
Pathogenic Bacteria Caused Urinary Tract Infections: A Review

Goljameen Midhat Abdulla¹, Shenay Ahmed Mohammed², Nuha Hamza Khedhir³, Qassim Jawell Odah Abed⁴, Ozdan Akram Ghareeb⁵

^{1,2,3,5} Department of Pharmacy, Medical Technical Institute/Kirkuk, Northern Technical University, Iraq.

⁴ Department of Nursing, AL-Kut Technical Institute, Middle Technical University, Iraq.

ABSTRACT: The urinary system is one of the most vital organs susceptible to infection; especially bacterial ones. Urinary tract infections (UTIs) mean colonization of urinary tracts by pathogenic microorganisms leading to inflammation of urinary system. In this study, we review the basic concepts of the most important pathogenic microbes infected this system. Enterobacteriaceae is a large group of Gram-negative bacillus bacteria that are naturally found as commensals in the intestine and are pathogenic and opportunistic, exploiting any opportunity to cause many infections, and they are the main cause of urinary tract infections. Uropathogenic *E. coli* strain causes approximately 90% of UTIs. Besides, *Klebsiella pneumoniae* represents most important pathogenic bacteria causing diseases, especially UTIs in children. It was found, that severity of this infection mainly related with virulence of causative bacteria as well as the host's immune system.

KEYWORDS: Urinary tract, inflammation, Uropathogenic, microorganisms.

INTRODUCTION

The urinary system is vital to the body as it represents key in removing metabolic waste products from bloodstream through urine that is sterile or has very few infectious microorganisms [1]. Urinary tract infections (UTIs) are considered the most important bacterial infection, affecting hundreds of millions of people annually with clearly morbidity and expensive medical costs. It is worth noting that UTIs include urethritis, cystitis, or pyelonephritis [2]. It is worth noting that about fifteen percentages of women around the world suffer from a urinary tract infection in their lifetime.

Besides, the highest incidence occurs in the age of sexual activity especially in females [3]. This maybe they have shorter urethra, as well as more hormonal activity, which affects acidity of urine and thus provides a suitable environment for bacterial growth [4]. Enterobacteriaceae represent more than 90% of the bacteria isolated in patients with UTIs, and these bacteria are part of the normal bacteria in humans [5], as the Enterococcus family are Gram-negative bacteria, aerobic or facultative anaerobic, some of which have the ability to ferment lactose and others are negative for oxidase test, capable of reducing nitrate to nitrite, catalase positive, and non-spore forming [6,7]. The pathogenicity of these bacteria depends on the presence of many virulence factors such as adhesion factors such as fimbriae, in addition to the secretion of toxins, iron uptake systems, O antigens, K antigens (capsules), production of hemolytic enzymes and other virulence factors [8,9]. Immune defenses play a key role in protecting the body from infections through warnings and special indicators such as the secretion of cytokines, which are similar to hormones in terms of function, as they transmit chemical signals between the body's structural cells and immune cells [10,11]. These infections can be treated with antibiotics; however, the mechanism of multi-resistance of bacteria against antibiotics poses a threat to the control of urinary tract infections [12]. The characteristic of bacterial resistance to antibiotics is either innate or acquired through the occurrence of mutations or through the transmission of genetic material between bacterial cells in several ways, such as conjugation, plasmids, transposons, transformation, or bacteriophages [13].

It is worth noting that, urinary tract infections have a disturbing impact on patients' relationships and reduce quality of life [14]. An objective of this review is explaining associated most bacteria with UTIs.

Classification of Urinary tract infections

Clinically, UTIs are classified as uncomplicated or complicated, or by site of infection. Also, this infection may be symptomatic or asymptomatic. Uncomplicated urinary tract infections usually affect healthy individuals without congenital or neurological abnormalities in the urinary tract [15,16].

The severity and duration of urinary tract infections depend mainly on the virulence factors possessed by the pathogenic bacteria along with the immune system of the host, combining with other factors that increase susceptibility to infection such as gender, age, and place of residence, urinary tract abnormalities, pregnancy, and the cleanings of drinking water [17,18].

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In previous studies dealt with the link between UTIs and the causing bacteria, they found that members of the enteric family are the most common types of bacteria that cause urinary tract infections, especially *Escherichia coli*, which represents about (80-90%) of them [19].

Simply, UTIs are defined as the colonization of urinary tracts by pathogenic microorganisms (figure 1), which lead to an inflammatory response of urinary system. The urine of healthy individuals is free of microorganisms, but contamination and inflammation occur as a result of the arrival of microorganisms present in the digestive system or in the anus and vagina to the organs of the urinary system close to them, in addition to the difference in the acidity function resulting from hormonal differences and associated pathological infections [20,21].

Generally, UTIs represents main types of bacterial infections after respiratory infections, and are common in infants and the elderly. Symptoms of advanced infections include frequent urination, pyelonephritis with urinary sepsis, kidney damage in young children, and premature birth, besides to complications resulting from the frequent use of antimicrobials, such as high-level resistance to antibiotics. In addition, the mortality rate is relatively high, as it usually leads to the development of kidney failure [22].

Females are more susceptible to urinary tract infections than males, as about half of the number of women is exposed to infection by (25-30%) once during their lives, and the high frequency of women suffering from debilitating recurrent urinary tract infections may reach 13%, especially in old age [23].

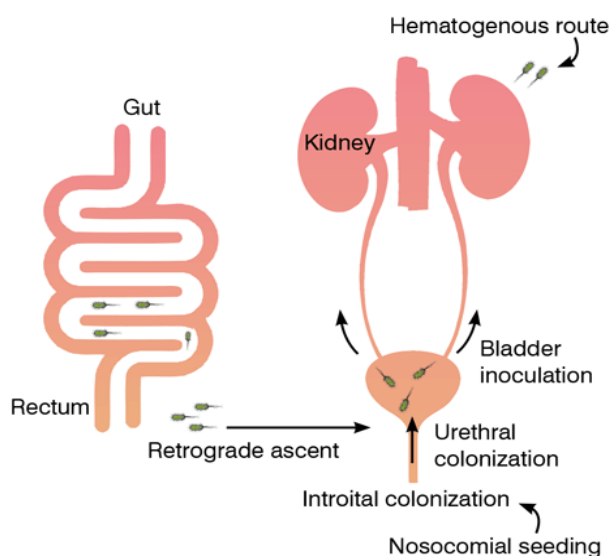


Figure 1: Urinary tract infections pathway.

BACTERIURIA

It can be explained as the presence of bacteria in the urine, and it comes in two forms: symptomatic or asymptomatic. According to the laboratory evaluation, it means the presence of 100,000 isolated bacteria per ml of a clean urine sample emptied into the midstream. A patient with asymptomatic bacteriuria has one or more bacterial colonization in the urine sample without symptoms, and this form is not considered an infection [24]. Asymptomatic bacteriuria term was inserted by Kass in 1960 on presumption that bacteria resort to multiplication in enormous numbers in a person's urine. This assumption provided a means of distinguishing between a contaminated sample and true bacteria in the urinary tract [25].

Scientific reasoning was understood and recommendations for antibacterial therapy were based on culture test results. In fact, no fixed number of bacteria can be considered decisive for the presence of bacteria in the urine in all types of urinary tract infections in all circumstances. Many micro-organisms constantly threaten the urinary tract, but their virulence is balanced by the host's body defenses. This infection is chiefly caused by bacteria, although other microorganisms may rarely be involved, such as fungi and viruses [26].

COMMON ENTEROBACTERIACEAE OF URINARY TRACT INFECTIONS

This family includes a large group of Gram-negative Bacillus bacteria, which are found naturally as commensal bacteria in the intestines of humans and animals. As this family includes many pathogenic, opportunistic bacteria that take advantage of any opportunity to cause many infections, as they are the main cause of wound infections and hospital-acquired injuries, in addition to respiratory and urinary system infections. Also, these bacteria cause relatively high mortality annually [27].

The most important common traits that members of this family possess is that they are facultative aerobic or anaerobic, and some of their members have the ability to ferment a wide range of sugars, especially lactose [28].

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In addition to being -ve for oxidase test and +ve for catalase test, most of its members have the capability to reduction nitrate to nitrite, as well as most of its members are mobile with peripheral flagella and do not form chalkboards, and the optimum temperature for their growth is 37⁰ C [29].

ESCHERICHIA COLI

These bacteria are among the most important members of the bacteria of the intestinal family, and these bacteria are naturally present as a normal flora in the large intestine of almost every human being, as they are considered opportunistic pathogens, although these bacteria may be detection in upper respiratory tract and the genitourinary system of some normal healthy persons [30,31].

Initially, it was found that the *E. coli* strain causing UTI clumps in human red blood cells through fimbria. A series of suggestions for virulence factors followed. Note that uropathogenic *E. coli* strain causes approximately 90% of UTIs [32]. Because urinary tract infections are usually initiated by urinary tract pathogenic strains of *E. coli*, the continued presence of uropathogenic strain in the colon creates a permanent source of bacteria and the potential for urethral contamination (figure 2). The virulence factors of these bacteria are classified based on their effect in host tissue into adhesion factors that prepare attachment and colonization to surface of host cell, or as toxins that are secreted and progressive toward site of action [33].

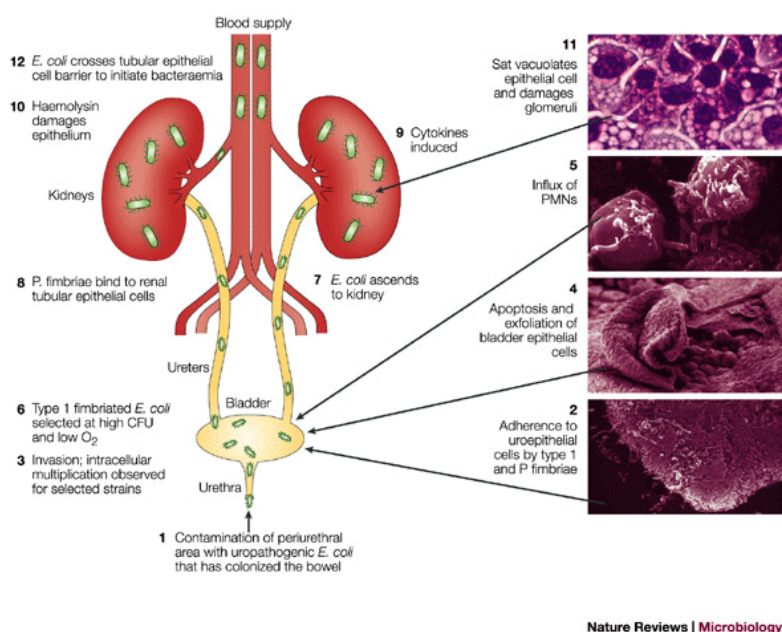


Figure 2: Urinary tract infections with *E. coli*.

Approximately half of all recurrent UTIs is caused by reinfection with the same strain from either an internal or external source. Internal includes rectal, fecal, vaginal flora, or possibly even bladder flora. It is worth noting that microorganisms approach the urinary tract through blood or lymphatic spread [34].

KLEBSIELLA PNEUMONIAE

Urinary tract infections usually occur mainly by Gram-negative bacilli, which constitute at least (80%) of the micro-organisms that cause urinary tract infections [35]. *Klebsiella pneumoniae* is one of the most important of these bacteria, along with *Escherichia coli*. These bacteria are often isolated in hospitals, and a large percentage of these bacteria are resistant to multiple antibiotics, which has become a huge challenge at the present time, and the ability of this resistant bacterium has made it one of the pathogens transmitted from hospitals [36,37]. This pathogenic bacterium is responsible for a large number of diseases that affect children, such as bacteremia, septicemia, and urinary tract infections [38].

OTHER BACTERIAL SPECIES

Another bacterial species of the family Enterococcus is *Serratia* spp., which is one of the main causes of nosocomial infections. Although it represents mainly a pathogen in hospitals, recently published population studies indicate that a large proportion of identified infections of this bacterium are community acquired. Patients most at risk are those in intensive care units who use medical devices and those who take broad-spectrum antibiotics. These bacteria can spread easily in hospital environment and contaminate medical equipment, tools, fluids and disinfectants [39].

Another bacterial species that causes urinary tract infections, but very rarely, is *Shigella* spp. These bacteria primarily cause gastrointestinal infections. Urinary tract infections (UTIs) due to these bacteria are relatively rare and can cause infections of the

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urinary tract, especially for women during pregnancy, and are likely to occur in newborns, malnourished children, and immunosuppressed patients [40].

Another bacterium that causes urinary tract infections is *Pseudomonas aeruginosa*, which is a Gram-negative motile bacillus with one polar flagellum. This bacterium is one of the opportunistic pathogens that affect people with immunodeficiency, as it causes many diseases that affect all human tissues and systems, such as the tract Urinary, respiratory, bone, joint and soft tissue (burns) and dermatitis [41]. The most common Gram-positive bacteria caused urinary tract infection includes *Staphylococcus aureus* and *Staphylococcus epidermidis* [42].

ANTIBIOTICS

The past decade has witnessed significant changes in the field of urinary tract infections in terms of pathogens and antibiotic treatment, which necessitates updating current trends. Due to the increase in antibiotic-resistant urinary pathogens around the world, especially the first-generation antibiotics Co-trimoxazole, Fluoroquinolones, Cephalosporins, it has resulted in harmful consequences not only for treatment, but also for the prevention of complications after therapeutic interventions [43].

In general, antibiotic treatment should not be initiated for a urinary tract infection unless the clinical criteria for a urinary tract infection are met. It is usually recommended that a urine sample be sent to the laboratory for urine analysis and culture on diagnostic media before initiating experimental antibiotic therapy [44].

CONCLUSION

According to the above, we conclude that Gram-negative bacilli constitute the majority of microorganisms that cause urinary tract infections, and the most important pathogenic bacteria are *Klebsiella*, along with *Escherichia coli*. The severity of the infection depends mainly on the virulence of the causative microorganisms in addition to risk factors related to the host, such as a weak immune system.

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