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# Introductory Chapter: An Overview on Urinary Tract Infections, Pathogens, and Risk Factors

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Payam Behzadi

Additional information is available at the end of the chapter

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## 1. Urinary tract infections and the related concerns

Urinary tract infections (UTIs), the second-ranked infectious diseases, are recognized as a big concern relating to global healthcare systems. The problem with UTIs is two-dimensional. From the economic aspect, patients with UTIs cost millions of US dollars (USD) for different governments annually. From the other dimension, there is a huge number of patients with UTIs which must be visited by a considerable number of physicians and specialists that involve an abundance of human resources in the public healthcare systems. So, the UTIs should be diagnosed and treated definitely at the earliest to decrease the costs and traffics in public healthcare systems [1–6].

Moreover, UTIs are known as multi-microbial infectious diseases, which can be happened by bacteria (Gram-positive and/or Gram-negative strains) and fungi. Among Gram-negative bacteria, the member of *Enterobacteriaceae* and, in particular, *Escherichia coli* and *Klebsiella pneumoniae* are the most common uropathogenic bacterial agents, which may cause different types of UTIs. Furthermore, Gram-negative bacteria, including *Streptococci*, *Staphylococci*, and *Enterococci*, are involved in UTIs in humans. On the other hand, fungi and particularly *Candida albicans* (*C. albicans*) strains may act as opportunistic pathogenic fungi for causing UTIs. However, the non-*C. albicans Candida* (NACA) such as *C. glabrata* and *C. tropicalis* are reported from some countries as the predominant species of the causative agents of UTIs [1, 2, 4, 7–14].

## 2. Urinary tract infections and diagnostics

Fortunately, the methodologies and procedures of diagnostics are in progress, and the use of molecular techniques (e.g., polymerase chain reaction (PCR)) and advanced pan-genomic

tools (e.g., microarray technology) help us to have accurate, sharp, reliable, and rapid detection and identification. Of course, it should be noticed that there is a close relationship between the number of specimens and the applied methodology. In other words, the application of PCR is useful for limited samples, while the microarray technology is a suitable choice when the number of specimens is huge. Thus, the methodologies of diagnosis and treatment should be carefully selected for accurate and definite detection to reduce the number of patients with UTIs [1, 2, 9, 11, 15, 16].

In recent years among several difficulties with UTIs, another problem has risen up quickly; the problem is the appearance of a diversity of antimicrobial-resistant pathogens. A typical example for this challenge is the presence of a wide range of extended spectrum  $\beta$ -lactamases (ESBLs) producing bacteria and, in particular, ESBLs producing *Enterobacteriaceae*. Although there are several groups of ESBLs producing bacteria in the family of *Enterobacteriaceae*, uropathogenic *Escherichia coli* (UPEC) and uropathogenic *Klebsiella pneumoniae* (UPKP) pathotypes are considered as important members, which are able to produce a variety of ESBLs [12, 17, 18].

### 3. The types of urinary tract infections

There are different types of UTIs including acute and/or chronic, asymptomatic and/or symptomatic (mild/moderate and/or severe), complicated and/or uncomplicated, and community and/or nosocomial acquired infections. If the UTIs occur  $\geq$  three times in a year or  $\geq$  two times continuously after disappearance (treatment) of the first infection in a half year, they are recognized as recurrent UTIs (rUTIs). In addition to this diversity, as the human's urinary tract (UT) is divided into two parts of lower and upper sections, the UTIs may occur in the lower part of the UT (known as cystitis) and/or upper part of the UT (known as nephritis). These characteristics are in association with microbial pathogenomics, duration of infection, and the abilities of human host. The threshold of microbial population for UTIs is reported as  $\geq 100,000$  living cells or colony-forming unit (CFU) per urine milliliter (ml); however, it varies from 100 to 1000 to 100,000 CFU/ml. Of course, the UTIs without syndromes and with syndromes are recognized as asymptomatic and symptomatic UTIs, respectively [1, 2, 4, 7–10, 12, 19–22].

### 4. Predisposing factors relating to urinary tract infections

There are a wide range of predisposing factors, which determine the rate of UTIs among human populations. Age, gender, pregnancy, sexual activities, multi-sexual partners, urination, personal hygiene, nutrition regime, application of spermicide devices and diaphragm, the presence or absence of vaginal *Lactobacilli*, catheterization, hospitalization, and microbial pathogenome and virulome are the most common factors that are involved in UTIs [1, 4, 7, 8, 12, 20, 21, 23, 24].

Generally, UTIs are appeared in women  $\geq 18$  years old; however, UTIs are recognized in children (girls and boys) and men. In accordance with previous reports, >30% of young women with the age of 24–26 have experienced at least once a diagnosed UTI. Besides, the rUTIs are common among both young and old women with different etiologies. In young women, several sexual intercourses, application of spermicidal devices, and different sexual partners increase the occurrence of rUTIs, while in old women, the lack of vaginal *Lactobacilli* populations, reduction of female hormones, catheterization, and UT surgeries are the most common causes of rUTIs. The patients susceptible to rUTIs are suggested to consume antibiotics as a proper prophylactic method. Besides, the use of some nutrients like cranberry may prevent or reduce the incidence of UTIs and particularly rUTIs in some cases. Interestingly, the rate of asymptomatic or symptomatic bacteriuria increases in both old men and women. But, several studies show that generally the untreated asymptomatic bacteriuria in pregnant women may lead to symptomatic, severe UTIs and even urosepsis. So, treatment of asymptomatic bacteriuria in pregnant women is a must [5, 21–23, 25–27].

Hospitalization is one of the significant factors associated with UTIs which results in secondary bacteremia. Normally, hospitalization and catheterization are important pre-disposed factors to nosocomial UTIs because the use of catheters (e.g., bladder catheter) may occur during hospitalization which results in UTIs. In parallel with catheterization, the problem of biofilm formation within catheters and the presence of multidrug-resistant pathotypes relating to microbial causative agents (e.g., ESBLs producing *Enterobacteriaceae*) considerably increase the rate of morbidity and mortality among patients with UTIs. *E. coli* and ESBLs producing *E. coli* are the pioneers of bacterial causative agents of nosocomial UTIs. In addition to bacterial pathogens, the presence of fungal populations and in particular *Candida* spp. must be considered as an important threat for progression of nosocomial UTIs among catheterized patients; hence, the catheters may act as an important source for aggregation of microbial pathogens, which are both antibiotic sensitive and antibiotic resistant. Thus, the use of assays pertaining to antibiotic susceptibilities and broad-spectrum antibiotics are pivotal items to reduce the number of patients with nosocomial UTIs [6, 24, 28].

Microbial pathogenome and virulome are significant factors, which determine the severity of UTIs. UPEC, UPKP, *Proteus* spp., *Pseudomonas aeruginosa*, *Enterococcus* spp., and other microbial pathotypes are able to occur in different types of UTIs in their human hosts. Some of microbial virulence genes are located on plasmids, while the others are situated on chromosomes. So, the presence or absence of microbial virulence genes affects directly on pathogen virulency and pathogenicity [1, 2, 4, 12, 14].

Genetic risk factors (e.g., blood group and stone formation) and diseases (hypertension), diabetes, strength of host's immune system, immune deficiency syndromes (e.g., AIDS), immunocompromised patients, spinal cord injuries, etc. are other predisposing factors, which increase the incidence of UTIs among human populations [4, 7, 8, 10, 13, 24].

In this book, which consisted of six chapters, the readers will obtain valuable information regarding UTIs and the related predisposing factors.

In Chapter 2, Sorwer Alam Parvez and Dolilur Rahman explain different important virulence factors of UPEC. In this chapter, a wide range of virulence factors pertaining to UPEC are mentioned and discussed. Readers may gain valuable information regarding UPEC virulome.

In Chapter 3, Mahabubul Islam Majumder, Saleh Ahmed, Ashiqur Rahman Khan, and Tarek Ahmed discuss about microorganisms in catheter-associated urinary tract infection (CAUTI). Because of the importance of the topic in UTIs, the authors have focused on the items which are pivotal to CAUTI and give effective and reliable information regarding the field.

In Chapter 4, Ajay Kumar Prajapati clearly represents the importance of diabetes as a significant predisposing factor for UTIs. So, the readers who are interested in UTIs relating to diabetes will obtain brilliant information regarding the subject.

In Chapter 5, Charalampos Konstantinidis and Achilleas Karafotias have a deep look into UTIs in neuro-patients. Today, there are many efforts to find out the solutions regarding neuro-patients with UTIs. I believe that the authors of this chapter represent considerable information in regard to this topic.

In Chapter 6, Elena Zaitseva, Elena Melnikova, Andrey Shadrin, Valentina Luchaninova, and Tatyana Komenkova clearly explain the importance of uropathogenic *Enterococcus faecalis* strains in pediatric UTIs. Moreover, the phenotypic and genetic diversity of the pathotypes is discussed and represented. The authors represent a valuable information in association with pediatric UTIs caused by uropathogenic *E. faecalis*.

I hope that this book offers practical information to the readers.

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## Author details

Payam Behzadi

Address all correspondence to: behzadipayam@yahoo.com

Department of Microbiology, College of Basic Sciences, Shahr-e-Qods Branch, Islamic Azad University, Tehran, Iran

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