

URINARY TRACT INFECTIONS AND THEIR CAUSATIVE PATHOGENS

N.M. Moydinova¹,M.Sh. Mominov²

Lecturer of the Department of Natural and
Medical Sciences Andijan Branch, Kokand
University, Andijan, 170100, Uzbekistan¹
Bachelor Student, Faculty of Medicine,

Andijan Branch, Kokand University, Andijan, 170100, Uzbekistan²

moydinovanurxon159@gmail.com¹

<https://orcid.org/0009-0003-9978-6276>²

Abstract:

Urinary tract infections (UTIs) are among the most common pathological conditions in urology, affecting individuals of various age groups and potentially leading to serious complications. This article provides a comprehensive analysis of the etiological factors, microbiological characteristics, and pathogenesis of UTIs, as well as the causative microorganisms, based on current scientific evidence. Diagnostic criteria are established using modern laboratory and instrumental methods and are discussed in correlation with relevant clinical and hygienic recommendations. Furthermore, contemporary treatment strategies for microorganism-induced urinary tract diseases are reviewed, including the principles of antibacterial therapy and the significance of symptomatic and pathogenetic approaches. Preventive measures—such as lifestyle modification, hygienic practices, and pharmacological prophylaxis—are also highlighted based on strong scientific evidence. This study has substantial scientific

and practical value, aiming to deepen the understanding of the clinical course of UTIs and to enhance the effectiveness of their diagnosis and treatment.

Keywords:

Urinary tract infection, hematuria, cystitis, urethritis, etiology, pathogenesis, diagnosis, laboratory investigations, instrumental investigations, treatment, antibiotic susceptibility testing (antibiogram), prevention, urological standards.

Introduction: Urinary Tract Infections (UTIs)

Urinary tract infections (UTIs) are among the most common diseases in urology. They affect patients of all age groups and, if left untreated, may cause damage to the kidneys and other organs. UTIs are particularly prevalent among women: approximately one in two women and one in five men experience at least one episode of UTI during their lifetime. Moreover, UTIs represent one of the most frequent hospital-acquired infections, occurring in up to 40% of catheterized hospitalized patients.

1. Routes of UTI Development

UTIs develop through three principal pathways:

- **Ascending route:** The most common and primary pathway, in which infection ascends from the lower urinary tract (urethra or bladder) to the kidneys, leading to pyelonephritis. Due to the shorter urethra, women are at a higher risk of ascending infection.
- **Hematogenous route:** Infection reaches the kidneys via the bloodstream from other organs and is usually associated with upper urinary tract infections.
- **Lymphogenous route:** A relatively rare pathway, also typically linked to upper urinary tract infections.

2. Causative Agents of Infection

Bacterial pathogens: *Escherichia coli* (80–90%), *Klebsiella pneumoniae*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Staphylococcus saprophyticus*, and *Streptococcus agalactiae*.

Viral and fungal pathogens: Adenoviruses (particularly in children and immunocompromised patients) and *Candida* spp. (commonly observed in catheterized patients or those receiving immunosuppressive therapy).

Note: *Proteus mirabilis* produces urease, which alkalinizes urine and promotes the formation of urinary calculi.

3. Pathogenesis and Clinical Manifestations

3.1. Bacterial Adhesion

Bacteria adhere to epithelial cells, initiating colonization and simultaneously triggering the inflammatory response. The adhesion process depends on the ability of microorganisms to attach to epithelial surfaces and plays a critical role in the onset and progression of infection. *Proteus mirabilis* produces the enzyme urease, which alkalinizes urine and promotes the formation of urinary calculi. In an alkaline environment, calcium and magnesium salts lose their solubility, leading to the formation of struvite precipitates.

3.2. Clinical Symptoms

The clinical manifestations of UTIs depend on the localization and stage of the infection.

Lower urinary tract infections (cystitis, urethritis):

- Dysuria – pain and burning during urination

- Pollakiuria – frequent urination with small urine volumes
- Pyuria – presence of pus in the urine
- Hematuria – presence of blood in the urine
- Pressure-like pain in the suprapubic and lower abdominal regions

Upper urinary tract infections (pyelonephritis):

- Flank pain, often unilateral
- Fever (38–40°C)
- Chills, rigors, nausea, and vomiting
- General weakness

Chronic infection:

- Mild or poorly expressed symptoms
- Periodic exacerbations
- Persistent discomfort in the lumbar and suprapubic regions
- Low-grade subfebrile temperature (37–37.5°C)

4. Diagnosis

Urinalysis: assessment of leukocytes, erythrocytes, nitrites, and proteinuria.

Nechiporenko test: quantitative determination of leukocytes, erythrocytes, and casts in urine.

Bacteriological culture and antibiotic susceptibility testing (antibiogram): identification of the causative pathogen and selection of appropriate antimicrobial therapy.

Laboratory tests: complete blood count, C-reactive protein (CRP), serum creatinine, and urea levels.

Instrumental investigations: ultrasonography (USG), cystoscopy, urography, computed tomography (CT), and magnetic resonance imaging (MRI).

Neurogenic bladder: results from damage to the central or peripheral nervous system, leading to incomplete bladder emptying, frequent urination, or impaired reflex control.

5. Treatment

Etiotropic therapy: Antibacterial treatment targeting the primary causative pathogens, as bacteria are the main etiology of UTIs.

Pathogenetic therapy: Interventions aimed at interrupting the mechanisms of disease progression.

Symptomatic and adjunctive therapy: Includes analgesics, antispasmodics, probiotics, and phytotherapy to alleviate symptoms and support recovery.

6. Prevention and Healthy Lifestyle Measures

- Adequate daily fluid intake (1.5–3 liters per day)
- Avoid prolonged urine retention
- Protection from cold exposure and wearing breathable, natural clothing
- Maintaining personal hygiene
- Strengthening the immune system
- In cases of recurrent infections, prophylactic antibacterial therapy under medical supervision

7. Risk Factors for Urinary Tract Infections

Several risk factors play a significant role in the development, recurrence, and severity of UTIs. Major risk factors include:

- Female sex (due to the shorter urethra)
- Pregnancy
- Diabetes mellitus
- Immunosuppression
- Presence of urinary tract calculi
- Prolonged urine retention
- Long-term catheterization
- Neurogenic bladder
- Prostatic enlargement in men

These factors contribute to urinary stasis, creating favorable conditions for microbial proliferation.

8. Special Clinical Considerations

8.1. UTIs During Pregnancy

In pregnant women, hormonal changes and uterine enlargement can compress the urinary tract, leading to reduced urine flow and increased susceptibility to infection. Even asymptomatic bacteriuria during pregnancy may progress to pyelonephritis. Therefore, early detection of UTIs and treatment with safe antibiotics are essential in pregnant patients.

8.2. UTIs in Children

In children, UTIs are often associated with congenital anomalies, vesicoureteral reflux, or inadequate adherence to hygiene practices. Clinical manifestations may include general weakness, fever, and loss of appetite.

8.3. UTIs in the Elderly

In elderly patients, UTIs often present atypically. Classical symptoms may be absent; however, confusion, weakness, and deterioration of the general condition are commonly observed. Such atypical presentations frequently result in delayed diagnosis.

9. Recurrent Urinary Tract Infections

If a patient experiences two to three or more episodes of UTIs within a year, the condition is considered recurrent. Recurrent UTIs may be associated with the following factors:

- Incompletely treated primary infection
- Inappropriate selection of antibiotics
- Self-medication or improper use of antibiotics
- Anatomical abnormalities
- Chronic inflammatory foci

In such cases, extended diagnostic evaluation and an individualized treatment plan are required.

10. Modern Principles of Antibacterial Therapy

Antibacterial treatment should be guided by the susceptibility of microorganisms to antibiotics. Empirical selection of drugs without performing an antibiogram may lead to the development of antimicrobial resistance.

Key principles include:

- Antibiotics should be taken only under medical supervision
- Complete the full course of therapy
- Do not discontinue treatment after symptom resolution

- In recurrent cases, low-dose prophylactic therapy may be indicated

11. Complications of Urinary Tract Infections

Untreated or late-diagnosed UTIs may lead to the following complications:

- Chronic pyelonephritis
- Renal failure
- Urosepsis
- Scarring of the renal parenchyma
- Arterial hypertension

Complications are particularly severe in children and pregnant women.

Conclusion

In conclusion, renal failure is a clinically and socially significant condition in modern medicine. This pathology results from impairment of the kidneys' filtration, excretory, and secretory functions, negatively affecting the patient's overall health and quality of life. Urological disorders—including urinary tract obstruction, prostatic diseases, urolithiasis, and chronic inflammatory processes—play a crucial role in the development of renal failure.

Early detection and timely management of the disease are essential for preserving kidney function. Therefore, accurate urological diagnosis, extensive use of instrumental and laboratory investigations, and individualized treatment strategies are of paramount importance. Addressing underlying urological causes in both acute and chronic renal failure helps prevent disease progression and associated complications.

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