ORIGINAL RESEARCH

Prevalence and Antibiotic Susceptibility of the Common Bacterial Uropathogen Among UTI Patients in French Medical Institute for Children

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Background: Urinary tract infections (UTIs) are the most prevalent infections, with a variety of etiologic agents, a high number of occurrences, relapses, and complications; also, antibiotic resistance of the pathogenic bacterium is a hugely significant challenge for physicians.

Objective: The goal of this research was to identify the common bacterial uropathogens as well as their susceptibility to commonly used antibiotics.

Materials and Methods: During the first six months of 2018, a descriptive cross-sectional study was conducted on urine samples of 1780 patients at FMIC based on culture. Bacterial typing was performed using cystine lactose electrolyte deficient agar and blood agar, and Kirby–Bauer disc diffusion was employed to assess the sensitivity of the bacteria to various antibiotics.

Results: Among 1780 patients in 341 (19.15%) samples, uropathogens were isolated. *E. coli* (63.9%), *Enterococcus* (11.1%), *Serratia* species (10.8%), *Staphylococcus* species (8.2%), *Klebsiella* (2.9%), *Proteus* species (1.8%), and *Pseudomonas aeruginosa* (1.2%) were the most common bacterial uropathogens. More than two-thirds of patients were female (69.6%), with the remaining 30.4% male. Ampicillin, amoxicillin, and erythromycin were the antibiotics with the highest resistance rates in bacterial uropathogens, at 92.6%, 82.9%, and 82.1%, respectively. Furthermore, ceftriaxone, ceftazidime, cefixime, and sulfamethoxazole were antibiotics with resistance rates exceeding 70%. The antibiotics pristinamycin and ticarcillin were the most sensitive, with a TRR of zero. Ertapenem, imipenem, amikacin, tazobactam, fosfomycin, vancomycin, and nitrofurantoin were the antibiotics with the lowest resistance rates (less than 10%).

Conclusion: *E. coli* was the most common bacterial uropathogen isolated in this study, followed by *Enterococcus* species. Our findings suggest that physicians, particularly in FMIC, consider *E. coli*, *Enterococcus*, *Serratia* and *Staphylococcus* as the most common bacteria, and use pristinamycin, ticarcillin, ertapenem, imipenem, amikacin, tazobactam, fosfomycin, vancomycin, and nitrofurantoin as sensitive antibiotics in empirical UTI treatment.

Keywords: antibiotic, bacterial, prevalence, susceptibility, uropathogen, UTI

Introduction

Urinary tract infections (UTIs) are the most common bacterial infection. Currently, they are one of the most frequent diseases which occur at any ages from the neonate to adult.[1] Data shows that worldwide 150 million people are suffering from UTIs in developing countries.[2,3] According to a 1997 assessment of National Ambulatory Medical Care and National Hospital Ambulatory Medical Care, UTIs account for approximately 7 million OPD visits, 1 million cases in emergency departments, and 100,000 hospital admissions. The incidence of UTIs is higher in women than men. By the age of 24, nearly one-third of women will have had at least one episode of a UTI that necessitates the use of antibiotics.[2,3] Approximately 50% of women will experience at least one episode of a UTI at some point in their lives, and nearly 20% to 40% of women will have recurring infections.[1,4] Infants, pregnant women[2,5] and the elderly, and patients with spinal

cord injuries, diabetes mellitus, multiple sclerosis, AIDS/HIV, and urologic abnormalities or catheters are all at higher risk of UTIs. Long-term catheterization increases the risk of UTIs, resulting in over 1 million UTI cases reported each year in hospitals and nursing homes.[3,5] UTIs are the second most common infection in elderly, accounting for approximately one-quarter of all infections.[2,3]

The bacterial uropathogens differ according to factors such as gender, age, hospitalization, catheterization, and previous antibiotic exposure.[6] According to various studies, *Escherichia coli* and other Enterobacteriaceae, *Staphylococcus*, and *Enterococcus* are the most prevalent uropathogens. Other etiological agents of UTIs include *Klebsiella pneumoniae*, *Klebsiella oxytoca*, *Streptococcus agalactiae*, *Streptococcus viridans*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Citrobacter freundii*, *Enterobacter cloacae*, and *Staphylococcus aureus*.[7]

Drug resistance of bacterial uropathogens is a major issue in medical settings today,[8] particularly in developing countries, where the issue is exacerbated by poverty, poor hygiene, and illiteracy.[1,9] Although antibiotic resistance is a global health issue,[6] developing countries are heavily involved in this problem due to the high prevalence of infectious diseases and the possibility that patients with resistant infections will not have access to the appropriate medications. On the other hand, factors such as poor sanitation, contaminated water, internal conflicts, and an increase in the number of immunocompromised HIV-infected individuals promote the emergence and rapid spread of resistant pathogens.[9,10]

Due to lack of hospital surveillance systems and computerized records in hospitals in developing countries such as Afghanistan, it is difficult to assess accurate incidences of UTI and bacterial resistance. As a result, the purpose of this study was to determine the prevalence of UTIs among patients at the French Medical Institute for Children, to identify the bacteria causing the infection and to investigate their antimicrobial resistance patterns, which may be of epidemiological significance given the prevalence of multidrug-resistant bacteria in Afghanistan.

Materials and Methods

This descriptive cross-sectional study was conducted at the French Medical Institute for Children from January to July 2018. The urine cultures of the 341 patients included in the study were evaluated for isolated microorganisms by culture. Patient information such as age, gender, as well as laboratory records on their susceptibility, antibiotic resistance and culture results, were collected.

This study was conducted in accordance with the Declaration of Helsinki and it was approved by the Ethical Board of the French Medical Institute for Children on September 14, 2017, proposal no: 09. All participants provided their consent before joining the study, and the consent of individuals under the age of 18 was taken from their parents or legal guardians.

Microbiological Methods for Bacteria Identification

Following the sample collection, urine samples with a clinical diagnosis of UTI were sent to the microbiology laboratory, after which they were cultured in cystine lactose electrolyte deficient agar and 5% sheep blood agar mediums. Uropathogenic bacteria was identified by standard conventional procedure in urine cultures, where a significant colony was detected by incubation at 37°C for 18–24 hours. Urinary tract infection was confirmed as a result of urine culture, with samples containing 100,000 CFU/mL and a single bacterial growth.

Antibiotic Susceptibility Method

The disk diffusion method was used to assess the in-vitro susceptibility of positive samples to the most commonly used antimicrobial drugs for UTI treatment, including ceftriaxone (30μg), amoxicillin-clavulanic acid (20/10μg), ceftazidime (30μg), aztreonam (30μg), ciprofloxacin (5μg), cefixime (5μg), trimethoprim-sulfamethoxazole (5/250μg), ertapenium (10μg), imipenem (10μg), amikacin (30μg), piperacillin/tazobactam (100/10μg), fosfomycin (200μg), ampicillin (10μg), gentamicin (10μg), pristinamycin, penicillin (10μg), and nitrofurantoin (300μg).

Statistical Analysis

Analysis of this study was performed using SPSS version 22.0. For continuous variables, the descriptive statistics were shown as mean and standard deviation. Nominal variables were presented as the number of cases and percentages. The overall resistance rate is calculated by adding the resistance rates of all tested cases to a specific antibiotic.

Table 1 Distribution of Patients in FMIC in the First Six Months of 2018 According to Uropathogenic Status by Sex

Uropathogenic Status	Male		Female		Total	
	n	%	n	%	N	%
Non-uropathogenic	440	30.58	999	69.42	1439	80.85
Uropathogenic	102	29.9	239	70.1	341	19.15
Total	542	30.4	1238	69.6	1780	100.0

Results

In the first half of 2018, out of 1780 patients registered in FMIC, 341 (19.15%) of them had uropathogenic infection and 1439 (80.85%) of them were negative for uropathogenic infection. Among those with positive infection, 239 (70.1%) were female and 102 (29.9%) were male (Table 1). The mean age of participants was 25.9 years, with a standard deviation of 17.2 years.

Among 341 patients who tested positive for bacteria in urine culture, bacterial microorganisms were isolated. The most common uropathogenic bacteria was *E. coli*, which counts for more than 60% of all cases. *P. aeruginosa*, *Proteus* spp., and *Klebsiella* spp. were the least common uropathogenic bacteria, with rates of less than 5%. The percentages of *Enterococcus* spp., *Serratia* spp., and *Staphylococcus* spp., were (11.1%, 38), (10.8%, 37), and (8.2%, 28), respectively (Figure 1).

Ampicillin, amoxicillin, and erythromycin had the highest rates of antibiotic resistance among bacterial uropathogens, at 92.6%, 82.9%, and 82.1%, respectively. Antibiotics having a resistance rate of more than 70% included ceftriaxone, ceftazidime, and cefixime sulfamethoxazole. Furthermore, pristinamycin and ticarcillin were the most sensitive antibiotics, with a TRR of zero. The antibiotics with resistance rates below 10% were ertapenem, imipenem, amikacin, tazobactam, fosfomycin, vancomycin, and nitrofurantoin. Ampicillin, erythromycin, sulfamethoxazole and amoxicillin were the most resistant antibiotics for *E. coli*, *Enterococcus* spp., *Staphylococcus* spp., *Serratia* spp., *Proteus* spp., and *Klebsiella* spp. In addition, amoxicillin, ceftazidime, and ampicillin were the most resistant antibiotics for *P. aeruginosa* (Table 2 and Figure 2).
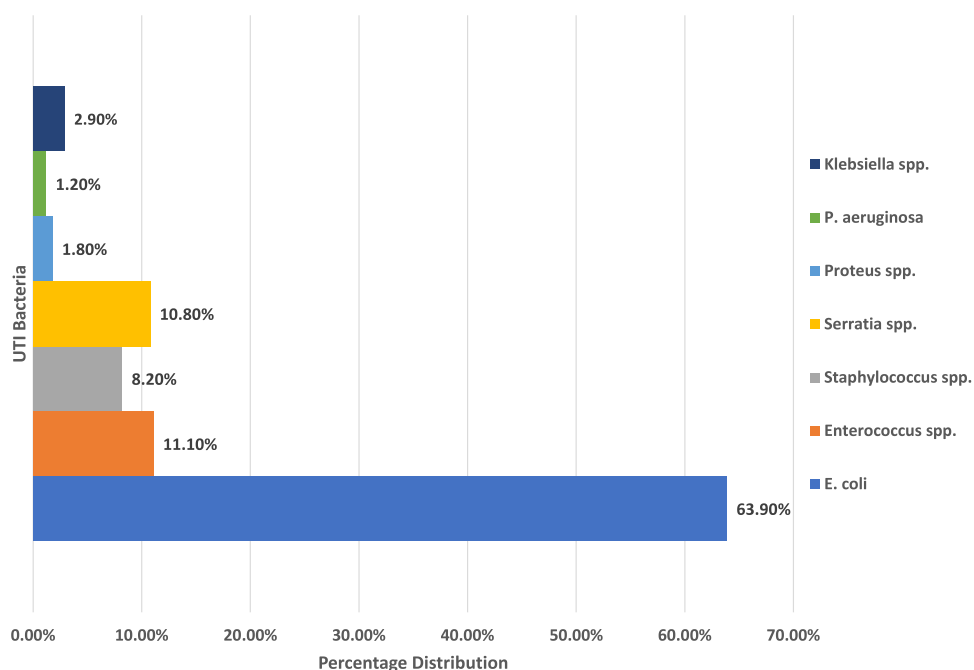
Figure 1 Distribution of microorganisms in positive samples of urine at the French Medical Institute for Children.

Table 2 Antibiotic Resistance of UTI Isolated Bacteria at the French Medical Institute for Children

Antibiotics	Uropathogenic Isolated Bacteria and Resistance Rate to Antibiotics						
	E. coli	Enterococcus spp.	Staphylococcus spp.	Serratia spp.	Proteus spp.	P. aeruginosa	Klebsiella spp.
Ceftriaxone (N=272)	165(77.4%)	4(40.0%)	0(0.0%)	21(65.6%)	1(20.0%)	1(100%)	5(50%)
Amoxicillin (N=281)	182(84.2%)	8(80%)	0(0.0%)	28(77.7%)	5(83.3%)	4(100%)	6(75.0%)
Ceftazidime (N=269)	163(77.9%)	1(33.3%)	0(0.0%)	21(56.7%)	2(33.3%)	4(100%)	4(50%)
Aztreonam (N=127)	55(56.7%)	0(0.0%)	0(0.0%)	9(42.8%)	1(50%)	1(50%)	1(33.3%)
Ciprofloxacin (N=243)	114(70.8%)	22(75.8%)	8(36.3%)	11(57.8%)	0(0.0%)	2(100%)	2(33.3%)
Cefixime (N=51)	34(87.1%)	0(0.0%)	2(100%)	2(50.0%)	–	–	1(20.0%)
Sulfamethoxazole (N=186)	97(81.5%)	15(57.6%)	12(80.0%)	10(71.4%)	2(50%)	1(100%)	2(28.5%)
Ertapenem (N=12)	0(0.0%)	–	–	–	–	–	1(25%)
Imipenem (N=115)	1(1.1%)	0(0.0%)	0(0.0%)	1(5.2%)	0(0.0%)	1(33.3%)	0(0.0%)
Amikacin (N=330)	6(2.7%)	21(65.6%)	0(0.0%)	3(8.1%)	0(0.0%)	1(25%)	0(0.0%)
Tazobactam (N=276)	7(3.2%)	0(0.0%)	0(0.0%)	0(0.0%)	1(16.6%)	1(33.3%)	0(0.0%)
Fosfomycin (N=246)	7(3.8%)	4(28.5%)	0(0.0%)	0(0.0%)	3(50.0%)	2(100%)	1(11.1%)
Ampicillin (N=284)	202(93.9%)	6(60.0%)	4(80.0%)	35(97.2%)	5(100%)	4(100%)	7(77.7%)
Gentamicin (N=330)	69(33.8%)	23(71.8%)	6(22.2%)	12(37.5%)	1(16.6%)	1(25%)	4(44.4%)
Pristinamycin (N=3)	–	0(0.0%)	–	–	–	–	–
Fusidic acid (N=51)	–	4(16%)	5(19.2%)	–	–	–	–
Clindamycin (N=52)	1(100%)	12(42.8%)	2(8.6%)	–	–	–	–
Rifampicin (N=52)	–	5(19.2%)	0(0.0%)	–	–	–	–
Ticarcillin (N=5)	–	0(0.0%)	0(0.0%)	–	–	–	–
Vancomycin (N=40)	0(0.0%)	1(100%)	0(0.0%)	–	–	–	–
Penicillin (N=43)	–	10(47.6%)	13(59.0%)	–	–	–	–
Cefoxitin (N=29)	–	5(55.5%)	1(5%)	–	–	–	–
Erythromycin (N=56)	2(66.6%)	26(81.2%)	18(75%)	–	–	–	–
Nitrofurantoin (N=244)	16(8.2%)	1(14.2%)	0(0.0%)	1(3.7%)	2(40%)	–	2(28.5%)

Note: – means that this bacteria did not test for that antibiotic.

Discussion

Urinary tract infections (UTIs) are the most common infections in society and hospitals. UTIs are known as a challenging issue for physicians due to their high rate of occurrence, relapse, complications, various etiologic agents and increasing drug resistance. Due to antibiotic misuse, which can present substantial therapeutic issues, bacterial resistance to antibiotics is a significant problem not only in UTIs but also in other diseases.

The prevalence of UTIs was found to be 19.15% in this study, while it was 13.9% in studies for isolating the etiologic agents and evaluating their resistance to antimicrobials conducted at Messalata Central Hospital, Libya.[11] A study from Pakistan on the frequency and antimicrobial susceptibility of bacterial uropathogens on 1512 samples discovered that the
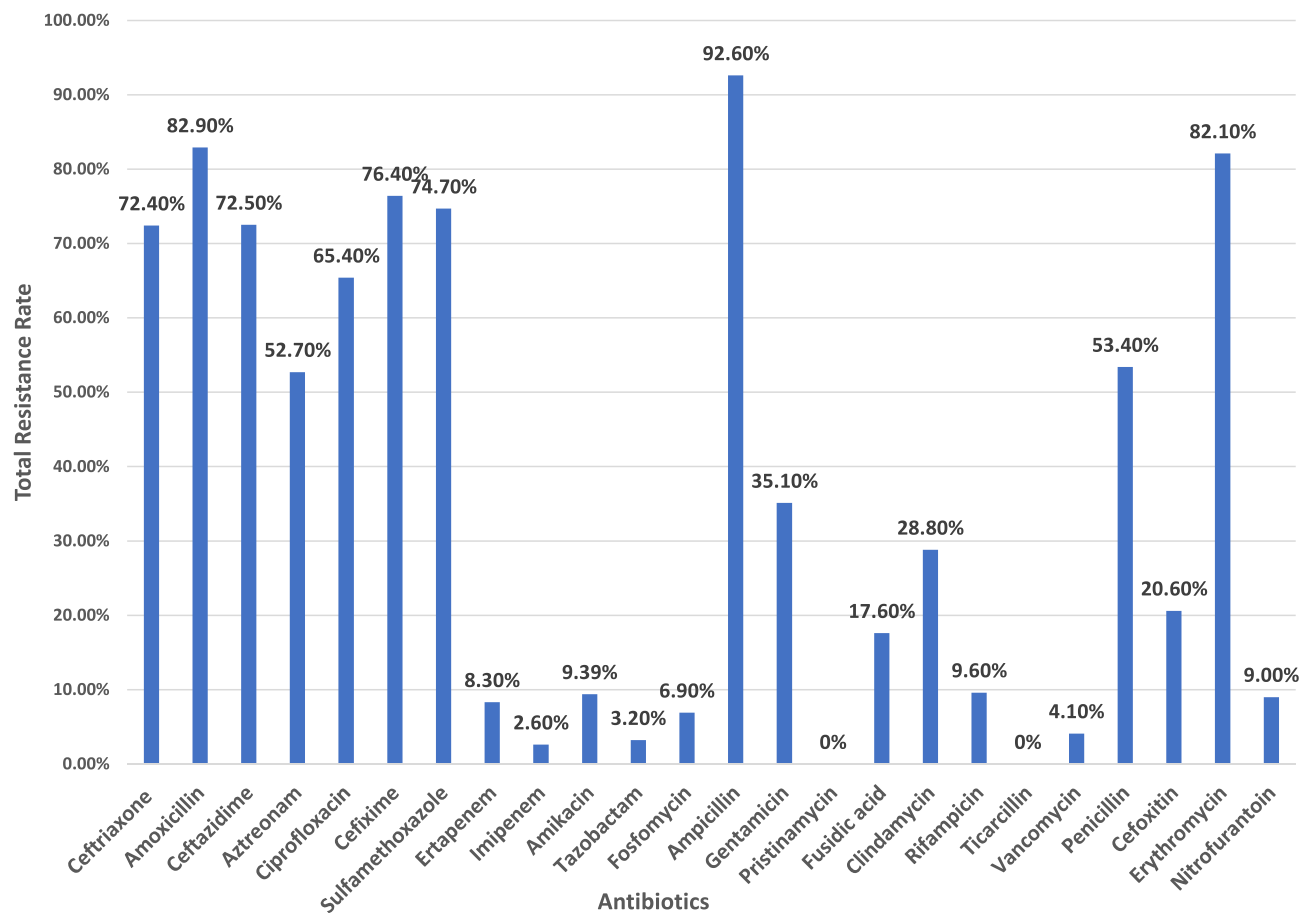
Figure 2 Total resistance rate in UTI isolated bacteria at the French Medical Institute for Children.

frequency of culture-based uropathogens was 17.9%.[12] However, research from Ethiopia discovered that, out of 687 urine samples, 28.38% of the patients had uropathogens. As a result, the prevalence of UTIs in Afghanistan is higher than in Libya and Pakistan, owing to poor adherence to hygiene and sanitation measures, as well as a lack of access to safe drinking water. The majority of patients in the current study, like many other studies,[12–15] were female because their urethra is considerably shorter and closer to the anus than it is in men; making it easier for bacteria from the anus to enter the urinary tract. The most common uropathogen in UTIs has been identified as *E. coli* in the current study, which was also concluded in various countries around the world at different times.[14–17] The second isolated uropathogen was *Enterococcus*, while some studies placed *Klebsiella*[11,14,16] as the second uropathogen in the general factor sequence. Moreover, in some studies *Enterococcus*[13] is reported as the second isolated uropathogen. Similar to that, *Enterococcus* (9.4%) came in second in the general factor in our study, followed by *Serratia* (9.1%). In the current study, isolated *E. coli* had the highest susceptibility to ertapenem, imipenem, amikacin, tazobactam, fosfomycin, and nitrofurantoin and the highest resistance to amoxicillin, cefixime, and ampicillin, with rates above 80%, because these three antibiotics are widely used in empirical therapy of UTI by physicians and patients in Afghanistan. *E. coli* isolates were 65.8%, 64.0%, 65.1%, and 66.4% susceptible to ciprofloxacin, nitrofurantoin, trimethoprim/sulfamethoxazole, and fosfomycin, respectively, compared to other studies such as research in Poland[14] and a study in Turkey that revealed high resistance to ampicillin (87.3%), cefuroxime (71.6%) and trimethoprim/sulfamethoxazole (60.8%). The lowest resistance to nitrofurantoin (21.4%), tazobactam (19.1%), imipenem (8.6%), meropenem (8.8%), amikacin (6.2%) and cefoperazone/sulbactam (4.7%) was seen for all microorganisms.[16] A study from Libya showed that amikacin had the highest susceptibility followed by imipenem and meropenem, with 0%, 0.6%, and 2.5% resistance rates, respectively, while cephalothin and ampicillin had the lowest sensitivity, with 80.6% and 90.0% resistance rates, respectively.[11] In a study in Isfahan,

bacterial uropathogens were relatively highly susceptible to imipenem (79.2%), ciprofloxacin (78.0%), and nitrofurantoin (70.8%) while sensitivity to cefotaxime (53%), cephalexin (39.8%) and trimethoprim/sulfamethoxazole (26.1%) was low; resistance to imipenem, cefotaxime, and cephalexin was more common in recurrent cases as well as in patients who had previously used antibiotics before being affected by a UTI.[15] The sensitive antibiotics in isolated uropathogens in a study from Ethiopia[18] and Pakistan[12] were amikacin, gentamicin and nitrofurantoin. Additionally, nitrofurantoin, fosfomycin, and amikacin were found to be highly sensitive antibiotics in a study conducted in Mexico by Lagunas-Rangel.[13] These antibiotics have also been shown to be highly sensitive in the current study.

In Afghanistan, there are geographical, social, economic, and lifestyle factors that influence drug resistance, particularly in UTIs. Geographically and socially, the majority of UTI patients lack access to medical facilities and thus utilize over-the-counter medications, which cause the resistance. Economically, most people do not have the opportunity to undertake urine culture and are treated empirically, which also increases the resistance rate. Regarding lifestyle, most people practice low sanitation and hygiene standards and consume contaminated water, which are additional variables that are thought to contribute to the rising rate of UTIs and resistance among UTI patients.

Conclusions

E. coli and *Enterococcus* spp. were the most frequently isolated UTI bacteria in this study in Afghanistan. Based on our research, it is recommended that physicians, particularly those working in the FMIC, use sensitive antibiotics such as pristinamycin, ticarcillin, ertapenem, imipenem, amikacin, tazobactam, fosfomycin, vancomycin, and nitrofurantoin in the empiric treatment of UTIs when they are suspected to be caused by *E. coli*, *Enterococcus*, *Serratia* and *Staphylococcus*.

Ethical Considerations

The research proposal was approved by the Ethical Committee of the French Medical Institute for Children [project no: 14.09.2017/09].

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Disclosure

The authors report no conflicts of interest in relation to this work.

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