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CLINICAL PROFILE AND MANAGEMENT OF RECURRENT URINARY TRACT INFECTIONS IN PEDIATRIC PATIENTS: A TERTIARY CARE HOSPITAL EXPERIENCE IN NORTH INDIA

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ABSTRACT

Background: Recurrent urinary tract infections (rUTIs) are a significant health concern among pediatric populations, characterized by frequent relapses and potential complications. Understanding the clinical spectrum, risk factors, and management outcomes of rUTIs is crucial for optimizing treatment strategies and improving patient outcomes.

Material and Methods: This retrospective cohort study evaluated rUTIs in children at a North Indian tertiary care hospital from July 2021 to June 2022. Children aged 0-18 years with confirmed rUTIs were included based on defined criteria. Data spanning January 2016 to December 2020 were collected from electronic medical records, encompassing demographics, clinical presentations, laboratory and imaging findings, and treatment details. Statistical analysis used descriptive statistics, with significance set at $p < 0.05$ using SPSS v.25.

Results: The study encompassed 242 children with recurrent urinary tract infections (rUTIs), aged 5.8 years on average (±3.2), comprising 98 (40.5%) males and 144 (59.5%) females. Common symptoms included fever in 188 children (77.7%), dysuria in 152 (62.8%), and abdominal pain in 114 (47.1%). Laboratory findings showed high rates of positive urinalysis (87.6%) and Escherichia coli as the predominant pathogen (71.9%). Recurrence of UTIs occurred in 98 children (40.5%), with complications in 34 cases (14.0%), including pyelonephritis (5.0%) and renal scarring (8.7%). Impaired renal function was noted in 15 cases (6.2%), and surgical interventions were performed in 12 cases (5.0%).

Conclusion: This study underscores the multifactorial etiology of rUTIs in children, influenced by demographic, microbial, and socioeconomic factors. The high prevalence of antimicrobial resistance highlights the importance of judicious antibiotic use and antimicrobial stewardship in clinical practice. Targeted interventions focusing on vulnerable populations and comprehensive management strategies are essential to mitigate the burden of rUTIs and improve long-term outcomes in pediatric patients.

Keywords: Recurrent urinary tract infections, Pediatric, Escherichia coli, Antimicrobial resistance, Socioeconomic factors.

INTRODUCTION

Urinary tract infections (UTIs) represent one of the most common bacterial infections in pediatric populations, with a significant prevalence among children worldwide.[1] It is estimated that approximately 8% of girls and 2% of boys will experience at least one UTI by the age of seven.[1] Recurrent urinary tract infections (rUTIs) in children, defined as two or more episodes within six months or three or more episodes within a year, are particularly concerning due to their potential to cause lasting kidney damage and other serious complications.[2]

The incidence of UTIs varies by age and sex, with the highest rates observed in the first year of life, particularly among uncircumcised male infants and female infants.[3] As children grow older, the incidence remains higher in females due to anatomical and physiological differences. Among those who experience a first UTI, 30% to 50% of females and 10% to 30% of males will develop a recurrent infection within the subsequent year.[3]

The etiology of rUTIs in children is multifactorial, encompassing a range of anatomical, functional, and genetic factors. Anatomical abnormalities such as vesicoureteral reflux (VUR), which affects about 1% of all children and up to 30% to 50% of those with a UTI, ureteropelvic junction obstruction, and dysfunctional voiding patterns are well-documented contributors.[4] Additionally, behavioral factors, including toilet training practices and hygiene habits, play a significant role. The pathogenic landscape is predominantly characterized by uropathogenic Escherichia coli (UPEC), which is responsible for 70% to 90% of pediatric UTIs, although a diverse array of other bacterial species can also be implicated.[5] The interplay between host factors and microbial virulence mechanisms complicates the clinical management of rUTIs, necessitating a comprehensive understanding of these dynamics to inform effective treatment and prevention strategies.[5]

The clinical spectrum of rUTIs is broad, ranging from asymptomatic bacteriuria to severe pyelonephritis with systemic involvement.[6] The recurrent nature of these infections often necessitates repeated courses of antibiotics, contributing to concerns about antimicrobial resistance and the disruption of normal microbiota. Moreover, rUTIs can lead to long-term renal damage, including scarring and reduced renal function, with renal scarring occurring in 15% to 20% of children after a first UTI and potentially increasing with recurrent episodes, particularly in the context of delayed or inadequate treatment.[7]

Despite the high burden and potential complications of rUTIs in children, there remains a need for further research to elucidate the precise mechanisms underlying recurrence and to optimize management protocols.[7] Current clinical guidelines emphasize the importance of accurate diagnosis, individualized treatment plans, and regular monitoring to prevent recurrence and mitigate complications. However, variations in clinical practice and the evolving landscape of antimicrobial resistance underscore the necessity for ongoing research and updated clinical recommendations.[8]

This study aimed to provide a comprehensive overview of the clinical spectrum of rUTIs in children, highlighting the latest evidence on epidemiology, pathophysiology, diagnostic approaches, and management strategies. By examining current trends and identifying gaps in the existing literature, we hope to contribute to the development of more effective, evidence-based interventions to improve outcomes for pediatric patients suffering from rUTIs.

MATERIAL AND METHODS

Study Design

This study was a retrospective cohort analysis conducted to evaluate the clinical spectrum of recurrent urinary tract infections (rUTIs) in children. The study was carried out in the department of Paediatrics at tertiary care hospital, North India, over a period of one years from July 2021 to June 2022. The study protocol was approved by the Institutional Review Board (IRB), and informed consent was obtained from the parents or guardians of all participants.

Study Population

Children aged 0 to 18 years who were diagnosed with rUTIs, defined as two or more episodes within six months or three or more episodes within a year, were included in the study. The diagnosis of UTI was confirmed by a positive urine culture, defined as $\geq 10^5$ colony-forming units (CFU)/mL of a uropathogen from a clean-catch midstream urine sample or $\geq 10^4$ CFU/mL from a catheterized specimen. Children with immunodeficiency disorders; Patients with incomplete medical records; Children who did not follow up for at least six months after the initial diagnosis of rUTI, Children with congenital anomalies of the kidney and urinary tract (CAKUT) that required surgical intervention; and Children on long-term antibiotic prophylaxis for reasons other than UTIs were excluded from the study.

Data Collection

Data of last five years (January 2016 to December 2020) were collected from the electronic medical records (EMR) system of tertiary care center, which included demographic data (age, gender, and socioeconomic status); clinical data (presenting symptoms, frequency and duration of UTI episodes, and associated comorbidities); laboratory data (urine culture results, antibiotic sensitivity profiles, and serum creatinine levels); imaging studies (results of renal ultrasound, voiding cystourethrogram (VCUG), and dimercaptosuccinic acid (DMSA) scan); and treatment data (details of antibiotic therapy, prophylactic antibiotics, and surgical interventions if any).

Statistical Analysis

Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. Continuous variables were expressed as means and standard deviations, while categorical variables were presented as frequencies and percentages. A p-value of <0.05 was considered statistically significant. All statistical analyses were performed using SPSS v.25.0, IBM Corp., Armonk, NY, USA.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki.

RESULTS

The study population consisted of 242 children with recurrent urinary tract infections (rUTIs), with a mean age of 5.8 years (±3.2). The cohort comprised 98 (40.5%) males and 144 (59.5%) females. Socioeconomic status varied, with 92 (38.0%) children classified as low income, 124 (51.2%) as middle income, and 26 (10.7%) as high income. Urban residency was predominant, with 147 (60.7%) children residing in urban areas compared to 95 (39.3%) in rural areas. Access to healthcare was regular for the majority, with 179 (74.0%) having consistent access, while 63 (26.0%) reported irregular access to healthcare services. [Table 1]

The predominant symptoms observed in the rUTI study group (N=242) included fever in 188 children (77.7%), dysuria in 152 children (62.8%), and abdominal pain in 114 children (47.1%). Other common symptoms reported were frequency of urination in 98 children (40.5%), urgency in 86 children (35.5%), and flank pain in 56 children (23.1%). Less frequently reported symptoms included vomiting in 42 children (17.4%), hematuria in 36 children (14.9%), and foul-smelling urine in 22 children (9.1%). [Table 2]

In the rUTI study cohort of 242 children, diagnostic findings revealed high prevalence rates of positive urinalysis (87.6%), including leukocyte esterase (81.8%) and nitrites (72.7%). Pyuria (WBC > 10/HPF) was present in 80.2% of cases, with hematuria noted in 27.7% and proteinuria in 24.0%. Escherichia coli was the predominant pathogen identified (71.9%), followed by Klebsiella (12.8%), Proteus (7.9%), and other pathogens (7.4%). Antimicrobial resistance was detected in 42.1% of cases, notably against Trimethoprim-Sulfamethoxazole (25.6%), Amoxicillin (21.9%), Ciprofloxacin (19.4%), and Nitrofurantoin (15.7%). Abnormal blood tests were observed in 23.1% of children, with elevated CRP in 17.8% and elevated WBC in 15.7%. Bacteremia was present in 9.1% of cases. [Table 3]

Imaging studies revealed significant abnormalities, with 68 children (28.1%) showing abnormal findings on ultrasonography, including hydronephrosis in 29 cases (12.0%), renal scarring in 21 cases (8.7%), kidney stones in 12 cases (5.0%), and bladder abnormalities in 6 cases (2.5%). Voiding cystourethrogram (VCUG) abnormalities were detected in 41 children (16.9%), with vesicoureteral reflux (VUR) noted in 36 cases (14.9%) and urethral abnormalities in 5 cases (2.1%). Abnormal renal scintigraphy findings were observed in 24 children (9.9%), including decreased renal function in 16 cases (6.6%) and cortical defects in 8 cases (3.3%). [Table 4]

All participants received initial antibiotic therapy, with Amoxicillin prescribed to 73 children (30.2%), Trimethoprim-Sulfamethoxazole to 54 children (22.3%), Ciprofloxacin to 32 children (13.2%), and Nitrofurantoin to 21 children (8.7%). Other antibiotics were administered to 62 children (25.6%). The mean duration of antibiotic treatment was 10.5 days (±3.2). Changes in antibiotic regimens were necessary in 45 cases (18.6%), primarily due to resistance in 29 cases (12.0%) and side effects in 16 cases (6.6%). Prophylactic antibiotics were used in 52 children (21.5%), most commonly Nitrofurantoin (8.7%) and Trimethoprim-Sulfamethoxazole (7.9%). Traditional medicine was utilized by 38 children (15.7%), including Ayurvedic treatments in 22 cases (9.1%), homeopathic remedies in 10 cases (4.1%), and other therapies in 6 cases (2.5%). Surgical interventions were performed in 12 cases (5.0%), including ureteral reimplantation in 5 cases (2.1%), endoscopic injections in 4 cases (1.7%), and nephrectomy in 3 cases (1.2%). [Table 5]

The recurrence of urinary tract infections (UTIs) was observed in 98 children (40.5%), with 72 children (29.6%) experiencing one recurrence, 21 children (8.6%) experiencing two recurrences, and 5 children (2.1%) experiencing three or more recurrences. Complications arising from UTIs were reported in 34 cases (14.0%), including pyelonephritis in 12 cases (5.0%), sepsis in 8 cases (3.3%), renal abscess in 6 cases (2.5%), hypertension in 4 cases (1.7%), and other complications in 4 cases (1.7%). Renal scarring was observed on follow-up in 21 children (8.7%), categorized as mild in 12 cases (5.0%), moderate in 7 cases (2.9%), and severe in 2 cases (0.8%). Impaired renal function was noted in 15 cases (6.2%), including decreased glomerular filtration rate (GFR) in 10 cases (4.1%) and chronic kidney disease in 5 cases (2.1%). [Table 6]

Table 1: Demographic and Socioeconomic Characteristics of Study Population

Variable	rUTI Group (N=242)
	n (%)/mean ± SD
Age (years)	5.8 ± 3.2
Sex	
Male	98 (40.5%)

Female	144 (59.5%)
Socioeconomic Status	
Low	92 (38.0%)
Middle	124 (51.2%)
High	26 (10.7%)
Residence	
Urban	147 (60.7%)
Rural	95 (39.3%)
Access to Healthcare	
Regular	179 (74.0%)
Irregular	63 (26.0%)

Table 2: Clinical Presentation of rUTIs among Study Population

Signs and Symptoms	rUTI Group (N=242)
	n (%)
Fever	188 (77.7%)
Dysuria	152 (62.8%)
Frequency	98 (40.5%)
Urgency	86 (35.5%)
Abdominal pain	114 (47.1%)
Flank pain	56 (23.1%)
Vomiting	42 (17.4%)
Hematuria	36 (14.9%)
Foul-smelling urine	22 (9.1%)

Table 3: Laboratory Findings of rUTIs among Study Population

Variable	rUTI Group (N=242)
	n (%)
Positive urinalysis	212 (87.6%)
Presence of leukocyte esterase	198 (81.8%)
Presence of nitrites	176 (72.7%)
Pyuria (WBC > 10/HPF)	194 (80.2%)
Hematuria	67 (27.7%)
Proteinuria	58 (24.0%)
Pathogen identified (E. coli)	174 (71.9%)
Pathogen identified (Klebsiella)	31 (12.8%)
Pathogen identified (Proteus)	19 (7.9%)
Pathogen identified (Others)	18 (7.4%)
Antimicrobial resistance	102 (42.1%)
Resistance to Trimethoprim-Sulfamethoxazole	62 (25.6%)
Resistance to Amoxicillin	53 (21.9%)
Resistance to Ciprofloxacin	47 (19.4%)
Resistance to Nitrofurantoin	38 (15.7%)
Blood tests abnormal	56 (23.1%)
Elevated C-reactive protein (CRP)	43 (17.8%)
Elevated white blood cell count (WBC)	38 (15.7%)
Presence of bacteremia	22 (9.1%)

Table 4: Imaging Studies Results of rUTIs among Study Population

Imaging Modality	rUTI Group (N=242)
	n (%)
Ultrasonography abnormal	68 (28.1%)
Hydronephrosis	29 (12.0%)
Renal scarring	21 (8.7%)
Kidney stones	12 (5.0%)
Bladder abnormalities	6 (2.5%)
Voiding cystourethrogram (VCUG) abnormal	41 (16.9%)
Vesicoureteral reflux (VUR)	36 (14.9%)
Urethral abnormalities	5 (2.1%)
Renal scintigraphy abnormal	24 (9.9%)
Decreased renal function	16 (6.6%)
Cortical defects	8 (3.3%)

Table 5: Treatment Details of rUTIs among Study Population

Variable	rUTI Group (N=242)
	n (%)
Initial antibiotic therapy	242 (100%)
Amoxicillin	73 (30.2%)
Trimethoprim-Sulfamethoxazole	54 (22.3%)
Ciprofloxacin	32 (13.2%)
Nitrofurantoin	21 (8.7%)

Other antibiotics	62 (25.6%)
Duration of treatment (days), mean ± SD	10.5 ± 3.2
Change in antibiotic regimen	45 (18.6%)
Due to resistance	29 (12.0%)
Due to side effects	16 (6.6%)
Use of prophylactic antibiotics	52 (21.5%)
Type of prophylactic antibiotic	
Nitrofurantoin	21 (8.7%)
Trimethoprim-Sulfamethoxazole	19 (7.9%)
Other	12 (5.0%)
Use of traditional medicine	**38 (15.7%)**
Ayurvedic	22 (9.1%)
Homeopathic	10 (4.1%)
Other	6 (2.5%)
Surgical intervention	12 (5.0%)
Ureteral reimplantation	5 (2.1%)
Endoscopic injection	4 (1.7%)
Nephrectomy	3 (1.2%)

Table 6: Follow-Up and Outcomes of rUTIs among Study Population

Variable	rUTI Group (N=242)
	n (%)
Recurrence of UTIs	98 (40.5%)
Number of recurrences	
1	72 (29.6%)
2	21 (8.6%)
≥ 3	5 (2.1%)
Complications	34 (14.0%)
Pyelonephritis	12 (5.0%)
Sepsis	8 (3.3%)
Renal abscess	6 (2.5%)
Hypertension	4 (1.7%)
Others	4 (1.7%)
Renal scarring on follow-up	21 (8.7%)
Mild scarring	12 (5.0%)
Moderate scarring	7 (2.9%)
Severe scarring	2 (0.8%)
Impaired renal function	15 (6.2%)
Decreased GFR	10 (4.1%)
Chronic kidney disease	5 (2.1%)

DISCUSSION

Urinary tract infections (UTIs) are a common pediatric health concern, often complicated by recurrence and associated morbidities. This study investigates the clinical spectrum, risk factors, and management outcomes of recurrent UTIs (rUTIs) in a cohort of 242 children, shedding light on significant aspects that influence disease progression and management strategies.

Prevalence and Clinical Presentation

In our cohort, the prevalence of rUTIs was substantial, affecting 40.5% of children, consistent with previous reports highlighting the persistent nature of this condition despite treatment efforts.[9] Clinical symptoms such as fever, dysuria, and abdominal pain were predominant, aligning with established patterns observed in pediatric UTIs.[10] Additionally, less common symptoms including flank pain and hematuria underscore the diverse clinical presentation encountered in pediatric practice.

Microbial and Antibiotic Resistance Patterns

Escherichia coli predominated as the causative pathogen in our study (71.9%), consistent with global trends in pediatric UTIs.[11] Alarmingly, antimicrobial resistance was prevalent, affecting 42.1% of isolates and commonly observed against Trimethoprim-Sulfamethoxazole and Amoxicillin. These findings underscore the critical need for antimicrobial stewardship and surveillance strategies to combat resistance and optimize treatment outcomes.[12] Comparative studies by Hameed et al., and Shkalim Zemer et al., have similarly reported high resistance rates and underscored the escalating challenge of antibiotic resistance in pediatric UTIs.[13,14]

Clinical Outcomes and Complications

Complications associated with rUTIs were observed in 14.0% of our study population, including pyelonephritis, sepsis, and renal scarring. These findings highlight the potential for severe morbidity and long-term renal sequelae in affected children, necessitating vigilant management and follow-up.[15,16] Our results align with those of Loukogeorgakis et al., and Lee et al., who reported similar rates of complications and emphasized the importance of timely diagnosis and management to mitigate adverse outcomes.[17,18]

Management Strategies and Interventions

In our cohort, treatment strategies encompassed a range of approaches, from initial antibiotic therapy to

prophylactic antibiotics and surgical interventions in select cases. The need for changing antibiotic regimens due to resistance (18.6%) underscores the evolving challenges in clinical management and the imperative of individualized treatment plans guided by antimicrobial susceptibility testing.[19,20]

Limitations and Future Directions

Limitations of our study include its retrospective nature and single-center design, which may limit generalizability to broader populations. Prospective multicenter studies are warranted to validate our findings and explore regional variations in UTI epidemiology and resistance patterns. Longitudinal studies are also needed to assess the impact of recurrent infections on renal function and quality of life in pediatric patients.

CONCLUSION

In conclusion, this study provides comprehensive insights into the clinical spectrum, risk factors, and management outcomes of recurrent urinary tract infections in children. Our findings underscore the multifactorial nature of rUTIs, influenced by demographic, microbial, and socioeconomic factors. Comparative analysis with peer-reviewed literature corroborates our findings, highlighting consistent trends in UTI epidemiology and emphasizing the imperative of tailored management strategies to optimize outcomes and mitigate complications in pediatric patients.

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