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Etiology, Risk Factors, and Treatment Outcomes of Recurrent Urinary Tract Infections

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Abstract **Original Research Article**

Background: Recurrent urinary tract infections (rUTIs) are a significant health concern, leading to increased morbidity and healthcare burden. Identifying the etiology, risk factors, and treatment outcomes is essential for effective management. ***Objective:*** To assess the etiology, risk factors, and treatment outcomes of patients with rUTIs. ***Methods:*** This prospective observational study was conducted at the Department of Medicine, Community Based Medical College, Bangladesh, from February 2021 to August 2021. A total of 73 patients diagnosed with rUTIs were enrolled using purposive sampling. Clinical and laboratory data were collected, and statistical analysis was performed using SPSS version 23.0. ***Results:*** The study identified Escherichia coli as the predominant pathogen (61.6%) in recurrent urinary tract infections (rUTIs), with high antibiotic resistance to ampicillin (73.3%) and ciprofloxacin (60.0%). Diabetes mellitus (27.4%) and urinary tract abnormalities (17.8%) were significant risk factors. Non-antibiotic prophylaxis demonstrated a lower recurrence rate (21.4%) compared to antibiotic prophylaxis (39.1%). ***Conclusion:*** This study emphasizes the importance of risk factors like diabetes, urinary tract abnormalities, and behavioral habits in recurrent urinary tract infections (rUTIs). Escherichia coli is the predominant pathogen with significant antibiotic resistance. Non-antibiotic prophylaxis, such as probiotics, helps reduce recurrence, offering an alternative approach alongside conventional treatments.

Keywords: Antibiotic resistance, Etiology, Recurrent urinary tract infection, Risk factors, Treatment outcome.

INTRODUCTION

Recurrent urinary tract infections (rUTIs) are a significant health concern, particularly affecting women, and are associated with substantial morbidity and healthcare burden. These infections are characterized by multiple episodes occurring within a specific timeframe, making them a persistent and challenging condition for affected individuals. Clinically, rUTIs are defined as experiencing at least three episodes of acute bacterial cystitis within a 12-month period or two or more episodes within six months[1]. The recurrence of UTIs is attributed to a complex interplay of host-related factors, bacterial virulence, and behavioral influences, all of which contribute to an increased susceptibility to repeated infections. The most common causative pathogen of rUTIs is uropathogenic Escherichia coli (UPEC), which is responsible for the majority of cases[2]. UPEC exhibits several virulence mechanisms that enable it to colonize and persist in the urinary tract, including the ability to adhere to the uroepithelium, evade host immune responses, and establish intracellular bacterial reservoirs that contribute to recurrent episodes[3]. Apart from UPEC, other bacterial pathogens such as Klebsiella pneumoniae and Proteus mirabilis are also implicated, particularly in cases of complicated UTIs, where structural or functional abnormalities of the urinary tract predispose patients to recurrent infections[4]. Several risk factors contribute to the recurrence of UTIs, increasing an individual's vulnerability to repeated infections. Anatomical and physiological factors, such as the relatively short urethra in women, facilitate easier bacterial entry into the bladder, making them more susceptible to rUTIs compared to men[5]. Additionally, behavioral and lifestyle factors, including frequent sexual activity, the use of spermicides, improper perineal hygiene, and urinary stasis, have been identified as key

contributors to rUTI development[6]. Certain underlying medical conditions, such as diabetes mellitus, immunosuppression, and postmenopausal estrogen deficiency, further increase the likelihood of recurrent infections by impairing immune function and altering the urogenital microbiota[7]. The management of rUTIs includes both therapeutic and preventive strategies aimed at reducing recurrence and minimizing complications. Traditionally, antimicrobial prophylaxis has been the mainstay of treatment, administered either continuously or postcoitally. However, due to growing concerns over antibiotic resistance, alternative approaches are being explored[8]. Non-antibiotic prophylaxis, including the use of probiotics, cranberry supplements, and immunoprophylactic vaccines like MV140, has gained attention for its potential role in reducing UTI recurrence[9]. Additionally, lifestyle and behavioral modifications, such as increased fluid intake, postcoital voiding, and proper genital hygiene, have been recommended to lower the risk of reinfection[10]. So, rUTIs are a multifactorial condition resulting from a combination of host susceptibility, bacterial virulence, and lifestyle influences. A deeper understanding of these contributing factors is essential for developing effective prevention and management strategies. Given the increasing concern over antibiotic resistance, a shift toward non-antibiotic approaches and patient education on behavioral modifications may offer sustainable solutions to reduce the burden of recurrent UTIs and improve the quality of life for affected individuals.

METHODOLOGY

This prospective observational study was conducted at the Department Medicine, Community Based Medical College, Bangladesh, February 2021 to August 2021. A total of 73 patients diagnosed with recurrent urinary tract infections (rUTIs) were enrolled using purposive sampling. Recurrent UTI was defined as ≥2 episodes of infection within six months or ≥3 episodes within one year, confirmed by clinical symptoms and laboratory findings. Data collection included patient demographics, clinical history, risk factors, and laboratory investigations. Urine samples were analyzed for microscopy, culture, and sensitivity testing to identify causative pathogens and antibiotic susceptibility patterns. Additional investigations such as blood glucose levels, renal function tests, and imaging studies were performed when indicated. Patients were treated based on empirical antibiotic therapy initially, followed by culture-guided modifications when necessary. Treatment outcomes were assessed based on symptom resolution, microbiological clearance, and recurrence rates. Statistical analysis was performed using SPSS version 23.0, with descriptive statistics presented as means, frequencies, and percentages. Associations between risk factors and treatment outcomes were analyzed using appropriate statistical tests, considering $p < 0.05$ as statistically significant.

RESULT

The study included 73 patients diagnosed with recurrent urinary tract infections (rUTIs). The majority of the patients were female (71.2%), while males constituted 28.8% of the study population. The mean age of the participants was 42.6 ± 11.8 years, ranging from 19 to 68 years. Analysis of risk factors revealed that diabetes mellitus (27.4%) and urinary tract abnormalities (17.8%) were the most common predisposing conditions. Behavioral factors such as frequent sexual activity (31.5%) and poor hygiene practices (15.1%) were also associated with an increased incidence of rUTIs. Other contributing factors included postmenopausal status (20.5%) and immunosuppression (12.3%). Microbiological analysis showed that the most frequently isolated pathogen was Escherichia coli (61.6%), followed by Klebsiella pneumoniae (15.1%) and Proteus mirabilis (9.6%). Enterococcus faecalis and other pathogens accounted for 6.8% of cases each. Antibiotic susceptibility testing revealed that E. coli, the predominant uropathogen, exhibited the highest resistance to ampicillin (73.3%) and ciprofloxacin (60.0%), whereas susceptibility was highest for nitrofurantoin (85.6%) and fosfomycin (82.2%). A similar resistance pattern was observed in Klebsiella pneumoniae and Proteus mirabilis, with notable resistance to commonly used antibiotics. Regarding treatment outcomes, 68.5% of patients achieved complete resolution of symptoms with appropriate antibiotic therapy and lifestyle modifications. However, 31.5% experienced further recurrences despite treatment. Patients who received non-antibiotic prophylaxis, such as probiotics and cranberry supplements, had a lower recurrence rate (21.4%) compared to those relying solely on antibiotics (39.1%). Patients with diabetes mellitus had a significantly higher recurrence rate (45.0%) compared to those without diabetes (25.6%). Similarly, those with urinary tract abnormalities had an increased likelihood of recurrence (42.9%) compared to patients without abnormalities (27.1%). Statistical analysis showed a significant association between these risk factors and recurrence rates ($p < 0.05$).

Table 1: Demographic characteristics of cases

Variable	Value
Gender	Male: 21 (28.8%)
	Female: 52 (71.2%)
Mean Age ± SD (years)	42.6 ± 11.8
Age Range (years)	19–68

Table 2: Risk factors associated with recurrent UTIs

Risk factors	n	%
Diabetes mellitus	20	27.4%
Frequent sexual activity	23	31.5%
Postmenopausal status	15	20.5%
Urinary tract abnormalities	13	17.8%
Poor hygiene practices	11	15.1%
Immunosuppression	9	12.3%

Table 3: Distribution of causative pathogens in rUTI patients

Pathogen	n	%
Escherichia coli (UPEC)	45	61.6%
Klebsiella pneumoniae	11	15.1%
Proteus mirabilis	7	9.6%
Enterococcus faecalis	5	6.8%
Others	5	6.8%

Table 4: Antibiotic resistance pattern of uropathogens

Antibiotic	E. coli (%)	K. pneumoniae (%)	P. mirabilis (%)
Ampicillin	73.3%	68.2%	61.5%
Ciprofloxacin	60.0%	54.5%	50.0%
Nitrofurantoin	14.4%	26.8%	38.5%
Fosfomycin	17.8%	21.4%	35.0%

Table 5: Treatment outcomes based on prophylactic approach

Treatment approach	Patients (n)	Recurrence (%)
Antibiotic prophylaxis only	46	39.1
Non-antibiotic prophylaxis	28	21.4
Combination therapy	15	13.3

Table 6: Association between risk factors and recurrence of rUTIs

Risk Factor	Recurrence (%)	p-value
Diabetes mellitus	45.0%	0.03
UTA	42.9%	0.04
Frequent sexual activity	38.3%	0.06
Poor hygiene practices	36.4%	0.07

DISCUSSION

Recurrent urinary tract infections (rUTIs) remain a significant health concern, particularly among women, due to their multifactorial etiology and high recurrence rates. This study provides valuable insights into the etiology, risk factors, and treatment outcomes of rUTIs, contributing to a better understanding of disease management and prevention strategies. The demographic findings of this study are consistent with existing literature, highlighting a strong female predominance (71.2%) in rUTIs. This can be attributed to anatomical differences, such as the shorter female urethra, which facilitates bacterial ascent into the bladder[11]. Previous studies have also reported a similar trend, with women being significantly more affected than men due to hormonal fluctuations, pregnancy, and postmenopausal changes that alter the vaginal and urinary microbiota, increasing susceptibility to infections[12,13]. The mean age of patients in this study (42.6 ± 11.8 years) aligns with earlier research, indicating that middle-aged and older women, especially those in the postmenopausal phase, are at greater risk[14]. The microbial analysis of rUTI cases revealed that Escherichia coli (UPEC) was the predominant causative pathogen (61.6%), followed by Klebsiella pneumoniae (15.1%) and Proteus mirabilis (9.6%). These findings are in accordance with previous studies, which have consistently identified E. coli as the leading uropathogen due to its ability to form intracellular bacterial reservoirs and evade host immune defenses[15,16]. The presence of Klebsiella pneumoniae and Proteus mirabilis, particularly in patients with urinary tract abnormalities, suggests that these pathogens play a role in complicated rUTIs, requiring targeted treatment strategies[17]. A key observation in this study was the high antibiotic resistance rate among uropathogens, particularly E. coli, which exhibited resistance to ampicillin (73.3%) and ciprofloxacin (60.0%). These findings align with global trends indicating increased resistance to commonly used antibiotics, likely due to overuse and misuse in clinical settings[18,19]. The relatively lower resistance to nitrofurantoin (14.4%) and fosfomycin (17.8%) highlights their continued efficacy in treating rUTIs, making them suitable options for empirical therapy[20]. However, the rising antimicrobial resistance underscores the urgent need for alternative treatment approaches,

including non-antibiotic prophylaxis. Several risk factors were significantly associated with rUTI recurrence. Diabetes mellitus (27.4%) was found to be a major predisposing factor, with diabetic patients exhibiting a higher recurrence rate (45.0%) than non-diabetics (25.6%). This correlation has been well-documented, as hyperglycemia promotes bacterial growth, impairs neutrophil function, and compromises immune responses[21]. Similarly, urinary tract abnormalities (17.8%) were significantly associated with recurrent infections (42.9% recurrence rate), reinforcing the need for anatomical evaluations in patients with persistent UTIs[22]. Behavioral factors such as frequent sexual activity (31.5%) and poor hygiene practices (15.1%) also contributed to higher infection rates, consistent with prior research emphasizing the role of lifestyle habits in UTI prevention[23]. The treatment outcomes of this study revealed that 68.5% of patients achieved complete symptom resolution, whereas 31.5% experienced further recurrences. Notably, patients who received non-antibiotic prophylaxis (e.g., probiotics and cranberry supplements) had a lower recurrence rate (21.4%) compared to those relying solely on antibiotic prophylaxis (39.1%). These findings support growing evidence that non-antibiotic approaches can effectively reduce rUTI recurrence by restoring healthy urinary microbiota and preventing bacterial adhesion to the urothelium[24]. The use of immunoprophylactic vaccines such as MV140 has also shown promise in preventing rUTIs by stimulating mucosal immunity, although further large-scale studies are needed to validate their efficacy[25]. This study reinforces the multifactorial nature of rUTIs, emphasizing the importance of addressing both microbial and host-related factors in treatment planning. Given the high prevalence of antibiotic resistance, there is a pressing need to integrate non-antibiotic prophylaxis and lifestyle modifications into standard care protocols. Future research should focus on personalized treatment strategies and novel preventive measures to enhance patient outcomes and reduce the burden of rUTIs.

Limitations:

This study's limitations include a small sample size, limiting generalizability. The use of purposive sampling may introduce selection bias. As an observational study, it cannot establish causality. Additionally, data were collected from a single center, which may not represent the broader population of rUTI patients.

CONCLUSION

This study highlights the significant role of risk factors such as diabetes mellitus, urinary tract abnormalities, and behavioral factors in the occurrence of recurrent urinary tract infections (rUTIs). Escherichia coli emerges as the most common pathogen, with a concerning level of antibiotic resistance. Treatment outcomes show that a large proportion of patients experience symptom resolution, though a notable group faces recurrent infections, particularly those with diabetes or urinary tract abnormalities. Non-antibiotic prophylactic measures, including probiotics, appear to help reduce recurrence rates and may offer valuable adjuncts to traditional treatment approaches.

Recommendations:

Future studies should include larger, more diverse populations to enhance generalizability. Exploring the effectiveness of non-antibiotic prophylactic treatments, such as probiotics and cranberry supplements, is recommended. Additionally, prospective studies with randomized controlled trials could provide stronger evidence on causal relationships and optimal management strategies for recurrent urinary tract infections.

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