

Current Trends in the Evaluation and Management of Urinary Tract Infections in Women

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ABSTRACT

An infectious disease that is prevalent in individuals of all ages and genders, Urinary system inflammation is the consequence of urinary tract infections (UTIs). These diseases are mostly caused by bacteria. Uropathogenic *Escherichia coli* (UPEC) is the most frequent cause of urinary tract infections. The development of new diagnostic techniques and treatment decision aids will speed up diagnosis and enhance antibiotic stewardship and accuracy. New preventive measures, including vaccination, bacterial interference, and catheter coatings and materials, are being researched and developed. The most common pathogen remained *Escherichia coli* (~62%), followed by *Enterococcus faecalis* (~8%) and *Klebsiella pneumoniae* (14%). Additionally, multidrug-resistant (MDR) UTIs are becoming more common. It has caused a significant increase in the burden of these diseases as well as the growth of antibiotic resistance. Taking probiotics, which are good bacteria, may help keep the urinary tract healthy and clear of many pathogens.

Keywords: Uropathogens, Urinary tract infections (UTIs), Antibiotic resistance, Catheter-associated UTI

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Introduction

The kidneys, ureters, bladder, and urethra comprise the urinary system, which is primarily accountable for filtering blood by removing waste and excess water. Eliminating metabolic waste products from circulation is a major function of the urinary system [1]. UTI is one of the most common illnesses affecting women worldwide, which is particularly common during pregnancy because of the anatomical and physiological changes that occur during this time. The likelihood of frequent episodes is considerable for individuals who do have a UTI. It is not unexpected that UTIs have substantial healthcare expenses, amounting to billions of dollars in the US, considering how frequently they can occur and the severity of the symptoms they cause. Pregnant women had a major prevalence of UTIs, with *Escherichia coli* being the most frequent causal agent. Urinary tract infections that are associated with abnormalities that increase the patient's risk of infection are known as complicated UTIs, like catheterization or anatomical or functional abnormalities. Even though the symptoms different depending on where the infection occurs, UTIs negatively affect patients' social and personal connections, which lowers their quality of life [2]. Common antibiotics are losing their effectiveness against a growing number of uropathogens. Because of this resistance, UTIs are more difficult to treat, which may result in longer hospital stays, higher medical expenses, and a higher chance of complications [3]. Current trend analysis aids in identifying the precise resistance strains and guides development of newer medicines or antibiotic substitutes. Research has concentrated on treatments and diagnosis, which may have restricted our comprehension of the perspective of the patient. Qualitative evidence synthesis (QES) is the process of compiling the results of qualitative research so that they can be used for clinical practice, education, and policymaking. The aim is to enhance knowledge transmission in order to more accurately understand this health experience and advance healthcare.

Pathophysiology and Risk Factors

The bacteria that most frequently cause urinary tract infections are the same ones that invade stomach and then spread to the urinary tract after invading peri-urethral region. Bacteria ascending from the urethra to the bladder are the most frequent way that infections occur. Women's anatomy, including the shorter urethra and its closer proximity to the anus, makes UTIs more likely in them [4]. It has also been demonstrated that a number of other factors, most notably sexual activity and spermicide use, raise the incidence of UTI in women. It is believed to have an influence on the vaginal micro biota, causing a decline in lactobacilli and a rise in dangerous Gram-negative bacteria, i.e., *E. coli*, to colonize the genital area. *K. pneumoniae*, this bacterium is the second most common cause of bacteremia, or bloodstream infections, linked to UTI infections, behind *E. coli* and *P. mirabilis* is more likely to cause infection of unusual urinary tract, such as a persistent catheter, although it can also cause a simple UTI. Pathogens that

are gram-positive in the three types of staphylococci that cause urinary tract infections are *Staphylococcus aureus*, *S. saprophyticus*, and other coagulase-negative staphylococci. Women who have gone through menopause are most at risk for recurring UTIs. Lower oestrogen level increases the possibility of vaginal atrophy, which affects the vaginal microbial flora by decreasing the percentage of ('protective') lactobacilli and causing vaginal dryness and elevated PH.

Clinical Presentation and Classification

The term "UTI" relates to the infection site. Urethritis is the inflammation of urethra, urethritis is inflammation of ureter, and pyelonephritis and cystitis are infections of the kidney and bladder, respectively. Uropathogens that live in the intestine and migrate to the bladder after unintentionally contaminating the urethra are typically the source of UTIs [5]. Three or more uncomplicated UTIs in a 12-month period or two or more infections in a 6-month period are considered recurrent UTIs; often, the same microbe that is responsible for the initial infections causes recurrences in that kind of infection.

Diagnostic Approaches

One of the most significant and major issues facing world health is the detection of urinary tract pathogens. Moreover, a bacterial count of 100,000 CFU/mL or above is known to be diagnostic of a UTI, due to this value, false negative results occur that miss many serious infections. By analyzing the bacterial culture in the patient's urine, UTIs can be identified. Quantitative urine culture is the gold standard method; however, it takes around 24 hours to get results, and another 24 hours are needed for antibiotic susceptibility testing [6]. When the number of bacteria in a urine sample is more than 105 CFU/mL, it is generally considered a positive marker of a symptomatic UTI. The test has a larger plate content and a longer incubation period than traditional urine culture, which makes it possible to identify slow-growing bacteria more accurately. The further technique is PCR or immunoassay technique, which are quick, but prior has a restriction of background contamination by external sources of DNA. With every acute episode, dipstick and culture are advised by the AUA/CUA/SUFU and COMEGO criteria. 180 micro culture wells are included in dipsticks [7] which are used in three stages: incubation, digital picture analysis with a cell phone, and dip-and-slide inoculation. This work focuses on the red-marked area.

Antimicrobial Therapy: Current Practices

Most UTIs are caused by gram-negative bacteria and are also becoming a greater public health issue due to their ability to acquire encoding extended-spectrum β -lactamases genes that are located on transferable plasmids. ESBL-positive *E. coli* has been associated with community-onset UTIs in a number of cases. Bacterial resistance to the beta-lactams and quinolones drugs classes, which is mostly acquired by intraspecies or cross-species transmission of plasmids containing genes resistant to antibiotics [8].

International recommendations recommend nitrofurantoin, fosfomicin, trometamol, and pivmecillinam as first-line antibiotics. It is suggested to use trimethoprim/sulfamethoxazole in regions where *E. coli* resistance is known to be less than 20%. Cephalosporin is another option for second-line treatment. Notably, it is advised that the course of treatment be brief, typically lasting one to five days. The most promising new antibiotics being developed to treat UTIs are gepotidacin and two oral carbapenems, sulopenem and tebipenem [9]. For the treatment of sudden onsets in patients with UTI, all guidelines suggested short (less than seven days) courses of antibiotics as compared to longer ones.

Challenges in UTI Management

Antimicrobial resistance is seen as a current global threat, and uropathogenic bacteria are exhibiting similar patterns globally. The USA conducted a study on antibiotic resistance changes in relation to *E. coli*, the primary cause of UTIs, between 2003 and 2012. ESBLs that are encoded on plasmids and typically carry other resistance genes against various antibiotic classes; they present a public health concern. ESBL-producing *Enterobacteriaceae*, which had a prevalence of 12.1%, which is lower than the prevalence for ESBL-producing *Enterobacteriaceae*, which are described in hospitalized patients in Europe (20%) and North America is (16.9%). There are other various resistance mechanisms in UTI pathogens that vary in their prevalence based on the local epidemiological settings, along with the prominent resistance mechanisms which have already been mentioned for ESBLs from the CTX-M, TEM, and SHV families already. Numerous approaches, e.g. use of bacteriocins, antimicrobial peptides, and antibiotic combinations, have attempted to cure infections caused by resistant organisms. Globally, there is increasing concern about UTI misdiagnosis [10]. An estimated 40% of UTI infections in patients over 65 in UK hospitals were misdiagnosed, which resulted in an over-prescription of antibiotics and aided in the rise of antibiotic resistance.

Non-Antibiotic Preventive Strategies

Alternative therapy can be studied as a preventive strategy for UTIs, apart from administering low-dose antibiotics to prevent UTIs and treating symptomatic acute cystitis, though there is currently no evidence of their effectiveness. Topical Estrogen Therapy and the Vaginal Laser Therapy, Through the following mechanisms, vaginal oestrogen transition further limits UTIs and reduces uro-pathogen vaginal colonization, An increase in the Lactobacillus population causes the vaginal pH level to become more acidic while restoring the vaginal flora to a premenopausal state. Reduction of uro-pathogen replication and also strengthening the uroepithelium's antibacterial capacity by stimulating antimicrobial peptides expression and an increase in the expression of intercellular junction proteins can also help prevent UTI. In this way, consuming probiotics beneficial bacteria can help maintain a healthy urinary system, which is free of harmful germs [11]. A class of probiotics called lactobacilli assists in the treatment of UTIs by inhibiting the adherence of bacteria with the cells of the urinary system. Others include Cranberries, D-mannose, glycosaminoglycan (GAG)-layer substituents, and also vaccinations that target bacterial adherence, are examples of anti-adhesive therapies. Numerous researchers have examined the potential of cranberries to prevent and treat urinary tract infections. Cranberries can reduce bacterial adherence to uroepithelial cells and lower the prevalence of UTIs. Maintaining good genital hygiene is essential to prevent genital infections and the potentially dangerous outcomes they might cause. Vaginal douching, which is frequently used to keep female genitalia clean.

Future Directions and Innovations

There are several basic strategies to lower the risk of UTI. The most significant risk factor for the occurrence of bacteriuria, which can occur in

3–7% each day, and UTIs, which can occur 0.3% each catheter day, is the duration of catheterization. Reduced use of catheters and their removal as medically possible are therefore the most crucial interventions. Regarding the antibiotics prophylaxis in the context of long-term persistent catheter [12]. It has been demonstrated that a sublingual vaccination made of inactivated whole bacteria can effectively lower the incidence of UTI recurrences nine months after the vaccine is administered in addition to the patient's potential drug sensitivities, the antibiotic that is recommended needs to account for local trends of uropathogen resistance. These days, it is evident that microbiota plays a major part in the pathophysiology of UTIs, and as a result, using antibiotics only is not only inefficient but also harmful. Support vector machines (SVM), random forests (RF), gradient boosting decision trees (GBDT), and artificial neural networks (ANN) are examples of popular machine learning techniques [13].

Conclusion

One of the most significant advancements in medical history and the turning point in the 20th century was the creation of antimicrobial therapy. Resistance has emerged as a result of misuse of some medicines, highlighting the significance of choosing therapies based on evidence. The quality of life is lower for patients who experience recurring UTIs as a result of treatment failure brought on by antibiotic-resistant bacteria. Empirical antibiotic treatment should be restricted to situations in which symptoms are severe infection is suspected. Targeting numerous infectious mechanisms which were expected to be a future trend in UTI care in order to minimize antibiotic resistance, lower the incidence of UTIs, and use less drugs. Early diagnosis and effective pathogen treatments are necessary, and rapid diagnostic procedures should be used. Patient care is affected by the clinical microbial threshold guidelines for UTI diagnosis. Based on SUC data, US regulatory agencies think that there are clinically recognized thresholds for identifying the presence of a UTI.

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