ACP Board Review Course Curriculum

Infectious Disease II

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- Cystitis and pyelonephritis
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- Tuberculosis
- Osteomyelitis
- *Clostridioides difficile* colitis

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Asymptomatic Bacteriuria

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Asymptomatic Bacteriuria: Risk Factors

- Female anatomy
- Pregnancy
- Diabetes
- Advanced age
- Spinal cord injury
- Indwelling urinary catheter

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Asymptomatic Bacteriuria: Diagnosis

Bacteria in an appropriately collected urine sample

No symptoms specifically related to UTI

- No dysuria, frequency, urgency, suprapubic pain
- Patients with spinal cord injury may not have specific UTI symptoms

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Asymptomatic Bacteriuria: Diagnosis

Bacteriuria + nonspecific symptoms ≠ UTI

- Dementia, delirium, failure to thrive

Pyuria ≠ UTI

Pyuria + bacteriuria ≠ UTI

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Asymptomatic Bacteriuria: Testing and Treatment

Indications for screening/treatment

- Pregnancy
- Upcoming invasive urologic procedure

Do not routinely screen/treat patients with:

- A urinary catheter
- Nonspecific symptoms

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Infectious Disease Q7

A 62-year-old woman reports fever, nausea, and abdominal pain.

She has diabetic kidney disease.

She has fever, hypotension, and tachycardia with left-sided costovertebral angle tenderness.

Leukocyte count is 24,000/µL; serum creatinine level is 2.8 mg/dL.

UA shows 220 leukocytes/hpf and many bacteria.

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Infectious Disease Q7

A 62-year-old woman reports fever, nausea, and abdominal pain. She has diabetic kidney disease. She has fever, hypotension, and tachycardia with left-sided costovertebral angle tenderness. Leukocyte count is 24,000/µL; serum creatinine level is 2.8 mg/dL. UA shows 220 leukocytes/hpf and many bacteria.

Which of the following is the most appropriate empiric antibiotic treatment?

A: Piperacillin-tazobactam

B: Cefazolin

C: Gentamicin

D: Vancomycin

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Cystitis and Pyelonephritis

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Urinary Tract Infections: Definitions

Uncomplicated

A UTI in a female who meets the following criteria:

- Premenopausal
- Nonpregnant
- Without urologic abnormalities
- Without comorbidities
- Without signs or symptoms of infection beyond the bladder

Complicated

A UTI that does not meet criteria for uncomplicated

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Uncomplicated Cystitis: Epidemiology and Risk Factors

Microbiology

- *Escherichia coli* (>75% of infections)
- Other Enterobacteriaceae, streptococci, enterococci, *Staphylococcus saprophyticus*

Risk factors

- Sexual activity
- Previous UTI
- Spermicide use

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Uncomplicated Cystitis: Diagnosis and Testing

- Dysuria, urgency, frequency
- Suprapubic pain
- Hematuria
- Testing (urinalysis/culture) not necessary

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Uncomplicated Cystitis: Treatment

Nitrofurantoin for 5 days

Trimethoprim-sulfamethoxazole (TMP-SMX) for 3 days

- Avoid if used in preceding 3 months
- Avoid if local resistance >20%

Fosfomycin single dose (lower efficacy)

Avoid fluoroquinolones (antibiotic stewardship)

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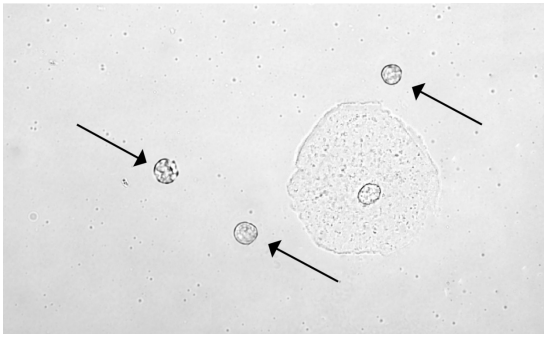
Complicated Cystitis: Testing and Treatment



Urinalysis and culture

Empiric treatment (nonpregnant patients)

- Oral fluoroquinolone for 5-7 days
- Ciprofloxacin, levofloxacin
- TMP-SMX, oral β-lactams, fosfomycin (given every 48 hours for a total of 3 doses)

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Pyelonephritis: Diagnosis

- Fever, chills
- Flank pain
- Nausea, vomiting
- Costovertebral angle tenderness

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Pyelonephritis: Testing

Urinalysis and culture

Blood cultures (critically ill patients)

Imaging if:

- Fever for >72 hours
- Persistent bacteremia

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Pyelonephritis: Outpatient Treatment

Patients without comorbidities not requiring hospitalization

- Fluoroquinolone
  - Ciprofloxacin for 7 days
  - Levofloxacin for 5 days
- If fluoroquinolone resistance rates exceed 10%
  - Initial dose of a long-acting parenteral antibiotic (e.g., ceftriaxone or a once-daily aminoglycoside)

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Pyelonephritis: Inpatient Treatment

Hospitalized patients without critical illness

- If at least one risk factor for multidrug-resistant (MDR) organism (recent hospitalization, recent antibiotic use, past MDR infection, travel to areas of high MDR prevalence):
  - Piperacillin-tazobactam
  - Cefepime
  - Antipseudomonal carbapenem
- If no risk factors for MDR organism:
  - Ceftriaxone or fluoroquinolone

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Pyelonephritis: Inpatient Treatment

Hospitalized patients with critical illness

- Severe sepsis and/or urinary tract obstruction
  - Piperacillin-tazobactam or cefepime
    - Depending on local MDRO prevalence
  - Antipseudomonal carbapenem (*Pseudomonas*, ESBL) and vancomycin (MRSA)
  - Imaging to evaluate for obstruction

Remember in each case to de-escalate per culture results

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Recurrent UTI

Reinfection (different bacteria)

- Most common cause of recurrent infection
- >2 weeks after original infection
- Treat with same first-line agent

Relapsed infection (same organism)

- Recurrence within 2 weeks of treating original infection
- Culture to guide antibiotic selection
- Treat for 7-10 days

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Prevention of Recurrent UTI

Prophylactic antibiotic indications

- Women with ≥3 UTIs in previous 12 months
- Women with ≥2 UTIs in 6 months

Daily prophylaxis

Postcoital prophylaxis

Self-diagnosis and self-treatment

Nonantibiotic preventive measures:

- Hydration, spermicide contraception avoidance, clean intermittent catheterization for neurogenic bladder, methenamine, vaginal estrogen for postmenopausal women

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Infectious Disease Q8

A 46-year-old man is evaluated for fever, dysuria, frequency, and perineal pain.

He is not sexually active.

Temperature is 101.8 °F.

Rectal exam reveals a tender, tense prostate.

Cultures are pending.

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Infectious Disease Q8

A 46-year-old man is evaluated for fever, dysuria, frequency, and perineal pain. He is not sexually active. Temperature is 101.8 °F. Rectal exam reveals a tender, tense prostate. Cultures are pending.

Which of the following is the most appropriate treatment?

A: Ampicillin

B: Ceftriaxone (single dose) and doxycycline

C: Ciprofloxacin

D: Meropenem

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Prostatitis

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Acute Bacterial Prostatitis: Diagnosis and Testing

- Fever, dysuria, urgency
- Pelvic pain
- Obstructive symptoms
- Tender, tense, or boggy prostate
- Urinalysis, urine Gram stain/culture
- Imaging not generally indicated

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Acute Bacterial Prostatitis: Treatment

Outpatient empiric treatment

- Ciprofloxacin or levofloxacin (preferred)
- TMP-SMX if susceptible or *E. coli* resistance <20%

Inpatient empiric treatment

- Extended-spectrum penicillin or cephalosporin (or carbapenem if recent urologic procedure or other risk factors for resistant pathogen)

De-escalate based on culture results

Treat for 4-6 weeks

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Chronic Bacterial Prostatitis: Diagnosis, Testing, and Treatment

Symptoms for >3 months

- Frequency, dysuria, hesitancy, prostatic pain
- Prostate tenderness, enlargement, ± bogginess

Urinalysis and urine culture

Treatment

- Empiric fluoroquinolone or TMP-SMX for 4-6 weeks
- NSAIDs

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Infectious Disease Q9

A 22-year-old asymptomatic woman is evaluated during an initial prenatal care visit at 6 weeks' gestation.

Urine dipstick is positive for nitrites and leukocyte esterase.

Urine culture grows >100,000 CFU/mL of *E. coli* susceptible to amoxicillin-clavulanate, nitrofurantoin, and TMP-SMX.

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Infectious Disease Q9

A 22-year-old asymptomatic woman is evaluated during an initial prenatal care visit at 6 weeks' gestation. Urine dipstick is positive for nitrites and leukocyte esterase. Urine culture grows >100,000 CFU/mL of *E. coli* susceptible to amoxicillin-clavulanate, nitrofurantoin, and TMP-SMX.

Which of the following is the most appropriate treatment?

A: Amoxicillin-clavulanate

B: Nitrofurantoin

C: TMP-SMX

D: No treatment

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Urinary Tract Infections in Pregnancy

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UTIs in Pregnancy: Diagnosis

Asymptomatic bacteriuria

Cystitis

- Frequency, urgency, dysuria, hematuria

Pyelonephritis

- Fever, chills, flank pain, nausea/vomiting

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UTIs in Pregnancy: Testing

Asymptomatic bacteriuria

- Routine screening with urine culture at 12-16 weeks or first prenatal visit
- Bacterial load ≥100,000 CFU/mL

Cystitis and pyelonephritis

- Urinalysis, urine culture

Blood cultures in critically ill patients

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UTIs in Pregnancy: Treatment

Treat asymptomatic bacteriuria and UTIs

Pyelonephritis requires hospitalization and parenteral β-lactam antibiotics

Culture guides therapy

β-lactam antibiotics

- Includes penicillin and β-lactamase inhibitor combinations

Fosfomycin

Nitrofurantoin

- Avoid in first trimester and at end of pregnancy
- Avoid in G6PD deficiency

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UTIs in Pregnancy: Treatment

TMP-SMX

- Use only during the second trimester

Tetracyclines and fluoroquinolones

- Contraindicated

Obtain post-treatment urinalysis and culture

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Meningitis

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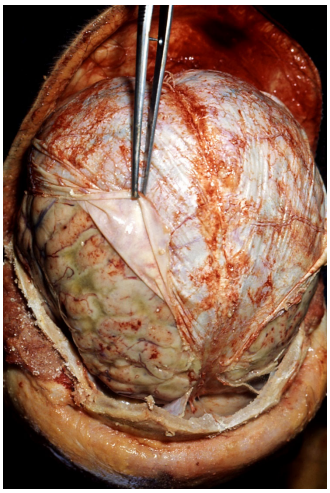
Acute Meningitis: Epidemiology/Causes

Bacterial

- *Streptococcus pneumoniae*: most common
- *Neisseria meningitidis*: second most common
  - Younger patients
  - Complement deficiencies (C5-C9)
- *Listeria monocytogenes*
  - Age >50 years
  - Cell-mediated immunodeficiency
- *Haemophilus influenzae*



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Acute Meningitis: Epidemiology/Causes

Viral

- Enteroviruses most common
- Herpes simplex virus (HSV)-1 and HSV-2
- Varicella zoster virus
- Acute HIV
- West Nile virus (meningitis/encephalitis)

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Acute Meningitis: Diagnosis

- Fever
- Headache
- Photophobia
- Nausea/vomiting
- Nuchal rigidity ± mental status changes

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Acute Meningitis: Testing

Blood cultures

CT before lumbar puncture if:

- Focal neurologic findings
- Altered mentation
- Immunocompromise
- Papilledema
- New seizure
- History of central nervous system disease

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Acute Meningitis: Cerebrospinal fluid (CSF) Analysis

CSF Parameter	Viral Meningitis	Bacterial Meningitis
Opening pressure	≤250 mm H_2O	200-500 mm H_2O
Leukocyte count	50-1000/µL	1000-5000/µL
Leukocyte predominance	Lymphocytes	Neutrophils
Glucose	>45 mg/dL	<40 mg/dL
Protein	<200 mg/dL	100-500 mg/dL

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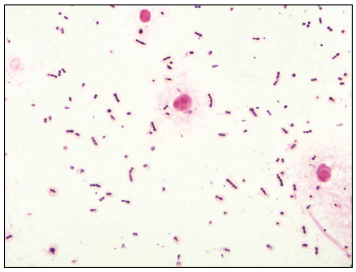
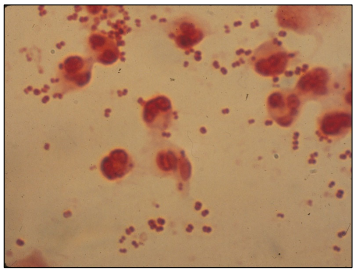
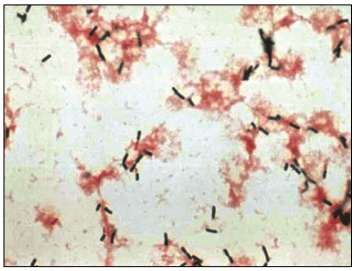
Acute Meningitis: Testing

Gram stain findings

- Gram-positive diplococci indicate *S. pneumoniae*
- Gram-negative diplococci indicate *N. meningitidis*
- Gram-positive rods indicate *Listeria*

CSF culture/multiplex PCR testing

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Acute Meningitis: Treatment

Immediate empiric antibiotic therapy

- Vancomycin + ceftriaxone
- Add ampicillin (*Listeria* coverage)
  - Age >50 years
  - Immunocompromise

Adjunctive dexamethasone if community-acquired bacterial meningitis suspected

- Before or at time antibiotics given
- Continue if *S. pneumoniae* identified

Symptomatic treatment sufficient for most viral meningitis

- Acyclovir if suspicion for HSV meningoencephalitis

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Tuberculosis (TB)

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Latent Tuberculosis: Diagnosis and Testing

>Two thirds of U.S. cases are in foreign-born persons

Diagnosis

- Positive interferon-γ release assay (IGRA) (preferred) or tuberculin skin testing (TST)
- No symptoms
- Normal chest radiograph

IGRA preferred for:

- High likelihood of infection/low to intermediate risk for progression
- History of bacillus Calmette-Guérin vaccination
- Unlikely to return for TST interpretation

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Criteria for TST Positivity by Risk Group

≥5 mm	≥10 mm	≥15 mm

• HIV positivity
• Contact with active TB
• Radiograph consistent with old TB
• Immunosuppressive conditions
• TNF-α inhibitor therapy
	• Recent (<5 years) arrivals from high-prevalence countries
	• Intravenous drug use
	• Residents/employees of high-risk congregate settings
	• High-risk comorbidities
	  ○ Silicosis
	  ○ Diabetes
	  ○ Severe kidney disease
	  ○ Jejunoileal bypass
	  ○ Solid organ transplantation
	  ○ Head/neck cancer
		All others

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Latent Tuberculosis: Treatment

Short course with rifamycins preferred

- Isoniazid (INH) and rifapentine once weekly for 3 months
- INH and rifampin once daily for 3 months
- Rifampin daily for 4 months

Rifamycins are potent CYP3A4 inducers

- Drug-drug interactions should be checked

Alternative regimens

- INH daily for 9 months: preferred for patients with HIV
- INH daily for 6 months: adequate in persons with adherence challenges
- INH twice weekly for 6-9 months (requires directly observed therapy)

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Active Tuberculosis: Diagnosis

- Fever, chills, night sweats
- Weight loss, anorexia, fatigue
- Cough >3 weeks ± hemoptysis
- Abnormal chest radiograph

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Active Tuberculosis: Radiography

Primary infection

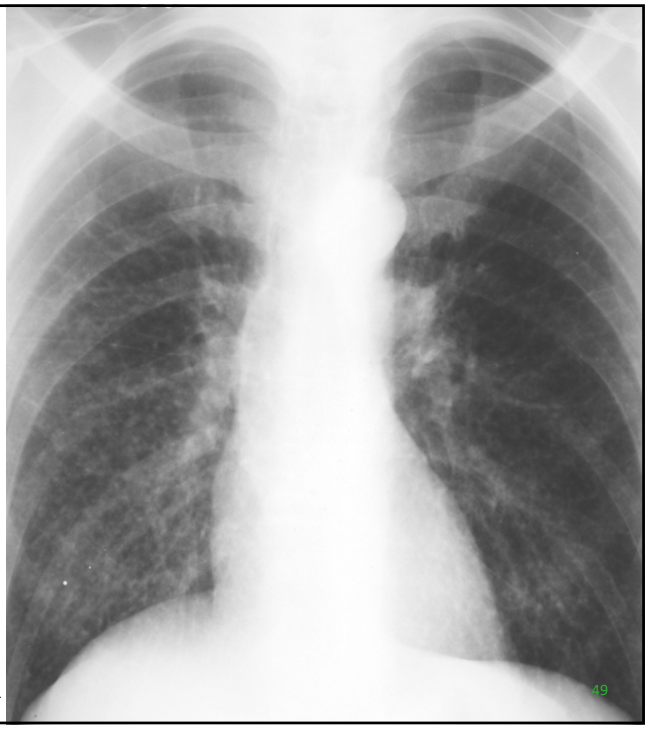
- Hilar lymphadenopathy or infiltrates

Reactivation

- Apical-posterior segments of the upper lobe
- Superior segments of the lower lobe

Cavities without air-fluid levels

Miliary TB



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Active Pulmonary Tuberculosis: Diagnostic Testing

Sputum acid-fast bacilli (AFB) smear

- Neither sensitive nor specific

Sputum nucleic acid amplification test (NAAT)

- More sensitive than AFB smear but less sensitive than AFB culture

AFB sputum culture

- Gold standard but takes several weeks

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Active Pulmonary Tuberculosis: Treatment

Initial intensive phase (2 months)

- Typical 4-drug regimen of INH, rifampin, pyrazinamide, ethambutol

Continuation phase (at least 4 months)

- Typical two-drug regimen of INH and rifampin

No longer contagious when the following achieved (all required):

- Adequate treatment for TB >2 weeks
- Improvement of symptoms
- 3 consecutive negative sputum AFB smears

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Infectious Disease Q10

A 59-year-old woman reports a 1-week history of increasing pain in the right foot.

She stepped on a nail 1 month ago.

Exam reveals tenderness and warmth directly below the proximal fifth metatarsal bone.

Plain radiograph of the foot is normal.

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Infectious Disease Q10

A 59-year-old woman reports a 1-week history of increasing pain in the right foot. She stepped on a nail 1 month ago. Exam reveals tenderness and warmth directly below the proximal fifth metatarsal bone. Plain radiograph of the foot is normal.

Which of the following is the most appropriate next imaging test?

A: CT

B: Gallium scanning

C: MRI

D: Three-phase bone scanning

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Osteomyelitis

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Osteomyelitis: Diagnosis

Hematogenous spread: Vertebral bodies

Contiguous spread: Nonhealing wound, adjacent soft tissue infection

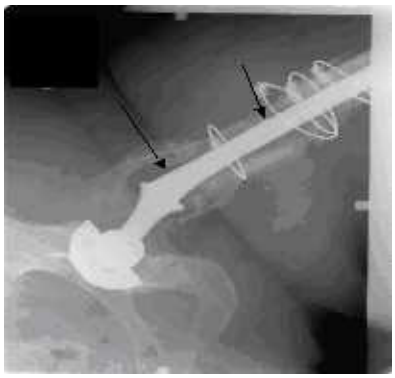
Acute osteomyelitis

- Symptoms develop over few days or weeks and include pain
- Fever may or may not be present

Chronic osteomyelitis

- Long-standing infection over months or years
- Draining sinus tract
- Fever usually absent

Prosthetic joint infection: chronic pain, loosening of prosthetic components



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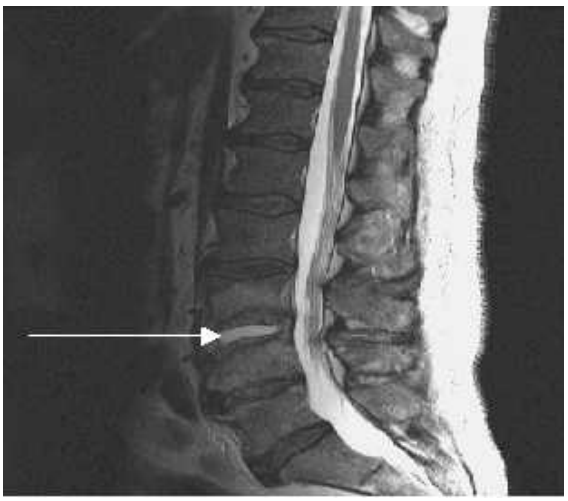
Osteomyelitis: Testing



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Plain radiography

- Initial test if symptoms >2 weeks
- Low cost
- Positivity establishes diagnosis

MRI

- Preferred modality
- Symptoms <2 weeks
- High suspicion, negative radiograph

CT if MRI contraindicated

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Osteomyelitis: Testing

ESR, CRP level frequently elevated

- Normal values do not exclude osteomyelitis

Blood cultures should be obtained if:

- Hematogenous osteomyelitis (e.g., vertebral)
- Sepsis

Deep bone culture/histopathologic exam

- Not required if blood culture (+)
- Obtain bone culture before antibiotic treatment, if patient is stable

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Osteomyelitis: Treatment

Antibiotic therapy based on bone or blood culture

- Acute osteomyelitis treatment duration is 4-6 weeks
- Chronic osteomyelitis treatment may require longer courses, surgery

Surgical debridement for extensive necrosis

Orthopedic hardware removal (if possible)

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Infectious Disease Q11

A 37-year-old man receiving parenteral antibiotics develops fever, watery diarrhea, and abdominal pain.

He is febrile (100.4 °F) with a soft abdomen.

Leukocyte count is 18,800/µL, serum creatinine level is 1.6 mg/dL, and stool *Clostridioides difficile* antigen/toxin assay is positive.

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Infectious Disease Q11

A 37-year-old man receiving parenteral antibiotics develops fever, watery diarrhea, and abdominal pain. He is febrile (100.4 °F) with a soft abdomen. Leukocyte count is 18,800/µL, serum creatinine level is 1.6 mg/dL, and stool *Clostridioides difficile* antigen/toxin assay is positive.

In addition to discontinuing the associated antibiotic agent, if possible, which of the following is the most appropriate treatment?

A: Oral fidaxomicin

B: Oral metronidazole

C: Oral vancomycin plus IV metronidazole

D: Oral vancomycin plus oral metronidazole

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Clostridioides difficile Colitis

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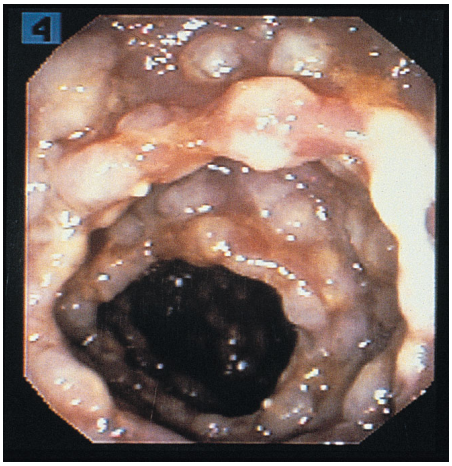
C. difficile Infection: Epidemiology

Leading cause of hospital-acquired diarrhea

Associated with:

- Antibiotics
- Immunosuppression
- Chemotherapy
- Older age, IBD, GI surgery

Increasingly seen in community settings



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C. difficile Infection: Diagnosis

Nonsevere

- Leukocyte count ≤15,000/µL *and*
- Serum creatinine level <1.5 mg/dL

Severe

- Leukocyte count >15,000/µL *or*
- Serum creatinine level ≥1.5 mg/dL

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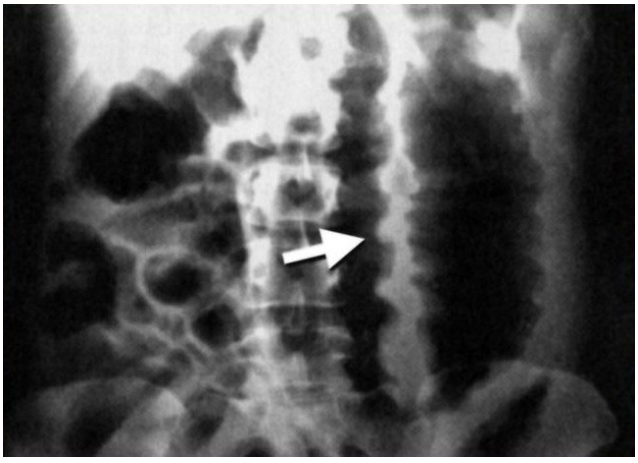
C. difficile Infection: Diagnosis



Fulminant

- Hypotension
- Shock
- Ileus

Complications

- Sepsis
- Toxic megacolon
- Perforation

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C. difficile Infection: Testing

NAAT alone

Two-step algorithm

- Glutamate dehydrogenase plus toxin
- If discordant, perform NAAT (if positive, toxin)

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C. difficile Infection: Treatment

Discontinue antibiotic

Nonsevere or severe disease

- Oral fidaxomicin (preferred) or oral vancomycin

Fulminant colitis

- Oral vancomycin + intravenous metronidazole
- Surgical evaluation for megacolon
- Vancomycin enema if ileus is present

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C. difficile Infection: Treatment

First recurrence

- Oral fidaxomicin (preferred) or oral vancomycin (tapered/pulsed)
- Adjunctive intravenous bezlotoxumab if recurrence within 6 months

Additional recurrences

- Oral fidaxomicin
- Oral vancomycin (tapered/pulsed)
- Oral vancomycin followed by oral rifaximin
- Adjunctive intravenous bezlotoxumab if recurrence within 6 months
- Fecal microbiota transplantation

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Infectious Disease II

- Answers to Multiple-Choice Questions

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Infectious Disease Q7

A 62-year-old woman reports fever, nausea, and abdominal pain. She has diabetic kidney disease. She has fever, hypotension, and tachycardia with left-sided costovertebral angle tenderness. Leukocyte count is 24,000/µL; serum creatinine level is 2.8 mg/dL. UA shows 220 leukocytes/hpf and many bacteria.

Which of the following is the most appropriate empiric antibiotic treatment?

A: Piperacillin-tazobactam

B: Cefazolin

C: Gentamicin

D: Vancomycin

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B: Ceftriaxone (single dose) and doxycycline

C: Ciprofloxacin

D: Meropenem

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Which of the following is the most appropriate treatment?

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B: Nitrofurantoin

C: TMP-SMX

D: No treatment

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