



Urinary Tract Infection: Clinical Signs, Bacterial Causes, And Associated Factors Among Urinary Tract Infection Patients Arriving At Urology Clinics In Major Hospitals In Sana'a City

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Abstract

Background and Aims: Urinary tract infection (UTIs) is one of the commonest infections encountered by clinicians and is the most neglected infection in studies due to its clinical symptoms, causative organisms, and associated risk factors. This investigation searches to determine clinical symptoms frequency, bacterial features, and risk factors of bacterial urinary tract infection in outpatients attending urology clinics in the major hospitals in Sana'a City.

Methods: In a cross-sectional study carried out over a 6-month period, 300 samples from patients suspected of having a UTI were investigated, of which 241 were culture-positive. Clinical and demographic data and factors affecting UTIs were collected in the standard questionnaire, and urine samples for culture were collected. The samples were cultured, examined for significant possible bacterial pathogens, isolated, and identified by standard laboratory techniques. The risk factors associated with UTI were also analyzed.

Results: The most common symptom was urine turbidity (85.1%), urinary urgency (78.0%), fever (64.7%), and dysuria (52.3%), while hematuria, kidney pain, and nausea/vomiting were less frequent. The most common isolates of UTI were *Escherichia coli* (42.7%) and *Klebsiella pneumoniae* (32.8%), followed by *Pseudomonas aeruginosa* (8.3%), while *Proteus mirabilis*, *Acinetobacter lowfii*, and *Citrobacter freundii* were rare. Also, *Enterococcus faecalis* (5.8%), *Staphylococci saprophyticus* (2.9%), *Staphylococci hemolyticus* (0.8%), and *Candida species* (7.9%) were isolated. There were significant risk factors for contracting UTI, including diabetic mellitus (23.2%, OR = 8.6, $p = 0.02$), UT catheters (7.9%, OR = 2.55, $p = 0.03$), UT stones (22.4%, OR = 2.5, $p = 0.03$), and pregnancy (17.64%, OR = 1.21, $p = 0.02$).

Conclusions: The results show the most common symptoms of UTI are urine turbidity, urinary urgency, fever and dysuria. The most common isolates of UTI were *Escherichia coli* and *Klebsiella pneumoniae*. There were significant risk factors for contracting an UTI, including diabetic mellitus, UT-catheters, UT-stones, and pregnancy.

Keywords: Urinary Tract Infection (Uti), Clinical Signs, Bacterial Causes, Associated Factors, Sana'a City, Yemen.

Introduction

An infection that affects a portion of the urinary tract is known as a urinary tract infection (UTI) [1]. Since it affects the upper urinary system, it is referred to as pyelonephritis, as opposed to the lower UTI, which is known as cystitis [2]. Lower urinary tract infections can cause pain during urination, frequent urination, and the sensation that you need to urinate even when your bladder is empty [2, 3]. Fever, flank pain, and infrequently, blood in the urine are signs of a kidney infection. The symptoms are nonspecific or nebulous in both young and old [1,4]. Urinary tract infections, or UTIs, are among the most prevalent infec-

tious disorders overall, with 10% of the population expected to experience one at some point in their life time [5, 6]. After upper respiratory tract infections, UTIs are known to be the most frequent infection of humen [7]. Young, healthy women can be diagnosed only on the basis of their symptoms [8]. It might be challenging to diagnose someone with nebulous symptoms since bacteria can exist without an infection [9]. Urine cultures can be helpful in complex cases or when treatment is unsuccessful [10].

If treatment is not received, an upper or lower UTI infection might have catastrophic effects and present with clinical symp-

toms or no symptoms at all [11]. While viruses and fungi are among the many microorganisms that can cause UTIs, bacteria account for the majority of UTI cases, accounting for over 95% of cases [12]. Since bacteria are a major contributor to urinary tract infections (UTIs), *Escherichia coli* is the most prevalent bacteria that causes UTIs, accounting for about 80% of cases. In order to reduce the length of the illness and stop infection from spreading to the upper urinary tract, which could result in renal failure, early detection and prompt diagnosis of UTIs are crucial [13, 14].

Inappropriate dosage and antibiotic selection result in treatment failure and an increase in antibiotic resistance; recurrent UTIs in particular can cause long-term harm like renal parenchymal scarring, reduced renal function, hypertension, and chronic kidney disease [15]. Furthermore, the use of antibiotics frequently or anomalies in the urinary tract are risk factors for the development of resistance. Despite regional variations, resistance to antibiotics used in empirical therapy is steadily rising globally, and in Yemen in particular [16–18, 19–31].

Female anatomy, sexual activity, diabetes, obesity, and family history are risk factors [32]. Sexual activity is a risk factor, however STIs (sexually transmitted infections) do not include UTIs [33]. Pyelonephritis is typically brought on by a bladder infection, although blood-borne bacterial infections can also cause it [34]. This study looks at the frequency of clinical symptoms, bacterial characteristics, and risk factors of bacterial UTIs among outpatients visiting urology clinics in Sana'a city's major hospitals.

Materials and Methods

Study Design and Area

A cross-sectional research spanning six months examined 300 samples from patients suspected of having a UTI; 241 of those samples tested positive for the infection. The standard questionnaire was used to gather clinical, demographic, and risk factor information for UTIs. Urine samples were also taken for culture. The samples underwent conventional laboratory procedures such as culture, examination for potential bacterial pathogens, isolation, and identification. Analysis was also done on the risk variables related to UTIs.

Data Collection

A pre-made questionnaire was used to gather clinical and demographic data. Physicians and assistants completed the data, which the research supervisor then examined.

Ethical Approval

The written consent in all cases was obtained. Approval was obtained from the participants prior to including in the study. Ethical approval was obtained from the Medical Research and Ethics Committee of the Faculty of Medicine and Health Sciences, Sana'a University with reference number (1752) on 01/12/2022.

Inclusion and Exclusion Criteria

The study included outpatient with suspected UTI, who had not received antimicrobials within the past 2 months, and obtained written consent.

Sample Collection

Cultivation and identification were performed at the Microbiology Department of the National Center of Public Laboratories (NCPHL), Sana'a City. Urine samples were collected from 300 outpatients with suspected UTI, who had not received antimicrobials within the past two months, and referred to the NCPHL for Urine Culture. There were 162 (54%) samples of female patients and 138 (46%) of male patients. The patient's age ranged from 5 years to 90 years (mean age 39.18 ± 19.24 years).

Isolation and Identification of Bacteria

Urine samples were examined and cultured within an hour of sampling. All samples were inoculated on blood agar plus MacConkey agar and incubated at 37°C for 24 h, and for 48 h in negative cases. The sample was considered positive for urinary tract infection if a single organism was cultured at a concentration of 105 CFU/ml, or when a single organism was cultured at a concentration of 104 CFU/ml and 5 leukocytes per high-power field were observed on urine microscopy. The bacteria were identified on the basis of standard culture and biochemical characteristics of the isolates. Gram-negative bacteria were identified by standard biochemical tests [12,13]. Gram-positive bacteria were identified by the corresponding laboratory tests: catalase, coagulase, CAMP test (for *Streptococcus agalactiae*), and Esculin agar (for enterococci) [35].

Statistical Analysis

Discrete variables were expressed as percentages and proportions were compared using the Chi-square test [36].

Results

Table 1 shows the age and gender distribution of patients clinically diagnosed with UTI in urology outpatient clinics in the main hospitals in Sana'a city. It included 300 patients with clinically diagnosed UTI, and the age of the patients ranged from 5 to 90 years with a mean \pm SD of 39.18 ± 19.24 years. The majority of patients were in the age group of 21–40 years (43.7%), followed by the age group of 41–60 years (24.7%) and then the age group of ≥ 61 years (16.7%). Also, 162 (54%) were female and 138 (46%) were male. Table 2 shows the distribution of significant growth and non-significant growth of pathogens in urinary tract infection samples. Significant growth of pathogens was found in 241 UTI patients (80.33%), and non-significant growth was found in 59 UTI samples (19.67%). Table 3 shows the distribution of age and sex among patients with urinary tract infection. Among the 241 patients with UTI, their ages ranged from 5 to 90 years with mean/SD (40.78 ± 19.9). The majority of patients were in the age group of 21–40 years (41.9%), followed by the age group of 41–60 years (24.5%), the age group of ≥ 61 years (19.5%), and the age group of ≥ 20 years (14.1%). One hundred and thirty (56.4%) were female and 105 (43.6%) were male. Table 4 shows the signs and symptoms most common among patients with urinary tract infections. The most common symptom was turbid urine, which was found in 205 patients with urinary tract infections (85.1%), followed by urinary urgency, which was found in 188 (78.0%), in addition to 156 patients (64.7%) suffering from fever, and 52.3% suffering from... dysuria. However, hematuria, kidney pain, and nausea/vomiting were less fre-

quent (29.5%, 25.5% and 14.5%, respectively). Table 5 shows the most common uropathogens isolated from urine samples of patients with urinary tract infections.

The most common Gram-negative isolates were *Escherichia coli* (42.7%), followed by *Klebsiella pneumoniae* (32.8%), *Pseudomonas aeruginosa* (8.3%), *Proteus mirabilis* (1.2%), *Acinetobacter lowfii* (0.4%), and *Citrobacter freundii* (0.4%). The Gram-positive isolates were *Enterococcus faecalis* (5.8%), *Staphylococci saprophyticus* (2.9%), and *Staphylococcus haemolyticus* (0.8%). Likewise, the *Candida* species represented 7.9% of the total. Table 6 shows the odd-ratio associated with urinary pathogens in the ability to cause urinary tract infection.

The most common risk factor was diabetes (23.2%) with an OR associated with contracting a UTI of 8.6 times, with a CI ranging from 2.4 to 36.46. This finding was highly significant with $\chi^2 = 11.97$ and $p(v) = 0.02$. The second high rate was the presence of catheters and stones at 7.9% and 22.4%, respectively, with an OR associated with contracting a UTI of 2.55 times, with a CI ranging from 1.04-6.25. This finding was highly significant with $\chi^2 = 4.43$ and $p(T) = 0.03$. There was a significant association between UTI and pregnancy in women with the pregnancy rate being 17.64% of the total patients with an OR equal to 1.21 times, with a CI ranging from 1.12-1.31. This result was highly significant with $\chi^2 = 5.39$ and $p(t) = 0.02$. In addition, there was no significant association with other risk factors.

Table 1: Age and Sex Distribution of Patients Clinically Diagnosed With Urinary Tract Infection in Urology Outpatient Clinics in the Main Hospitals In Sana'a City.

Age group / Years	Frequency	%
≤20	45	15.0
21-40	131	43.7
41-60	74	24.7
≥61	50	16.7
Total	300	100
Mean / SD	39.18 ± 19.24	
Median/ range	35(5-90)	
Mode	30	
Gender		
Females	162	54.0
Males	138	46.0
Total	300	100

Table 2: Distribution of Urology Patients According to Bacterial Growth Rate in Urine Samples

Growth rate	Frequency	%
Significant growth (≥ x10 ⁵ /ml)	241	80.33
Non-significant growth (< x10 ⁵ /ml)	59	19.67
Total	300	100

Table 3: The Age And Gender Distribution Among Patients with Urinary Tract Infections with Significant Positive Bacterial Growth

Age group in years	Frequency	%
≤20	34	14.1
21-40	101	41.9
41-60	59	24.5
≥61	47	19.5
Total	241	100
Mean / SD	40.78 ± 19.9	
Median/ range	38(5-90)	
Mode	30	
Gender		
Females	136	56.4
Males	105	43.6
Total	241	100

Table 4: The Most Common Signs And Symptoms Among Patients With Urinary Tract Infections With Significant Positive Bacterial Growth

Symptoms	Yes		No	
	No.	%	No.	%
Turbid urine	205	85.1	36	14.9
Urinary urgency	188	78.0	53	22.0
Fever	156	64.7	85	35.3
Dysuria	126	52.3	115	47.7
Hematuria	71	29.5	170	70.5
kidney pain	59	25.5	182	75.5
Nausea/ vomiting	35	14.5	206	85.5
Total	100/241			

Table 5: Bacterial Pathogens Isolated From Urine Samples of Patients with Urinary Tract Infections

Name of pathogens	Frequency	%
Escherichia coli	103	42.7
Klebsiella pneumoniae	79	32.8
Pseudomonas aeruginosa	20	8.3
Candida sp	19	7.9
Enterococcus faecalis	14	5.8
Staphylococci saprophyticus	7	2.9
Proteus mirabilis	3	1.2
Staphylococci hemolyticus	2	0.8
Acintobacter lowfii	1	0.4
Citrobacter freundii	1	0.4
Mono-growth of pathogens	233	96.7
Mixed-growth of pathogens	8	3.3

Table 6: Factors Associated With Urinary Tract Infections Among Urinary Tract Infection Patients who Attended Urology Clinics In The Main Hospitals In Sana'a City

Risk factors	Yes		No		OR	CI		χ^2	p
	No.	%	No.	%		Lower	Upper		
Diabetic mellitus	56	23.2	185	76.8	8.63	2.4	36.46	11.97	0.01
Autoimmune diseases	5	2.1	236	97.9	1.23	0.141	10.72	0.035	0.85
Pregnancy (No.=136)	24	17.64	112	82.35	1.21	1.12	1.31	5.39	0.02
Qat chewing	143	59.3	98	40.7	1.15	0.65	2.042	0.022	0.64
Presence of catheters	19	7.9	222	92.1	2.55	1.04	6.254	4.436	0.035
Presence of stones	54	22.4	187	77.6	2.551	1.04	6.254	4.436	0.035
Immunosuppressive drugs	6	2.5	235	97.5	1.48	0.175	12.541	0.131	0.72

OR Odds ratio = > 1 (there is a risk), CI Confidence intervals, χ^2 Chi-square = > 3.9 (significant) and PV Probability value = < 0.05 (significant).

Discussion

Urinary tract infections are a frequent illness in both children and adults, with a higher incidence rate in females. However, the current study found that 46% of cases were male and 54% were female, which is different from earlier research that found that more than 75% of UTI cases were female [37–39]. Because of their shorter urethras and greater proximity to the anus, women are more likely than men to get UTIs [40]. After menopause, a woman's risk of UTIs rises because her vaginal flora becomes less protective, and her estrogen levels drop [40]. Recurring UTIs are also linked to vaginal atrophy, which can occasionally happen after menopause [41]. The majority of bacteria that colonize the lower urinary tract are Gram-negative, and this is typically the cause of infection. Depending on the pathogen's properties, the infection may spread from the bladder to the kidneys. It is well recognized that infections are rarely spread by the hematogenous pathway and can instead arise from the agent entering the urinary tract through the bloodstream during sepsis. Predisposing variables for UTIs include vesicoureteral reflux, voiding dysfunctions, neurogenic bladder, urine incontinence, constipation, bladder neck obstruction, and catheter use [37]. Genetic and familial predisposition is another aspect [38].

The most prevalent symptom in the current study was cloudy urine, which was reported by 205 patients (85.1%) with UTIs. This was followed by urinary urgency, which was reported by 188 patients (78.0%), fever (64.7%), and dysuria (52.3%). But less frequently occurring symptoms included hematuria, kidney pain, and nausea/vomiting (29.5%, 25.5%, and 14.5%, respectively). Our findings are in line with other reports, although Farajnia et al. [1] and Woodford and George [1,4] have noted that in both the very young and the elderly, the symptoms are ambiguous or non-specific. The bulk of our patients (41.9%) belonged to the age range of 21 to 40 years. This is in contrast to other reports that indicate bacterial UTI rates rise with age and peak in age groups older than 60 years [40]. Premenopausal (for women) and immunocompromised individuals, as well as diabetes mellitus, were among the risk factors for UTIs that increased with age [42].

The results of the current study illustrate that among the heterogeneous causative bacteria for UTI, Enterobacteriaceae are the dominant pathogens, followed by Gram-positive cocci. In detail, the most common Gram-negative isolates were *Escherichia coli* (42.7%), followed by *Klebsiella pneumoniae* (32.8%), *Pseudomonas aeruginosa* (8.3%), *Proteus mirabilis* (1.2%), *Acinetobacter baumannii* (0.4%), and *Citrobacter freundii* (0.4%). The Gram-positive isolates were *Enterococcus faecalis* (5.8%), *Staphylococcus saprophyticus* (2.9%), and *Staphylococcus haemolyticus* (0.8%). Likewise, the *Candida* species represented 7.9% of the total. These results are consistent with reports published in Yemen previously and from other countries around the world [29,31,39,43].

In the current study, the predominant uropathogen was *Escherichia coli* (42.7%), followed by *Klebsiella pneumoniae* (32.8%), while other bacterial causes were less frequent (Table 4). Current results are similar to other nosocomial investigation

studies published in Europe and North America that support *E. coli*, *Klebsiella* spp., and *Enterococci* spp. as the prevalent bacterial pathogens that cause UTI [31, 35]. Also, the current study results are different from the findings of the Rebmann and Greene studies and Gaynes and Edwards reviews, in which *Klebsiella* spp. were the most commonly identified bacteria (8/16, 50%), followed by *Enterococci* (7/16, 44%). Although *E. coli* is known to be the most predominant etiology for UTI [23, 36], it was isolated from 42.7% of positive bacterial culture patients enrolled in this study. This finding might suggest dissimilarity in the bacterial population consistent with different localities and suggest the role of the environment in determining the bacterial population in each area, including hospitals [37].

Numerous possible risk factors for the emergence of a bacterial UTI were assessed in this investigation. The obtained results were in line with previous research [42, 22, 23], showing that DM and UTI are independently linked in 23.2% of patients with UTI who also have diabetes mellitus (OR= 2.4, 95% CI =36.46, p=0.01). The most significant risk factor for the formation of bacterial UTI is catheterization and UT stones, both of which were found to be associated with increased risk of UTI in the current study [19]. These findings are consistent with the previously published research, which found that renal stones and catheterization are significant risk factors for the development of bacterial UTIs, as other studies have confirmed [22, 25]. This correlation can be explained by the fact that a longer catheter will most likely increase the likelihood of bacteria growing inside the bladder's lumen or surrounding the catheter. Moreover, numerous additional studies have demonstrated that an extended catheterization duration is a significant risk factor for developing a UTI [22, 25].

Additionally, incorrect delay in removing a catheter when it is no longer needed and needless urinary catheter installation are the two main significant variables that cause CAUTIs and have been the main focus of quality improvement areas [26, 27]. Unfortunately, 38% of attending physicians do not know their patients are using a urinary catheter [28]. Furthermore, no clear indication supports the implantation of a catheter exists in 20% to 50% of instances [1, 28]. Pregnancy and UTI were significantly associated in the current study (OR=1.21 times, p = 0.02). This finding is consistent with the idea that because of the elevated risk of kidney infections during pregnancy, urinary tract infections—including the asymptomatic presence of bacteria in the urine—are more problematic [40].

High progesterone levels during pregnancy increase the risk of reduced bladder and ureteric muscle tone, which increases the possibility of reflux—a condition in which urine runs back up the ureters and toward the kidneys [40]. Although there is no higher risk of asymptomatic bacteriuria in pregnant women, if bacteriuria is present, there is a 25–40% chance of a kidney infection [40]. Therefore, treatment is advised if urine testing reveals infection-related symptoms, even in the absence of symptoms [44, 45]. Since cephalexin and nitrofurantoin are usually regarded as safe during pregnancy, they are frequently used [45]. Preterm birth or pre-eclampsia—a condition of elevated blood

pressure and renal malfunction during pregnancy that can cause seizures—can be caused by a kidney infection during pregnancy [40]. Pregnant women may experience recurrent urinary tract infections [46]. The most effective way to treat these recurrent infections in pregnant women is not well understood [46].

Conclusion

The findings indicate that fever, dysuria, urine turbidity, and urinary urgency are the most typical UTI symptoms. *Klebsiella pneumoniae* and *Escherichia coli* were the most often isolated UTIs. Pregnancy, UT stones, UT catheters, and diabetes mellitus were among the major risk factors for acquiring a UTI. Additionally, the current study has found several characteristics that are independently linked to UTIs, which could aid medical professionals in identifying patients who are at risk. Although the quality of patient treatment could be enhanced by this knowledge alone, the clinical usefulness of these risk factors has not yet been established. It may take longer to determine the usefulness of this approach in preventing UTIs.

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A Dispute of Interest

Regarding this project, there is no conflict of interest.

Author's Contributions

First author Safa'a M Darwiesh did the fieldwork for this study as part of a PhD in the department of Medical Microbiology, Faculty of Medicine and Health Sciences, Sana'a university. Additional authors assisted with data analysis, drafting and reviewing the manuscript, and giving final clearance to the study.

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