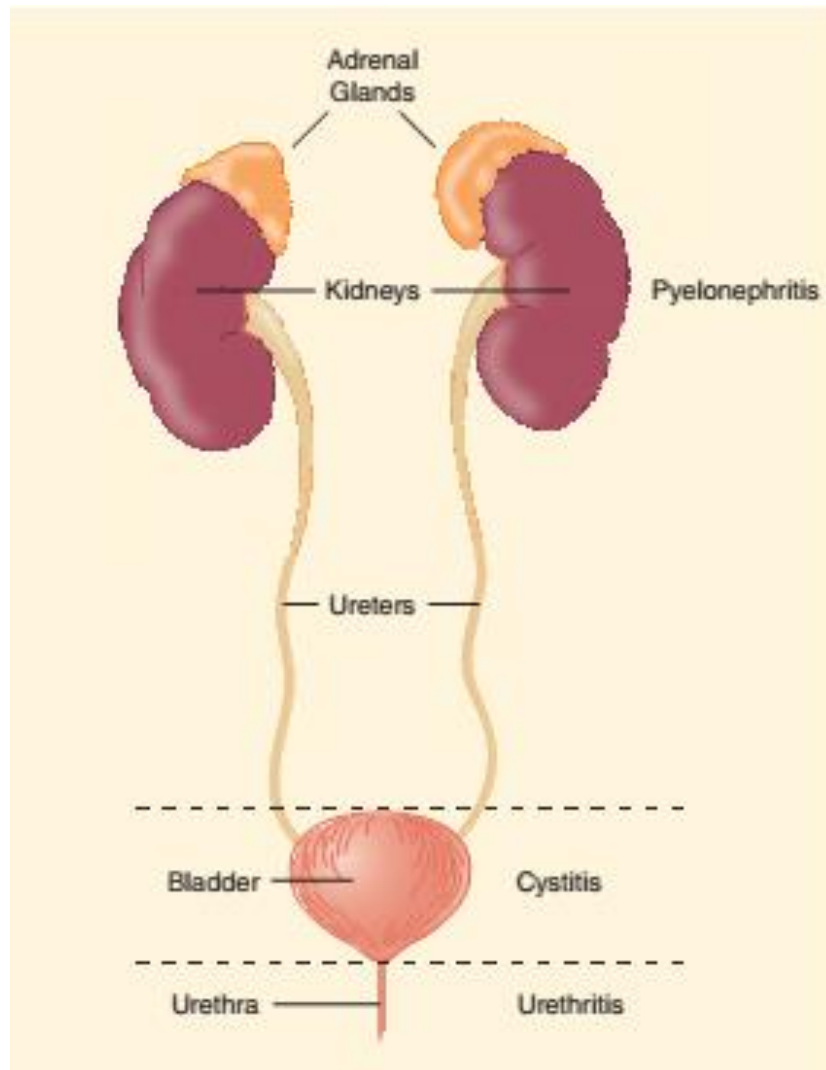


# Urinary Tract Infection

Elham Seid

# Introduction

- Acute infections of the urinary tract fall into two general anatomic categories:
  - **Lower tract infection** (urethritis and cystitis) and
  - **Upper tract infection** (acute pyelonephritis, prostatitis)
- Infections of the urethra and bladder are often considered **superficial** (or mucosal) infections, while prostatitis and pyelonephritis signify **tissue invasion**.



## Cont...

- Uncomplicated UTI refers to acute cystitis or pyelonephritis in
  - Nonpregnant outpatient women
  - Without anatomic abnormalities
  - Without instrumentation of the urinary tract;
- UTI in male is not uncomplicated since it is rare and most often involve structural abnormalities
- Recurrent UTI is not necessarily complicated

## Cont...

- UTIs:
  - Catheter-associated (or nosocomial) vs non-catheter-associated (or community-acquired)
  - Symptomatic Vs asymptomatic
- asymptomatic bacteriuria: when there is significant bacteriuria (more than  $10^5$  bacteria/mL ) in the absence of symptoms
- symptomatic abacteriuria: consists of symptoms of frequency and dysuria in the absence of significant bacteriuria
  - Commonly with chlamydia infections

## Cont...

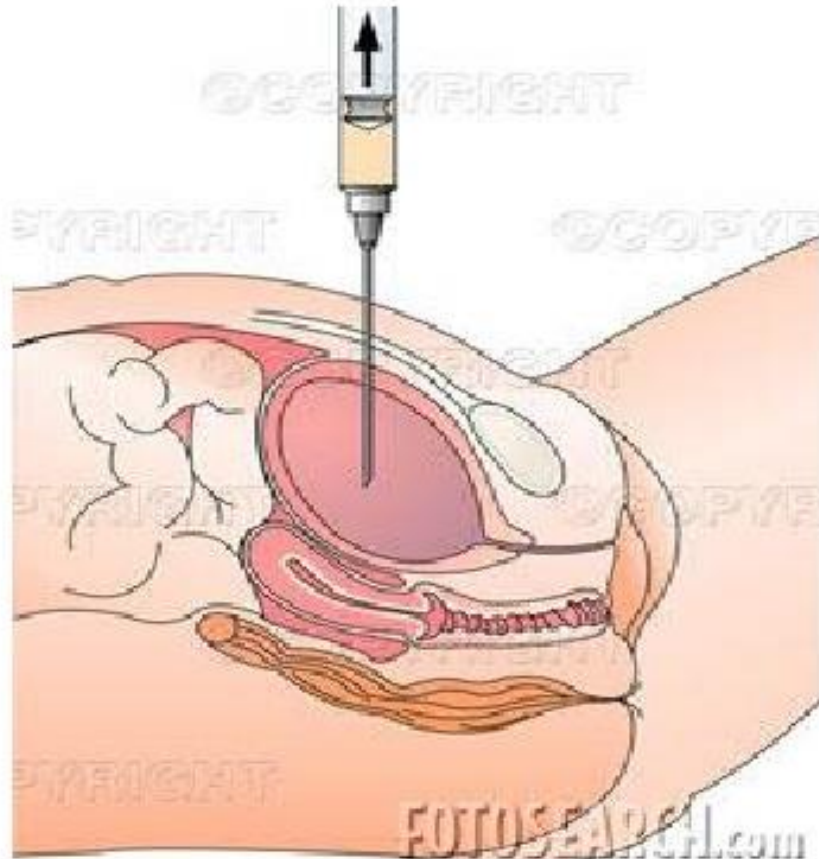
- from a **microbiologic**, UTI exists when pathogenic microorganisms are detected in the urine, urethra, bladder, kidney, or prostate.
- in most instances, growth of  $\geq 10^5$  /ml organisms from a properly collected midstream "clean-catch" urine sample indicates **infection**.
- However, significant **bacteriuria** is lacking in some cases of true UTI. Especially in symptomatic patients, fewer bacteria ( $10^2$ – $10^4$ /mL) may signify infection.

## Cont...

- In urine specimens obtained by suprapubic aspiration or "in-and-out" catheterization and in samples from a patient with an indwelling catheter, colony counts of  $10^2$ – $10^4$ /mL generally indicate infection.
- Conversely, colony counts of  $>10^5$ /mL in midstream urine are occasionally due to specimen contamination, which is especially likely when multiple bacterial species are found.

# Suprapubic aspiration

- On rare occasions, the health care provider may collect a urine sample by inserting a needle directly into the bladder (suprapubic tap) and draining the urine; this method is used only when a sample is needed quickly and technically competent staff are available





# Collection of Urine

## Catheterized Patients



- Another method is the catheterized urine specimen in which a lubricated catheter (thin rubber tube) is inserted through the urethra (tube-like structure in which urine is expelled from the bladder) into the bladder. This avoids contamination from the urethra or external genitalia.

# Epidemiology

- prevalence of UTIs varies with age and gender.
- neonatal boys are five to eight times more likely to have UTIs(vesicoureteral reflux )
- Between the ages of 1 and 6 years, UTIs occur more frequently in females.
- The vast majority of acute symptomatic infections involve young women.
- The development of asymptomatic bacteriuria is rare among men under 50 but common among women between 20 and 50.

# Etiology

- Uncomplicated infection
  - Gram-negative bacilli. **Escherichia coli** causes 80%-90% of community acquired infection
- Other causative organisms
  - Proteus and Klebsiella spp., P. aeruginosa and Enterobacter spp., account for a smaller proportion of uncomplicated infections.
- Complicated infection:
  - E.coli ~ 50%
  - Proteus spp., K. pneumoniae, Enterobacter spp., P. aeruginosa, staphylococci, and enterococci

## Cont...

- **VRE** have become more widespread, especially in patients with long-term **hospitalizations or underlying malignancies**.
- **Candida spp.** are common causes of UTI in the **critically ill** and chronically **catheterized** patient.
- Most UTIs are caused by a single organism; however, in patients with stones, indwelling urinary catheters, or chronic renal abscesses, **multiple organisms** may be isolated

# Pathophysiology

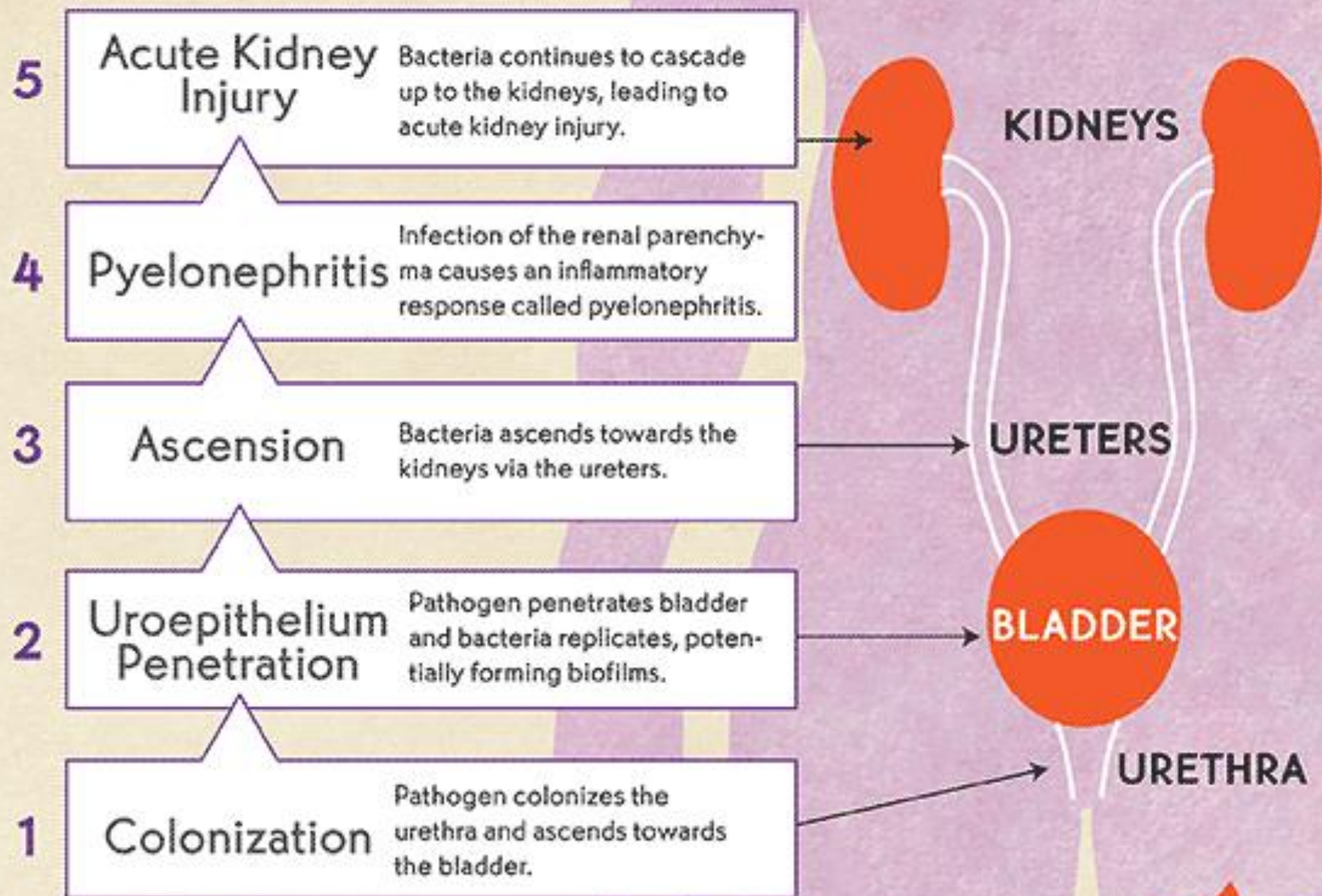
- Route of infection is via three routes
  - ascending, hematogenous (descending), and lymphatic pathways
- **Ascending Pathway**
- involved when bacteria colonizing the urethra subsequently travel upwards, or ascend, the urethra to the bladder and cause cystitis and continue to ascend to the ureters and cause pyelonephritis
- Women are at high risk of UTI due to
  - The short length of the female urethra and its proximity to the perirectal area

## Cont....

- the use of spermicides and diaphragms as methods of contraception
- Massage of the female urethra and sexual intercourse allow bacteria to reach the bladder
- **Hematogenous Pathway**
- involved through the seeding of the urinary tract with pathogens carried by the blood supply
- **S.aureus** bacteremia can cause renal abscesses via the hematogenous route
- E. coli and P. aeruginosa are less likely to seed the kidneys via hematogenous spread



# Stages of a Urinary Tract Infection



## Cont....

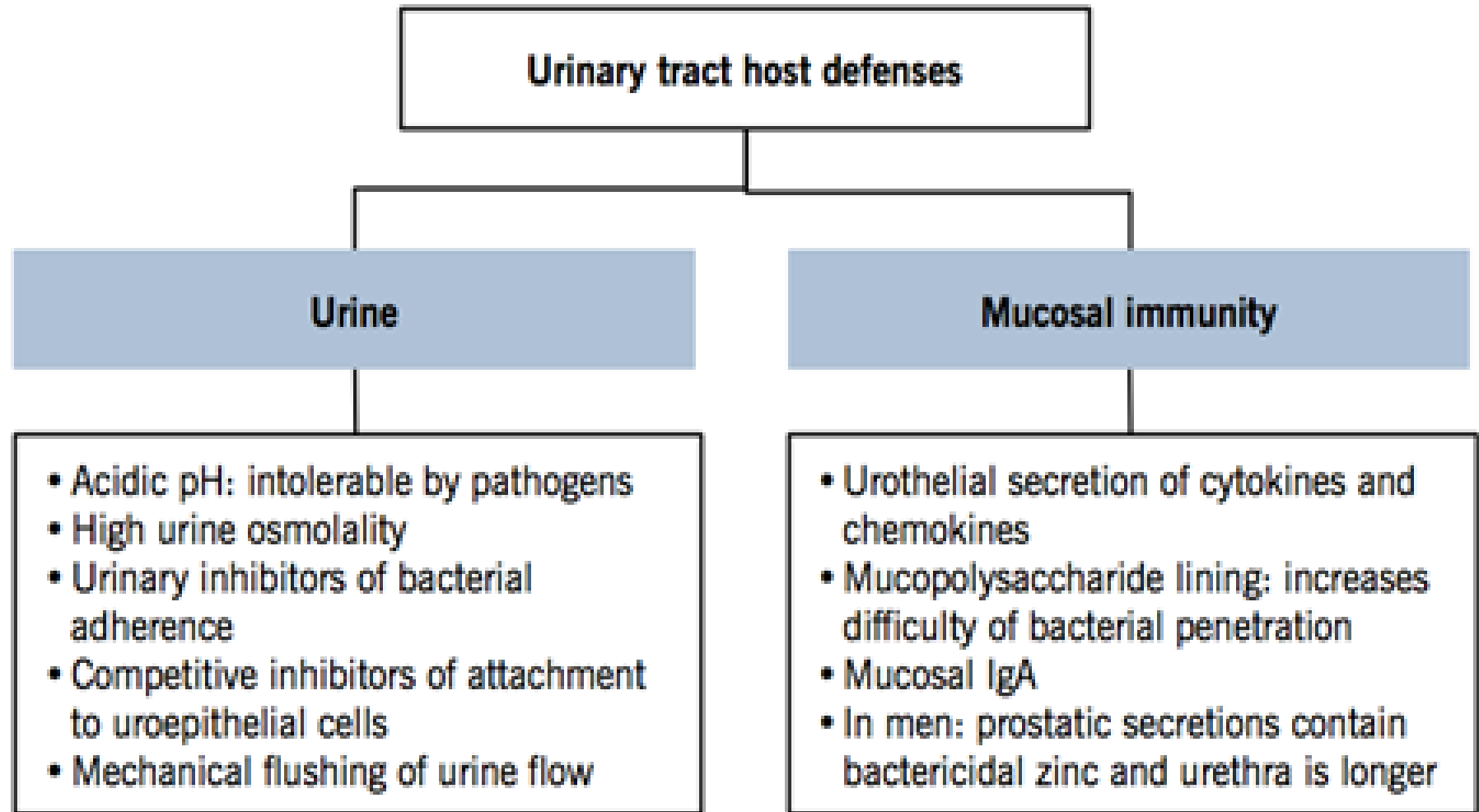
- Three factors determine the development of infection:
  1. the size of the inoculum
  2. the virulence of the microorganism, and
  3. the competency of the natural host defense mechanisms



# Cont....

- **Host Defense Mechanisms**
- Under normal circumstances, bacteria placed in the bladder are rapidly cleared,
  - ⇒through the flushing and dilutional effects of voiding
  - ⇒as a result of the antibacterial properties of urine and the bladder mucosa.
- The introduction of bacteria into the bladder stimulates micturition with increased diuresis and efficient emptying of the bladder

# Urinary tract host defense mechanisms



# Risk factors

- sexual intercourse
- use of a cervical diaphragm/spermicidal
- diabetes
- pregnancy
- uncircumcised males
- prostatic hyperplasia
- urologic instrumentation,
- urethral catheterization
- urinary tract obstruction

# Risk factors

- Use of spermicidal cpds with a diaphragm alters the normal introital bacterial flora and has been associated with marked increases in vaginal colonization with *E. coli*
- **Pregnancy**
- Decreased ureteral tone
- Decreased ureteral peristalsis
- Temporary incompetence of the vesicoureteral valves
  - result in urinary stasis and reduced defenses against reflux of bacteria to the kidneys
- Bladder catheterization during or after delivery

# Clinical presentation

- **Cystitis**
  - dysuria, frequency, urgency, and suprapubic pain
  - urine often becomes grossly cloudy and malodorous and is bloody
  - white cells and bacteria in urine
  - N:B temperature of  $>38.3^{\circ}\text{C}$  ( $>101^{\circ}\text{F}$ ), nausea, and vomiting, usually indicate concomitant renal infection, as does CVAT

# Cont.....

- **Acute Pyelonephritis**
  - High fever, shaking chills, nausea, vomiting, abdominal pain, and diarrhea.
  - Tachycardia, and generalized muscle tenderness
  - Marked tenderness on deep pressure in one or both costovertebral angles or on deep abdominal palpation.
  - Leukocytosis and bacteria detectable in Gram-stained urine
- **Urethritis**
  - Dysuria, frequency, and pyuria
- **Elderly patients:** altered mental status, change in eating habits, or gastrointestinal symptoms.

# Diagnosis

- **Physical Examination**
- upper UTI: costovertebral tenderness
- **Laboratory Tests**
- Bacteriuria
- Pyuria (WBC count more than  $10/\text{mm}^3$ )
- Nitrite-positive urine (with nitrite reducers)
- Leukocyte esterase-positive urine

# Urine collection

- Three acceptable methods:
- Midstream clean-catch method:
  - 20 to 30 mL of urine is voided and discarded, the next part of the urine flow is collected (refrigerated as soon as possible).
  - preferred method for the routine collection of urine for culture
- Catheterization:
  - for patients who are uncooperative or who are unable to void urine)
  - 1% to 2% procedure associated infection
- Suprapubic bladder aspiration (newborn, critically ill)



# Pyuria, Hematuria, and Proteinuria

- Microscopic examination
- Pyuria:
  - WBC count of greater than 10 WBC/mm<sup>3</sup> of urine
  - is non specific (only tell inflammation)
- Sterile pyuria:
  - associated with urinary tuberculosis; chlamydial; fungal urinary infections
- Hematuria:
  - renal calculi, tumors, or glomerulonephritis
- Proteinuria
  - is found commonly in the presence of infection

# Chemistry

- The nitrite test can be used to detect the presence of nitrate-reducing bacteria in the urine (eg, *E. coli*).
  - False-positive tests are uncommon
  - False-negative tests common in presence of gram-positive organisms or *P. aeruginos* that don't reduce nitrate
- The leukocyte esterase test
  - is a rapid dipstick test to detect pyuria
  - Found in neutrophil granules; indicate presence of WBCs
  - sensitive and highly specific test for detecting more than 10 WBC/mm<sup>3</sup>

## Cont....

- Leukocyte esterase test plus the nitrite test:
  - the reported positive predictive value and specificity is 79% and 82%, respectively,
  - For outpatient evaluation of uncomplicated UTIs
- “Gold standard” test: Urine culture

# Culture

- Quantitative method of urine culture
  - urine in the bladder is normally sterile
  - Patients with infection has  $>10^5$  bacteria/mL of urine.
  - one-third of women with symptomatic infection: may have  $<10^5$  bacteria/mL.
- Major issue:
  - patients with UTI, Symptomatic or asymptomatic, also may have  $<10^5$  bacteria/mL of urine

# Treatment

- Goal of therapy
  - to eradicate the invading organism
  - to prevent or to treat systemic consequences
  - to prevent the recurrence of infection,
  - minimize unnecessary exposure to noncausative organisms  
(avoid resistance)

# Treatment

- **Non pharmacologic treatment**
- Fluid hydration.....rapid dilution; forced removal
- Intake of large volumes of cranberry juice in patient with recurrent UTIs (prevent adhesion)
- Lactobacillus probiotics (lower vaginal pH so reduce E.coli colonization)
- Topical estrogen replacement for postmenopausal women (reduce pH)

# Treatment

- **Pharmacologic treatment**
- Initial selection of an antimicrobial agent depends on :
  - The severity of the presenting signs and symptoms,
  - The site of infection
  - whether the infection is determined to be uncomplicated or complicated
  - antibiotic susceptibility,
  - side-effect potential and cost of therapy

# Treatment

- Ideally, the antimicrobial agent chosen should be
  - well tolerated,
  - well absorbed,
  - achieve high urinary concentrations, and
  - have a narrow spectrum of activity
- treatment is based on type of infection:
  - acute uncomplicated cystitis,
  - symptomatic abacteriuria,
  - asymptomatic bacteriuria,
  - complicated UTIs, or
  - recurrent infections,



# Treatment

- **Acute Uncomplicated Cystitis**
- occur in women of childbearing age and often associated with sexual activity
- urine culture: is not normally required due to the causative mo and their susceptibility are known
- **First line treatment**
- Nitrofurantoin 100 mg bid × 5 days
- Cotrimoxazole 1 DS tablet bid × 3 days
- Fosfomycin trometamol 3g single dose

# Treatment

- fluoroquinolones reserved for patients with suspected or possible pyelonephritis (due to the collateral damage risk)
- Amoxicillin or ampicillin should not be used due to the high incidence of resistant E. coli.
- **Alternative**
- Amoxicillin/-clavulanate, cefdinir, cefaclor, or cefpodoxime proxetil for 3 to 7 days

# Treatment

- **Symptomatic Abacteriuria**
- etiology : E. coli, Staphylococcus spp., or Chlamydia trachomatis.
- Chlamydial treatment should consist of 1 g azithromycin or doxycycline 100 mg twice daily for 7 days.
- **Asymptomatic Bacteriuria**
- Most of the patients are elderly and female
- In nonpregnant females, therapy is controversial;

# Treatment

- **Complicated Urinary Tract Infections**
- **Acute Pyelonephritis**
  - patients with infection-related vomiting, decreased appetite, and dehydration need to be admitted
  - Gram stain and culture are important to ensure antimicrobial coverage
- **Outpatient**
  - Ciprofloxacin 500 mg  $\times$  14 days
  - Levofloxacin 250mg/d  $\times$  10 days
  - Cotrimoxazole (if susceptible) 1 DS tablet BID  $\times$  14 days
  - Amoxicillin–clavulanate 500mg  $\times$  14 days (G+ve bacteria)

# Treatment

- **Inpatient treatment**
- IV fluoroquinolone, Ampicillin with aminoglycoside
- ampicillin–sulbactam, ticarcillin–clavulanate, or piperacillin–tazobactam
- Carbapenems or IV trimethoprim sulfamethoxazole
- N:B If the patient has been hospitalized within the past 6 months or has a urinary catheter consider *P.aeruginosa*, enterococcus and other resistant microorganisms

# Treatment

- **Urinary Tract Infections in Males**
- most common causes are instrumentation of the UT, catheterization, and renal and urinary stones
- uncomplicated infections are rare, but they may occur in young males due to
  - homosexual activity, noncircumcision, and having sex with bacteria colonized partners
- prolonged treatment is required (10-14days)
- since the cause is not predictable culture should be obtained before treatment
- cotrimoxazole or the quinolone should be considered
  - achieve high renal tissue, urine, and prostatic concentrations

# Treatment

- **Urinary Tract Infections in Pregnancy**
- About 4% to 7% of pregnant patients develop asymptomatic bacteriuria; of these, 20% to 40% will develop acute pyelonephritis
- If untreated, ASB may cause prematurity, low birth weight, and stillbirth
- Seven day course of amoxicillin, amoxicillin– clavulanate, or cephalexin is effective in 70% to 80% of patients
- sulfonamides should not be administered during the 3<sup>rd</sup> trimester due to possible development of kernicterus & hyperbilirubinemia
- Tetracyclines and fluoroquinolones should be avoided

# Recurrent Infections..... Management

- Reinfections .....accounts up to..... 80%
- Two groups:
  - Those with less than 2-3 episodes per year
  - those who develop more frequent infections (> 3episodes).
- Risk Factors..... Patient counseling
  - sexual intercourse ..... void after
  - diaphragm or spermicide use for birth control.
  - Nylon panties; back to front wiping
- Short-course better.....
  - Trimethoprim-sulfamethoxazole (one-half of a single-strength tablet), trimethoprim (100 mg daily)
  - a fluoroquinolone (levofloxacin 500 mg daily)
  - nitrofurantoin (50 or 100 mg daily)
- Duration.....6 months, urine cultures to be followed monthly.



Thank you