.46±3.03 years minimum 1 year and maximum 11 years, mean children weight was 15.83±7.16 kg and mean duration of symptoms was 1.80±044 months. Girls were in majority 67.4% and boys were 33.6%. Most of the cases 656% were from rural areas and 34.4%from urban areas. Escherichia coli was the most common causative organism, cases (83.6%). Followed Escherichia coli combined with Klebsiella (1.6%), Klebsiella alone (1.6%), and Klebsiella combined with Enterobacter (1.6%), Enterobacter (3.3%), while Pseudomonas was identified in 3 cases (4.9%) and Staphylococcus saprophyticus found in (3.3%) of the cases. (Table I)

Table 1. Frequency of causative organisms. (n=61)

Organisms	**N**	**%**
Escherichia coli	51	83.6
Escherichia coli + Klebsiella	1	1.6
Klebsiella	1	1.6
Klebsiella + *Enterobacter*	1	1.6
Enterobacter	2	3.3
Pseudomonas	3	4.9
Staphylococcus Saprophyticus	2	3.3
Total	61	100.0

Based on the antibiotic sensitivity pattern, the Meropenem showed the highest sensitivity (90.2%), followed by Fosfomycin and Nitrofurantoin, both with 50 patients (82%) being sensitive. Imipenem and Piperacillin were sensitive (80.3%) each, while Amikacin was sensitive in 70.5%. In contrast Amoxicillin and Chloramphenicol were lower sensitive, (21.3%) and (24.6%) respectively. Sensitivity to Ceftriaxone was moderate in (50.8%) patients, while Vancomycin, and Cephalexin were sensitive in (37.7%), and (37.7%) patients, respectively. The resistance rates for Amoxicillin and Chloramphenicol were higher, as showed in Table 2.

Table II: Antibiotic sensitivity pattern among patients with UTI. (n=61)

Antibiotics sensitive pattern		N	%
Amoxicillin	Sensitive	13	21.3
	Resistant	48	78.7
Chloramphenicol	Sensitive	15	24.6
	Resistant	46	75.4
Ciprofloxacin	Sensitive	22	36.1
	Resistant	39	63.9
Gentamicin	Sensitive	21	34.4
	Resistant	40	65.6
Vancomycin	Sensitive	23	37.7
	Resistant	38	62.3
Tetracycline	Sensitive	19	31.1
	Resistant	42	68.9
Cephalexin	Sensitive	23	37.7
	Resistant	38	62.3
Ceftriaxone	Sensitive	31	50.8
	Resistant	30	49.2
Fosfomycin	Sensitive	50	82.0
	Resistant	11	18.0
Amikacin	Sensitive	37	70.5
	Resistant	24	29.5
Meropenem	Sensitive	55	90.2
	Resistant	6	9.8
Imipenem	Sensitive	49	80.3
	Resistant	12	19.7
Piperacillin	Sensitive	49	80.3
	Resistant	12	19.7
Nitrofurantoin	Sensitive	50	82.0
	Resistant	11	18.0

Analysis of 61 bacterial isolates showed significantly high resistance to Amoxicillin and significant sensitivity to Fosfomycin and Nitrofurantoin (p=<0.05). Imipenem also showed notable sensitivity (p=0.017), while other antibiotics displayed variable efficacy. Fosfomycin, Meropenem, Imipenem, Piperacillin and Nitrofurantoin emerged as the most effective option. (Table III)

Discussion

Urinary tract infections (UTIs) are one of the most frequent infections in children and a significant cause of illness. Inadequate or delayed treatment with the right antibiotics can result in severe complications.[9] Present study aimed to evaluate the causative organisms and their antibiotic sensitivity in the pediatric population with urinary tract infections (UTI), with an overall mean age of 5.46 ± 3.03 years and a female predominance of 67.4%. The findings are consistent with the study by Duicu C et al,[10] where the average age was 4.13 ± 4.48 years, and there was a similar gender distribution with 147 boys and 184 girls out of 331 cases. Similarly, Hantoosh SM al[11] reported a female predominance of 61% in their UTI population, with males comprising 39%. In comparison, Biswas D et al[12] found that most of their study population was aged 4 years and below, with a female predominance of 65%, while the remaining were males. However, inconsistently, another study by Qadir S et al[13] found a lower mean age of 41.51 ± 18.34 months in their pediatric population with UTI. This lower mean age could be attributed to broader selection criteria for age range, while consistently they found a higher prevalence of UTIs among girls, with 75.58% of cases compared to 23.25% in boys. Higher incidence of UTIs in girls across these studies is likely due to anatomical and behavioral factors. Girls have a shorter urethra, which allows bacteria easier access to the bladder. Additionally, girls often wipe from back to front, which can transfer bacteria from the rectum to the urethra. Improper hygiene practices may also contribute to the increased risk of UTI in girls. These findings highlight the importance of gender-specific considerations in understanding and managing pediatric UTIs.

In the present study, the majority of cases (65.6%) were from rural areas, while 34.4% were from urban areas. *Escherichia coli* was the most common causative organism, accounting for 83.6% of the cases. Other pathogens identified included *Escherichia coli* combined with *Klebsiella* (1.6%), *Klebsiella* alone (1.6%), and *Klebsiella* combined with *Enterobacter* (1.6%), as well as *Enterobacter* (3.3%). *Pseudomonas* was found in 4.9% of cases, and *Staphylococcus saprophyticus* was identified in 3.3%. These findings are consistent with the study by Cag Y et al[14] who reported that *Escherichia coli* was the most commonly isolated pathogen (67.7%), followed by *Klebsiella* spp. (10.7%) and *Enterococcus* spp. (8.8%). Similarly, Hantoosh SM et al[11] also reported that the E_coli was the most common causative pathogen 74%, followed by 41% Enterococcus faecalis, 33% Enterobacter aerogenes, 36% Klebsiella pneumoniae, 29% Proteus mirabilis, and 19% Pseudomonas aeruginosa. Consistently Sohail M et al[15] reported the E-

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Table 3. Cross-tabulation analysis for sensitivity pattern according bacteria isolates (n=61)

Antibiotics sensitivity pattern		BACTERIAL ISOLATES							Total	p-value
		Escherichia Coli	*Escherichia Coli + Klebsiella*	*Klebsiella*	*Klebsiella + Enterobacter*	*Enterobacter*	*Pseudomonas*	*Staphylococcus Saprophyticus*		
Amoxicillin	Sensitive	13	0	0	0	0	0	0	13	0.778
	Resistant	38	1	1	1	2	3	2	48	
Chloramphenicol	Sensitive	13	0	0	0	0	1	1	15	0.872
	Resistant	38	1	1	1	2	2	1	46	
Ciprofloxacin	Sensitive	19	0	1	0	0	2	0	22	0.379
	Resistant	32	1	0	1	2	1	2	39	
Gentamicin	Sensitive	19	0	0	0	0	1	1	21	0.806
	Resistant	32	1	1	1	2	2	1	40	
Vancomycin	Sensitive	18	1	1	1	0	0	2	23	0.076
	Resistant	33	0	0	0	2	3	0	38	
Tetracycline	Sensitive	15	1	0	1	0	0	2	19	0.071
	Resistant	36	0	1	0	2	3	0	42	
Cephalexin	Sensitive	20	0	0	1	0	1	1	23	0.639
	Resistant	31	1	1	0	2	2	1	38	
Ceftriaxone	Sensitive	25	0	1	1	1	1	2	31	0.501
	Resistant	26	1	0	0	1	2	0	30	
Fosfomycin	Sensitive	46	1	1	1	1	0	0	50	0.001
	Resistant	5	0	0	0	1	3	2	11	
Amikacin	Sensitive	37	0	1	1	1	3	0	43	0.135
	Resistant	14	1	0	0	1	0	2	18	
Imipenem	Sensitive	44	1	1	1	1	1	0	49	0.017
	Resistant	7	0	0	0	1	2	2	12	
Piperacillin	Sensitive	39	1	1	1	2	3	2	49	0.818
	Resistant	12	0	0	0	0	0	0	12	
Nitrofurantoin	Sensitive	45	1	1	1	1	1	0	50	0.008
	Resistant	6	0	0	0	1	2	2	11	

coli most frequent causative organism among 72% of the specimens followed by 11% Klebsiella, 4% Enterococcus and 7% Enterobacter. However in the study by Mushtaq A el at[16] reported that frequently isolated organism was *E. coli* (39.4%), with a higher prevalence in females compared to males, followed by 21.2% *Proteus* species, 9.1% *Klebsiella and 12.1% Streptococcus faecalis* and interestingly, *Streptococcus faecalis* was more frequently among males than in females. Out findings were also by few other recent studies where E-colie was most frequent causative organism in children with UTI.[17,18] E. coli has been consistently identified as the most prevalent causal bacterium among children having urinary tract infections (UTIs) in numerous studies due to its presence in the gastrointestinal system and ability to adhere to uroepithelial cells and the small urethra in children, especially among females, makes it simpler for E. coli to enter the urinary system and cause the disease.

In this study based on the antibiotic sensitivity pattern, the Meropenem showed the highest sensitivity (90.2%), followed by Fosfomycin and Nitrofurantoin, both with 50 patients (82%) being sensitive. Imipenem and Piperacillin were sensitive (80.3%) each and Amikacin in 70.5%. In contrast Amoxicillin and Chloramphenicol were lower sensitive, (21.3%) and (24.6%) respectively. Sensitivity to Ceftriaxone was moderate in (50.8%) patients, while Vancomycin, and Cephalexin were sensitive in ((37.7%), and (37.7%) patients, respectively. The resistance rates for Amoxicillin and Chloramphenicol were higher. In the comparison of this study Iqbal F et al[19] reported that the most effective antibiotics against *E. coli* include Meropenem, with a sensitive rate of 97.2%, followed by Fosfomycin 90.2%, and Amikacin at 89.7%. On the other hand, the highest resistance was observed with Co-trimoxazole, which showed an 86% resistance rate, followed by Amoxicillin/clavulanic acid at 69.8%, and Cefixime at 70.7%. In the study by Sohail M et al[15] the Cefixime exhibited the highest resistance, with a rate of 95%, followed by Ceftriaxone at 88.33% and Amoxicillin at 78%. Our results were partially supported by the Giri A *et al*[20] *where Escherichia coli* was most sensitive to

Giri A, with a sensitivity rate of 95.5%, followed by Ciprofloxacin at 91.1% (41 cases) and Amikacin at 88.8%. Our were further supported by the Joya M et al[21], where Ampicillin and amoxicillin, showed highest resistance rates, Ceftriaxone, ceftazidime, cefixime, and sulfamethoxazole also showed resistance above 70% an imipenem, Fosfomycin and nitrofurantoin had the lowest resistance rates, all under 10%. Our findings were also in aligns to the study by İdil N et al[22] in terms of resistance pattern. Consistently Mohsenpour et al[23] found nitrofurantoin with highest sensitivity for uropathogens. There is disparity in sensitivity and resistance patterns among uropathogens that cause UTIs in children and it can be related to several factors like regional variations are important because antibiotic usage behaviors, availability, and adherence to treatment guidelines vary by area. Furthermore, overuse or misuse of antibiotics in specific locations might promote resistance, resulting in disparities in pathogen responses. Differences in sample size, research demographics, and laboratory methodologies for assessing sensitivity and resistance can all contribute to these discrepancies. Additional studies are needed to address the variations in sensitivity and resistance patterns of uropathogens causing UTIs in children. Regional epidemiological investigations should be done to better understand geographic variations in resistance trends and create tailored treatment guidelines. Evaluating the impact of antibiotic stewardship programs can help improve prescribing habits and reduce resistance.

Conclusion

Study observed the E-coli as predominant uropathogens causing UTI among pediatric population with significant discrepancy in the antibiotic sensitivity patter. Antibiotics including Fosfomycin, Meropenem, Imipenem, Piperacillin, Nitrofurantoin and Amikacin found to be the highly sensitive, while alarming resistance rate observed for most commonly used antibiotics like Amoxicillin, Ciprofloxacin, Gentamicin and Ceftriaxone. Due several limitations specifically very limited sample size the findings cannot recommended as finally conclusive. However to validate the findings further large scale and longitudinal studies are recommended.

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