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Clinical and Bacteriological Profile of Urinary Tract Infection in Children; A Tertiary Care Hospital Experience

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Abstract

Background: *Urinary tract infections (UTIs) are common bacterial infections in children, impacting health and development. Girls have a 3-10% risk of UTIs before age 14, and boys have a 1-3% risk. UTIs are more common in boys during the first year and in girls after that. They often ascend from the urethra and are diagnosed by over 100,000 CFU/ml in urine. Early diagnosis is crucial to prevent renal scarring and future morbidities. Common pathogens include E. coli, with increasing antimicrobial resistance complicating treatment.*

Aim of the Study: *The study aim to provide insights into the current trends of UTI in children and guide effective treatment strategies in our clinical setting.*

Methods: *This prospective observational study was conducted over one year at the Department of Pediatric, 250 Bedded General Hospital, Khulna, Bangladesh, to evaluate the clinical and bacteriological profile of pediatric UTIs. It included children aged one month to 14 years with symptomatic UTIs and positive urine cultures. Recurrent UTIs, other pyuria causes, chronic illnesses, recent antibiotic use, and mixed microbial growth were excluded. Data on demographics, symptoms, and risk factors were collected and analyzed using SPSS software.*

Result: *The study analyzed 190 children with UTIs, with the highest prevalence in the 2-12 months age group (51.58%). The sample included 44.74% males and 55.26% females. Fever (70%) was the most common symptom, followed by abdominal pain (46.84%). Escherichia coli was the predominant pathogen (66.32%). Antibiotic resistance was highest for amoxicillin (97.62%) and lowest for amikacin (30.16%). Other significant pathogens included Enterococcus, Klebsiella, Pseudomonas, and Acinetobacter, showing varied resistance patterns.*

Conclusion: *This study examines the clinical and bacteriological profiles of UTIs in children, finding high prevalence in those aged 2-12 months, predominantly affecting females. Escherichia coli was the main pathogen. Significant antibiotic resistance, especially to amoxicillin and cefixime, highlights the need for updated guidelines and prudent antibiotic use.*

Keywords: *Bacterial infections, Antimicrobial resistance, pathogens and UTI.*

1. Introduction

Urinary tract infections (UTIs) are among the most common bacterial infections in children, with significant implications for their health and development. The prevalence of UTIs in children varies by age, gender, and geographical region [1]. According to reports, girls are at a 3-10% risk, and boys have a 1-3% risk of experiencing a UTI before the age of 14 [2,3]. It impacts male children more frequently than female children during the first year of life but tends to affect females more often after the age of one [4]. UTIs primarily occur due to an infection that ascends from the urethra [5].

A urinary tract infection (UTI) is characterized by the presence of a substantial quantity of organisms—specifically, more than 100,000 colony-forming units (CFU) per milliliter of a single species in the urine sample, accompanied by symptoms [2]. The diagnosis of UTI is very often missed in young children due to minimal and nonspecific symptoms [6]. Diagnosing

urinary tract infections (UTIs) in young children is crucial because it can indicate potential urinary tract abnormalities [7]. The developing renal cortex in young children is vulnerable to renal scarring, resulting in hypertension and chronic renal failure. These morbidities in adults often originate in childhood [6]. Therefore, early diagnosis is crucial for preserving the renal function of the developing kidney [7,8]. The diagnosis of UTI in children is often challenging due to the nonspecific nature of symptoms, especially in infants and young children [9]. Fever is the most common presenting symptom, followed by abdominal pain, dysuria, and decreased appetite [10]. Gram-negative bacteria, particularly Escherichia coli, are the most common causative agents of UTI in children [11]. Other commonly involved pathogens include Klebsiella pneumoniae, Proteus mirabilis, Enterococcus faecalis, and Staphylococcus aureus [12,13]. The advent of antimicrobial therapy has significantly enhanced the management of urinary tract infections (UTIs). However, antimicrobial resistance has emerged as a growing issue, raising substantial concerns across numerous countries [14-16]. Over the last few decades, resistance has developed against many commonly prescribed UTI antibiotics, including ampicillin, co-trimoxazole, nitrofurantoin, and fluoroquinolones [17]. UTIs are a significant risk factor for the progression of renal insufficiency or end-stage renal disease [8]. This study aimed to assess the clinical and bacteriological profile of urinary tract infections (UTIs) in children. We sought to evaluate the presentation and symptoms of UTIs, identify the causative bacterial pathogens, and analyze their antibiotic sensitivity patterns in a pediatric population.

2. Methodology & Materials

A prospective observational study was conducted at the Department of Pediatric, 250 Bedded General Hospital, Khulna, Bangladesh. The study spanned one year, from January 2020 to December 2020, and aimed to evaluate the clinical and bacteriological profile of urinary tract infections (UTIs) in children. Patient history was recorded, and clinical examinations were performed. Complicated UTIs involving the upper urinary tract were diagnosed if any of the following criteria were met: fever >39°C, systemic toxicity, persistent vomiting, dehydration, renal angle tenderness, and elevated serum creatinine levels. Informed consent was obtained from the parents or guardians of all participants prior to their enrollment in the study.

Inclusion Criteria

- Children from the age of 1 month to 14 years.
- Children with clinical signs and symptoms of UTI, such as fever, dysuria, frequency, urgency, abdominal pain, or hematuria.
- Children with a positive urine culture confirm the presence of a bacterial pathogen.

Exclusion Criteria

- Recurrent UTIs, other causes of pyuria such as acute interstitial nephritis, glomerulonephritis, and vasculitis, asymptomatic bacteriuria, known urinary malformations, chronic illnesses, current prophylactic antibiotic treatment.
- Cases where antibiotics were administered within seven days prior to sample collection.
- Children with mixed microbial growth were excluded.

The following tests were conducted for all patients: complete blood count, blood urea, serum creatinine, and electrolyte levels. Blood cultures were taken from infants to rule out septicemia. Urine samples were analyzed using wet-mount microscopy to detect pyuria, hematuria, and other abnormal cells. For older children, clean-catch midstream urine samples were collected, while urine samples from infants and younger children were obtained through transurethral bladder catheterization.

Data were collected using a structured proforma, which included demographic information (age, gender, and socioeconomic status), clinical presentation (symptoms and duration), and risk factors (such as toilet training status and history of previous UTIs). Urine samples were collected from all participants for laboratory analysis. For infants and non-toilet-trained children, urine samples were obtained using sterile urine bags, while midstream clean-catch urine samples were collected from toilet-trained children. Data were entered into a Microsoft Excel spreadsheet and analyzed using SPSS software version 26.0. Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. The prevalence of various bacterial pathogens and their antibiotic resistance profiles were determined.

3. RESULT

The study included 60 children diagnosed with urinary tract infections (UTIs). The highest prevalence of UTI was observed in the 2-12 months age group, with 98 (51.58%) cases; 62(32.63%) cases recorded in the group of 1-5 years and only 6 cases (3.16%) in the > ten years age group (Table 1). Among the 190 patients, 85(44.74%) were male and 105(55.26%) were female (Figure 1). Table 2 outlines the clinical features of UTI in the studied children. Fever was the most common symptom (70.00%). Abdomen Pain was reported in 89 children (46.84%), while dysuria was observed in 73(38.42%) children. Vomiting occurred in 57(30.00%) cases, and 47(24.74%) children exhibited an increased frequency of urination.

Poor feeding or decreased appetite was noted in 44(23.16%) children, and diarrhea was present in 38(20.00%) cases. Escherichia coli was the most frequently isolated pathogen, accounting for 126 cases (66.32%). Enterococcus species were isolated in 22 samples (11.58%), while Klebsiella spp. were found in 16 cases (8.42%). Pseudomonas aeruginosa was present in 13 samples (6.84%), and Acinetobacter species were isolated in 10 cases (5.26%) (Table 3).

According to antibiotic sensitivity patterns, in E. coli isolates (n=126), resistance to amoxicillin, cotrimoxazole, cefixime, cefuroxime, and ceftazidime was notably high, with 97.62%, 97.62%, 89.68%, 97.62%, and 82.54% resistance rates, respectively. Ciprofloxacin and levofloxacin showed moderate resistance, with 50.00% and 39.68%, respectively. Amikacin and nitrofurantoin demonstrated better efficacy with 30.16% and 47.62% resistance rates, respectively. Enterococcus isolates (n=22) showed high sensitivity to azithromycin (27.27%) and vancomycin (72.73%). Klebsiella (n=16) had significant resistance to ciprofloxacin (81.25%) and ceftriaxone (62.50%). Pseudomonas (n=13) showed considerable resistance to amikacin (53.85%) and ciprofloxacin (53.85%). Acinetobacter isolates (n=10) were highly resistant to amoxicillin and aztreonam (100.00% and 70.00%, respectively). The highest resistance was observed to amoxicillin, cotrimoxazole, cefixime, cefuroxime, and ceftriaxone, with 97.62%, 97.62%, 89.68%, 97.62%, and 82.54% resistance rates, respectively. Moderate resistance was noted to ciprofloxacin (50.00%) and levofloxacin (60.32%). The lowest resistance was observed for nitrofurantoin (52.38%) and amikacin (69.84%) (Table 5).

Table 1. *Age distribution of the study children (N=60).*

Age range (in years)	Frequency (n)	Percentage (%)
1-12 months	30	50.00
1-5	20	33.33
6-10	8	13.33
>10	2	3.33

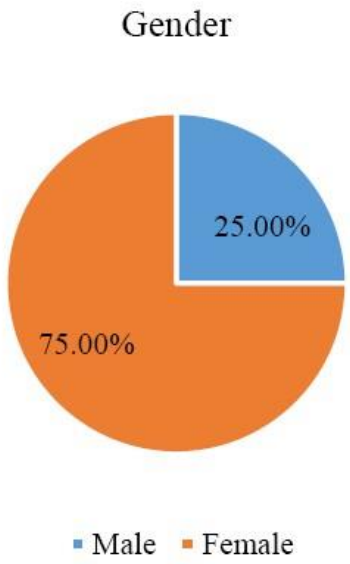

Figure 1. *Gender distribution of the study children (N=60).*

Table 2. *Clinical features of UTI in children.*

Clinical Features	Frequency (n)	Percentage (%)
Fever	42	70.00
Pain abdomen	28	46.67
Dysuria	23	38.33
Vomiting	18	30.00
Frequency of urination	15	25.00
Poor feeding/Decreased appetite	14	23.33
Diarrhoea	12	20.00
Urgency of urination	10	16.67
Irritability	9	15.00
Incontinence	6	10.00
Hematuria	5	8.33
Malodorous urine	2	3.33
Constipation	4	6.67

Table 3. *Bacterial Species Isolated from Urine Samples of UTI Patients (n=60)*

Bacterial isolates	Frequency (n)	Percentage (%)
E coli	40	66.67
Enterococcus	7	11.67
Klebsiella	5	8.33
Pseudomonas	4	6.67
Acinetobacter	3	5.00
Proteus	1	1.67
Total	60	100.00

Table 4. *Antibiotic sensitivity pattern of isolates*

Antibiotics	E coli (n=40)		Enterococcus (n=7)		Klebsiella (n=5)		Acinetobacter (n=3)		Pseudomonas (n=4)		Proteus (n=1)	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Amikacin	12	30.00	1	14.29	1	20	2	66.67	2	50	0	0
Amoxycillin	1	2.50	4	57.14	0	0	0	0.00	0	0	0	0
Azythromycin	9	22.50	2	28.57	2	40	3	100.00	2	50	1	100
Aztreonem	2	5.00	1	14.29	0	0	0	0.00	0	0	0	0
Ciprofloxacin	20	50.00	3	42.86	4	80	2	66.67	2	50	1	100
Ceftriaxone	7	17.50	3	42.86	3	60	2	66.67	0	0	1	100
Cotrimoxazole	1	2.50	0	0.00	0	0	0	0.00	0	0	0	0
Cefixime	4	10.00	1	14.29	3	60	2	66.67	0	0	0	0
Cefuroxime	1	2.50	0	0.00	5	100	2	66.67	0	0	0	0
Cefepime	2	5.00	1	14.29	0	0	0	0.00	0	0	0	0
Ceftazidime	7	17.50	0	0.00	3	60	2	66.67	2	50	0	0
Collistin	3	7.50	2	28.57	1	20	0	0.00	0	0	0	0
Gentamicin	9	22.50	3	42.86	1	20	0	0.00	2	50	0	0
Levofloxacin	16	40.00	2	28.57	3	60	3	100.00	0	0	0	0
Meropenem	6	15.00	4	57.14	1	20	0	0.00	2	50	0	0
Netilmicin	7	17.50	1	14.29	1	20	2	66.67	2	50	0	0
Nalidixic acid	8	20.00	0	0.00	4	80	0	0.00	0	0	0	0
Nitrofurantoin	19	47.50	1	14.29	2	40	2	66.67	0	0	0	0
Piperecillin	3	7.50	2	28.57	0	0	2	66.67	0	0	0	0
Vancomycin	0	0.00	5	71.43	0	0	0	0.00	0	0	0	0

Table 5. *Antibiotic Resistance Patterns of Commonly Used Antibiotics Against E. coli*

Antibiotics	Frequency (n)	Percentage (%)
Amoxycillin	39	97.5
Azythromycin	31	77.5
Cotrimoxazole	39	97.5
Cefixime	36	90
Cefuroxime	39	97.5

Ceftazidime	33	82.5
Ceftriaxone	33	82.5
Gentamicin	31	77.5
Amikacin	28	70
Nitrofurantoin	21	52.5
Levofloxacin	24	60
Ciprofloxacin	20	50

4. DISCUSSION

Urinary tract infections (UTIs) are a common condition in children with diverse clinical and bacteriological profiles. This study provides insights into the age and sex distribution, clinical manifestations, bacterial etiology, and antibiotic sensitivity patterns of UTIs in a pediatric population. The majority of UTI cases were observed in children aged 2-12 months (51.58%), followed by those aged 1-5 years (32.63%). This finding is consistent with previous studies that highlight the high incidence of UTIs in younger children due to anatomical and physiological factors [5]. Malla et al., Singh et al., and Benachinmardi et al. have similarly observed that the highest proportion of patients, ranging from 35% to 50%, falls within this age group [18-21]. Females were more frequently affected compared to males, aligning with known patterns where females have a higher incidence of UTIs due to anatomical predispositions (Muller et al., 2021). The higher prevalence of this disease in female children is likely due to the shorter length of the female urethra, among other factors [10]. However, this finding contrasts with studies by Rekha et al. and GK Rai et al., which reported a higher prevalence of urinary tract infections in male children (53.3%) [22-23]. The clinical presentation of UTIs in this cohort was dominated by fever (70%), which is a common symptom and often the primary reason for seeking medical attention in young children [18,19,24-26]. Abdominal pain (46.84%) and dysuria (38.42%) were also prevalent, reflecting symptoms commonly associated with UTIs in pediatric patients [19,25]. Other symptoms, such as vomiting (30%) and poor feeding (23.16%), further illustrate the systemic impact of UTIs on young children's health [9]. The bacteriological analysis revealed *Escherichia coli* as the most common pathogen (66.32%), followed by *Enterococcus* (11.58%) and *Klebsiella* (8.42%). This finding corroborates previous studies that consistently identify *E. coli* as the predominant pathogen in pediatric UTIs, accounting for 60-80% of cases [9,10]. The isolation of other pathogens like *Klebsiella* and *Pseudomonas* is note worthy, as these organisms are often associated with complicated UTIs and may indicate underlying anatomical abnormalities. This finding closely aligns with the earlier research conducted by Ladhini and Grandsen [27]. However, the distribution of isolated organisms shows significant variation across different international studies. In a study conducted in Iran, the most prevalent microorganism was *E. coli* (54.80%), followed by *Klebsiella* (16.0%). Other notable pathogens included coagulase-negative *Staphylococci* (11.2%), *Enterobacter sp*. (9.6%), and *Proteus* (1.4%), with *Pseudomonas* also at 1.4% [28]. Antibiotic sensitivity patterns (Table 4) reveal a high sensitivity of E. coli to ciprofloxacin (50%), levofloxacin (39.68%), and nitrofurantoin (47.62%). However, Singh et al. and Ibeneme et al. have observed greater sensitivity of E. coli to ceftriaxone in their respective regions, with rates of 80% and 85.7%, respectively [19,29]. Similarly, Edlin et al. reported higher sensitivity of E. coli to cotrimoxazole (76%) and ciprofloxacin (90%) in the United States [30]. Enterococcus spp. Demonstrates high susceptibility to Vancomycin (71.73%) and moderate susceptibility to Meropenem (59.09%). Rekha et al. and Benachinmardi et al. have observed comparable sensitivity patterns of Enterococcus spp. in their respective regions [21,22]. Afsharpaiman et al. reported that imipenem was the most effective antimicrobial agent against *Enterococcus*[31].

However, various studies have identified cephalosporins and ciprofloxacin as the least effective agents against *Enterococcus*, which is contrary to our findings [32,33]. Klebsiella spp. Displays significant susceptibility to Cefuroxime (100%) and Ciprofloxacin (81.25%) in our study. In a study conducted at S.S.G. Hospital in India, Klebsiella was identified as the second most prevalent organism and demonstrated the highest sensitivity to Ofloxacin, Amikacin, and the combination of Piperacillin and Tazobactam [34]. The susceptibility of Acinetobacter to Azithromycin (100%) and Ciprofloxacin (70%) is noteworthy.

In our study, Acinetobacter spp. Exhibited sensitivity to Azithromycin, levofloxacin, and nitrofurantoin. However, the number of this isolate could be higher in our study (only 10). In contrast, the research conducted by Badhon R et al. reported that Acinetobacter spp. was sensitive to Sparfloxacin, Norfloxacin, and Cefpirome, revealing a divergence from our findings [35]. Pseudomonas shows good susceptibility to Azithromycin (53.85%). A study by Sodani et al. found that Amikacin showed the highest sensitivity (65%) against P. aeruginosa isolates, followed by piperacillin/ tazobactam (52.5%), gentamicin (47.5%), and colistin (45%) [36]. Another study by Nag et al. found that Pseudomonas was sensitive to Amikacin and nitrofurantoin but resistant to ampicillin, nalidixic acid, and cefotaxime [10].Only three isolates of Proteus were tested, showing 100% susceptibility to Azithromycin and Levofloxacin. Rajagopal G. et al. reported in their study that Proteus species demonstrated a 60% sensitivity to Amikacin and a 75% sensitivity to Nitrofurantoin [1]. This finding contrasts with the results of our study. The resistance patterns observed in our study reveal a concerning trend in the efficacy of commonly used antibiotics. E. coli isolates exhibited extremely high resistance rates to several antibiotics. Specifically, amoxicillin, cotrimoxazole, cefixime, cefuroxime, and other beta-lactams showed resistance rates exceeding 97%. Resistance to ceftriaxone and ceftazidime, with rates of 82.54% and 82.54%, respectively, highlights the prevalence of extended-spectrum beta-lactamase (ESBL)-producing E. coli. Interestingly, resistance to gentamicin and Amikacin was also notable, with rates of 77.78% and 69.84%, respectively. These amino glycosides are often used as a part of combination therapy for severe UTIs, but their decreased susceptibility poses a challenge. Nitrofurantoin, typically considered effective against uncomplicated UTI pathogens, showed a resistance rate of 52.38% [37]. In a study conducted by Nag et al., E. coli was resistant to nalidixic acid in 60.9 % [10]. This may indicate the emerging resistance of organisms to common antibiotics. However, a greater degree of resistance was observed against ampicillin, cotrimoxazole, and nalidixic acid. Similar patterns of antibiotic resistance have been reported in other studies [10,34,35]. Nevertheless, our study found that cephalosporins exhibited higher resistance rates to E. coli and other pathogens. This highlights significant concerns for patient care, as many traditional antibiotics, though cost-effective and readily available, are becoming ineffective.

5. Limitation of the Study

This study provides important information about the clinical and bacteriological profile of UTI in children, but it has several limitations. One limitation is the identification of bacterial isolates. While E. coli was the predominant pathogen, other rarer bacteria may have been underrepresented due to the relatively small sample size. The study only analyzed antibiotic resistance patterns at one point in time, and it did not evaluate the development of resistance over time, which is an important aspect in understanding the dynamics of resistance.

6. Conclusion & Recommendation

This study highlights the clinical and bacteriological profile of urinary tract infections (UTIs) in children at a tertiary care hospital. UTIs were most prevalent in children aged 2-12 months, with a higher incidence in females. Escherichia coli was the predominant pathogen, followed by Enterococcus and Klebsiella species. Alarmingly high antibiotic resistance was observed, especially against commonly used antibiotics like amoxicillin and cefixime. Nitrofurantoin and amikacin showed comparatively lower resistance rates. These findings underscore the urgent need for judicious antibiotic use and the development of updated guidelines for the effective management of pediatric UTIs to mitigate the rising threat of antibiotic resistance.

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