Part 1: UTI in urology (Surgical UTI)

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UTI definitions

- UTI is an inflammatory response of the urothelium to bacterial invasion.
- Usually associated with bacteriuria and pyuria
- **Bacteriuria** is the presence of bacteria in the urine, which is normally free of bacteria (either bacterial colonization or infection, or contamination)
- Significant bacteriuria: when the number of bacteria in a suprapubically aspirated, catheterized, or voided specimen exceeds the number usually caused by contamination of the skin, the urethra, or the prepuce or introitus.

UTI definitions

- **Pyuria,** the presence of white blood cells (WBCs) in the urine.
- Indicates: infection or an inflammatory response to bacterium, stones, or other indwelling foreign body.
- Pyuria without bacteriuria warrants evaluation for tuberculosis, stones, or cancer.

➔ UTIs classified **clinically** by their presumed site of origin:

- ***Cystitis***: clinical syndrome of dysuria, frequency, urgency, and occasionally suprapubic pain
- ***Acute pyelonephritis*** is a clinical syndrome of chills, fever, and flank pain that is accompanied by bacteriuria and pyuria

UTI definitions

- **Complicated vs Uncomplicated UTI:**
- **Uncomplicated**: infection in a healthy patient with a structurally and functionally normal urinary tract.
- Usually women with bacterial cystitis or acute pyelonephritis, and bacteria are usually susceptible to a short course of oral antimicrobial therapy.
- **Complicated infection**: + factors that increase the chance of acquiring bacteria and decrease the efficacy of therapy.
- Structurally or functionally abnormal urinary tract, compromised host, increased virulence or antimicrobial resistance of bacteria

Factors That Suggest a Complicated UTI

- Functional or anatomic abnormality of urinary tract
- Male gender
- Pregnancy
- Elderly patient
- Diabetes
- Immunosuppression
- Childhood urinary tract infection
- Recent antimicrobial agent use
- Indwelling urinary catheter
- Urinary tract instrumentation
- Hospital-acquired infection
- Symptoms for more than 7 days at presentation

Definitions

- **Functional abnormalities**:
- I) Renal diseases that reduce the concentrating ability of the kidney: e.g. postobstructive nephropathy, sickle cell nephropathy, lithium nephropathy, chronic tubulointerstitial nephritis, and inherited diseases such as medullary cystic kidney disease
- II) voiding dysfunction that alter bladder-emptying capabilities: enlargement of the prostate or congenital or acquired sites of residual urine, such as calyceal or urethral or bladder diverticula, BOO, neurogenic bladder

Definitions

- UTIs may also be defined by their relationship to other UTIs:

I) **First** or **isolated** infection is one that occurs in an individual who has never had a UTI or has one remote infection from a previous UTI

II) **Unresolved** infection is one that has not responded to antimicrobial therapy and is documented to be the same organis with a similar resistance profile

III) **Recurrent** infection is one that occurs after documented, successful resolution of an antecedent infection.

Definitions

- Types of **Recurrent Infections**:

I) **Reinfection** describes a new event associated with reintroduction of bacteria into the urinary tract.

2. **Bacterial persistence** refers to a recurrent UTI caused by the same bacteria reemerging from a focus within the urinary tract, such as an infectious stone or the prostate.

UTI: EPIDEMIOLOGY

- UTIs are the most common bacterial infection.
- The most common primary diagnoses for women visiting the emergency department
- **CAUTIs are the most common nosocomial infection,** constituting more than 80% of nosocomial UTIs
- **Once a patient has an infection, he or she is likely to develop subsequent infections**
- Nearly 30% of women have had a symptomatic UTI requiring antimicrobial therapy by age 24, and
- Almost half of all women experience a UTI during their lifetime.

UTI: EPIDEMIOLOGY

- 20-40% of women who have had one previous cystitis episode are likely to experience an additional episode.
- 25-50% of whom will experience multiple recurrent episodes
- The incidence of UTIs is also elevated during pregnancy and in patients with spinal cord injury (SCI), diabetes, multiple sclerosis, organ transplant recipients, and human immunodeficiency virus (HIV) infection/acquired immunodeficiency syndrome (AIDS)
- No clear association has been described between recurrent uncomplicated UTIs and renal sequelae such as scarring, hypertension, or progressive renal insufficiency

UTI: PATHOGENESIS

- **UTIs occur as a result of interactions between the uropathogen and the host.**
- **Successful infection of the urinary tract is determined in part by the virulence factors of the bacteria, the inoculum size, and the inadequacy of host defense mechanisms.**
- These factors also play a role in determining the ultimate level of colonization and damage to the urinary tract

UTI: PATHOGENESIS

I) Routes of Infection:

A) Ascending Route: Most bacteria enter the urinary tract from the bowel through the urethra into the bladder.

- Bacterial Adherence to the introital and urothelial mucosa plays a significant role in ascending infections.
- Added Risks for this: significant soilage of the perineum with feces, use spermicidal agents, and intermittent or indwelling catheters.

UTI: PATHOGENESIS

- **B)** Hematogenous Route: the kidney is occasionally secondarily infected in patients with Staphylococcus aureus bacteremia originating from oral sites or with Candida fungemia
- **C)** Lymphatic Route: Direct extension of bacteria from the adjacent organs via lymphatics. Such as a severe bowel infection or retroperitoneal abscesses
- **D)** Direct extension of bacteria from adjacent organs (intraperitoneal abscesses or vesicointestinal or vesicovaginal fistulas)

UTI: PATHOGENESIS

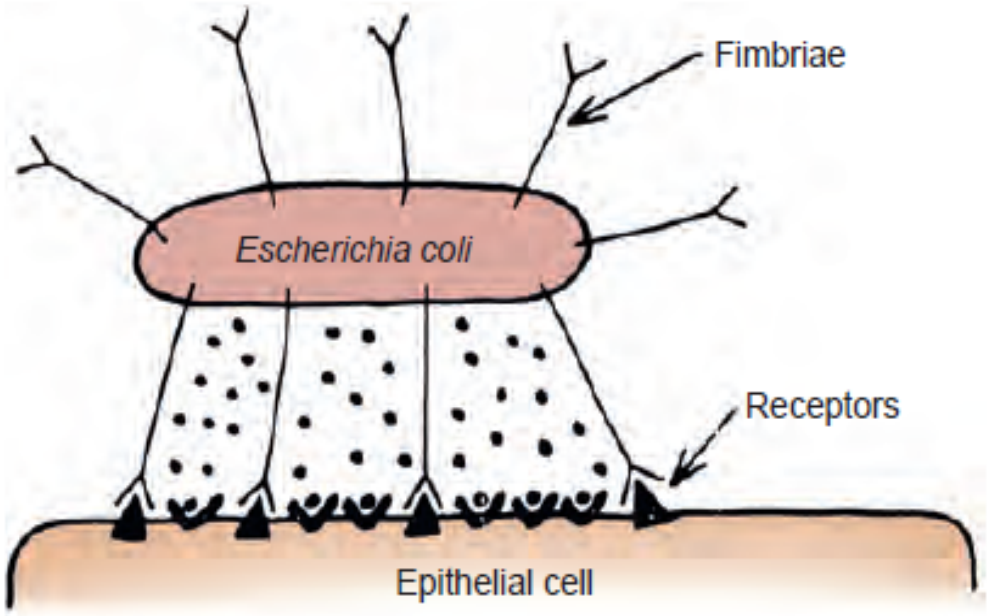
- II) Bacterial Virulence Factors:
- Virulence characteristics play a role in determining if an organism will invade the urinary tract and the subsequent level of infection within the urinary tract
- Uropathogenic strains in the bowel flora, such as UPEC, can infect the urinary tract not only by chance but also by the expression of virulence factors that enable them to adhere to and colonize the perineum and urethra and migrate to the urinary tract.

UTI: PATHOGENESIS

- II) Bacterial Virulence Factors:
- ***E. coli* is by far <u>the most common cause</u> of UTIs, accounting for 85% of community-acquired and 50% of hospital-acquired infections**
- A) Bacterial Adherence: Bacterial adherence is a specific interaction that plays a role in determining the organism, the host, and the site of infection.
- ➔ Bacterial Adhesins:

UTI: PATHOGENESIS

- Bacterial Adhesins: are classified as either **fimbrial (Pili)** or **afimbrial.**
- Pili are defined functionally by their ability to mediate hemagglutination of specific types of erythrocytes.
- The most well-described pili are types 1, P, and S



Bacterial adherence. Adhesins on pili (fimbriae) mediate attachment to specific epithelial cell receptors.

UTI: Natural Defenses of UT

- I) The normal flora of the vaginal introitus, the periurethral area, and the urethra usually contain microorganisms such as lactobacilli, coagulase-negative staphylococci, corynebacteria, and streptococci that form a barrier against uropathogenic colonization
- II) Urine: osmolality, urea concentration, organic acid concentration, & pH.
- Bacterial growth is inhibited by either very dilute urine or a high osmolality when associated with a low pH

UTI: Natural Defenses of UT

- II) Urine: Uromodulin (Tamm-Horsfall protein), a kidney-derived mannosylated protein play a defensive role by saturating all the mannose-binding sites of the type 1 pili, thus potentially blocking bacterial binding the urothelium
- III) Bladder: Bacteria make their way into the bladder fairly often. Whether small inocula of bacteria persist, multiply, and infect the host depends in part on the ability of the bladder to empty

Clinical Presentation

- *Dysuria* is central in the diagnosis of UTI; other symptoms of *frequency*, *urgency*, *suprapubic pain*, and *hematuria* are variably present.
- Acute-onset dysuria is a highly specific symptom, with more than 90% accuracy for UTI in young women in the absence of concomitant vaginal irritation or increased vaginal discharge
- **Diagnosis:** Typically, for a diagnosis of cystitis, acute-onset symptoms should occur in conjunction with the laboratory detection of a uropathogen from the urine.

Diagnosis

- *Urine Collection:*
- 1) Voided Specimen (MSU): In circumcised men, voided specimens require no preparation
- In uncircumcised men, the foreskin should be retracted and the glans penis washed with soap and then rinsed with water before specimen collection
- The female should be instructed to spread the labia, wash and cleanse the periurethral area with moist gauze

Diagnosis: *Urine Collection:*

- 2) Catheterized Specimens: Diagnostic accuracy can be improved by reducing bacterial contamination.
- It carries a risk of iatrogenic infection
- Catheterization of a male patient for urine culture is not indicated unless the patient cannot urinate
- 3) Suprapubic Aspiration: is highly accurate, but because it carries some morbidity there is limited clinical usefulness except for a patient who cannot urinate on command, such as patients with spinal cord injuries, and useful in neonates

Diagnosis

- ***I) Urinalysis***: For patients with urinary symptoms, microscopic urinalysis for bacteriuria, pyuria, and hematuria should be performed
- Microscopic bacteriuria is found in >90% of infections with counts of 10^5 cfu/ml of urine or greater and is a highly specific finding.
- Bacteria are usually not detectable microscopically with lower colony count infections (10^2 to 10^4/mL). (i.e., a false-negative result)
- The second error of urinalysis (i.e., a false-positive result) is bacteria are seen in the microscopic sediment, but the urine culture shows no growth
- ➔ lactobacilli and corynebacteria are readily seen under the microscope; and although they are gram-positive, they often appear gram-negative (gram-variable) if stained

Diagnosis

- ***I) Urinalysis***: midstream urine specimen can be questioned if numerous squamous epithelial cells (indicative of preputial, vaginal, or urethral contaminants)
- The presence of bacteriuria has a sensitivity for UTI of 40% to 70%, and a specificity of 85% to 95%, depending on the number of bacteria observed
- Pyuria: at least 5 to 10 leukocytes per high-power field, The absence of pyuria should cause the diagnosis of UTI to be questioned until urine culture results are available
- Significant pyuria in the absence of bacteriuria: TB, staghorn calculi and stones of smaller size, any injury to the urinary tract, chlamydial urethritis, glomerulonephritis and interstitial cystitis.

Diagnosis

- ***II) Rapid Screen Methods: (dipstick)***
- bacteria reduce the nitrate normally present in urine to **nitrite**.
- Pyuria: by determining leukocyte esterase activity
- But due to substantial variability in the sensitivity and specificity results, their main role is in screening asymptomatic patients and do not replace careful microscopic urinalysis in symptomatic patients
- Although dipsticks are most helpful in ruling out a UTI, each parameter has false positives and negatives, which make it less reliable in determining whether a patient has a UTI

Diagnosis

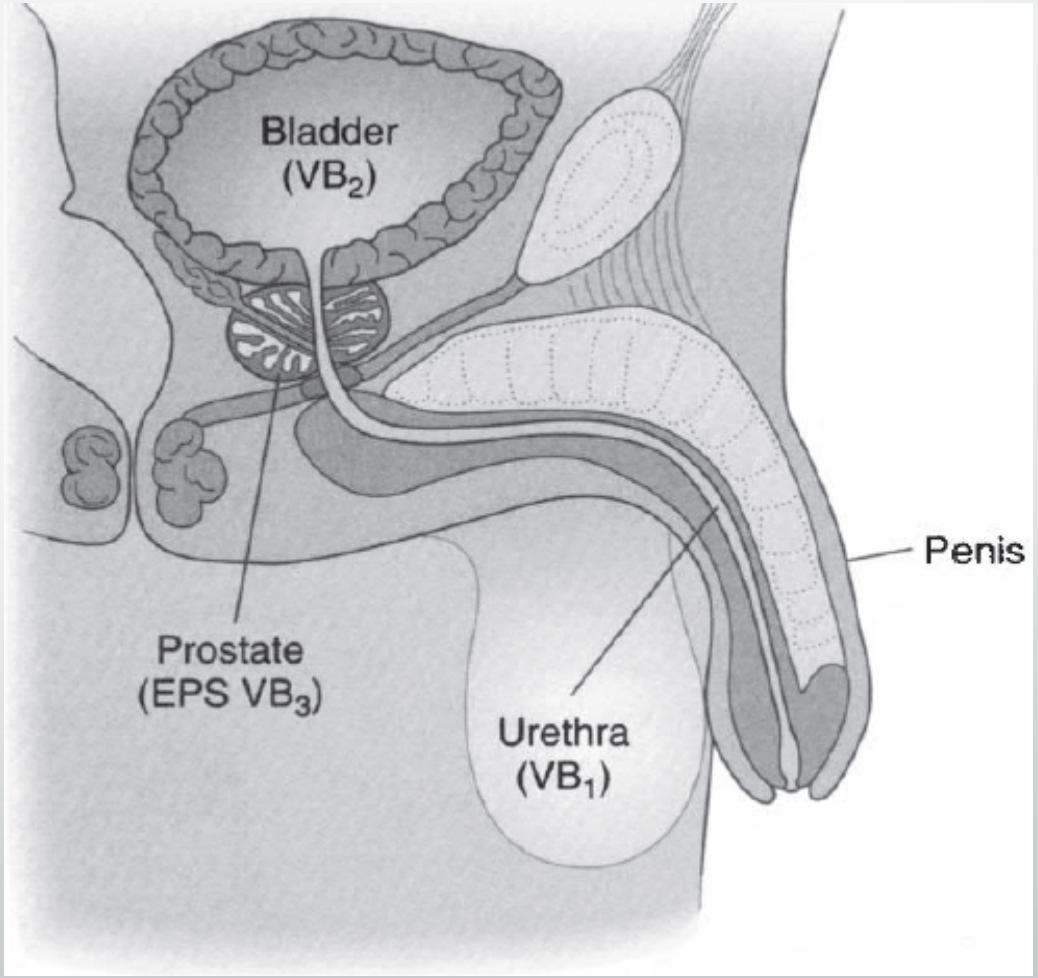
- ***III) Urine culture***: remains the mainstay of diagnosis of an episode of acute cystitis; urinalysis provides little increase in diagnostic *accuracy*
- A threshold of $\geq 10^2$ CFU/mL E. coli from voided specimens had 88-93% positive predictive value for bladder bacteriuria ***in patients with a high suspicion of UTI***.
- Still a 10^5 CFU/mL threshold for bacterial growth on midstream voided urine may help distinguish bladder bacteriuria from contamination in ***asymptomatic***, ***pre-menopausal women***.

Diagnosis

- ***IV) Localization Studies:*** A) ***Ureteral catheterization*** (during Cystoscopy) allows not only separation of bacterial persistence into upper and lower urinary tracts but also separation of the infection between one kidney and the other, and even localization of infection to ectopic ureters or to non-refluxing ureteral stumps
- B) ***Stone Cultures***: Urinary and stone cultures must be analyzed separately because results may be discordant
- Manipulation of infected stones, and possible release of endotoxins into the bloodstream, can lead to systemic inflammatory response syndrome (SIRS) or potentially fatal urosepsis

Diagnosis

- ***IV) Localization Studies:***
- Stone cultures, rather than periprocedure urine cultures, are a better predictor of postoperative sepsis and SIRS
- C) ***<u>Prostate and Urethral</u>*** Localization Studies:
- VB1, VB2, EPS, VB3



Diagnosis: Imaging

- Imaging studies are not required in most cases of UTI because clinical and laboratory findings alone are sufficient for correct diagnosis and adequate management of most patients
- Indications: infections in most men, compromised hosts, febrile infections, signs or symptoms of urinary tract obstruction, failure to respond to appropriate therapy, and a pattern of recurrent infections suggesting bacterial persistence.
- Identification of underlying abnormalities that require modification of medical management or percutaneous or surgical intervention

Correctable Urologic Abnormalities That Cause Bacterial Persistence	
• Infection stones	• Chronic bacterial prostatitis
• Unilateral infected atrophic kidneys	• Foreign bodies
• Ureteral duplication and ectopic ureters	
• Urethral diverticula and infected periurethral glands	
• Unilateral medullary sponge kidneys	
• Nonrefluxing, normal-appearing, infected ureteral stumps after nephrectomy	
• Infected urachal cysts	• Papillary necrosis
• Infected communicating cysts of the renal calyces	
• Perivesical abscess with fistula to bladder	

Diagnosis: Imaging

- **Ultrasonography**: noninvasive, easy and rapid to perform, and offers no radiation or contrast agent risk to the patient
- Identify calculi and hydronephrosis, pyonephrosis, and perirenal abscesses
- Due to limited sensitivity, a single radiograph for (KUB) calculi could accompany ultrasonography
- Ultrasonography is also useful for diagnosing postvoid residual urine
- Disadvantages: dependent on the skills of the examiner, technically poor in patients who are obese or have other anatomic challenges, or who have dressings, drainage tubes, or open wounds overlying the area of interest

Diagnosis: Imaging

- **Computed Tomography and Magnetic Resonance Imaging:**
- The best for acute focal bacterial nephritis, renal and perirenal abscesses, and radiolucent calculi
- MRI provided some advantages in delineating extrarenal extension of inflammation. Pelvic MRI is the most useful imaging modality for detecting a urethral diverticulum
- **Voiding Cystourethrogram:** In women with a history of febrile UTIs, known VUR as a child, or recurrent pyelonephritis as an adult.
- Also in patients with a history of recurrent UTIs and hydronephrosis.

Bladder Infections

- I) **<u>Uncomplicated Cystitis</u>**:
- The overwhelming majority of infections encountered in urology
- Most cases of uncomplicated cystitis occur in women
- Young men may also experience acute cystitis without underlying structural or functional abnormalities of the urinary tract
- *E. coli* is the causative organism in 75% to 90%
- *S. saprophyticus*, a commensal organism of the skin, is the second most common cause of acute cystitis in young women, accounting for 10% to 20%

Bladder Infections

- I) **Uncomplicated Cystitis**: Clinical Presentation
- Symptoms: frequency, urgency, painful urination, incomplete emptying, suprapubic pain/pressure, low back pain, and hematuria
- **Management**:
- Three-day therapy with TMP-SMX or TMP is the preferred regimen for uncomplicated cystitis in women (Or nitrofurantoin 5-day therapy and fosfomycin singledose therapy)
- Seven-day therapy is the preferred regimen for cystitis in men

Bladder Infections

- II) **Complicated Cystitis**: The clinical spectrum ranges from mild cystitis to life-threatening infections and urosepsis
- Management: patients with mild to moderate illness who can be treated as an outpatient with oral therapy, 10 to 14 days of fluoroquinolones
- For patients requiring hospitalization, IV antimicrobials should be administered based on the susceptibility patterns of the known uropathogens
- Usually continued for 10 to 14 days on culture-specific antibiotics and switched from parenteral to oral therapy when the patient is afebrile and clinically stable

Bladder Infections (complicated UTI)

- II) **Emphysematous cystitis**: is a rare and potentially life-threatening form of complicated cystitis that is associated with a mortality rate of up to 7%
- The pathognomonic finding of this disease process is gas noted within the wall on cross-sectional imaging.
- Emphysematous cystitis is typically observed in elderly women (60–70 years of age) with poorly controlled diabetes
- *E. coli* (60%) then comes *K. pneumoniae* (10%–20%)
- Symptoms: most common abdominal pain (80%), gross hematuria (60%), and obstructive urinary symptoms (10%). Fever 30-50%

Bladder Infections (complicated UTI)

- II) **<u>Emphysematous cystitis</u>**:
- A CT scan is necessary to make the diagnosis and exclude other sources of pelvic air such as a fistula, trauma, or gangrene of adjacent structures
- CT scan of the pelvis will also show air pocketed diffusely within the bladder wall, and possibly intraluminally

Computed tomography of emphysematous cystitis. *Arrows* indicate intramural gas; there is also air in the bladder lumen (*).

Bladder Infections (complicated UTI)

- II) **Emphysematous cystitis**: Management
- The majority (90%) of these patients are treated with medical therapy alone,
- which consists of antibiotics (parenteral), bladder drainage, and treatment of comorbid conditions such as poorly controlled diabetes
- The need for surgical intervention is rare and can include debridement, partial cystectomy, and total cystectomy in advanced cases

Bladder Infections (rUTI)

- III) Recurrent Urinary Tract Infections: A recurrent UTI is defined as two UTIs in a 6-month period or three or more UTIs in a 12-month period
- Either: **Bacterial Persistence**, caused by the same bacterial strain, usually leads to recurrent infections in a short time frame
- Or: **Reinfections**, caused by a different organism or the same organism more than 2 weeks after treatment
- The history and physical exam should eliminate overt external anatomic or obvious functional abnormalities of the urinary tract that predispose to recurrent UTIs

Bladder Infections (rUTI)

- III) rUTI: Symptoms such as pneumaturia, fecaluria, obstipation, as well as prior history of diverticulitis, prior pelvic surgery, or radiation should raise suspicion for vesicoenteric or vesicovaginal fistula
- Chronic constipation, diarrhea, and fecal incontinence are reversible contributing factors (increase ascending UTI)
- Significant risk factors for recurrence in women include sexual activity, a new sexual partner within the past year, menopause, spermicidal use, family history of UTI in a first-degree female relative, and recent antimicrobial use
- In postmenopausal women, risk factors for recurrent UTIs include incontinence, elevated postvoid residual, and presence of a cystocele

Bladder Infections (rUTI)

- III) rUTI:
- Physical examination, palpating the suprapubic area and performing a pelvic examination are important
- **Workup**: urinalysis and urine culture, is imperative in patients.
- Obtaining a postvoid urine residual and uroflow measurement provides important information
- In women with risk factors for a complicated UTI the evaluation should include **imaging** and **cystoscopy**.
- Preferred imaging includes renal and bladder ultrasound with possible plain radiograph of the abdomen (KUB). No abnormality ➔ CT scan

Bladder Infections (rUTI) Management

- I) Behavioral Modification:
- 1. Hydration is recommended to augment innate immunity by sloughing of urothelial cells and flushing of adherent bacteria
- 2. Frequent voiding helps to continually empty the bladder
- 3. Emptying the bladder after intercourse, minimize the likelihood that the transient bacteriuria will progress to clinical UTI
- 4. Avoid spermicides (because they contribute to decreased population of normal vaginal flora and subsequently alter the vaginal pH in favor of for uropathogenic bacteria.

Bladder Infections (rUTI) Management

- II) Non-Antibiotic Management:
- Estrogen: the lack of estrogen causes marked changes in the vaginal microflora, including a loss of lactobacilli and increased colonization by E. coli
- Local vaginal estrogen is effective in preventing recurrent UTIs in postmenopausal women. The beneficial effect from vaginal estrogen use can take at least 12 weeks to manifest
- Oral estrogens compared are not effective in preventing UTI

Thank you