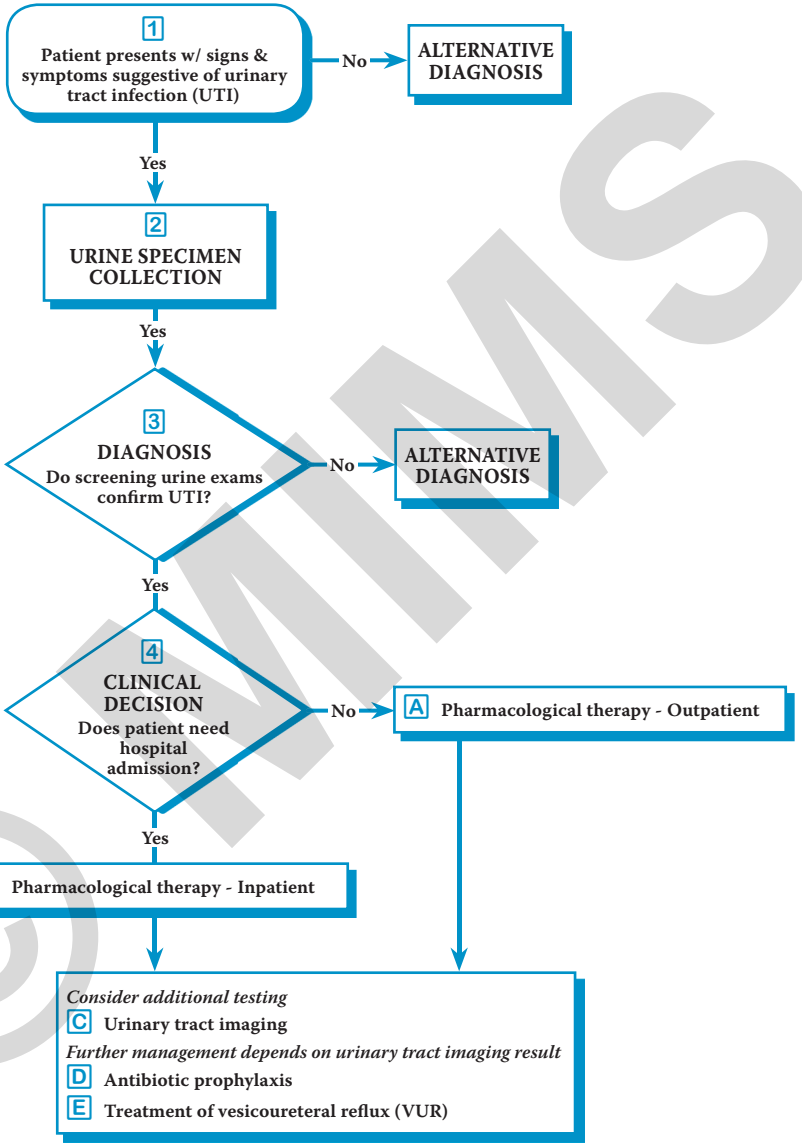
Urinary Tract Infection (1 of 13)



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1 CLINICAL PRESENTATION

Signs & symptoms consistent w/ urinary tract infection (UTI) based on patient's age

Infants <3 months
- Nonspecific: Fever, feeding difficulties, vomiting, lethargy, irritability, failure to thrive
- Less common: Abdominal pain, jaundice, hematuria, strong-smelling urine, sepsis syndrome, shock

Toddlers & preschoolers
- Unusual odor of urine
- Abdominal or flank pain
- Frequency, dysuria, urgency
- Nonspecific signs may be present

School age
- Classical symptoms more common: Fever, frequency, urgency, dysuria
- Strong-smelling urine, new onset urinary incontinence, changed behavior
- Abdominal or flank pain

Consider UTI in all seriously ill children even when there is evidence of infection outside the urinary tract

Signs & symptoms consistent w/ UTI based on severity

Simple UTI
- Mild pyrexia, good fluid intake, mild dehydration, good treatment compliance

Severe UTI
- Fever ≥39°C, persistent vomiting, severe dehydration, poor treatment compliance

Risk factors
- Temp ≥38°C
- Uncircumcised boys <1 year
- Sexual activity among young girls
- Fecal & perineal colonization
- Family history of vesicoureteral reflux (VUR) or renal disease
- Urinary tract malformation, functional urinary abnormalities [eg VUR, neurogenic bladder], enlarged bladder
- History of UTI, dysfunctional voiding
- Presence of a spinal lesion, abdominal mass
- High BP
- Fever of uncertain origin

2 URINE SPECIMEN COLLECTION

- It is difficult to obtain an uncontaminated urine specimen

Bag
- Least traumatic method
- Useful in infants
- A plastic bag is taped at the perineal area & urine is collected after the child voids
- Because of high risk of contamination, a bagged specimen is not useful in accurately documenting UTI
- Useful in ruling out UTI when result is negative
- Not ideal for urine culture: 88% false positive result, 63% specificity; 95% false positive rate for febrile boys, 99% false positive rate for circumcised boys

Clean-catch midstream urine specimen
- May be obtained from toilet trained patients w/ no apparent infection or abnormality of the external genitalia
- Cleansing before specimen collection is not needed
- Likely to be contaminated by periurethral & preputial organisms, especially in young girls & uncircumcised boys
- Useful in ruling out UTI when result is negative

Urethral catheterization
- Traumatic & invasive procedure that may introduce periurethral organisms into an otherwise sterile urinary tract
- 95% sensitivity, 99% specificity of urine sample when used for culture
- Requires cleansing & strict aseptic technique
- Initial portion of urine should be discarded because it may be contaminated by periurethral organisms
- Recommended in febrile infants of unknown origin that appears to be ill & would require antimicrobial therapy

Suprapubic aspiration (SPA)
- Gold standard for identifying bacteria within the bladder
- Traumatic, difficult to perform
- Recommended for the following:
  - Diapered, uncircumcised boys whose urethral openings are difficult to see
  - Patients w/ urgent indications for treatment who cannot produce a clean-catch midstream urine specimen & cannot be catheterized
  - Febrile infants of unknown origin that appears to be ill & would require antimicrobial therapy
- It is difficult to obtain an uncontaminated urine specimen

3 DIAGNOSIS

- Febrile infants w/ unknown origin that is unlikely to have UTI, it is sufficient to have clinical monitoring without testing

Urine dipstick test

- May reduce the need for culture especially in patients w/ a low likelihood of UTI (eg vague urinary complaints, w/ an alternative cause of fever)
- Urine dipstick may have lower sensitivity in infants
- Not recommended in children who frequently void

Leukocyte esterase

- Produced by activated white blood cells (WBC)
- May be falsely negative if WBC are not present during a UTI
- Sensitivity of 48-86% & specificity of 17-93%

Nitrite

- Gram-negative bacteria reduce dietary nitrates to nitrites
- May be falsely negative if pathogen is Gram positive or bacterial metabolism has not yet produced nitrites
- Sensitivity of 45-60% & specificity of 85-98%

Urine microscopy

- Findings supportive of UTI
  - ≥5-10 WBC/high power field
  - Any bacteria seen on Gram stain of unspun urine, w/ sensitivity of 93% & specificity of 95%
- Urine specimen should have been collected <1 hour after voiding or <4 hours after voiding when refrigerated
- WBC casts are almost pathognomonic of pyelonephritis

Urine culture

- Gold standard for UTI diagnosis
- Results may take 24-48 hours
- Indicated in the following patients:
  - Diagnosed w/ acute pyelonephritis or upper UTI
  - Have a high to intermediate risk of serious illness
  - <3 years of age
  - W/ a high likelihood of UTI (eg classic urinary symptoms)
  - Have cloudy urine or single positive results for leukocyte esterase or nitrite activity
  - W/ recurrent symptoms
- Diagnostic thresholds for urine culture based on method of specimen collection:

Collection method	Diagnostic threshold
Clean-catch voiding	10^5 colony forming units (cfu)/mL Repeat testing if 10^4-10^5 cfu/mL
Urethral catheterization	10^5 cfu/mL
Suprapubic aspiration (SPA)	Any number of cfu/mL (>10 identical colonies)

Etiology

Probable pathogen

- *E coli* is the causative agent of the majority of UTI
- *Klebsiella* spp., *Citrobacter* spp., *Enterococcus* spp., *Pseudomonas aeruginosa*, *Staphyloccus saprophyticus, S. aureus*, *Proteus* sp

Probable non-pathogen

- Coagulase negative staphylococci, *Viridans streptococci*
- Diphtheroids, lactobacilli

C-reactive protein

- May help differentiate upper UTI from lower UTI & other causes of bacteriuria
- A concentration of >20 ug/mL signifies a serious bacterial infection; may be useful in ruling out acute pyelonephritis/upper UTI in patients w/ pyuria & fever who may have viral infection

Additional lab exams

Blood culture

- Unnecessary in most children w/ UTI
- Must be done in children w/ septic syndrome or septic shock & febrile infants

Complete septic work up

- Must be done in neonates to avoid missing a diagnosis of meningitis & in children w/ septic syndrome or septic shock

Presumed UTI

- Diagnosed while urine culture results are pending in a patient w/ abnormal lab exams & clinical findings consistent w/ UTI

3 DIAGNOSIS (CONT'D)

Definite UTI
- Diagnosis requires both positive results from urinalysis & culture obtained through catheterization or SPA
  - Culture results should have presence of >50,000 cfu/mL
- Acute pyelonephritis is suggested in a patient who presents w/ dysuria & urinary frequency associated w/ flank pain, high-grade fever (temp >38.5°C) & chills
- An immunocompromised patient or patient <2 months is assumed to have acute pyelonephritis or complicated UTI

Atypical UTI
- Serious illness
- Poor urine flow
- Abdominal or bladder mass
- Elevated creatinine
- Septicemia
- Failure to respond within 48 hours to appropriate antibiotic therapy
- Infection w/ non-*E coli* organisms

Recurrent UTI
- ≥2 episodes of UTI w/ acute pyelonephritis/upper UTI ***or***
- 1 episode of UTI w/ acute pyelonephritis/upper UTI plus ≥1 episodes of cystitis/lower UTI ***or***
- ≥3 episodes of UTI w/ cystitis/lower UTI

Uncomplicated UTI
- Infected patient w/ morphologic & functional normal upper & lower urinary tract, normal renal function & competent immune system

Complicated UTI
- Occurs in newborns w/ clinical evidence of pyelonephritis & in children w/ known mechanical or functional obstructions or upper or lower urinary tract problems

Cystitis
- Lower urinary tract infection that is rarely diagnosed in newborns & infants
- Symptoms include dysuria, stranguria, frequency, urgency, malodorous urine, incontinence, hematuria & suprapubic pain

Pyelonephritis
- Upper urinary tract infection w/ symptoms of fever ≥38°C w/ nonspecific signs eg poor appetite, failure to thrive, lethargy, irritability, vomiting or diarrhea

4 CLINICAL DECISION

Consider hospital admission in the following patients:
- Who need intravenous (IV) fluids
- Who need IV antibiotics because of severe illness
- Unresponsive to oral antibiotics
- ≤4 months of age
- W/ questionable compliance w/ treatment
- W/ difficulty w/ follow-up
- W/ whom clinician or family is uncomfortable managing the patient as an outpatient

A PHARMACOLOGICAL THERAPY - OUTPATIENT

- Starting empiric treatment w/ a broad-spectrum antibiotic is recommended in a patient w/ presumptive UTI once a specimen for culture & urinalysis, preferably obtained from catheterization or SPA, is sent
- The agent to be given should be based on the antibiotic susceptibility patterns of the infecting pathogen
- Timely treatment w/ antibiotics decreases the severity of renal scarring
- Local resistance patterns must be considered when choosing an antibiotic
- Practicality should be considered when deciding which route of administration of treatment is to be chosen
  - Oral treatment has the same efficacy as that of parenterally administered therapies
  - Parenteral outpatient treatment may be adminstered to patients w/ acute pyelonephritis but do not require hospital admission

Cephalosporins

- 1st-, 2nd- & 3rd-generation cephalosporins may be used in the treatment of UTI
- Oral Cefixime has been shown to be cost-effective & efficacious

Penicillins

- Eg Amoxicillin, Ampicillin, Co-amoxiclav

Quinolones

- Eg Ciprofloxacin, Nalidixic acid
- Provides excellent coverage against Gram positive & Gram negative organisms in the urinary tract
- Drug-induced arthrotoxicity shown in animal models has discouraged use in children, although they may still be considered in the treatment of UTI

Others

- Co-trimoxazole
- Nitrofurantoin
  - Not considered adequate for pyelonephritis because of poor tissue penetration
  - May be used to treat cystitis in older children

Treatment Modification

- Antibiotic treatment may need to be modified based on urine culture, however changing antibiotics may not be necessary if clinical resolution occurs
- If the patient's condition does not improve after 24-48 hours of treatment, re-evaluation should be done

Duration of Treatment

Lower UTI/cystitis

- Short courses (2-4 days) of treatment may be equally effective as longer courses (7-14 days) for older patients

Upper UTI/acute pyelonephritis

- A 7-14 day course of antibiotics should be given to patients w/ upper UTI/acute pyelonephritis

B PHARMACOLOGICAL THERAPY - INPATIENT

- An immunocompromised patient or infant younger than 2 months is assumed to have acute pyelonephritis or complicated UTI & should be managed in the hospital

Parenteral Antibiotic Therapy

- Ampicillin or cephalosporin ***plus*** aminoglycoside (eg Gentamicin, Tobramycin) cover most urinary tract pathogens
  - Once-daily dosing is recommended for patients receiving aminoglycosides
  - Ampicillin provides coverage against Gram positive cocci or Enterococcus
- 3rd- or 4th-generation cephalosporin may be used as an alternative initial treatment when antimicrobial resistance is increasing or when there is concern about adverse reactions (eg nephrotoxicity)
  - Eg Ceftazidime, Cefotaxime, Ceftriaxone
- Co-amoxiclav may also be used
- If IV treatment is not possible in a patient who requires parenteral therapy, then IM treatment should be considered

Shifting to Oral Antibiotic Therapy (Switch Therapy)

- Parenteral treatment is given until patient is clinically stable & afebrile for 48-72 hours
- A short course of IV antibiotics followed by oral antibiotics is as effective as a longer duration of IV antibiotics
  - Please see **Pharmacological therapy – Outpatient** for options for oral antibiotic therapy

Duration of Treatment

- A 7-14 day course of antibiotics should be given to patients w/ upper UTI/acute pyelonephritis

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C URINARY TRACT IMAGING

- In the acute setting, diagnostic urinary tract imaging is generally not necessary unless the diagnosis of UTI is equivocal
- Imaging studies can most often be done after the resolution of the acute infection because management during this time is based on patient's clinical profile
- Routine imaging for patients w/ a first UTI is not recommended because imaging has not been shown to alter outcomes; also, it is not cost-effective

Indications for early imaging during UTI

- Persistence of signs & symptoms of UTI after 48 hr of appropriate antibiotic therapy
  - To identify conditions that require invasive therapy (eg renal abscess, anatomic abnormalities) that may be corrected surgically
- Possible urinary tract obstruction (eg abdominal mass, elevated creatinine, poor urine flow, sepsis)
- In rare cases when localization is clinically important
- Atypical UTI in all patients
- Recurrent UTI in patients <6 months

Indications for delayed imaging

- Atypical UTI in patients <3 years
- Recurrent UTI in all patients

Types of Imaging Studies

Ultrasound

- Identify abnormalities in renal size & shape, scars, duplication anomalies, ureteric dilatation
- Indicated in children <2 years old w/ UTI & additional risk factors
- May reveal bladder diverticula or ureteroceles
- Doppler ultrasonography can detect small areas of inflammation in the kidneys
- Recommended early imaging test in infants & children w/ atypical UTI to identify structural urinary tract abnormalities
- Renal & bladder ultrasound is recommended for febrile infants if evaluation of the renal parenchyma & size are needed
- Advantages: Noninvasive & radiation-free
- Disadvantage: Results are operator-dependent

Voiding cystourethrogram (VCUG)

- Invasive procedure requiring urethral catheterization; should only be done when hydronephrosis, scarring, findings suggestive of high-grade VUR/obstructive uropathy, atypical/complicated disease are seen w/ renal & bladder ultrasound (RBUS)
- Detects & grades VUR accurately & can show bladder & urethral anatomy, periureteral diverticula, spinal abnormalities
- Disadvantages: Radiation exposure, possibility of introducing infection into the urinary tract, retrograde filling of the bladder may be necessary
- In a patient for VCUG prophylactic antibiotics should be given for 3 days, w/ the procedure taking place on the 2nd day

Radionuclide cystography

- May be considered for patients w/ reflux
- Advantages: Less radiation exposure
- Disadvantages: Poor image resolution, low sensitivity for lower UTI & other abnormalities

Tc 99m dimercaptosuccinic acid renal scintigraphy (DMSA)

- Gold standard for localizing infection to the renal parenchyma
- More sensitive in detecting cortical scarring than ultrasound & IV pyelogram
- Radiolabeled DMSA is injected intravenously & binds to renal proximal tubular cells, after which renal cortical images are taken
  - An area of decreased uptake delineates an area of focal defect in the renal parenchyma
  - Star-shaped defect in the renal parenchyma may indicate acute pyelonephritis
  - A focal defect in the renal cortex may signify chronic lesion or renal scar
- Renal scarring may indicate that VUR is likely to persist in patients w/ reflux

D ANTIBIOTIC PROPHYLAXIS

- Goal of antibiotic prophylaxis is to prevent infection, renal damage & scarring by sterilizing urine
- Routine antibiotic prophylaxis in patients w/ first-time UTI is not recommended
- Asymptomatic bacteriuria in a patient w/ a normal urinary tract is not an indication for antibiotic prophylaxis
- Antibiotic prophylaxis may reduce the number of positive urine cultures but has not been clearly shown to reduce the number of new symptomatic UTI or new renal parenchymal defects
- Possible drawbacks of antibiotic prophylaxis:
  - Patient inconvenience
  - Poor compliance
  - Colonization w/ resistant organisms
- Prophylaxis may be considered in the following patients:
  - W/ history of VUR
  - Immunosuppressed
  - W/ partial urinary tract obstruction
  - W/ recurrent UTI
- Antibiotics used for prophylaxis should ideally be administered orally & achieve high concentrations in the urine while maintaining low fecal concentrations
- Antibiotics that may be used for prophylaxis: Co-trimoxazole, Nalidixic acid, Nitrofurantoin, cephalosporins, fluoroquinolones

E TREATMENT OF VESICOURETERAL REFLUX (VUR)

- Not all cases of VUR require treatment
- Intervention for VUR does not always prevent complications
- Long-term antibiotic therapy may be given to prevent infections in a child who is expected to outgrow reflux
- Surgery is recommended for higher grades of reflux
  - Open surgical repair including ureteral implantation
  - Endoscopic treatment
- Correction of dysfunctional elimination, ie constipation has been shown to decrease recurrent UTI

Dosage Guidelines

AMINOGLYCOSIDES

Drug	Dosage	Remarks
Amikacin	5-15 mg/kg/day IM/IV divided 8-12 hrly **Neonate:** 10 mg/kg/day loading dose followed by 15 mg/kg/day divided 12 hrly **Max dose:** 1.5 g/day	**Adverse Reactions** • Ototoxic effects (can cause irreversible ototoxicity resulting in hearing loss, dizziness, vertigo); Renal effects (reversible nephrotoxicity, acute renal failure has been reported usually when other nephrotoxic drugs have also been administered); Neuromuscular effects (neuromuscular blockade resulting in resp depression & muscular paralysis); Hypersensitivity reactions **Special Instructions** • Ototoxicity & nephrotoxicity are most likely in patients w/ renal impairment, in patients who are receiving high doses or for long periods or who are also receiving or have received other ototoxic/nephrotoxic drugs - Consider monitoring of serum conc &/or peak serum conc/MIC ratio in these patients • Use w/ caution in neonates due to renal immaturity, patients w/ conditions associated w/ muscle weakness, w/ preexisting renal dysfunction, w/ vestibular or cochlear impairment
Bekanamycin	10-20 mg/day IM divided 12 hrly	
Gentamicin	3-7.5 mg/kg/day IM/IV divided 8-12 hrly ***or*** 5-6 mg/kg/day IM/IV 24 hrly	
Kanamycin	15 mg/kg/day IM divided 6-12 hrly **Max dose:** 500 mg/day	
Netilmicin	**>1 yr:** 6-7.5 mg/kg/day IM/IV divided 8 hrly **Neonate >1 wk-1 yr:** 7.5-9 mg/kg/day IM/IV divided 8 hrly **Premature & full-term neonate <1 wk:** 6 mg/kg/day IM/IV divided 12 hrly	
Tobramycin	6-7.5 mg/kg/day IM/IV divided 6-8 hrly ***or*** 5-6 mg/kg/day IM/IV 24 hrly	

ANTIBACTERIAL COMBINATIONS

Drug	Dosage	Remarks
Co-trimoxazole [Sulfamethoxazole (SMZ) & Trimethoprim (TM)]	6-12 mg/kg/day PO divided 12 hrly based on TM	**Adverse Reactions** • GI effects (N/V, anorexia, diarrhea, rarely antibiotic-associated diarrhea/colitis, glossitis, stomatitis); Dermatologic effects (rash, pruritus, photosensitivity); Hypersensitivity reactions can range from mild (eg rash) to severe/life-threatening (eg Stevens-Johnson syndrome); Urogenital effect (crystallization in the urine) • Rarely hematologic effects which may be more common if given for long periods or w/ high doses; Rarely hepatic, renal effects; Aseptic meningitis has occurred **Special Instructions** • Maintain adequate fluid intake • Contraindicated in patients <2 mth of age & patients w/ sulfonamide allergy • Use w/ extreme caution or not at all in patients w/ hematological disorders esp megaloblastic anemia due to folic acid deficiency • Use w/ caution in patients w/ renal impairment or severe hepatic dysfunction & in patients w/ folate deficiency (may consider administration of Ca folinate) • Use w/ caution in patients w/ G6PD deficiency

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Dosage Guidelines

CEPHALOSPORINS

Drug	Dosage	Remarks
First Generation		
Cefadroxil	25-50 mg/kg/day PO single dose or divided 12 hrly May be increased to 100 mg/kg	**Adverse Reactions** • Hypersensitivity reaction (urticaria, pruritus, severe reactions eg anaphylaxis can occur); GI effects (diarrhea, N/V, rarely antibiotic-associated diarrhea/ colitis); Other effects (Candidal infections, inj site inflammation) • High doses may be associated w/ CNS effects (encephalopathy, convulsions); Rarely hematologic, hepatic & renal effects have occurred • Prolonged prothrombin time (PT), prolonged activated partial thromboplastin time (APTT), &/or hypoprothrombinemia (w/ or w/o bleeding time) have been reported & occurs most frequently w/ N-methylthiotetrazole (NMTT) side chain containing cephalosporins **Special Instructions** • May be taken w/ food to decrease gastric distress • Ceftriaxone is contraindicated in hyperbilirubinemic neonates • Avoid simultaneous administration of Ceftriaxone w/ IV Ca-containing soln • Use suspension containing sodium benzoate w/ caution in neonates as this has been associated w/ gasping syndrome • Use w/ caution in patients allergic to Penicillin, there may be 10% chance of cross sensitivity; & patients w/ renal impairment & GI disease esp w/ history of colitis
Cefalexin	25-100 mg/kg/day PO divided 6 hrly **Max dose:** 4 g/day	
Cefazolin	20-50 mg/kg/day IM/IV divided 6-12 hrly **Max dose:** 100 mg/kg/day	
Second Generation		
Cefaclor	**>1 mth:** 20-40 mg/kg/day PO divided 8 hrly **Max dose:** 1 g/day	
Cefamandole	50-100 mg/kg/day IM/IV divided 4-8 hrly **Severe infections:** 150 mg/kg/day	
Cefprozil	**>12 yr:** 500 mg PO 24 hrly	
Cefuroxime	10 mg/kg PO 12 hrly **Max dose:** 500 mg/day 30-100 mg/kg/day IM/IV divided 6-8 hrly	
Third Generation		
Cefdinir	14 mg/kg/day PO 24 hrly or divided 12 hrly	
Cefixime	**>12 yr:** 100 mg PO 24 hrly **≥6 mth:** 1.5-3 mg/kg PO 12 hrly **Severe infections:** 6 mg/kg PO 12 hrly	
Cefoperazone	25-200 mg/kg/day IM/IV divided 6-12 hrly **Max dose:** 12 g/day **Neonate <8 days:** 50-200 mg/kg/day IM/IV divided 12 hrly	
Cefotaxime	**>12 yr:** 1 g IM/IV 12 hrly **1 mth-12 yr:** 50-100 mg/kg/day IM/IV divided 6-12 hrly **Severe infections:** 150-200 mg/kg/day **Max dose:** 12 g/day **Premature & newborn:** 50 mg/kg/day IM/IV divided 12 hrly	
Cefpodoxime	8-10 mg/kg PO 12 hrly	
Ceftazidime	30-100 mg/kg/day IM/IV divided 8-12 hrly **Max dose:** 6 g/day	
Ceftriaxone	20-80 mg/kg IM/IV 24 hrly **Max dose:** 80 mg/kg/day **Neonate:** 20-50 mg/kg IM/IV 24 hrly **Max dose:** 50 mg/kg/day	

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Dosage Guidelines

CEPHALOSPORINS (CONT'D)		
Drug	**Dosage**	**Remarks**
Fourth Generation		
Cefepime	>2 mth & ≤40 kg: 50 mg/kg IM/IV 8-12 hrly **1-2 mth:** 30 mg/kg IM/IV 8-12 hrly	**Adverse Reactions** • Hypersensitivity reactions (urticaria, pruritus, severe reactions eg anaphylaxis can occur); GI effects (diarrhea, N/V, rarely antibiotic-associated diarrhea/ colitis); Other effects (Candidal infections, inj site inflammation) • High doses may be associated w/ CNS effects (encephalopathy, convulsions); Rarely hematologic, hepatic & renal effects have occurred • Prolonged prothrombin time (PT), prolonged activated partial thromboplastin time (APTT), &/or hypoprothrombinemia (w/ or w/o bleeding time) have been reported & occurs most frequently w/ N-methylthiotetrazole (NMTT) side chain containing cephalosporins **Special Instructions** • May be taken w/ food to decrease gastric distress • Use susp containing sodium benzoate w/ caution in neonates as this has been associated w/ gasping syndrome • Use w/ caution in patients allergic to Penicillin, there may be 10% chance of cross sensitivity; & patients w/ renal impairment & GI disease esp w/ history of colitis
Cephalosporin w/ Beta-lactamase Inhibitor		
Cefoperazone/ sulbactam	40-80 mg/kg/day IM/IV divided 6-12 hrly (1:1 Ratio) **Severe infections:** 160 mg/kg/day IM/IV divided 6-12 hrly 30-60 mg/kg/day IM/IV divided 6-12 hrly (2:1 Ratio) **Severe infections:** 240 mg/kg/day IM/IV divided 6-12 hrly	

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Dosage Guidelines

OTHER ANTIBIOTICS		
Drug	**Dosage**	**Remarks**
Nitrofuran Derivatives		
Nitrofurantoin	**>1 mth:** 5-7 mg/kg/day PO divided 6 hrly **Long-term UTI prophylaxis:** 1 mg/kg/day PO single dose or divided 12 hrly **Max dose for UTI prophylaxis:** 100 mg/day	**Adverse Reactions** • GI (N/V, abdominal pain, diarrhea, anorexia, rarely *C difficile* associated diarrhea/colitis); CNS (dizziness, drowsiness, fatigue, headache, rarely irreversible peripheral polyneuropathy); Hypersensitivity reactions (rash, angioedema, Stevens-Johnson syndrome, exfoliative dermatitis, pancreatitis, etc); Pulmonary (acute pulmonary sensitivity reactions have occurred including pulmonary fibrosis); hematologic effects; hepatic effects; neuromuscular effects have occurred (arthralgia, numbness, paresthesia, weakness); ocular effects (amblyopia, nystagmus, optic neuritis) **Special Instructions** • Take w/ food to decrease GI effects - Maintain adequate hydration (2-3 L/day of fluids) unless instructed to restrict fluid intake • Avoid in patients w/ renal impairment, patients w/ G6PD deficiency • Use w/ caution in the elderly & in patients w/ preexisting pulmonary, hepatic, neurological or allergic disorders & in those w/ conditions (eg anemia, DM, electrolyte imbalance, debility or Vit B deficiency) which may predispose to peripheral neuropathy • Withdraw if signs of peripheral neuropathy develop

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Dosage Guidelines

PENICILLINS		
Drug	**Dosage**	**Remarks**
Aminopenicillins w/ or w/o Beta-lactamase Inhibitors		
Amoxicillin	20-40 mg/kg/day PO divided 8 hrly	**Adverse Reactions** • Hypersensitivity reactions (rash, urticaria, pruritus, severe reactions eg anaphylaxis can occur); GI effects (diarrhea, N/V, rarely antibiotic-associated diarrhea/colitis); Other effect (Candidal infections) • Rarely hematologic, renal & hepatic effects; High doses may be associated w/ CNS effects (encephalopathy, convulsions) **Special Instructions** • Avoid in patients w/ Penicillin allergy • Use w/ caution in patients w/ renal impairment
Amoxicillin/ clavulanic acid (Co-amoxiclav, Amoxicillin/ clavulanate)	20-40 mg/kg/day PO divided 8 hrly based on Amoxicillin **≤3 mth:** 25-30 mg/kg IV 8-12 hrly **3 mth-12 yr:** 25-30 mg/kg IV 6-8 hrly	
Amoxicillin/ sulbactam	*FC Tab* **Childn ≥12 yr:** 500 mg PO 8 hrly *Susp* 40-100 mg/kg/day 8-12 hrly **Childn >20 kg:** 10-20 mL 8-12 hrly **Childn 2-6 yr:** 10 mL 8 hrly **<2 yr & nursing infant:** 5 mL 8 hrly or 7.5 mL 12 hrly *Inj* **1yr or older weighing ≤40 kg:** 60-150 mg/ kg/day IV/IV infusion 8 hrly May be increased to 150 mg/kg/day for severe infections **Max dose:** 4 g Sulbactam/8 g Amoxicillin 24 hrly	
Ampicillin	50-100 mg/kg/day PO divided 6 hrly 50-100 mg/kg/day IM/IV divided 6 hrly	
Ampicillin/ sulbactam (Sultamicillin: Pro-drug of Ampicillin/ sulbactam, the 2 drugs are linked chemically w/ a double ester)	**<30 kg:** 25-50 mg/kg/day PO divided 12 hrly based on Ampicillin 150 mg/kg/day IM/IV divided 6-8 hrly	
Antipseudomonal Penicillins w/ or w/o Beta-lactamase Inhibitors		
Piperacillin	**<7 days/<2 kg:** 150 mg/kg/day IV/IM in 3 divided doses **>7 days & >2 kg:** 300 mg/kg/day IV/IM in 3-4 divided doses **1 mth-12 yr:** 100-300 mg/kg/day IV/IM in 3-4 divided doses	
Piperacillin/ tazobactam	**Childn 1 mth - 12 yr:** 100-300 mg/kg/day IV in 3-4 divided doses **Neonate >7 days or >2 kg:** 300 mg/kg/day IV in 3-4 divided doses **Neonate <7 days or <2 kg:** 150 mg/kg/day IV in 3 divided doses May be adminstered as slow IV inj over 3-5 min or as IV infusion over 20-40 min	

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Dosage Guidelines

QUINOLONES

Drug	Dosage	Remarks
Ciprofloxacin	10-30 mg/kg/day PO divided 12 hrly **Max dose:** 1.5 g/day 7.5-16 mg/kg/day IV divided 12 hrly	**Adverse Reactions** • GI effects (N/V, diarrhea, abdominal pain, dyspepsia, diarrhea, rarely antibiotic-associated diarrhea/colitis); CNS effects (headache, dizziness, sleep disorders, restlessness, drowsiness); Dermatologic effects (rash, pruritus, photosensitivity); hypersensitivity reactions can range from mild (eg rash) to severe/life-threatening (eg Stevens-Johnson syndrome) • Rarely hematologic effects; hepatic & renal effects • Some quinolones have the potential to prolong the QT interval **Special Instructions** • Administer at least 2 hr before or 3 hr after Al or Mg containing antacids, dietary supplements containing Zn or Fe or buffered ddI preparations • Avoid exposure to strong sunlight or tanning beds • Use w/ caution in patients w/ epilepsy or history of CNS disorders, in patients w/ impaired renal or hepatic function
Nalidixic acid	50 mg/kg/day PO divided 6 hrly	

SULPHONAMIDES

Drug	Dosage	Remarks
Sulfafurazole (Sulfisoxazole)	**Initial dose: >2 mth:** 75 mg/kg/day PO in divided doses **Maintenance dose: >2 mth:** 150 mg/kg/day PO in divided doses **Max dose:** 6 g/day	**Adverse Reactions** • GI effects (N/V, diarrhea, anorexia); Dermatologic effects (rash, pruritus, photosensitivity); Cardiovascular effects (myocarditis, vasculitis) Hepatic effects (liver necrosis, hepatomegaly, jaundice); Metabolic effects (hypoglycemia, hypothyroidism); Misc effects (hypersensitivity reactions, serum sickness-like syndrome) • Potentially fatal: blood dyscrasias, Stevens-Johnson syndrome, toxic epidermal necrolysis, anaphylaxis **Special Instructions** • Contraindicated in patients w/ severe renal/hepatic failure, blood disorders, acute porphyria & infants ≤2 mth • Adequate fluid intake is necessary to reduce risk for crystalluria • Use w/ caution in patients w/ impaired renal or hepatic function, history of allergy/asthma, AIDS, G6PD deficiency, SLE

All dosage recommendations are for children w/ normal renal & hepatic function unless otherwise stated.
Not all products are available or approved for above use in all countries.
Products listed above may not be mentioned in the disease management chart but have been placed here based on indications listed in regional manufacturers' product information.

Specific prescribing information may be found in the latest MIMS.

Please see the end of this section for the reference list.