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### Urinary Tract Infection

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# Urinary Tract Infection

Amanda Weilbacher RN

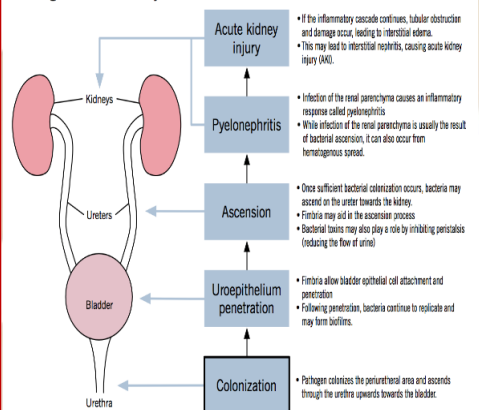
Otterbein University, Westerville, Ohio

## Introduction

Urinary tract infection (UTI) is a common infection that affects numerous men and women throughout their lives. UTI is an inflammation of the urinary epithelium often caused by bacteria from the gastrointestinal tract or vaginal colonization when uropathogens adhere to uroepithelial cells and travel up the urethra (Zak, 2014). UTI is the second most common infection in the use of antimicrobial treatment in primary and secondary care settings (McLafferty, Johnstone, Hendry, & Farley, 2014). The prominence of UTIs and the increased antimicrobial resistance in the population has created a need for further knowledge of UTI pathology and its prevention in primary care settings. Over six to eight million cases of uncomplicated UTIs occur in the United States annually, with greater than 80% associated with the *Escherichia coli* (*E. coli*) bacteria, and contributing an estimated one to two billion dollars in healthcare costs annually (Vincent et al., 2010). Advanced Practice Nurses (APNs) must be knowledgeable of the causes, symptoms and pathophysiology of UTI to care for their patients (Nazarko, 2014).

Clinically, UTIs are defined as complicated and uncomplicated. Complicated UTIs are defined as UTIs associated with components that jeopardize the host defense, such as urinary obstruction, neurologic disease that inhibits urinary drainage, renal failure, renal transplantation, renal calculi and urinary catheters; Uncomplicated UTIs affect individuals who are otherwise healthy, and without structural urinary tract abnormalities (Flores-Mireles, Walker, Caparon, & Hultgren, 2015). UTIs are also differentiated by the location, cystitis (lower) and pyelonephritis (upper) of the urinary tract. The fecal flora, which includes *E. coli*, is the usual uropathogen and depending on the host's defense system, can ascend the urinary tract from urethra to the bladder (cystitis) and possibly later manifestation in the kidney (pyelonephritis) (Zak, 2014).

Pathogenesis of urinary tract infection



## Causes & Signs & Symptoms

The pathogenesis of UTIs encompass three components of infection: host, pathogen, and environment. The severity of the infection can be determined by the innate defense mechanism of the individual and the virulence of the pathogen. Genetics have also been noted to suggest a familial predisposition to UTIs, specifically in the Toll-like receptor gene pathway (Zaffanello et al., 2010).

### Structural defenses of the urinary tract

- Sterile urine which aids in elimination of waste materials
- Mucosal lining of the lower two-thirds of the urethra in both men and women
- Ability of the bladder to contract and remove urine, and the sphincters of the urethra which inhibit backflow (Casey, 2014).
- The acidic pH and soluble factors in urine contribute to the host defense by flushing out pathogens and by Tamm-Horsfall proteins which bind to bacteria preventing adherence to the cell lining of the urinary tract (Casey, 2014).

### Causes of UTI

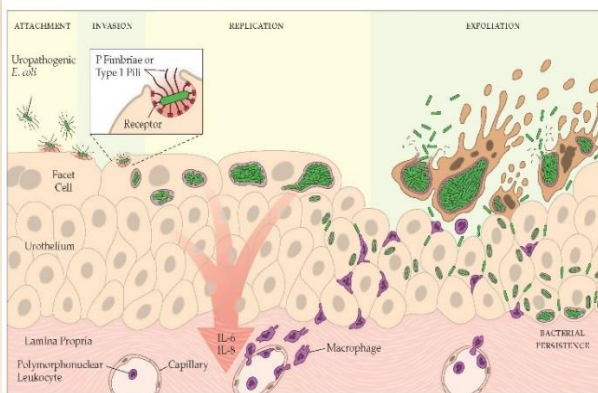
- Gram-negative and Gram-positive bacteria, as well as fungi can cause UTIs.
- The most common causative agent for UTI is uropathogenic *Escherichia coli* (UPEC), but can also be caused by *Klebsiella pneumoniae*, *Staphylococcus saprophyticus*, *Enterococcus faecalis*, group B *Streptococcus* (GBS), *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Candida* spp (Flores-Mireles et al., 2015).

### Signs & Symptoms:

- Dysuria
- Fever
- Urinary frequency/ Urgency
- Flank pain
- Nocturia
- Suprapubic pain
- Hematuria
- Nausea/ Vomiting
- Pyuria
- Nitrates in the urine
- Malodorous urine
- Leukocytes in urine

## Pathophysiology

Periurethral contamination by an uropathogen residing in the gut usually initiates the infection, followed by colonization of the uropathogen in the urethra, and migration of the pathogen to the bladder (Nazarko, 2014). Adherence of the pathogen to the uroepithelial by appendages such as pili and flagella aid in the pathogen ascension of the genitourinary tract and colonization (Flores-Mireles et al., 2015). At this point, the host inflammatory response is initiated, including neutrophil infiltration, release of prostaglandins, and contribution of reactive oxygen species which aid in bacterial destruction, but also are instrumental in host cell damage (Casey, 2014). The influx of neutrophils and other white blood cells (WBCs) can lead to edema of the bladder wall, which leads to supra-pubic pain. Some of the WBCs are also excreted during urination which leads to cloudy urine and the presence of leukocytes in urinalysis (McLafferty et al., 2014).



Many bacteria begin the evasion of host defenses by production of biofilms, bacterial morphologic changes, and multiplication. The ascending migration to the bladder allows the pathogen to bind to the bladder epithelium, comprised of umbrella cells, which includes uroplankins, a major protein component that form a crystalline array that protects the mammalian bladder from toxins in the urine (Flores-Mireles et al., 2015). The adherence, colonization, and invasion on the uroepithelium, specifically the bladder, enables the pathogen to produce toxins and proteases which release iron and nutrients from the damaged host cells and feed the pathogen growth. (Flores-Mireles et al., 2015). If host defenses are insufficient, the pathogens are able to migrate to the kidneys which can lead to bacteremia if the tubular epithelial barrier of the kidneys is breached (Barber, Norton, Spivak, & Mulvey, 2013). The most common symptoms of UTI are dysuria, nocturia, polyuria, suprapubic tenderness, hematuria, increased frequency of urination, discomfort with micturition, malodorous urine, and in the older population, sometimes confusion or altered mental status (Caterino, Sisbarro, Espinola, & Camargo, 2012) (Nazarko, 2014) (McLafferty et al., 2014) (Sheerin, 2015).

## Presentation of Case

Mrs. Jones is a 47 year old female who complains of urinary urgency, feeling like she has to void, but urinates very little, has some burning with urination, and suprapubic tenderness. Mrs. Jones has very little past medical history other than three uncomplicated vaginal births over twenty years ago, has been told she is pre-diabetic, and is mildly obese. A urinalysis is obtained, demonstrating the presence of leukocytes, nitrites, and glucose. Mrs. Jones bladder is palpable, suprapubic tenderness is noted. Mrs. Jones admits to recent sexual activity, current practice of incorrect wiping after urination, and "eating a lot of sugar". Mrs. Jones is diagnosed with a UTI with a urine culture pending. She is initiated on trimethoprim/sulfamethoxazole and educated on the correct post voiding wiping of front to back and the importance of increasing her water intake, and voiding post coitus.

## Significance of Pathophysiology

UTI is one of the most common infections that affects 40% of women and 12% of men during their lives, and accounts for seven million clinic visits per year (Sheerin, 2015). APNs are likely to see patients with UTIs and must be cognizant of the pathophysiology of UTI and also the changes that occur in the urogenitary system with age. Age related changes include decreased contractility of the bladder walls, leading to residual urine in the bladder, decreased acidity of the perineum and vagina due to menopause, and a strong correlation between an enlarged prostate, or benign prostatic hyperplasia and the development of UTI in older men (McLafferty et al., 2014). The hormonal changes that occur with aging can also lead to less acidic perineum and vagina (Nazarko, 2014). The changes decrease the first line of defense against pathogens associated with UTI. Women also have increased risk of UTI due to the shorter length of their urethra of approximately 5 cm, thus being more readily and easily prone to migratory micro-organisms; while men have longer urethras measuring approximately 15cm in length, providing a better defense (Nazarko, 2014). Cardiovascular Disease and dyslipidemia have also shown to increase the risk for UTI in older men (Nazarko, 2014).

UTI treatment varies depending on the type of pathogen, its virulence, and the extent of the infection. Acute cystitis is the most common bacterial infection and one of the most common in the United States (Barber, Norton, Spivak, & Mulvey, 2013). According to the Agency for Healthcare Research and Quality (AHRQ), the first line antibiotic treatment of uncomplicated UTI (which includes cystitis) is trimethoprim/sulfamethoxazole or nitrofurantoin, and the second line antibiotics ciprofloxacin, levofloxacin, amoxicillin, or first generation cephalosporin unless otherwise contraindicated (U.S. Department of Health and Human Services, 2016). Due to the nature of the pathogen and its ability to invade, replicate and persist within the hosts epithelial cells, the over use of antibiotics, and the lack of education regarding UTIs, many UTIs are recurrent (Barber et al., 2013).

## Conclusion

UTIs are one of the most common bacterial infections accruing billions of dollars in health care costs yearly (Flores-Mireles et al., 2015). The variety of uropathogens and the overarching range of virulence factor in addition to the rising threat of antimicrobial resistance comminates the only viable treatment option of antibiotics (Vincent et al., 2010) (George, Norman, Ramana, Mukjerjee, & Rao, 2015). Research on the identification of the mechanisms of virulence and which act prophylactically against uropathogens, specifically the initial attachment of the bacteria through adhesion, without altering the normal flora show promise in the prevention of UTI (Flores-Mireles et al., 2015). Patient education is also vital to treatment and prevention of UTI. Correct wiping motion of front to back for women, post coitus voiding for both males and females aids in preventing uropathogens from entering the urinary system, and increasing water intake to flush bacteria from the bladder can all aid in prevention of UTI (Armstrong, 2015) (Tehrani & Nikpour, 2014). APNs must also consider the comorbidities, such as diabetes or chronic kidney disease, of patients with recurrent UTIs in concordance with the UTI pathology (Armstrong, 2015). The treatment of UTIs and recognition of the causes, symptoms, and presentation, and the education of patients enables the APN to provide the most competent care for patients.

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