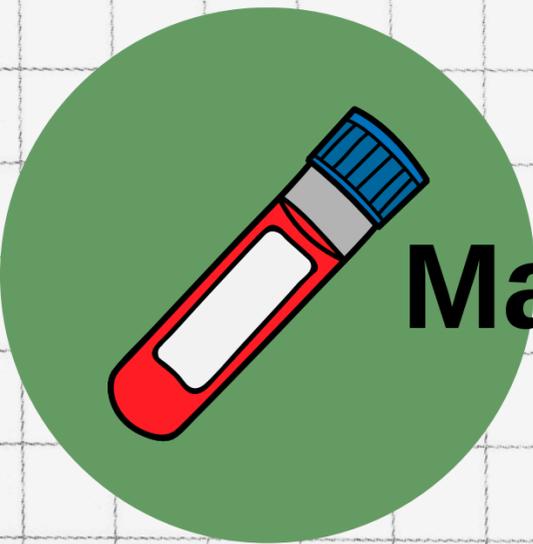


# Urology

# UTI



**Malak Algol + Roaa Fararjeh + Wesam Qatawne**

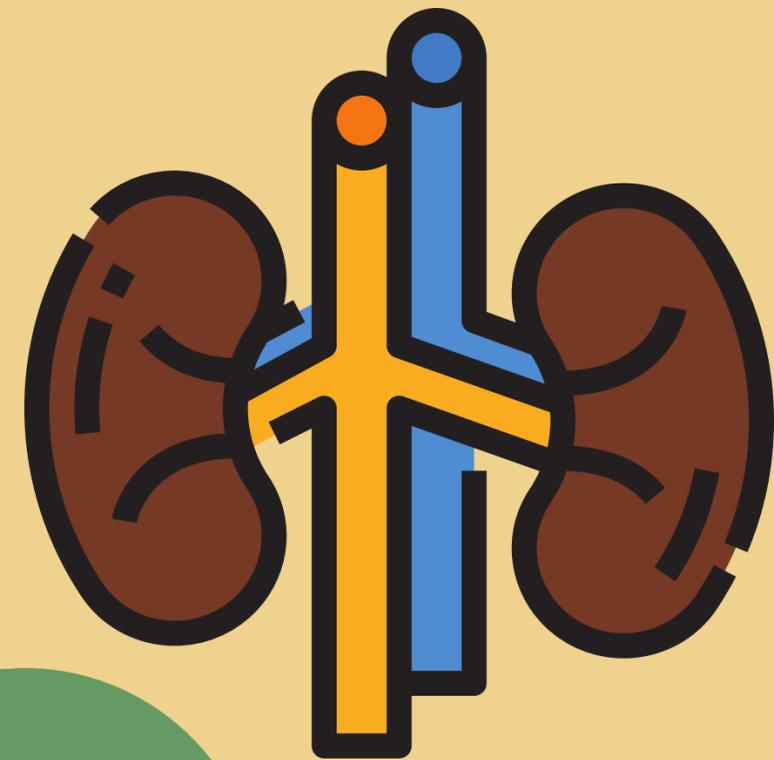
# DEFINITION

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Urinary tract infection (UTI) is a term that is applied to a variety of clinical conditions ranging from localized infection of the bladder with lower urinary tract symptoms to pyelonephritis with severe infection of the kidney and the potential for resultant urosepsis

# EPIDEMIOLOGY

- Neonates: Males have twice the rate of UTIs compared to females.
- 6-12 months: Male-to-female ratio is 1:4.
- Overall: More common in females.
- Children: Uncircumcised males have 85% higher incidence.
- Elderly (>65 years): Increased risk due to incontinence and chronic catheter use.
- Morbidity and Mortality: Highest in infants and the elderly



# RISK FACTORS



**Structural or functional abnormalities of the urinary tract: :**

- Prevent bladder emptying and/or result in urinary stasis.. include:
  - Benign prostatic hyperplasia
  - Congenital malformations causing vesicoureteral reflux
  - Urinary bladder diverticulum
  - Neurogenic bladder
  - Urinary tract calculi

# RISK FACTORS



## Sex:

- **Female individuals:** anatomically predisposed because the urethra is shorter and anal and genital regions are in **close proximity** → bacteria spreading from the anal region → colonization of vagina → ascending UTIs
- **Male individuals:** higher risk in uncircumcised male infants

## Pregnancy:

hormonal changes during pregnancy → urinary stasis and vesicoureteral reflux  
→ increased risk of UTIs

# RISK FACTORS

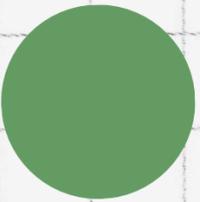
📌 Postmenopause: ↓ estrogen → ↓ vaginal lactobacilli → ↑ vaginal pH → ↑ colonization by E. coli

📌 Chronic constipation: common cause of UTIs in children

↳ being risk factor by mechanical compression on bladder neck

📌 Prior conditions:

- Previous UTI
- History of kidney surgery
- Immunosuppression
- Diabetes mellitus



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# RISK FACTORS



## Sexual Intercourse

- **Postcoital cystitis (honeymoon cystitis):** a lower urinary tract infection that occurs in women after recent sexual activity. It can cause irritation of the urethral meatus and facilitate bacterial entry into the urethra (e.g., from the genital and/or anal region).
- **Diaphragm and spermicide use**



## Catheter-associated urinary tract infection (CAUTI):

- Caused by indwelling urinary catheters
  - Most common cause of nosocomial urinary tract infection
- 
- 
- 

# PATHOGENS

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## Bacteria:

- Infection ascends from the urethra to the bladder.
- Can ascend further to the ureters and the renal pelvises.
- Causative organisms:
  - Escherichia coli: leading cause of UTI (approx. 80%)
  - Staphylococcus saprophyticus: 2nd leading cause of UTI in sexually active women
  - Klebsiella pneumoniae: 3rd leading cause of UTI- Proteus mirabilis.
  - Nosocomial bacteria: Serratia marcescens, Enterococci spp., and Pseudomonas aeruginosa are associated with increased drug resistance.
  - Enterobacter species.
  - Ureaplasma urealyticum

# PATHOGENS

---

## Viruses:

- Immunocompromised patients and children are particularly susceptible to viral UTI.
- Adenovirus, cytomegalovirus, and BK virus are commonly involved in hemorrhagic cystitis.

# PATHOGENESIS

- **Bacterial Entry:**

- Ascending Infection: Commonly from periurethral bacteria (E. coli).
- Other Routes:
  - Hematogenous spread (e.g., Staphylococcus aureus, Candida).
  - Lymphatogenous spread via pelvic lymphatics.
  - Direct extension from adjacent organs (e.g., fistulas, abscesses).

-  **Bacterial Pathogenic Factors:**

- **E. coli:-** Adhesion: Pili-mediated attachment to epithelial cells.
- **Hemolysin** Production: Aids tissue invasion.
- **K Antigen:** Prevents phagocytosis

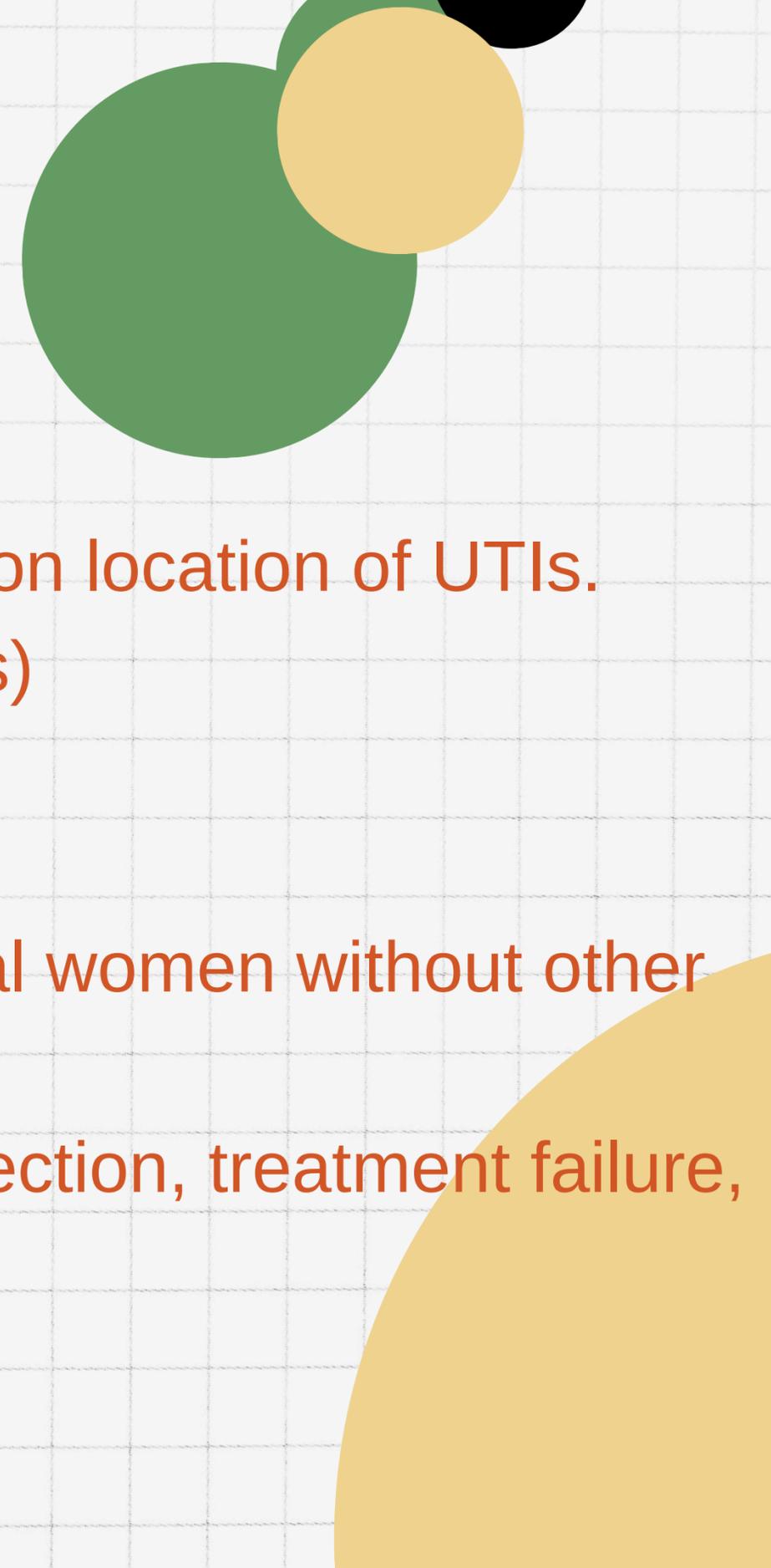
# PATHOGENESIS

## Host Defenses factors:

- Normal vaginal and periurethral **flora** In females: contain microorganisms like lactobacillus that help prevent uropathogenic **colonization**
- **Unobstructed urinary flow** with the subsequent washout of ascending bacteria is essential in preventing UTI
- Urine Properties: (its osmolality, urea concentration, organic acid concentration, and pH) inhibit bacterial growth and colonization. It also contains factors that inhibit bacterial adherence, such as **Tamm Horsfall glycoprotein (THG)**
- Urinary Epithelium: Acts as a barrier and initiates immune responses.
- Serum & Urinary Antibodies: Enhance phagocytosis and inhibit adherence.

# CLASSIFICATION

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## By location of infection:

- Lower UTI: Infection of the bladder (cystitis), the most common location of UTIs.
- Upper UTI: Infection of the kidneys and ureter (pyelonephritis)

## By severity of infection:

- Uncomplicated UTI: Infection in nonpregnant, premenopausal women without other risk factors for infection.
- Complicated UTI: Infection in patients with risk factors for infection, treatment failure, or recurrence.
- Urosepsis.

# CLASSIFICATION

## 📌 By source of infection:

- community- acquired UTI: acquired outside of a healthcare settings and/or that manifests within 48 hours of hospital admission
- health care- associated UTI

## 📌 By frequency:

- Recurrent UTI:  $\geq 3$  episodes of symptomatic, culture-proven UTI in one year or  $\geq 2$  episodes in 6 months.

## 📌 By clinical presentation:

- Asymptomatic bacteriuria (ASB): Significant bacteriuria without clinical features of UTI.  
*↳ seen by culture only, don't treat it except in pregnant women or before procedures*
- UTI: bacteriuria and clinical features of UTI

# CLINICAL FEATURES

## 📌 lower UTI:

- Irritative lower urinary tract symptoms (LUTS)[ Increased urinary frequency, Urinary urgency, Dysuria]
- Hematuria • Suprapubic tenderness

## 📌 upper UTI (pyelonephritis)

- Symptoms of lower UTI
- Fever, Flank pain, Costovertebral angle tenderness, Fatigue/malaise, Nausea and vomiting.

# DIAGNOSIS

- Factor indicate complicated UTI :- Important
1. male
  2. pregnant
  3. DM
  4. immuno compromised
  5. anatomical or functional abnormality
  6. foreign body, catheter
  7. extreme age
  8. persistent symptoms > 1 week
  9. recent instrumentation

An **uncomplicated** UTI consists of an infection in an otherwise **healthy** patient with normal urinary tract anatomy. On the other hand, a **complicated** UTI can occur when **anatomic abnormalities, immunocompromised state, or multi-drug-resistant** bacteria allow for increased bacterial colonization or decreased therapeutic efficacy. Diagnosis of UTI in an adult is sometimes difficult to establish and relies on **urinalysis** and **urine culture**. Occasionally, **localization** studies may be required to identify the source of the infection. Most often, the urine is obtained from a voided **specimen**. Standard diagnosis of UTI is completed by urinalysis and urine culture of 100 CFU/mL (where CFU = colony-forming units) of bacteria.

American Academy of Pediatrics (AAP) guidelines suggest that if a urinalysis demonstrates **positive leukocyte esterase or nitrite on testing**, urine should be obtained via **catheterization** or **suprapubic aspiration** for culture prior to start antimicrobial therapy. In children who are not toilet-trained, a urine collection device, such as a bag, is placed over the genitalia, and the urine is cultured from the bagged specimen. These two methods of urine collection are easy to obtain, but potential contamination from the vagina and perirectal area may occur. A negative urine culture via a bagged specimen in children ensures that there is a low likelihood. If a patient has an indwelling catheter, a urine specimen should be obtained from the collection port on the catheter.

Test	Purpose/Action	Interpretation	
<b>Urine Dipstick Test</b>	Tests for leukocyte esterase and nitrite		<b>80–90% sensitive, 60–98% specific</b> for UTI when both are positive
<b>Leukocyte Esterase</b> <i>highly sensitive</i>	Produced by the breakdown of white blood cells (WBCs) in urine	Indicates presence of WBCs in urine (5–15 WBC per high-power field (hpf))	
<b>Urinary Nitrite</b> <i>= more specific - poorly sensitive (have false negative chance)</i>	Produced by reduction of dietary nitrates by many Gram-negative bacteria	Presence suggests Gram-negative bacterial infection. More reliable when bacterial count is >100,000 CFUs/mL	
<b>Microscopic Examination</b>	Examines urine sediment after centrifugation for WBCs and bacteria	Counts WBCs and bacteria in the urine to confirm UTI.	<i>“general if WBC more than 5”</i> Pyuria threshold: <b>3 WBC/hpf</b> in dilute urine, <b>6 WBC/hpf</b> in concentrated urine for UTI diagnosis in children.

# Urine Culture

The gold standard for identification of UTI is the quantitative culture of urine for specific bacteria. Defining the CFU/mL that represents clinically significant infection can be difficult. It is dependent on the method of collection, the sex of the patient, and the type of bacteria isolated.

Traditionally, cultures demonstrating **100,000 CFU/mL** are considered diagnostic of a UTI, but now AAP guidelines suggest pyuria and 50,000 CFU/mL of a single organism are diagnostic of UTI

according mode of sample collection <sup>o</sup>-

- by catheterization → 1000 /mL considered positive
- by suprapubic aspiration → any growth of bacteria considered positive

→ in midstream clean catch

# Localization Studies

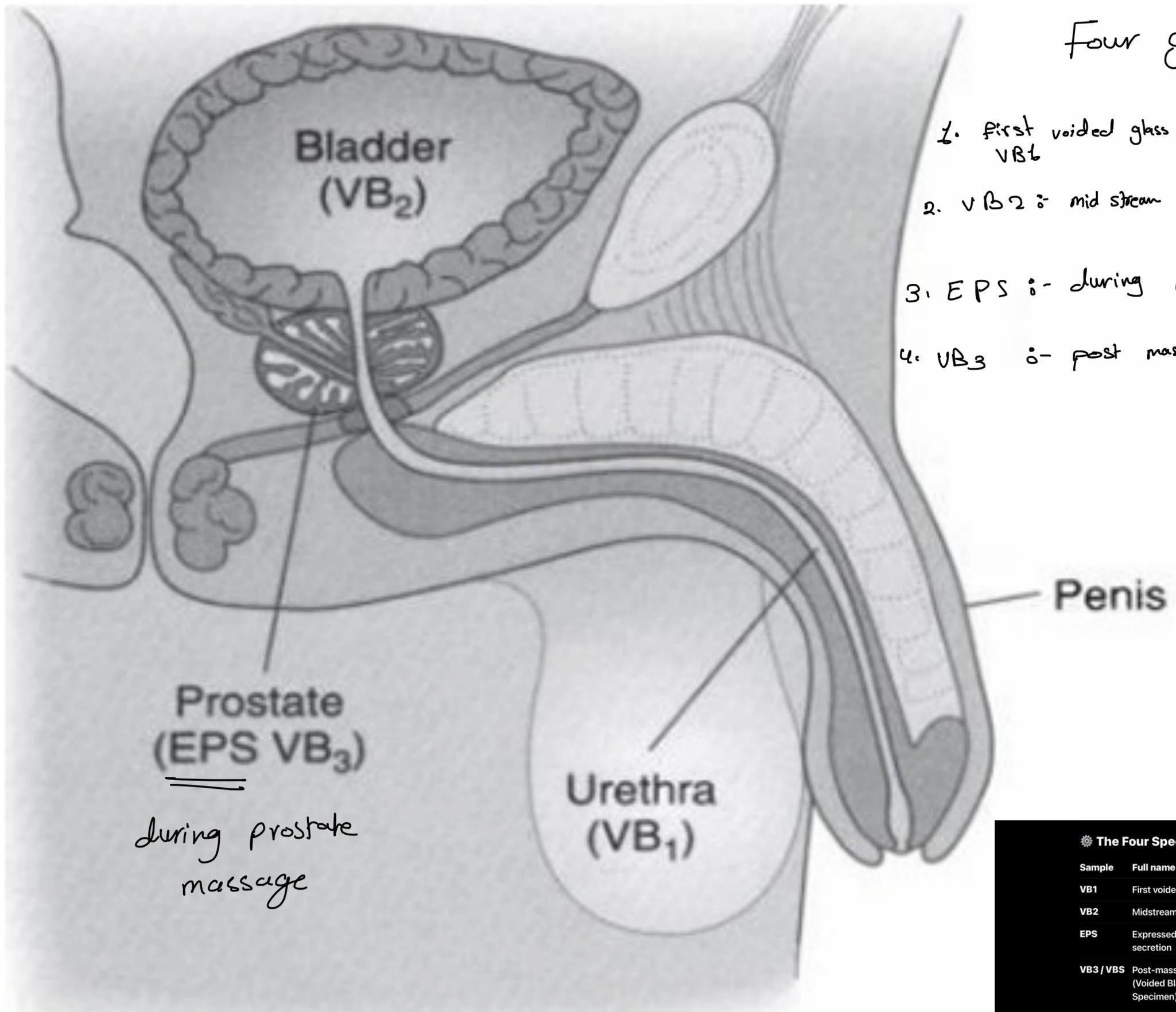
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Occasionally, it is necessary to localize the site of infection. For **upper urinary tract** localization the bladder is irrigated with sterile water and a ureteral catheter is placed into each ureter. A specimen is collected from the renal pelvis. Culture of this specimen will indicate whether infection in the upper urinary tract is present. In men, infection in the lower urinary tract can be differentiated (Figure). A specimen is collected at the beginning of the void and represents possible infection in the urethra (VB1). Next, a midstream specimen (VB2) is collected and represents possible infection in the bladder. The prostate is then massaged and the patient is asked to void again (VB3), this specimen represents possible infection of the prostate

to know the source of infection

### Four glass test :-

1. First voided glass (10 ml) → for analysis + culture (to diagnose urethritis)   
 VB1
2. VB2 :- mid stream clean catch
3. EPS :- during prostate massage
4. VB3 :- post massage



two glass test :-  
(use now)

- First → pre massage
- second → post massage

during prostate massage

⚙️ The Four Specimens:			
Sample	Full name	Represents	Diagnostic significance
VB1	First voided urine	Urethra	Positive → Urethritis
VB2	Midstream urine	Bladder	Positive → Cystitis
EPS	Expressed prostatic secretion	Prostate fluid (after prostatic massage)	Positive → Prostatitis
VB3 / VBS	Post-massage urine (Voided Bladder Specimen)	Prostate	Used to confirm Prostatitis if EPS cannot be collected

# ANTIBIOTICS

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The goal in treatment is to eradicate the infection by selecting the appropriate antibiotics that would target specific bacterial susceptibility. The general principles for selecting the appropriate antibiotics include: - Consideration of the infecting **pathogen** (antibiotic susceptibility, single-organism vs polyorganism infection, pathogen vs normal flora, community vs hospital-acquired infection); - The patient (allergies, underlying diseases, age, previous antibiotic therapy, other medications currently taken, outpatient vs inpatient status, pregnancy); - The site of infection (kidney vs bladder vs prostate

# ANTIBIOTICS

Because most antibiotics are cleared from the body by the liver or the kidney, certain antimicrobial agents need to be adjusted in the presence of liver or renal disease:

Renal diseases (Cr clearance <30 mL/min)
Aminoglycosides
β-Lactams
Cefoxitin, ceftizoxime
Cefonicid, ceftazidime
Cefuroxime, cefepime
Cefpirome, moxalactam
Carbenicillin, ticarcillin, ticarcillin–clavulanate
Vancomycin
Tetracyclines (except doxycycline)
Sulfonamides
Hepatic diseases (with elevated bilirubin)
Chloramphenicol
Tetracyclines
Clindamycin, rifampin, pefloxacin
Renal–hepatic diseases
Ceftriaxone
Cefoperazone
Carbenicillin
Ticarcillin
Azlocillin
Mezlocillin
Piperacillin

Recommended antimicrobial agents and duration of therapy based upon the type of UTI for adult

Diagnosis	Choice of antibiotics	Duration of therapy
Cystitis	1st: TMP-SMX 2nd: Fluoroquinolone	1–3 days
Pyelonephritis	1st: Fluoroquinolone 2nd: 2nd-generation cephalosporin 3rd: Aminopenicillin/BLI	7–10 days
Complicated UTI <sup>a</sup>	1st: Fluoroquinolone 2nd: Aminopenicillin/BLI 3rd: 3rd-generation cephalosporin Aminoglycosides	Afebrile: 2 weeks Febrile: continue for additional 3–5 days after last fever (minimum 2 weeks)
Prostatitis	1st: Fluoroquinolone 2nd: 2nd-generation cephalosporin 3rd: 3rd-generation cephalosporin	Acute: 2 weeks Chronic: 4–6 weeks
Epididymitis	1st: Fluoroquinolone 2nd: 2nd-generation cephalosporin or 1st: Doxycycline 2nd: Macrolide	14 days
Urethritis <sup>b</sup>	1st: IM ceftriaxone + azithromycin 2nd: Doxycycline	Single dose 7 days

Antibiotic	Mechanism of Action	Spectrum of Activity	Adverse Reactions	Contraindications/Precautions
<b>TMP-SMX</b> ↳ contraindicated on 3 <sup>rd</sup> trimester ↳ contraindicated in first tri	inhibits bacterial folate metabolism (antimetabolite)	Good against many Gram-negative and Gram-positive bacteria (except Enterococcus and Pseudomonas spp.)	Hypersensitivity, rashes, gastrointestinal upset, leukopenia, thrombocytopenia, photosensitivity	Not for patients with folic acid deficiency, G6PD deficiency, AIDS, or pregnant women.
<b>Fluoroquinolones</b> (not for pregnant)	Inhibits bacterial DNA gyrase (inhibits replication)	Broad spectrum (primarily Gram-negative, some Gram-positive)	Mild gastrointestinal upset, dizziness, lightheadedness	Contraindicated in pregnancy, and should be used cautiously in children due to potential cartilage damage.
↳ safe in 2 <sup>nd</sup> trimester <b>Nitrofurantoin</b> drug of choice for cystitis	Inhibits bacterial enzymes and DNA activity	Effective against most Gram-negative (except Pseudomonas, Proteus), Staphylococci, and Enterococci	Gastrointestinal upset, peripheral neuropathy, hepatotoxicity, pulmonary hypersensitivity, interstitial changes	Contraindicated in renal impairment (CrCl < 30 mL/min), should not be used for complicated UTI, pyelonephritis, or prostatitis.
↳ not for pregnancy <b>Aminoglycosides</b> protein synthesis inhibitor	Inhibits bacterial DNA and RNA synthesis	Effective against most Gram-negative bacteria, some Gram-positive (with ampicillin)	Nephrotoxicity, ototoxicity	Use with caution in renal impairment; monitor drug levels to avoid toxicity.
<b>Cephalosporins</b> ↳ can be given in pregnancy	Inhibits bacterial cell wall synthesis	Broad spectrum: 1st-gen (Gram-positive, E. coli, Proteus, Klebsiella), 2nd-gen (anaerobes, H. influenzae), 3rd- & 4th-gen (broad Gram-negative)	Hypersensitivity, GI upset	Caution in patients with known cephalosporin allergies; adjust dose in renal impairment.

# ACUTE PYELONEPHRITIS

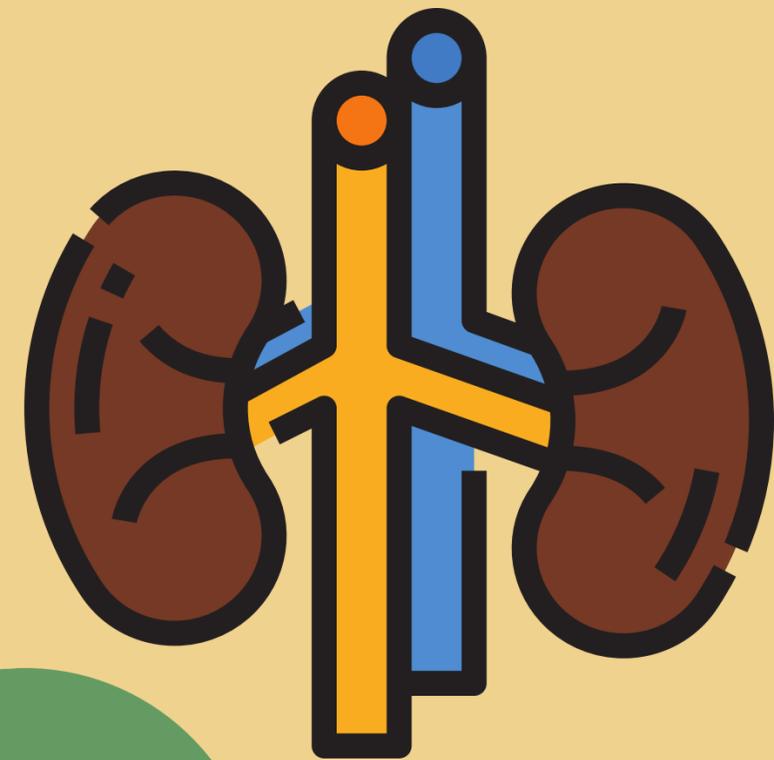
**Definition:** Inflammation of the kidney and renal pelvis. •

**Symptoms:**

- Chills, fever, costovertebral angle tenderness
- Lower tract symptoms: dysuria, frequency, urgency

**Common Pathogens:**

- E. coli(70-80%), Klebsiella, Proteus, etc.
- Gram-positive: Streptococcus faecalis, S. aureus



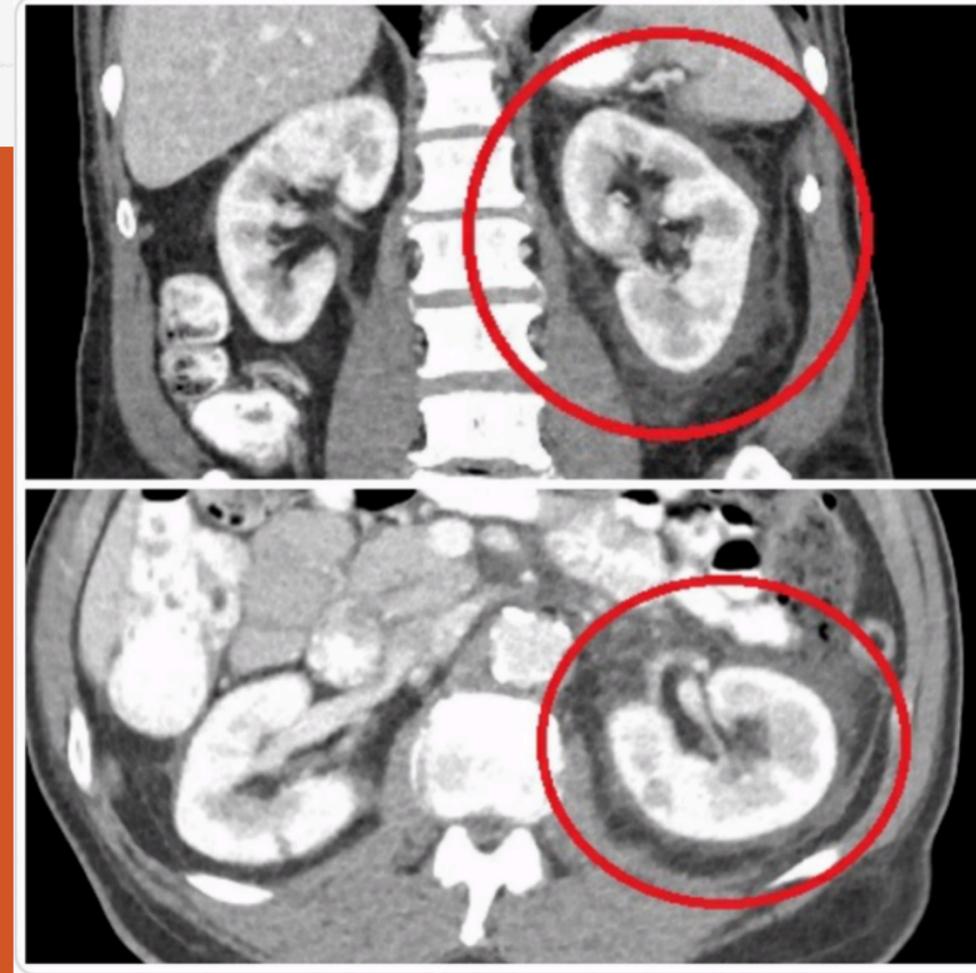
# ACUTE PYELONEPHRITIS

## Risk Factors:

- Sexual activity, UTI history, diabetes, urinary incontinence

## findings :

- Urinalysis: WBCs, RBCs, positive urine culture
- Blood tests: Leukocytosis, ↑ ESR, ↑ C-reactive protein



↓ CT finding :-  
→ differ cortico medullary differentiation  
→ nephromegaly  
→ decrease on attenuation of the kidney

# ACUTE PYELONEPHRITIS

## MANAGEMENT

### Hospitalization:

- Required for 10-30% of cases, especially with sepsis.
- Empiric Antibiotic Therapy:
- IV Ampicillin + Aminoglycosides
- Alternatives: Amoxicillin + Clavulanic Acid, 3rd Gen Cephalosporins

### Outpatient: Fluoroquinolones, TMP-SMX (7-14 days)

\* outpatient management ⊕ not on fluoroquinolones. give long acting Antibiotic on hospital like aminoglycosides then at home continue treatment for 14 day with other medication

### Severe Cases:

- Bacteremia: 7-10 days parenteral therapy, then oral 10-14 days

### Pregnancy:

- Admission with parenteral antibiotics due to risk of preterm labor



# EMPHYSEMATOUS PYELONEPHRITIS

↳ patient very ill (toxic)

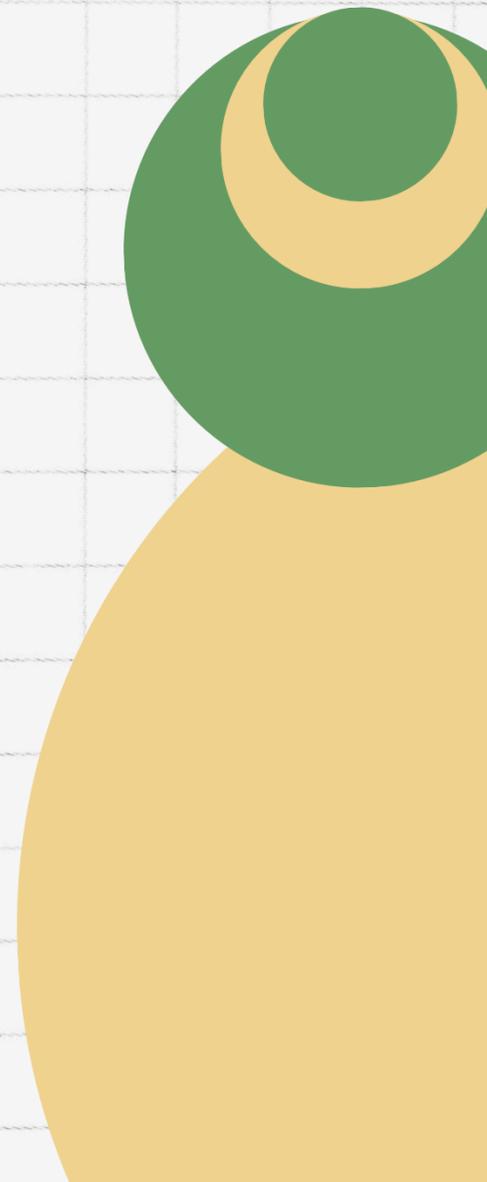
**Definition:** Necrotizing infection with gas in renal tissues.

**Risk Factors:**

- 95% have diabetes, higher incidence in women
- Renal failure, immunosuppression, obstruction, polycystic kidney

**Symptoms:** Fever, flank pain, vomiting, pneumaturia

**Common Pathogens:** • E. coli(66%), Klebsiella pneumonia(26%), others



# EMPHYSEMATOUS PYELONEPHRITIS

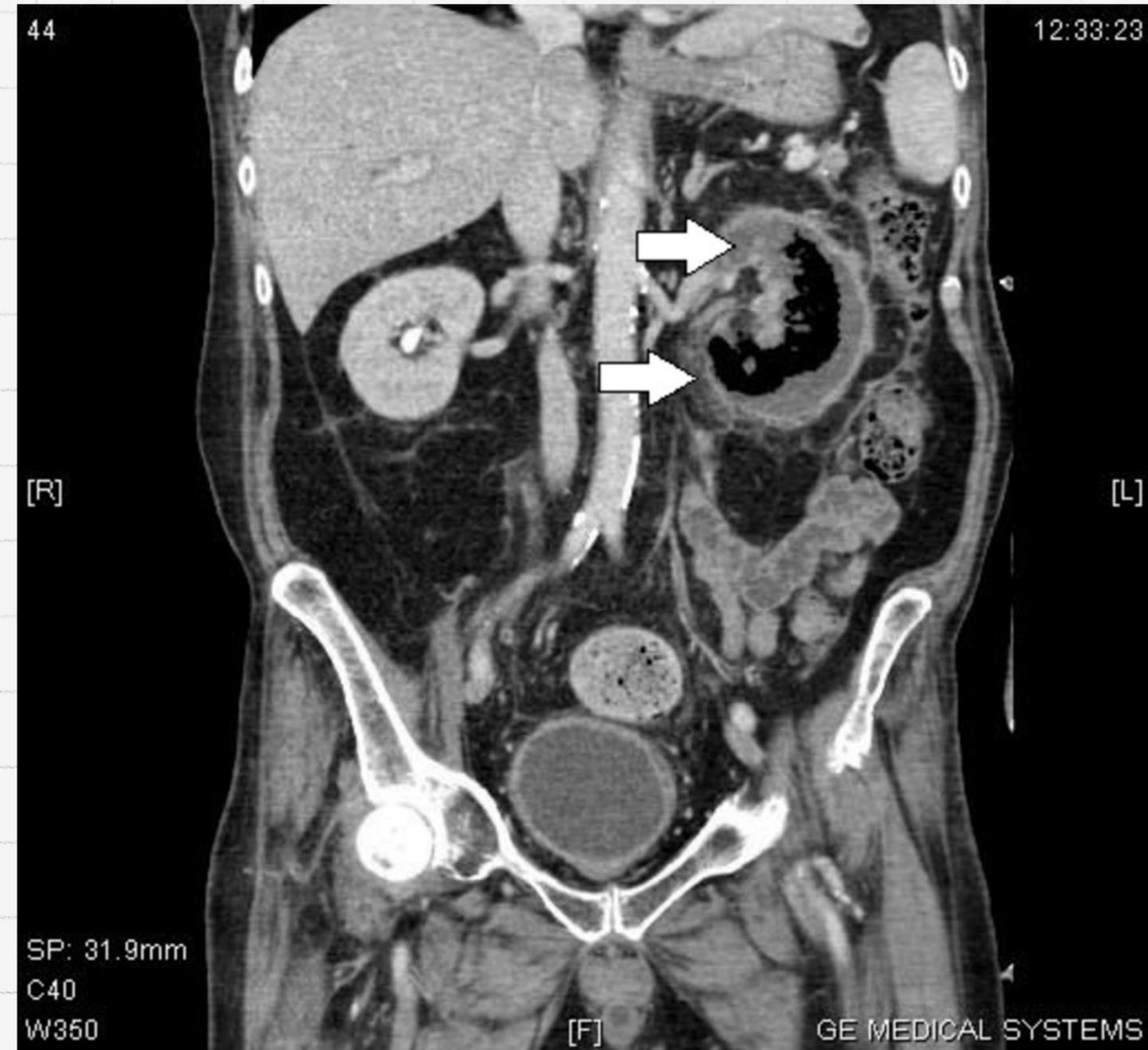
## Diagnosis:

- Radiographs (KUB) for gas detection
- CT scan (more sensitive)

↳ without  
Contrast

## Management:

- Blood glucose control, relieve obstruction
- Parenteral antibiotics, fluid resuscitation



# RENAL ABSCESSSES

↳ prolonged symptoms

**Definition:** Severe infection causing liquefaction of renal tissue; may extend beyond Gerota's fascia.

- High-Risk Groups:
- Diabetes, hemodialysis, IV drug users

## Common Pathogens:

- **E. coli(75%)**, others: Klebsiella, Proteus, S. aureus

- **Symptoms:** • Fever, flank/abdominal pain, chills, dysuria— (>2 weeks)

**Abscesses that form in the renal cortex are likely to arise from hematogenous spread, whereas those in the corticomedullary junction are caused by Gram-negative bacteria in conjunction with some other underlying urinary tract abnormalities, such as stones or obstructio**

# RENAL ABSCESSSES

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## Diagnosis:

- **Ultrasound:** Anechoic mass, posterior enhancement, lack of vascularity on Doppler imaging
- **CT scan:** Hypoattenuation, enlarged kidney

## Management:

- **Antibiotics, percutaneous drainage if no response in 48 hours**
  - **Drainage indicated for abscesses >3 cm**
- 

# XANTHOGRANULOMATOUS PYELONEPHRITIS (XGP)

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## Definition:

Chronic infection leading to severe kidney damage; often hydronephrotic and obstructed , unilaterally in most cases.

Severe inflammation and necrosis obliterate the kidney parenchyma.

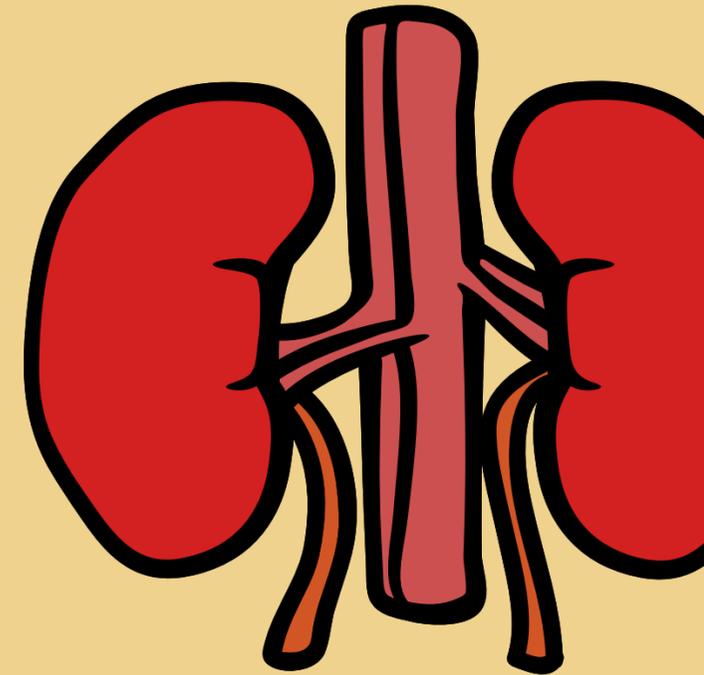
Characteristically, foamy lipid-laden histiocytes (xanthoma cells) are present and may be mistaken for renal clear cell carcinoma

## Presentation:

- Flank pain, fever, chills, persistent bacteriuria, palpable mass
- history of urolithiasis is present in about 35% of patients
- Urinalysis commonly demonstrates leukocytes, bacteria, and proteinuria.

## Common Pathogens:

- Serum blood analysis reveals anemia and may show hepatic dysfunction in approximately 50% of the patients
- E. coli, Proteus specie



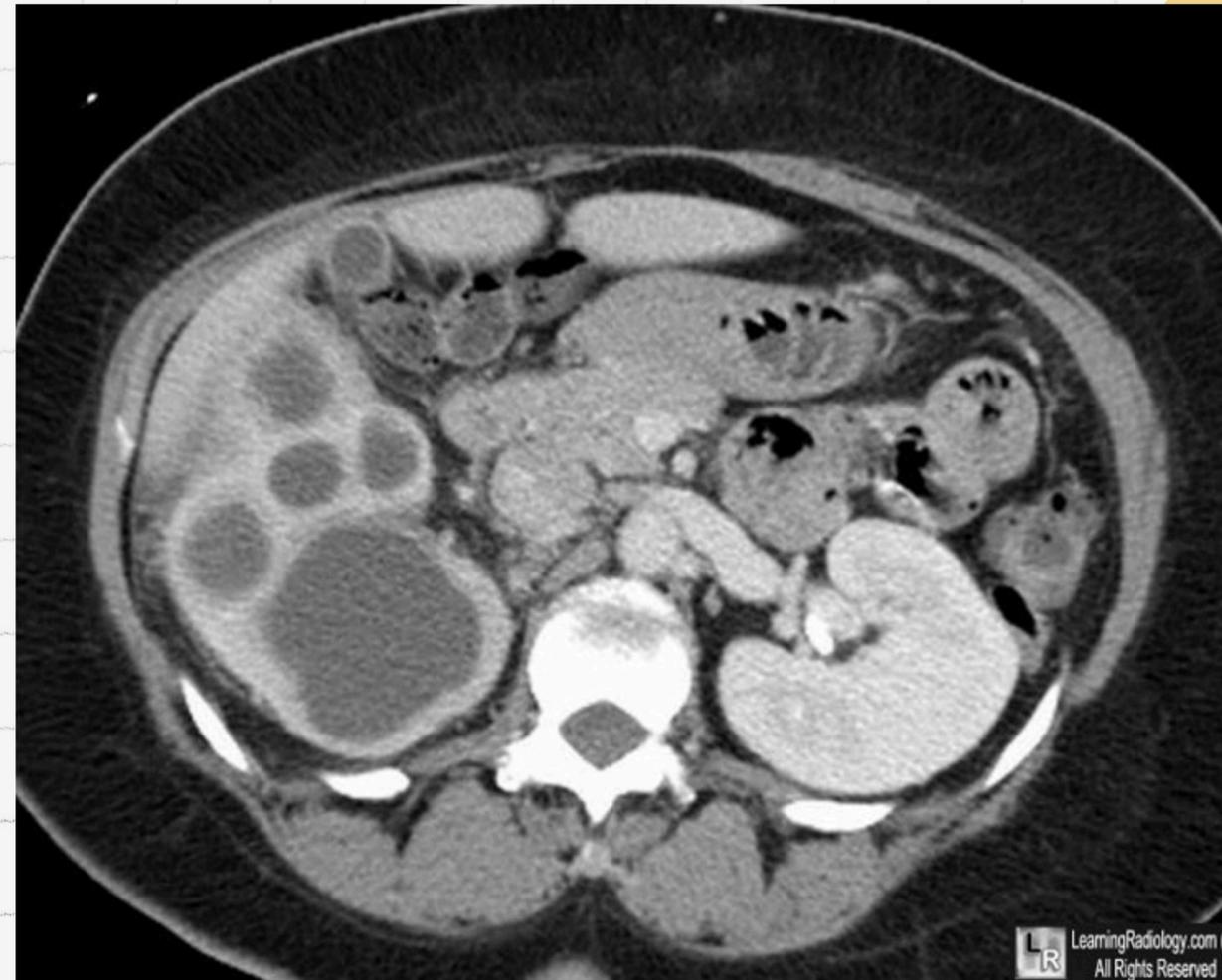
# XANTHOGRANULOMATOUS PYELONEPHRITIS (XGP)

## Diagnosis:

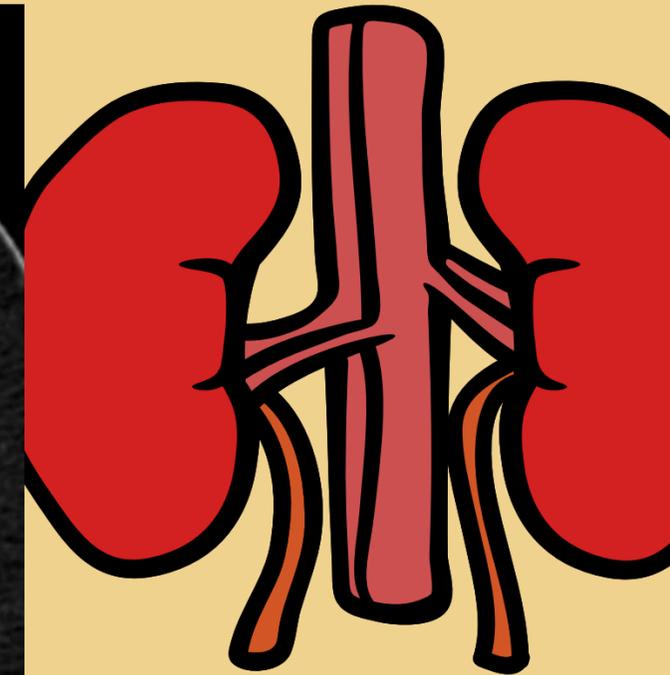
- **CT scan:** Heterogeneous, nonenhancing reniform mass On contrast-enhanced images, these lesions will have a prominent blush peripherally, while the central areas, which are filled with pus and debris, do not enhance.

## Management:

- **Kidney-sparing surgery if localized**
- **Nephrectomy if infection is diffuse**



bear paw sign'



# ACUTE CYSTITIS

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**Definition:** Infection of the lower urinary tract, mostly affecting the bladder.

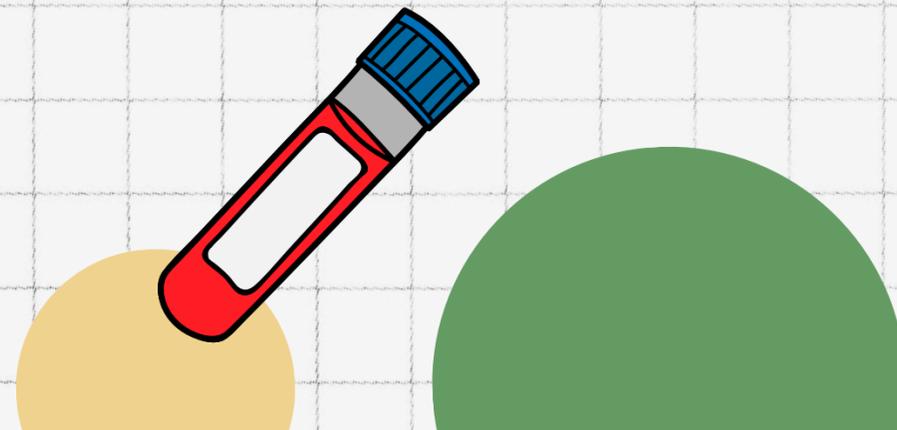
- Acute cystitis more commonly affects women than men.

**Symptoms:**

- Dysuria, frequency, urgency, low back and suprapubic pain, hematuria, cloudy/foul-smelling urine.
- Rare systemic symptoms (fever)

**Common Pathogens:**

- E. coli, Proteus, Klebsiella, Enterobacter
- The primary mode of infection is ascending from the periurethral/vaginal and fecal flora. The diagnosis is made clinical



# ACUTE CYSTITIS

## Diagnosis:

- **Urinalysis:** WBCs, possible hematuria
- **Urine culture** for pathogen identification

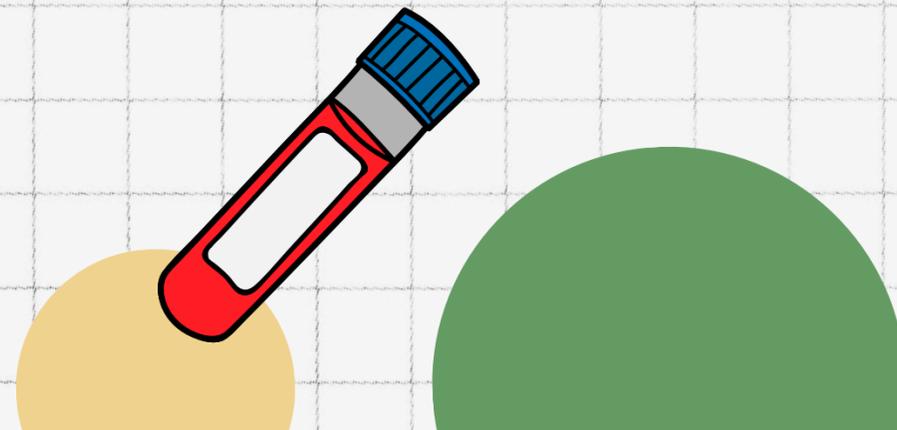
## Management:

- **Antibiotics:** <sup>→ first line</sup> TMP-SMX, Nitrofurantoin, ~~Fluoroquinolones (e.g. ciprofloxacin)~~  
or Fosfomycin

**Recurrent cases (bacterial persistence or reinfection with another organism): Prophylactic antibiotics, surgical intervention if needed**



Image 1: Demonstrating large renal abscess on axial CT scan with arrow tip on hyperdense rim.  
Case courtesy of Dr. Ian Bickle, Radiopaedia.org, rID: 29853



# ACUTE BACTERIAL PROSTATITIS

## Definition:

Inflammation of the prostate associated with UTI. It is believed that infection results from ascending urethral infection or reflux of infected urine from the bladder into the prostatic ducts.

## Symptoms

- **Abrupt onset: Fever, chills, malaise, myalgia, lower back/perineal pain**
- **Urinary retention, tender/enlarged prostate on DRE ,frequency, urgency, dysuria**
- **Serum blood analysis typically demonstrates leukocytosis.**
- **Prostate-specific antigen levels are often elevated.**

## Common Pathogens:

- **E. coli, Enterococci** Acute bacterial prostatitis is uncommon in prepubertal boys but frequently affects adult men. It is the most common urologic diagnosis in men young than 50 years and third most common in men older than 50 years

# ACUTE BACTERIAL PROSTATITIS

↳ prostate massage is contraindicated in this case

## Diagnosis:

- Microscopic exam, culture of prostatic expressate, urine culture
- Management:
- Antibiotics: Trimethoprim, Fluoroquinolones (4-6 weeks)
- Severe cases: Hospitalization, parenteral antibiotics (Ampicillin + Aminoglycoside)
- Urinary retention: Suprapubic catheter (avoid transurethral)

### Recurrent UTI

Defined as  $\geq 2$  episodes in 6 months or  $\geq 3$  episodes in 1 year.

It may occur due to either persistence or reinfection.

\* Persistence (Relapse) : Infection with the same organism that was not completely eradicated after treatment.

#### • Mechanism:

- Inadequate antibiotic therapy (wrong drug, dose, duration).
- Antibiotic resistance.
- Presence of a nidus for infection (stone, abscess, obstruction, foreign body, fistula).
- Timing: Recurrence usually occurs within 2 weeks of treatment.
- Key clue: Same organism, same antibiogram on urine culture.

### Recurrent UTI

• Reinfection: Infection due to a different organism (or sometimes the same organism but after a sterilized urine period).

#### • Mechanism:

- New infection from periurethral flora ascending into urinary tract.
- Common in women (short urethra, sexual activity, postmenopausal changes).
- Timing: Recurrence occurs  $>2$  weeks after treatment (can be months later).
- Key clue:
- Different organism on urine culture.
- Or same organism but after urine was sterile between infections.