
بسم الله الرحمن الرحیم

Urinary Tract Infections

Javad Minooeifar

MD, MPH

Urinary Tract Infections

- **Definition**

Urinary tract infection (UTI) is defined as symptomatic infection of one or more anatomic sites in the urinary tract. The clinical spectrum ranges from asymptomatic bacteriuria to sepsis due to UTI.

Urinary Tract Infections (TERMINOLOGY)

TERMINOLOGY

The term *cystitis:*

dysuria,
frequency,
urgency,
and occasionally suprapubic tenderness.

Sometimes due to **inflammation** without bacterial infection and can

be caused by **urethritis** (e.g., gonorrhea, chlamydial urethritis)

Urinary Tract Infections (TERMINOLOGY)

- ***Acute pyelonephritis:*** characterized by
- flank pain, tenderness, or both,
- and fever,
- often associated with dysuria, urgency, and frequency.
- However, these symptoms can occur in the absence of infection (e.g., in renal infarction or renal calculus).

Urinary Tract Infections (TERMINOLOGY)

- ***Uncomplicated* UTI** refers to infection in a structurally and neurologically normal urinary tract.
- **complicated UTI** includes:
  - infection in the presence of factors that predispose to persistent or relapsing infection, such as foreign bodies (e.g., calculi, indwelling catheters or other drainage devices);
  - obstruction;
  - immunosuppression;
  - renal failure;
  - renal transplantation; and
  - urinary retention from neurologic disease.

Urinary Tract Infections (TERMINOLOGY)

In addition:

- infection in men,
- pregnant women,
- children,
- and patients who are hospitalized or in health care–associated settings may be considered **complicated**.
- In the patient with complicated infection, infecting microorganisms are more likely to be resistant to antimicrobial agents.

Urinary Tract Infections (TERMINOLOGY)

- **Recurrences** of UTI may be relapses or reinfections.
- **Relapse** of bacteriuria refers to a recurrence of bacteriuria with **the same infecting microorganism** that was present before therapy was started. This is caused by the persistence of the organism in the urinary tract.
- **Reinfection** is a recurrence of bacteriuria with a microorganism different from the original infecting bacterium. It is a new infection.

Urinary Tract Infections (TERMINOLOGY)

- The term **urosepsis** means sepsis syndrome caused by UTI. Utilizing the term *sepsis* and indicating the specific clinical syndrome to which the sepsis is secondary (e.g., pyelonephritis or acute prostatitis) is a better way to refer to sepsis secondary to infection in the urinary tract.
- Sepsis= 2 of SIRS + infection
- Body temperature >100.4 °F (38 °C) or <96.8 °F (36 °C)
- Heart rate >90 bpm.
- Respiratory rate >20 breaths/minute or
- $PaCO_2$ <32 mm Hg

SEPSIS STEPS

SIRS

T: >100.4 F
< 96.8 F
RR: >20
HR: >90
WBC: >12,000
<4,000
>10% bands
PCO2 < 32 mmHg

SEPSIS

2 SIRS

+

Confirmed **or** suspected infection

SEVERE SEPSIS

Sepsis +

Signs of End Organ Damage

Hypotension (SBP <90)

Lactate >4 mmol

SEPTIC SHOCK

Severe Sepsis with persistent:

Signs of End Organ Damage

Hypotension (SBP <90)

Lactate >4 mmol

Slides Courtesy of Curtis Merritt, D.O.

Urinary Tract Infections(microbiology)

- **Escherichia coli** is the most frequent infecting organism in initial infections.
- In **recurrent UTIs**, especially with complicated UTI (e.g., obstructive uropathy, congenital anomalies, neurogenic bladder, fistulous communication involving the urinary tract):
  - Proteus, Pseudomonas, Klebsiella, and Enterobacter spp., antibiotic-resistant E. coli,
  - enterococci and staphylococci **increases greatly**.
- In the presence of complicated UTI, it is not uncommon to isolate multiple organisms from the urine.

Urinary Tract Infections(Epidemiology)

- UTIs are much more common in women than in men. Premenopausal women are at especially high risk for acute cystitis. The strongest risk factors in premenopausal women include:
  - sexual intercourse,
  - use of spermicides,
  - and history of previous UTI, as well as diabetes

Urinary Tract Infections(Epidemiology)

- At least 10% of men and 20% of women older than 65 years have asymptomatic bacteriuria.
- In contrast to young adults, in whom bacteriuria is 30 times more frequent in women than in men

Urinary Tract Infections(Epidemiology)

The majority of older men with UTI have underlying urologic abnormalities.

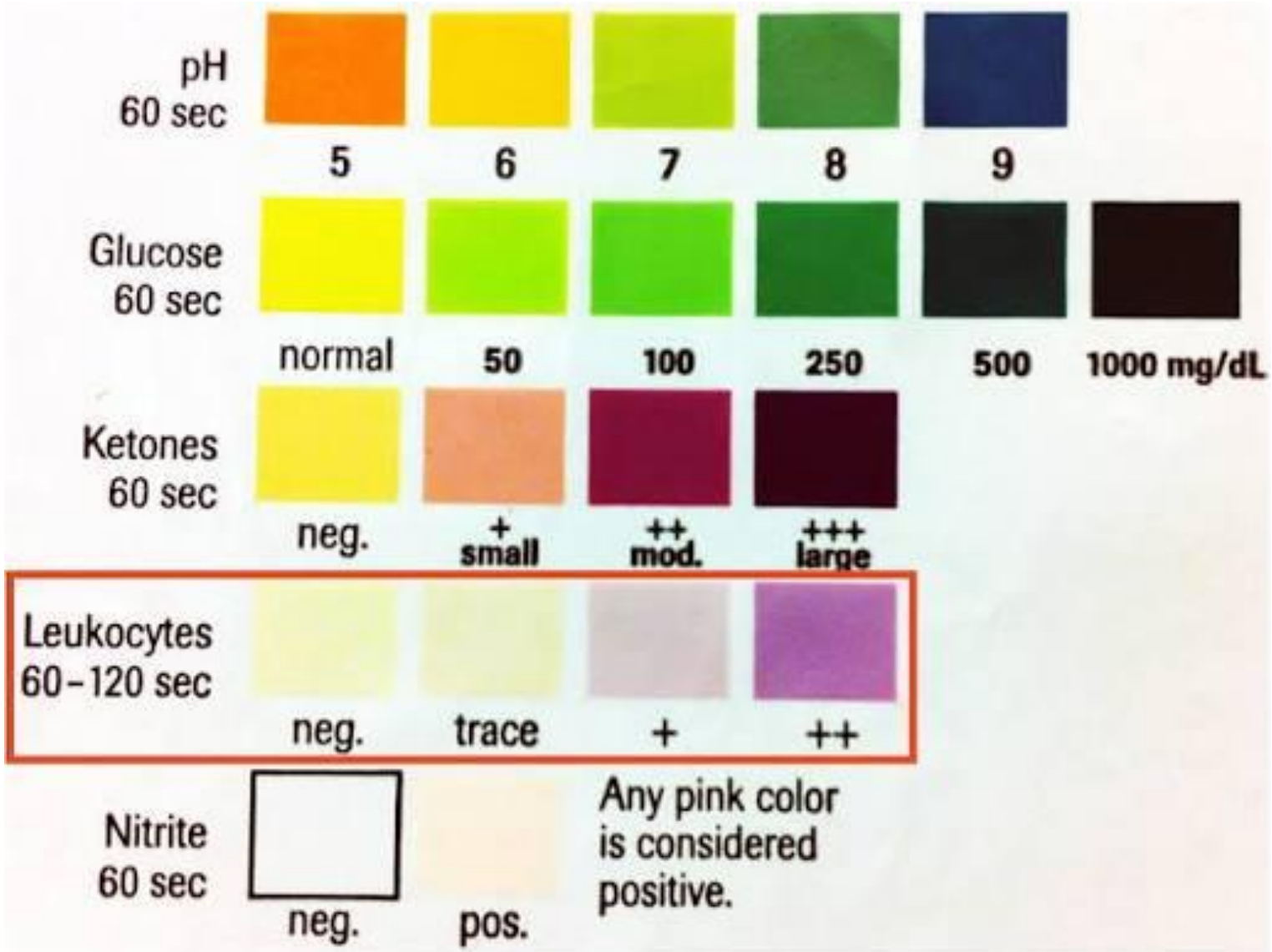
Urinary incontinence also contributes to UTI in postmenopausal women.

Urinary Tract Infections (DIAGNOSIS)

- Using the preferred definition of pyuria, which is at least 10 leukocytes/ mm3 of midstream urine. In fact, with symptomatic infection, most have hundreds of leukocytes per cubic millimeter.
- A less reliable method uses a urine specimen that is centrifuged for 5 minutes at 2000 rpm and then the sediment is examined under high power. With this method, 5 to 10 leukocytes/high-power field in the sediment is the upper limit of normal.
- The finding of pyuria is nonspecific, and patients with pyuria may or may not have infection.
- The absence of pyuria should strongly call into question a diagnosis of UTI.

Urinary Tract Infections (DIAGNOSIS)

- The dipstick leukocyte esterase test is a rapid screening test for detecting pyuria and has largely replaced microscopic methods. Although the sensitivity and specificity are high for detecting more than 10 white blood cells/mm_3 of urine (75%–96% and 94%–98%, respectively), **a positive test by no means indicates UTI.**
- in patients with a negative leukocyte esterase test and UTI symptoms, a urine microscopic examination for pyuria or a urine culture should be considered.


pH
60 sec
5
6
7
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9
Glucose
60 sec
normal
50
100
250
500
1000 mg/dL
Ketones
60 sec
neg.
+
small
++
mod.
+++
large
Leukocytes
60–120 sec
neg.
trace
+
++
Nitrite
60 sec
neg.
pos.
Any pink color
is considered
positive.

Urinary Tract Infections (DIAGNOSIS)

- Microscopic or sometimes gross hematuria is occasionally seen in patients with UTI (i.e., hemorrhagic cystitis). However, red blood cells may be indicative of other disorders, such as calculi, tumor, vasculitis, glomerulonephritis, and renal tuberculosis.
- White cell casts in the presence of an acute infectious process are strong evidence for pyelonephritis, but the absence of white cell casts does not rule out upper tract infection. White cell casts can also be seen in renal disease in the absence of infection.

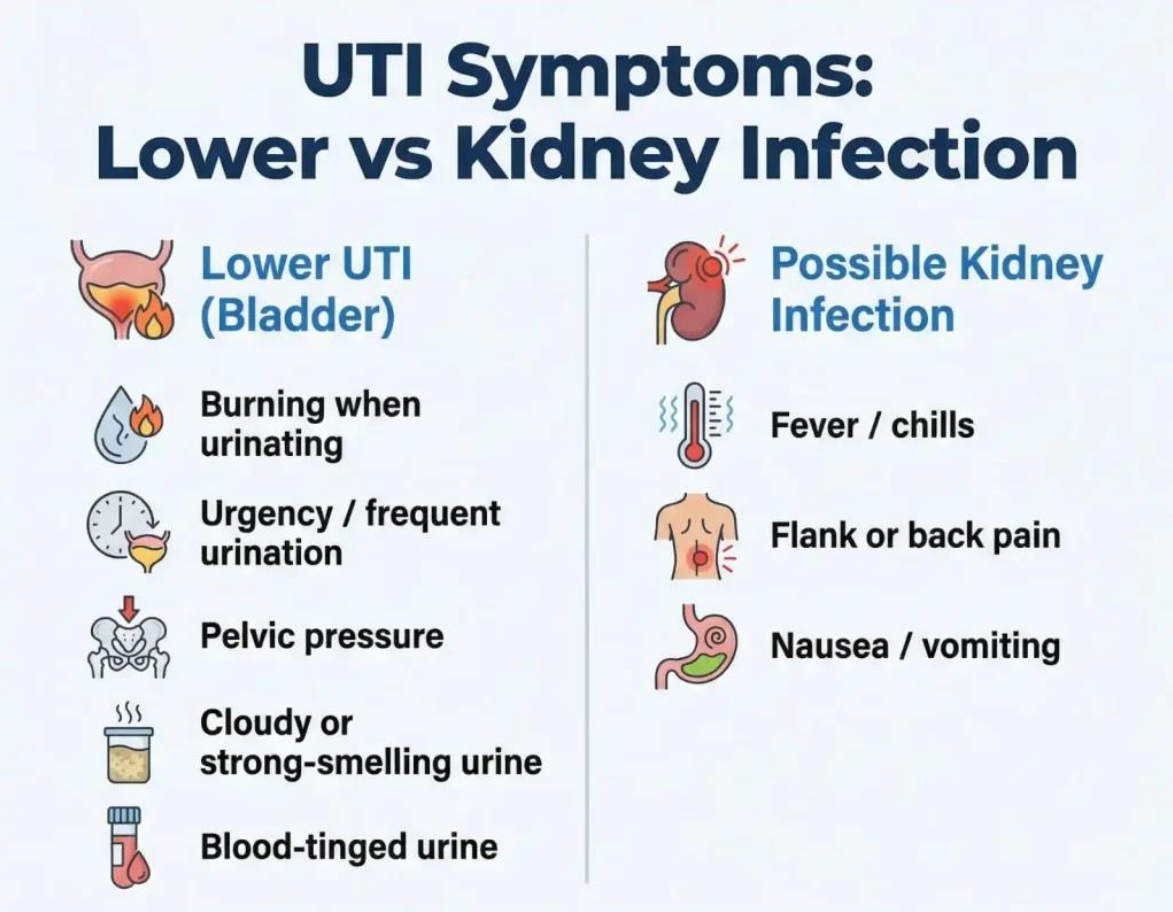
Urinary Tract Infections (DIAGNOSIS)

- Proteinuria is a common although not universal finding in UTI. Most patients with UTI excrete less than 2 g of protein/24 h; excretion of 3 g/24 h or more suggests glomerular disease.

Urinary Tract Infections (DIAGNOSIS)

- The ability to identify bacteria in the urine depends on whether the specimen has been centrifuged and on whether it has been stained with Gram or methylene blue stain .
- Smaller numbers of bacteria can be detected microscopically:
  - in a stained than in an unstained specimen,
  - and in centrifuged than in uncentrifuged urine.
- The presence of at least one bacterium per oil immersion field in a midstream clean-catch, Gram-stained, uncentrifuged urine specimen correlates with 10^5 bacteria/mL of urine or more.

Lower UTI


UTI Symptoms:
Lower vs Kidney Infection
Lower UTI (Bladder)
Burning when urinating
Urgency / frequent urination
Pelvic pressure
Cloudy or strong-smelling urine
Blood-tinged urine
Possible Kidney Infection
Fever / chills
Flank or back pain
Nausea / vomiting

Acute Uncomplicated Cystitis

- case : A 27-year-old woman calls her physician's office reporting 3 days of a burning sensation during urination with urinary frequency and discomfort in her lower abdomen. She recalls having the same symptoms a year ago, which was the only other time she was treated for a UTI. She is otherwise healthy and takes no medications. Her last menstrual period was 2 weeks ago.

Acute Uncomplicated Cystitis

Question : What is the best next step in the management of this patient?

(a) Ask her to submit a urine sample for urinalysis and urine culture and recommend antibiotics pending culture results.

(b) Prescribe ciprofloxacin 500 mg twice daily for 7 days.

(c) Prescribe nitrofurantoin 100 mg twice daily for 5 days.

(d) Prescribe amoxicillin 875 mg twice daily for 5 days.

(e) Prescribe cefpodoxime 100 mg twice daily for 5 days.

Acute Uncomplicated Cystitis

Diagnosis and Testing

- Acute **uncomplicated** cystitis (also known as “simple cystitis”) is a type of UTI, specifically an infection of the bladder in an otherwise immunocompetent host with normal urinary tract anatomy.
- The classic symptoms are dysuria, urinary frequency, urinary urgency, or suprapubic pain in the absence of systemic illness (eg, fever, rigors, or vomiting) or upper urinary tract involvement (eg, flank pain or costovertebral angle tenderness).

Acute Uncomplicated Cystitis

- Testing with urinalysis or urine culture up front is not indicated in most cases of **uncomplicated** cystitis. Having classic symptoms of acute uncomplicated cystitis, as in case 1, can be sufficient to make a clinical diagnosis.
- Management of UTI (cystitis) in males differ somewhat from UTI in females. Pretreatment cultures should be obtained in all circumstances in males with suspected uUTI

Acute Uncomplicated Cystitis

The following are examples of situations where a urinalysis and urine culture should be sent when evaluating a patient for a UTI:

- Signs or symptoms of upper tract disease or systemic illness.
- Atypical symptoms, such as a patient who has dysuria and vaginal symptoms that are also suggestive of vaginitis.
- Patients at high risk of developing complications, such as those who are immunocompromised or have urological abnormalities.
- Patients at risk of infection with multidrug-resistant organisms (MDRO), such as those with a history of infections with MDROs or who have had recent courses of antibiotics or a recent hospitalization.
- Lack of improvement or progression of symptoms.

TABLE 74.3 First-Line Agents for Therapy for Uncomplicated Urinary Tract Infection

ANTIMICROBIAL AGENT	DOSE	DURATION OF THERAPY
Trimethoprim-sulfamethoxazole	One double-strength tablet (160/800 mg) twice daily	3 days
Nitrofurantoin monohydrate/ macrocrystals	100 mg twice daily	5 days
Fosfomycin trometamol	3 g (sachet dissolved in water)	Single dose
Pivmecillinam	185 mg three times daily	3–7 days

TABLE 74.4 Antimicrobial Regimens for Continuous Prophylaxis

DRUG	DOSE
Trimethoprim (TMP)	100 mg once daily
Trimethoprim-sulfamethoxazole (TMP-SMX)	40 mg/200 mg once daily
TMP-SMX	40 mg/200 mg thrice weekly
Nitrofurantoin monohydrate/macrocrystals	50 mg daily
Nitrofurantoin monohydrate/macrocrystals	100 mg daily
Cephalexin	125 mg once daily
Cephalexin	250 mg once daily
Fosfomycin	3 g every 10 days

TABLE 74.5 Antimicrobial Regimens for Postcoital Prophylaxis

DRUG	DOSE
TMP-SMX	40 mg/200 mg postcoitally (1 hour)
TMP-SMX	80 mg/400 mg postcoitally (1 hour)
Nitrofurantoin	50-100 mg postcoitally (1 hour)
Cephalexin	250 mg postcoitally (1 hour)

Table 2. Oral Antibiotics for the Management of Cystitis and Pyelonephritis

Antibiotic	Acute Uncomplicated Cystitis	Pyelonephritis
Nitrofurantoin	• First-line agent • 100 mg twice daily for 5 days[a]	• Avoid due to suboptimal concentrations in renal parenchyma
Trimethoprim-sulfamethoxazole	• First-line agent • 1 DS tablet twice daily for 3 days[a] • Avoid if used in the past 3 months or if prevalence of local resistance is known to exceed 20%. (Rates of TMP-SMX resistance in *E coli* isolates in most of the United States exceed 20%.)	• Can be used if bacteria are identified to be susceptible. • 1 DS tablet twice daily • *Note:* The Infectious Diseases Society of America (IDSA) recommends 14 days, but more recent data indicate that 7 days would be adequate provided the patient is improving clinically.
Fosfomycin	• First-line agent. • 3 g as 1 dose	• Avoid due to suboptimal concentrations in renal parenchyma
Oral β-lactams (eg, amoxicillin-clavulanic acid or cefpodoxime)	• Use only if the above first-line agents cannot be used • *Example* (not comprehensive list): ◇ Amoxicillin, clavulanic acid 500/125 mg twice daily for 5-7 days[a] ◇ Cefpodoxime, 100 mg twice daily for 5-7 days[a]	• Not recommended as an initial agent. • Can consider using oral β-lactam agent if pathogen known to be susceptible and after the patient receives an initial intravenous dose of a long-acting parenteral antimicrobial, such as 1 g of ceftriaxone.
Fluoroquinolones (eg, ciprofloxacin)	• Effective but use only if alternative oral antimicrobials for acute cystitis are not available or possible • *Example:* Ciprofloxacin 250 mg twice daily for 3 days[a]	• Ciprofloxacin 500 mg twice daily for 7 days

Doses listed in this table are for creatinine clearance > 60. Abbreviations: DS, double strength; TMP-SMX, trimethoprim-sulfamethoxazole.
[a]Duration of therapy for cystitis are based on guideline recommendations for *women*. For uncomplicated cystitis in men, consider duration of ~7 days provided there is no

Acute Uncomplicated Cystitis

Review of Question 1

- This patient had symptoms that would be classic for simple cystitis (burning, frequency, suprapubic pain), so she can be started on treatment without confirmatory laboratory testing. Of the treatment options listed, nitrofurantoin is the only first-line agent. Ciprofloxacin should be reserved for pyelonephritis or more complicated infections, and β-lactams such as amoxicillin are second-line agents. Thus, the answer is (c), prescribe nitrofurantoin 100 mg twice daily for 5 days.

chronic cystitis

- Chronic cystitis refers to long-standing bladder inflammation with lower urinary tract symptoms; evaluation and management are etiology-specific.
- Symptoms Core features Persistent or recurrent urgency, frequency, dysuria, suprapubic/pelvic pain, and sometimes hematuria are typical of both infectious cystitis and interstitial cystitis/bladder pain syndrome (IC/BPS).
- IC/BPS adds bladder-related pain, pressure, or discomfort lasting >6 weeks without infection.
- Radiation, chemical, autoimmune, and ketamine cystitis produce similar LUTS, often with hematuria and pain.

chronic cystitis

Causes

- **Infectious chronic cystitis –**
  - Recurrent *bacterial* UTI (including postmenopausal rUTI).
  - **Viral, chlamydial, mycobacterial, fungal, schistosomal** infections as nonbacterial cystitis.
- **Noninfectious etiologies**
  - **IC/BPS** (chronic bladder pain with LUTS, no infection).
  - - **Radiation cystitis,**
  - **chemotherapy-related (e.g., cyclophosphamide) chemical cystitis**.
  - **Autoimmune/eosinophilic cystitis**.
  - **Ketamine-induced cystitis (KC)** in chronic recreational users, with severe frequency, pain, and progressive bladder injury.

chronic cystitis

Diagnostic evaluation Baseline

- **Urinalysis and urine culture** for any chronic LUTS to distinguish bacterial infection from IC/BPS and noninfectious causes.
- **Targeted microbiology**: PCR/culture for viruses, *Chlamydia*, mycobacteria, fungi, schistosoma when suspected.
- **Bladder-focused evaluation** - For suspected Interstitial Cystitis, consider **cystoscopy** (especially if Hunner lesions, hematuria, or malignancy concern) and optional urodynamics.
- **Cystoscopy with biopsy** is standard for eosinophilic cystitis; also used in radiation/chemical cystitis to exclude tumor.
- **Imaging** (US/CT/MRI) when alternative pathology suspected (stones, masses, diverticula, neurogenic bladder, radiation injury, TB).

Acute Bacterial Prostatitis

- Patients complain of abrupt onset of symptoms typical for a lower urinary tract infection. Acute edema of the prostate may lead to lower urinary tract obstruction. Signs of systemic toxicity are common. On physical examination, patients may have fever and lower abdominal or suprapubic tenderness. Findings on rectal examination are frequently impressive, with palpation revealing an exquisitely tender and tense prostate.

Acute Bacterial Prostatitis

- Urinalysis is abnormal, with pyuria, and urine culture is positive unless the patient has received prior antimicrobial therapy. Bacteremiamay occur spontaneously or may result from excessively vigorous rectal examination.

TABLE 112.1 Lower Urinary Tract Localization Using Sequential Urine Cultures[a]

SPECIMEN	SYMBOL	DESCRIPTION
Voided bladder 1	VB_1	Initial 5–10 mL of urinary stream
Voided bladder 2	VB_2	Midstream specimen
Expressed prostatic secretions	EPS	Secretions expressed from prostate by digital massage
Voided bladder 3	VB_3	First 5–10 mL of urinary stream immediately after prostatic massage

[a]Unequivocal diagnosis of bacterial prostatitis requires that the colony count in the VB_3 specimen greatly exceed the count in the VB_1 specimen, preferably by at least 10-fold.

TABLE 112.3 Antibiotic Treatment Recommendations

POPULATION	PREFERRED REGIMEN(S)	ALTERNATIVE REGIMENS	ORGANISMS TARGETED
Empiric Antibiotic Therapy for Acute Bacterial Prostatitis in Adults[a,18,24,101]			
Nonhospitalized persons ≥35 years old without risk factors for sexually transmitted infections	• Trimethoprim-sulfamethoxazole (one double-strength tab orally every 12 hours) for 4–6 weeks or[b] • Fluoroquinolone (ciprofloxacin 500 mg orally every 12 hours or levofloxacin 500 mg orally once daily) for 4–6 weeks		• Enteric pathogens (Enterobacteriaceae)
Nonhospitalized persons ≤35 years old who are sexually active and men ≥35 years who engage in high-risk sexual behavior	• Ceftriaxone 500 mg IM in one dose (1 g for persons ≥150 kg) *plus* doxycycline 100 mg orally twice a day for 10 days	• Unable to tolerate doxycycline: single azithromycin dose (1 g orally) • Unable to tolerate ceftriaxone: single 240 mg IM dose of gentamicin *plus* single 2 g oral dose of azithromycin	• *N. gonorrhoeae* • *C. trachomatis*[a]

Bacterial Orchitis

- Pyogenic bacterial orchitis usually occurs because of contiguous spread from an inflammatory process in the epididymis that causes an epididymo-orchitis. Most cases of pyogenic orchitis are caused by *E. coli, K. pneumoniae, P. aeruginosa,* staphylococci, or streptococci. This seeding seems to be a particular risk with brucellosis in endemic areas.

Bacterial Orchitis

- A patient with pyogenic orchitis appears acutely ill, with high fever and marked discomfort and swelling of the involved testicle. In general, the pain is described as radiating to the inguinal canal, and it frequently is accompanied by nausea and vomiting. On examination, there is usually an acute hydrocele. The testis is swollen and exquisitely tender.

Bacterial Orchitis

- The overlying scrotal skin is generally erythematous and edematous. Complications of pyogenic bacterial orchitis include testicular infarction, abscess formation, and pyocele of the scrotum. Surgery usually is required for treatment of these conditions.

EPIDIDYMO-ORCHITIS – Guidelines for diagnosis and treatment (2024)

Diagnosis (clinical)

- Acute onset scrotal pain
- Tenderness on palpation
- Urethral discharge of dysuria
- Pyrexia
- Hydrocele may be present

Exclude testicular torsion

If a young man or adolescent presents with a painful swollen testicle of sudden onset then the diagnosis is testicular torsion until proven otherwise

Investigations

- Diagnosis of urethritis with microscopy
- Urethral swab for NAAT
- MSU for microscopy and culture
- CRP, ESR (should not delay treatment)
- Screening for other STIs / blood borne viruses (if sexually transmitted)

Treatment

Empirical antibiotic therapy – see Figure 1.

Follow-up

- If no improvement at 3 days patients should be re-reviewed
- Patients should be assessed at 2 weeks
- Test of cure should be sent for STI causes

Further investigation

If failure to improve / diagnostic doubt a scrotal ultrasound should be requested

Diagnosis and Investigation

History suggestive of sexually transmitted pathogen

Ceftriaxone 1g intramuscularly single dose (40, 41) **(1A)**

+

Doxycycline 100mg orally twice daily for 14 days (40, 41) **(1A)**

Risks for both sexually transmitted and enteric pathogens

Ceftriaxone 1g intramuscularly single dose (40) **(1A)**

+

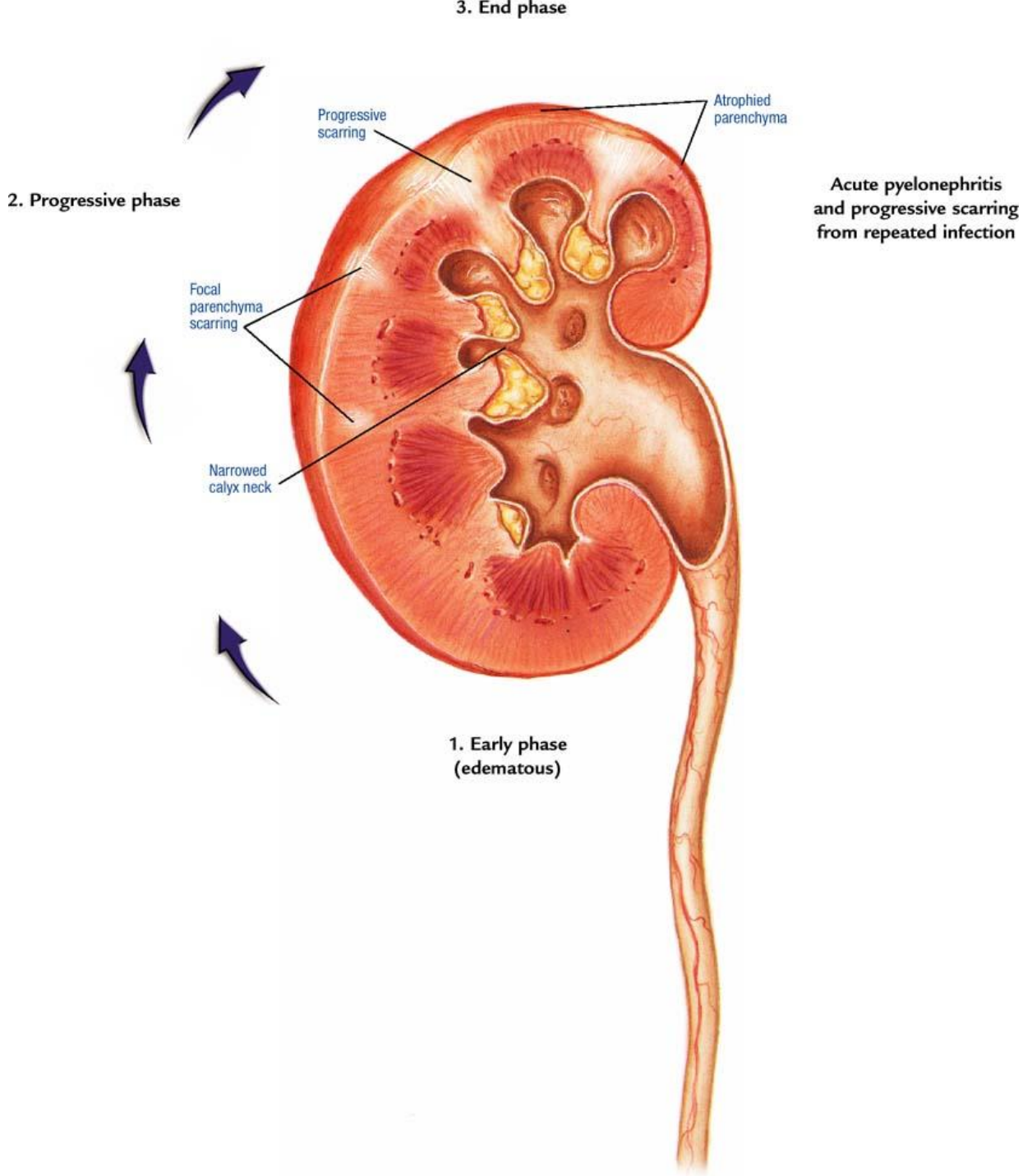
Ofloxacin 200mg orally twice daily for 10-14 days (40, 42) **(1A)**
OR
Levofloxacin 500mg orally once daily for 10-14 days (1, 10) **(2C)**

History suggestive of enteric pathogen

Ofloxacin 200mg orally twice daily for 10-14 days (40 ,41) **(1A)**
OR
Levofloxacin 500mg orally once daily for 10-14 days (40, 10) **(2C)**

Treatment

EADV JEADV


3. End phase
Progressive scarring
Atrophied parenchyma
2. Progressive phase
Acute pyelonephritis and progressive scarring from repeated infection
Focal parenchyma scarring
Narrowed calyx neck
1. Early phase (edematous)

acute pyelonephritis

- **Pyelonephritis** is a bacterial infection of the kidney that usually begins as a urinary tract infection (UTI) and ascends from the bladder to the kidneys. It can be acute or chronic.
- In the United States found overall annual rates of 15–17 cases per 10,000 females and 3–4 cases per 10,000 males.

Causes

- Most commonly Escherichia coli (E. coli)
- Other gram-negative bacteria: Klebsiella, Proteus, Enterobacter
- Most bacterial data are derived from research with Escherichia coli, which accounts for 70-90% of uncomplicated UTIs and 21-54% of complicated UTIs.

acute pyelonephritis

Risk factors:

- Urinary tract obstruction (stones, enlarged prostate)
- Vesicoureteral reflux (backward flow of urine)
- Indwelling catheters
- Diabetes mellitus
- Female anatomy (shorter urethra)

acute pyelonephritis

Symptoms

- High fever and chills
- Flank pain (back/side pain near the kidney)
- Nausea and vomiting
- Dysuria (painful urination)
- Frequency and urgency of urination
- Cloudy or foul-smelling urine
- Hematuria (blood in urine)

Elderly patients may present with typical manifestations of pyelonephritis, or they may experience fever, mental status change, decompensation in another organ system, or generalized deterioration.

acute pyelonephritis

Diagnosis

- Urinalysis: presence of WBCs, bacteria, nitrites
- Urine culture: to identify causative bacteria
- Blood tests: raised WBC count, elevated CRP/ESR
- Imaging: ultrasound or CT scan if obstruction or abscess is suspected.

Indications for imaging studies are as follows:

- Fever or positive blood culture results that persist for longer than 48 hours
- Sudden worsening of the patient's condition
- Toxicity persisting for longer than 72 hours
- Complicated urinary tract infection

acute pyelonephritis

Complications may involve any of the following:

- Acute kidney injury
- Chronic kidney damage leading to hypertension and kidney failure
- Sepsis syndromes
- Renal papillary necrosis
- Xanthogranulomatous pyelonephritis
- Abscesses may include renal cortical abscess, renal corticomedullary abscess, or perinephric abscess. Older adults have a higher incidence of renal corticomedullary abscesses, which affect men and women equally.

acute pyelonephritis

Abscesses

- For renal cortical abscesses modern antibiotics alone often are curative. A semisynthetic penicillin, cephalosporin, fluoroquinolone, or vancomycin is recommended. Generally, parenteral antibiotics should be administered for 10-14 days, followed by oral therapy for 2-4 weeks. Fever should resolve within 5-6 days, and pain should resolve within 24 hours.
- If patients do not respond within 48 hours, percutaneous (or open) drainage should be performed. Other surgical options are enucleation of the carbuncle or nephrectomy.

Table 1.2: Dosing of oral antibiotics for complicated UTI

Drug	Oral absorption (%)	Urinary excretion (%)	Dose for patients with normal renal function	Refs:
Amoxicillin-clavulanate	80 (amoxicillin)[61] variable (clavulanate)[62]	50-70 (amoxicillin)[61] 25-40% (clavulanate)[61]	875mg-125mg every 12 to 8 hours[52-55,63-67] Other regimens may be more effective[a]	
Cefixime	50[68]	50[68]	400mg once daily[26]	
Cefpodoxime	50[68]	~30[68]	200mg to 400mg every 12 hours[51,55,72]	
Ceftibuten	75-90[68]	56[68]	9mg/kg daily (children)[b] 400mg daily or 200mg every 12 hours (adults)[73,74]	
Cefuroxime	52[68,70]	50[68,70]	500mg every 12 hours[55,71]	
Cephalexin	90[68]	90[68]	500mg to 1000mg every 6 hours[50,52-54,63-66,69] Other regimens may be more effective[a]	
Ciprofloxacin	70[75]	40-50[75]	500mg to 750mg every 12 hours [50,55,65,76,77]	
Levofloxacin	99[78]	64-100[78]	500mg to 750mg daily[21,50,72,77]	
Other oral beta-lactams (e.g. amoxicillin, cefadroxil, cefaclor, cefdinir)	Comparative clinical outcomes data vs highly bioavailable oral alternatives are more limited and/or discouraging; consider use with infectious disease pharmacist consultation if alternatives are not available.			
Trimethoprim-sulfamethoxazole	70-90[79]	84 (sulfamethoxazole), 66 (trimethoprim)[79]	800mg-160mg every 12 hours[55,76]	

acute pyelonephritis

The United Kingdom's National Institute for Health and Care Excellence (NICE):

For non-pregnant women and males aged 16 years and over, first-choice oral antibiotics are as follows:

- Cephalexin
- Amoxicillin/clavulanate (if culture confirms susceptibility)
- Trimethoprim (if culture confirms susceptibility)
- Ciprofloxacin (but consider safety issues; discontinue at the first signs of a serious adverse reaction, including tendon pain or inflammation)

Chronic Pyelonephritis

- Chronic pyelonephritis is characterized by inflammation and scarring induced by:
  - recurrent or persistent kidney infection,
  - vesicoureteral reflux,
  - or other causes of urinary tract obstruction.
- It occurs almost exclusively in patients with major anatomic anomalies, most commonly young children with vesicoureteral reflux (VUR).

Chronic Pyelonephritis

Complications of chronic pyelonephritis can also include the following:

- Proteinuria
- Focal glomerulosclerosis
- Progressive renal scarring leading to end-stage renal disease [10]
- Xanthogranulomatous pyelonephritis (XPN)
- Pyonephrosis - May occur in cases of obstruction