GERIATRIC PHARMACIST

BOOT CAMP

Infectious Diseases in Older Persons

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Meet The Speaker

- Dr. Millard is the Program Manager of Infectious Diseases for the Veterans Integrated Service Network 20 PBM Clinical Pharmacy Services, and a Clinical Pharmacist Practitioner.
- He is the primary author on multiple issued medical device/utility patents regarding diagnostic modalities in non-invasive detection of neurological diseases.
- Dr. Millard has presented posters and presentations at local, state, and national healthcare conferences.
- He is well published with several peer-reviewed manuscripts regarding but not limited to MRSA resistant mechanism(s), *C. difficile*, gram-negative resistance, and asymptomatic bacteriuria.
- Teaching responsibilities include training medical & pharmacy providers on best clinical practices.
- Dr. Millard is the recipient of numerous national awards for developing and implementing leading practices in addition to his dedication to patient safety and excellence in clinical practice.

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Disclosure

- Dr. Millard does not have relevant financial relationships with ineligible companies.
- The views expressed in this presentation reflect those of the presenter, and not those of the Department of Veteran Affairs.
- AI was not used in creation of this educational content
- None of the planners for this activity have relevant financial relationships to disclose with ineligible companies.

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Learning Objectives

1. Determine therapeutic options for urinary tract infections, *Clostridioides difficile* infection, pneumonia, and immunizations in the older adult.
2. Interpret infectious clinical findings and incorporate functional status into therapeutic decision-making.
3. Resolve and/or prevent infectious disease medication-related problems.
4. Apply infectious disease therapy recommendations and person-specific goals to senior patient cases.

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Age Related Changes

- Pharmacokinetic changes
  - Absorption
  - Distribution
  - Metabolism
  - Excretion

	Alterations	Effect
A	↓ Active transport ↓ First pass	Unpredictable absorption
D	↓ Total body water ↑ Total body fat	↓ Vd for water soluble therapy ↑ Vd for fat soluble therapy
M	↓ Phase I metabolism ↓ Hepatic blood flow	↓↑ therapeutic activity
E	↓ Renal excretion	↑ half-life of therapy

Vd: volume of distribution

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Hammerlein, et al. Clin Pharmacokinet. 1998;35:49-64
Bender AD. J Am Geriatr Soc. 1968;16:1331-9

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Age-Related Changes

- The treating of a person or people differently from others based on assumptions or stereotypes relating to their age
- Older adults are more prone to infections
  - Increased severity and susceptibility to infectious diseases
  - Increased risk of complications from infectious diseases
  - Increased risk of multi-drug resistant organisms (MDROs)
- Immunosenescence ✓ 60?
- Basal body temperature ↓

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Allen JC et al. Vaccine. 2020;38(52):8264-72
Pera A et al. Maturitas. 2015;82(1):50-5

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Patient Classification

Patient A – 48 y/o
- WBCs: 38,000
- Bands: 48%
- Temp: 103.7°F
- RR: 31
- Pulse oximetry: 89%
- CXR: large consolidation RLL
- Lactic acid: 1.7 mmol/L

Patient B – 96 y/o
- WBCs: 12,200
- Bands: 11%
- Temp: 100.0°F
- RR: 22
- Pulse oximetry: 74%
- CXR: large consolidation RLL
- Lactic acid: 4.5 mmol/L

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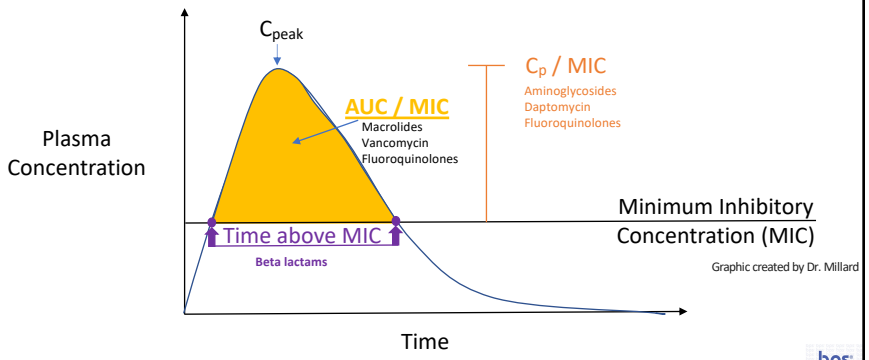
Pharmacokinetics - Optimized Dosing



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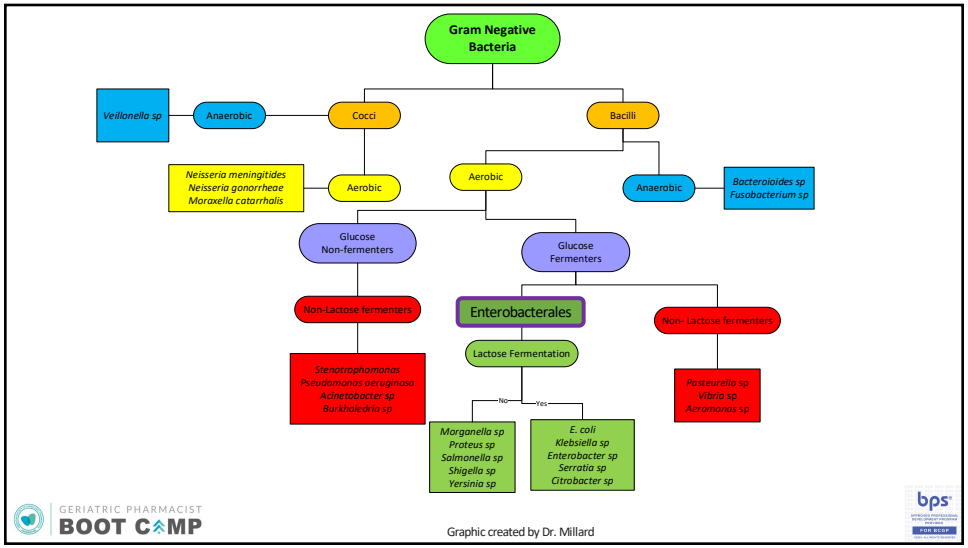
Onufrak NJ et al. Clin Ther. 2016;38(9):1930-1947
Evans L. et al. Crit Care Med. 2021;49(11):1063-1143

8


Gram Negative Bacteria
Veillonella sp
Anaerobic
Cocci
Bacilli
Neisseria meningitides
Neisseria gonorrheae
Moraxella catarrhalis
Aerobic
Aerobic
Anaerobic
Bacteroioides sp
Fusobacterium sp
Glucose Non-fermenters
Glucose Fermenters
Non-Lactose fermenters
Enterobacterales
Non- Lactose fermenters
Stenotrophomonas
Pseudomonas aeruginosa
Acinetobacter sp
Burkholedria sp
Lactose Fermentation
Pasteurella sp
Vibrio sp
Aeromonas sp
No
Yes
Morganella sp
Proteus sp
Salmonella sp
Shigella sp
Yersinia sp
E. coli
Klebsiella sp
Enterobacter sp
Serratia sp
Citrobacter sp
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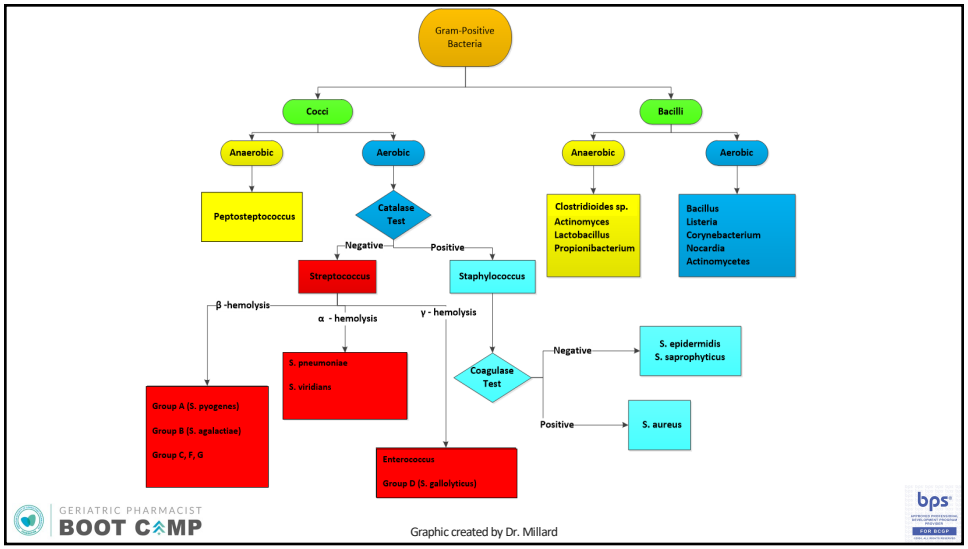
Gram-Positive Bacteria
Cocci
Bacilli
Anaerobic
Aerobic
Anaerobic
Aerobic
Peptosteptococcus
Catalase Test
Clostridioides sp.
Actinomyces
Lactobacillus
Propionibacterium
Bacillus
Listeria
Corynebacterium
Nocardia
Actinomycetes
Negative
Positive
Streptococcus
Staphylococcus
β -hemolysis
α - hemolysis
γ - hemolysis
S. pneumoniae
S. viridians
Group A (S. pyogenes)
Group B (S. agalactiae)
Group C, F, G
Coagulase Test
Negative
Positive
S. epidermidis
S. saprophyticus
S. aureus
Enterococcus
Group D (S. gallolyticus)
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Most Common Bacteria per site

- Urinary Tract → *Escherichia coli*
- Pneumonia without risk factors → *Streptococcus pneumoniae*
- Septic Arthritis → *Staphylococcus aureus*
- Purulent cellulitis → *Staphylococcus aureus*
- Non-purulent cellulitis → β-hemolytic streptococci (etc. *S. pyogenes*)

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Rowe T. et.al. Infect Dis Clin North Am. 2014;28:75-89.
Stevens DL. et al. Clin Infect Dis. 2014;59(2):e10-e52.
Frazee BW. et al. Ann Emerg Med. 2009;54(5):695-700
Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67

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Diagnostic vs Surveillance

Loeb Criteria	McGeer Criteria	NHSN Criteria
• Intended to be used as minimum diagnostic criteria for initiating antibiotics • Considers the patient's symptoms, presentation, and diagnostic results to start empiric antibiotics • Information is incorporated into the AHRQ communication forms	• Intended to be used as a retrospective surveillance tool • Considers all completed diagnostic workup and reported symptoms • Should be used after the antibiotic is prescribed and often times once antibiotic therapy is completed	• Intended to be used as a prospective surveillance tool • Criteria based on laboratory results or include specific sign and symptoms • Criteria are specifically designed to remove subjectivity and ensure accurate, reproducible and comparable surveillance data for a facility over time and across facilities.

NHSN: National Healthcare Safety Network
AHRQ: Agency for Healthcare Research and Quality

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Loeb M, *et al*. Infect Control Hosp Epidemiol 2001;22:120-4
Stone ND, et al. Infect Control Hosp Epidemiol. 2012;33(10):965-77
https://www.cdc.gov/nhsn/pdfs/pscmanual/17pscnosinfdef_current.pdf (Accessed Jan 26, 2025)

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Antibiogram

Cumulative antimicrobial susceptibility report for commonly isolated bacteria

Percent Susceptible 2018-2019 Isolates	Number of Isolates	Aminoglycoside			β-Lactams	β-Lactam/ inhibitor combo			Cephalosporin					Carbapenem		Folate path inhibitor	Quinolones		Monobactam	Nitrofurans
									1st	2nd		3rd	4th							
		Amikacin	Gentamicin	Tobramycin	Ampicillin [1]	Augmentin [2]	Unasyn [2]	Zosyn	Cefazolin	Cefoxitin	Cefturoxime	Ceftazidime	Ceftriaxone	Cefepime	Ertapenem	Meropenem	Bactrim	Ciprofloxacin	Levofloxacin	Aztreonam	Nitrofurantoin [3]
Escherichia coli	31,872	100	93	93	56	85	63	97	86	92	91	95	94	95	100	100	77	81	82	96	96
NORTHWEST	1,805	99	94	95	59	85	65	98	93	98	94	91	97	98	100	100	80	86	84	95	96
NORTHCENTRAL	1,462	99	91	93	61	90	66	98	92			95	96	99	100	100	79	79	81	94	96
NORTHEAST [4]	11,436	100	94	94	58	87	64	97	90	93	91	96	96	97	100	100	80	84	85	97	96
KC-METRO	7,491	100	91	92	54	82	61	96	79			96	93	94	100	100	75	86	81	96	98
SOUTHEAST	3,719	100	91	92	55	87	66	97	85		93	94	94	95	100	100	76	78	79	94	92
SOUTHCENTRAL	1,336	100	92	93	57		65	96	90	89		93	92	94	100	100	76	79	76		94
WICHITA-METRO	2,865		89	90	48		55	94	84				86	92		100	73	81			95
SOUTHWEST	1,758		93	92	55	82	60	96	85				94	95	100	100	73	79	82	91	97
Klebsiella aerogenes (formerly Enterobacter)	576	99	99	100				85				86	86	97	97	100	98	98	98	89	22
Klebsiella oxytoca	792	100	98	97		94	63	91				95	95	97	100	100	94	98	98	95	87
Klebsiella pneumoniae	5,942	100	98	97		95	86	95				97	96	97	99	100	92	96	97	97	48
Morganella morganii	240	100	87	93				98				79	92	97	100	100	74	83	82	96	
Proteus mirabilis	3,385	100	87	87		96	85	98				98	97	97	100	100	74	67	70		
Pseudomonas aeruginosa	5,017	97	93	98				92				91		91		94		86	80	91	
NORTHWEST	250	96	93	94				91				90		88		90		81	71	90	
NORTHCENTRAL	174	97	89	99				98				97		91		95		89	86	97	
NORTHEAST [4]	1,205	100	92	99				97				92		95		96		90	86	92	
KC-METRO	1,586	95	92	97				90				91		89		90		89	79	91	
SOUTHEAST	344	100	92	98				90				87		89		93		76	73	87	
SOUTHCENTRAL	385		94	99				99				95		93		98		82	82	95	
WICHITA-METRO	1,002		93	98				84						93		96		85		95	
SOUTHWEST	71	100	98	95				91				95		95		92		83	82	95	

Gray = Insufficient data to compile total susceptibility, or not tested, or inappropriate in clinical use because of intrinsic use

1) Ampicillin predicts amoxicillin susceptibility

2) Ampicillin/sulb. generally predicts amoxicillin/clav. susceptibility (except for A.baumannii which is intrinsically resistant)

3) Nitrofurantoin only for urinary infections

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https://www.kdhe.ks.gov/2020-Kansas-Antibiogram

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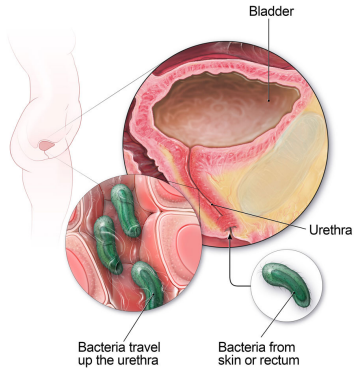
Urinary Tract Infections (UTIs)



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Urinary Tract Infection Basics. CDC.gov, 22 Jan. 2024. https://www.cdc.gov/uti/about/ Accessed 02/27/2025

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Clinical Significance

- UTIs account for over 8 million outpatient visits and 100,000+ hospitalizations annually in the United States
- A large nationwide retrospective cohort predominately represented by older adults identified 50% of urine cultures were collected on asymptomatic patients
  - Most common antibiotic prescribed fluroquinolones (34%)
  - 70% of patients received an inappropriate duration of therapy
  - **Only** 22% of patients received author's preferred antibiotic selection and duration
- U.S. Department of Health and Human Services established 2030 goal to reduce UTI-related hospitalizations for older adults

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Simmering et al. Open Forum Infect Dis. 2017 Winter; 4(1): ofw281
Rovelsky et al. Antimicrob Steward Healthc Epidemiol. 2022; 2(1): e168.
Reduce the rate of hospital admissions for urinary tract infections among older adults. Odphp.health.gov. https://odphp.health.gov/healthypeople/ Accessed 02/27/2025

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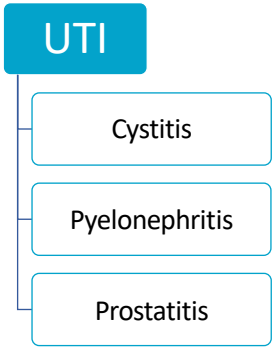
Epidemiology

- Most commonly occurring bacterial infections
- Pathogens in older adults:
  - *Gram negatives:*
    - *E. coli* up to 69%
    - *Proteus* spp. up to 14%
    - *Klebsiella* spp. up to 13%
  - *Gram positives:*
    - *Enterococcus* spp. up to 8%
    - *Staphylococcus* spp. 4%



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Rowe T. et.al. Infect Dis Clin North Am. 2014;28:75-89.
Mody L, et. al. JAMA. 2014;311:844-54.

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Classification of Urinary Infections

Lower UTIs ≠ Uncomplicated
Upper UTIs ≠ Complicated

- Lower – Cystitis
- Uncomplicated
  - Infection in a structurally and neurologically normal urinary tract female aged 20 – 40 years old
- Catheter associated UTI (CA-UTI)
  - Symptomatic UTI with presence of catheter or it's removal within the past 48 hours
  - 1 or more bacteria ≥ 10^3 CFU/mL
- Upper – Pyelonephritis
- Complicated
  - Functional or structural abnormalities present in the urinary tract
    - Indwelling catheters
    - Pregnant women
    - Male
    - Children
    - Hospitalized patients
    - Calculi

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DiPiro JT et al. Pharmcotherapy: A Pathophysiologic Approach, 11th ed.

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Urinalysis

Test	Result
Squamous epithelial	Trace
Leukocyte esterase	Large
Urine color	Yellow
Appearance, urine	Hazy
Specific Gravity	1.006
Urobilinogen	Negative
Urine Nitrite	Positive
Urine Blood	Small
Urine Bilirubin	Negative
Urine Ketones	Negative
Urine Glucose	Negative
Urine Protein	Negative
Urine pH	6
Urinary WBC	TNTC
Urinary RBC	3--5
Urine Bacteria	Few
Urine Mucus	Trace

Graphics created by Dr. Millard

Test	Result
Leukocyte esterase	Large
Urine Nitrite	Positive
Urinary WBC	TNTC
Urinary RBC	3--5
Urine Mucus	Trace

TNTC: too numerous to count

Negative Predictive Value of a UA = 94%

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Oh P. et al. Neurourol Urodyn. 2024;43(8):1850-1858
Rowe T. et.al. Infect Dis Clin North Am. 2014;28:75-89.

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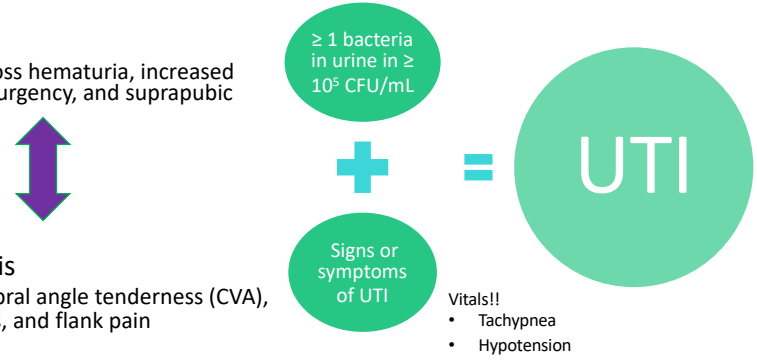
Diagnosis & UTI Symptomatology

- Cystitis
  - Dysuria, gross hematuria, increased frequency, urgency, and suprapubic pain
- Pyelonephritis
  - Costovertebral angle tenderness (CVA), fever, rigors, and flank pain



Vitals!!
- Tachypnea
- Hypotension

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Gupta et. al. Clin. Infect. Dis. 2011;52(5)
Hooton et. al. Clin. Infect. Dis. 2010;50(5):625-63

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Asymptomatic Bacteriuria (ASB)

- Is the presence of 1 or more species of bacteria growing in the urine:
  - ≥10^5 colony-forming units (CFU)/mL
  - ≥10^8 CFU/L
  - ≥10^3 CFU/mL (catheter associated bacteriuria)

AND

- The **absence of signs or symptoms** attributable to urinary tract infection (UTI)

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Nicolle et al. Clin. Infect. Dis. 2019;68(10):1611-1615
Hooton et. al. Clin. Infect. Dis. 2010;50(5):625-63

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Asymptomatic Bacteriuria

- Should ASB be screened for and treated in functionally impaired older individuals residing in the community or long-term care facilities?
  - Recommend against screening or treating ASB (*strong recommendation)*
- Patients with functional and/or cognitive impairment with bacteriuria who are with acute mental status changes or confusion **and** are without systemic signs of infection:
  - Recommend assessment for other causes and observation without antibiotics (*strong recommendation)*

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Nicolle et al. Clin. Infect. Dis. 2019;68(10):1611-1615

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Clinical Practice Guidance

Question	Answer	Comments: if yes and screen positive for ASB
Should patients with diabetes be screened or treated for ASB?	No	
Should kidney transplant patients be screened or treated for ASB?	Depends	Post transplant: 0 – 30 days consider treatment 0 – 60 days consider treatment*
Should spinal cord injury patients be screen or treated for ASB?	No	
Should patients with indwelling catheters receive antimicrobial prophylaxis at time of catheter removal or exchange?	No	Exception: yes, if mucosal trauma occurs
Should patients undergoing endourological procedures be screened or treated for ASB?	Yes	Short course of 1 or 2 doses Antibiotics 30 – 60 minutes before procedure
Should ASB be screened for and treated in pregnant women?	Yes	Targeted therapy Duration: 4 – 7 days

*If two consecutive urine samples yield >10^5 of same pathogen may consider 5 days of treatment

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Goldman JD. Clinical Transplantation. 2019;33:e13507
Nicolle et al. Clin. Infect. Dis. 2019;68(10):1611-1615
Hooton T., et. al. Clin. Infect. Dis. 2010;50:625-63

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Antibiotic*	Dose	Therapy Duration	Renal Adjustments (mL/min)
Uncomplicated cystitis: Patient must be symptomatic and have absence of fever, flank pain, no suspicion for pyelonephritis			
Nitrofurantoin	100 mg po bid	5 days	Avoid in patients with CrCl < 30
Trimethoprim/sulfamethoxazole	160/800 mg po bid	3 days	Reduce dose if CrCl between 15 – 29 Avoid if CrCl < 15
Cephalexin	500 mg po tid – 4 time a day	7 days	Reduce frequency if CrCl < 30
Fosfomycin	3 grams po once	1 day	No adjustment
Amoxicillin/clavulanate	500/125 mg po bid or tid	3 – 7 days	Reduce dose if CrCl 10 – 30
Cefpodoxime	200 mg po bid	3 – 7 days	Reduce frequency if CrCl < 30
Ciprofloxacin**	250 – 500 mg po bid	3 days	Reduce frequency if CrCl < 30
Levofloxacin**	250 – 500 mg po daily	3 days	Renal adjust dose and frequency if CrCl < 50

CrCl: creatine clearance (mL/min)

*Local resistance rates of uropathogens do not exceed 20%

Box Warning: **Risks outweigh benefits in uncomplicated urinary infection

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Gupta K. et. al. Clin. Infect. Dis. 2011;52(5):e103-e20

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Antibiotic*	Dose	Duration	Renal Adjustments
Pyelonephritis:			
Ciprofloxacin	500 mg po bid	7 days	Yes
Levofloxacin	750 mg po daily	5 days	Yes
Trimethoprim/sulfamethoxazole	160/800 mg po bid	14 days	Yes
Cefpodoxime	200 - 400 mg po bid	14 days	Yes
Amoxicillin/clavulanate	500/125 mg po tid	14 days	Yes
Ampicillin/sulbactam	1.5 – 3 grams IV every 6 hours	14 days	Yes
Ceftriaxone	1 gram IV every 24 hours	14 days	No
Cefepime	1 gram IV every 6 – 12 hours	14 days	Yes **Neurotoxicity**

*If fluoroquinolone resistance exceeds 10% or oral beta-lactams are utilized a one-time IV dose of 1 gram ceftriaxone, or a consolidated 24-hour dose of aminoglycoside is recommended

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Gupta et. al. Clin. Infect. Dis. 2011;52(5):e103-e20
Hooton T., et. al. Clin. Infect. Dis. 2010;50:625-63
Payne et al. Critical Care (2017) 21:276

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Antibiotic[A]	Dose	Duration	Comments
CA-UTIs and without pyelonephritis			
Ciprofloxacin	500 mg po bid	7 - 14 days[B]	Renal adjustment
Levofloxacin	750 mg po daily	5 days	If not severely ill, renal adjustment
Trimethoprim/sulfamethoxazole	160/800 mg po bid	14 days	Renal adjustment
Cefpodoxime	200 mg po bid	7 -14 days[B]	Renal adjustment
Amoxicillin/clavulanate	500/125 mg po tid	7 - 14 days[B]	Renal adjustment
Ampicillin/sulbactam	1.5 – 3 grams IV every 6 hours	7 - 14 days[B]	Renal adjustment
Ceftriaxone	1 gram IV every 24 hours	7 - 14 days[B]	
Cefepime	1 gram IV every 12 hours	7 - 14 days[B]	**Neurotoxicity** Renal adjustment

[A] If indwelling catheter is still indicated and has been in place for more than 2 weeks the catheter should be replaced
[B] Decided based on prompt resolution of symptoms and defined as resolution of symptoms within 72 hours of therapy start

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Hooton T. et. al. Clin. Infect. Dis. 2010;50:625-63
Payne et al. Critical Care (2017) 21:276

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Clinical Pearls For Urinary Isolates

Pathogen	Antibiotic	Dose & Duration	Comments
ESBL *E. coli*	Fosfomycin PO	3 grams every 48 hours x 1 – 3 doses	Only effective in cystitis Avoid in patients with dysphagia
ESBL	Nitrofurantoin PO	100 mg twice daily x 14 days	Only effective in cystitis
Proteus mirabilis	Nitrofurantoin	Not applicable	Pathogen intrinsically resistant
Staphylococcus aureus	Vancomycin	Dependent on source identification	Should trigger additional workup for systemic infection – may represent hematogenous infection
Urinary pathogens	Moxifloxacin	Not applicable	Not effective for urinary tract infections

ESBL: extended-spectrum beta-lactamase

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Clifford K. et. al. Sr Care Pharm. 2019;34:645-59.

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Case Study #1

- AD is a 65 y/o male who presented to the ED with a 5-day history of diarrhea, dysuria, flank pain, and chills. In the ED patient found to be in atrial flutter.
- PMH: DM, HLD, GERD, HTN, and esophageal dysphagia
- PE: T 101.9^{o}F; BP 100/53 mmHg; HR 77 bpm; RR 28 RR; CVA tenderness positive
- Urinalysis: WBCs TNTC, RBCs 3-5, Leukocyte esterase large, nitrite positive
- MRI consistent with right pyelonephritis
- EKG: QTc 580 msec, normal QRS interval, regular rate rythm
- CrCl is approximately 70 mL/min

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Case Study #1

Which of the following is the most appropriate treatment regimen for AD at this time?

A. Levofloxacin 500 mg IV q24h for 5 days
B. Ceftriaxone 1 gram IV q24h for 14 days
C. Cefdinir 300 mg PO q12h for 14 days
D. Ciprofloxacin 500 mg PO q12h for 7 days

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2023 AGS-Beers Criteria

Medication	Rationale	Recommendation	Strength of Recommendation
Nitrofurantoin	Long-term use with increased risk of pulmonary toxicity, hepatoxicity, and peripheral neuropathy.	Avoid in patients with CrCl < 30 mL/min Avoid for long-term suppression	Strong
Trimethoprim-Sulfamethoxazole	Increases risk of worsening renal function and hyperkalemia	Reduce dose if CrCl between 15 – 29 mL/min Avoid if CrCl < 15 mL/min	Strong
Ciprofloxacin	Increased risk of CNS effects and tendon rupture	Reduce dose if CrCl < 30 mL/min	Strong

CrCl: creatinine clearance

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Fick D., et. al. J Am Geriatr Soc. 67(4):674–94

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UTI Clinical Pearls

- A positive urinalysis via pyuria, leukocyte esterase, or positive nitrites ONLY tells that bacteria are present and does **NOT diagnose** a UTI
- Urine culture reported in CFUs that are less than 100,000 CFUs/mL are typically associated with contaminants
- By definition, un-complicated UTIs are limited **only** to young and healthy female between 20 – 40 years old. All other UTIs are considered complicated which by itself is not clinically relevant.
- Duration is typically 7 – 14 days pending prompt clinical response and therapy selected

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2019 Antibiotic Resistance Threats. CDC.gov https://www.cdc.gov/antimicrobial-resistance/ Accessed 2/27/2025

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Pathophysiology

- *C. difficile* is part of our normal microbiota
- Infection results when disruption occurs in the dominate anaerobes that constitute one's microbiota
- 1 course of antibiotic therapy disrupts the microbiota with effect lasting months to years
- Spores are highly resistant to acid, most antibiotic therapies, allowing passage through the GI tract setting the stage for fecal to oral transmission

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Bien J, et. al. Therap Adv Gastroenterol. 2013;6(1):53-68.
Elvers KT, et. al. BMJ Open 2020;10:e035677

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Risk Factors

- **<u>Antibiotic exposure is the single most important risk factor</u>** for developing *Clostridioides difficile infection* (CDI)
- Age ≥ 65 years, even higher risk if ≥ 75
- Immunosuppression
- Acid suppressive therapy
  - PPI's carry a higher risk than H2RA
- Gastrointestinal tract instrumentation or surgery
- Previous case of CDI

GERIATRIC PHARMACIST BOOT CAMP

McDonald LC, et. al. Clin. Inf. Dis. 2018;66(7):e1-e48
Johnson S, et al. Clin Infect Dis. 2021;73:e1029–e104

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Clinical Presentation

- New onset of watery diarrhea
  - ≥3 unformed stools in 24 hours
  - 6 watery stools in 36 hours
  - 8 watery stools in 48 hours
- Increased WBC count
- Acute kidney injury
- Severe abdominal pain and cramps
- Febrile
- Serious complications (ileus, hypotension, and toxic megacolon)

GERIATRIC PHARMACIST BOOT CAMP

McDonald LC, et. al. Clin. Inf. Dis. 2018;66(7):e1-e48.

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Overview of Available Diagnostic Tests

Test	Method	Sensitivity (%)	Specificity (%)
Cell culture cytotoxin assay	Gold standard; not routinely done requires highly specialized skills, delayed results in days	Not applicable	~100
PCR	Detects toxigenic genes (i.e., *tcA, tcdB, tcdC,* binary toxin), results in minutes to hours	85 – 98	85 - 100
GDH	Glutamate dehydrogenase (GDH) immunoassay uses antibodies to detect presence of GDH enzyme (present in all *C. diff*), only used as screening	75 – 95	70 – 80
EIA	Enzyme Immunoassay (EIA), detects toxins A and B; rapid and inexpensive	< 70	95 – 98

Sensitivity, think of screening tool: a negative test rules **out** the disease
Specificity, think of confirmation tool: a positive test rules **in** the disease

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McDonald LC, et. al. Clin. Inf. Dis. 2018;66(7):e1-e48.

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Diagnostic Considerations

- Stool culture: gold standard, but not done in clinical practice
- Testing should only be performed on unformed stool
- **NOT recommended to test for cure or test asymptomatic patients**
- Confounding Factors: laxative use within 48 hours, enteral nutrition
- Polymerase chain reaction (PCR) cannot differentiate colonization from CDI

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McDonald LC, et. al. Clin. Inf. Dis. 2018;66(7):e1-e48.

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Severity Classification & Initial Treatment

Classification	Criteria	Initial CDI episode
Non-severe	WBC count <15,000 cells/μL **AND** SCr <1.5 mg/dL	Preferred: fidaxomicin 200 mg PO 2 times a day for 10 days Alternative: vancomycin 125 mg PO 4 times a day for 10 days *Metronidazole 500 mg PO 3 times a day for 10 – 14 days
Severe	WBC count ≥15,000 cells/μL **OR** SCr ≥1.5 mg/dL	Preferred: fidaxomicin 200 mg PO 2 times a day for 10 days Alternative: vancomycin 125 mg PO 4 times a day for 10 days
Fulminant	Hypotension, shock, ileus, or toxic megacolon	Vancomycin 500 mg PO q6h PLUS metronidazole 500 mg IV 3 times a day If ileus present: add vancomycin per rectum 500 mg in 100 – 500 mL of saline for retention enema 4 times daily

*Only indicated if preferred or alternative agents are unavailable or contraindicated
PO: by mouth
Fidaxomicin: Medicare drug plan cost coverage ranges from 85 – 100% pending on source

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McDonald LC, et. al. Clin. Inf. Dis. 2018;66(7):e1-e48.
Johnson S. et al, Clin. Inf. Dis. 2021;73(5):e1029-e1044.

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1st Recurrence Treatment

Recurrence	Recommended and Alternative Treatments	Comments
First CDI recurrence	Preferred: fidaxomicin 200 mg PO q12h for 10 days OR twice daily for 5 days followed by once every other day for 20 days Alternative: vancomycin PO in a tapered and pulsed regimen Adjunctive treatment: bezlotoxumab* 10 mg/kg given intravenously once during administration of SOC antibiotics	Tapered/pulsed regimen vancomycin: 125 mg 4 times daily for 10 – 14 days, then 2 times daily for 7 days, then once daily for 7 days, then every 2 to 3 days for 2 – 8 weeks

SOC: Standard of care; PO: by mouth
*Caution for use in patients with congestive heart failure

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Johnson S. et al, Clin. Inf. Dis. 2021;73(5):e1029-e1044.

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2 or more Recurrence Treatments

Recurrence	Recommended and Alternative Treatments	Comments
Second or subsequent CDI	Fidaxomicin 200 mg PO q12h for 10 days OR twice daily for 5 days followed by once every other day for 20 days Vancomycin pulsed/tapered regimen Vancomycin 125 mg 4 times a day PO for 10 days followed by rifaximin 400 mg PO 3 times a daily for 20 days Fecal microbiota transplantation (FMT)	Avoid Fidaxomicin in patients with macrolide allergy Adjunctive treatment: Bezlotoxumab* 10 mg/kg given intravenously once during administration of SOC antibiotics At least 2 recurrences should be treated prior to offering fecal microbiota transplantation

SOC: Standard of care; PO: by mouth
*Caution for use in patients with congestive heart failure

GERIATRIC PHARMACIST BOOT CAMP

Johnson S, et al. Clin. Inf. Dis. 2021;73(5):e1029-e1044

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Infection Control Measures

- Use contact precautions with private rooms and isolation for duration of diarrhea and at least an additional 48 hours after diarrhea resolves
- Use gloves and gowns at all times upon entering the room
- Perform hand hygiene before and after contact with patient via either method:
  - Soap and water hand hygiene
  - Alcohol-based hand hygiene
- In CDI outbreak setting perform hand hygiene with soap and water preferred over alcohol-based hand hygiene products
- Clean contaminated rooms with bleach instead of ammonium-based agents

GERIATRIC PHARMACIST BOOT CAMP

McDonald LC, et. al. Clin. Inf. Dis. 2018;66(7):e1-e48

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Bezlotoxumab

- Monoclonal antibody directed against *C. difficile* toxin B
- Given as a single infusion in addition to standard of care antibiotics
- Patient population(s):
  - Initial CDI with at least 1 risk factor for recurrence
    - Age ≥ 65, or immunocompromised, AND severe CDI on presentation
  - 1st CDI recurrence and initial CDI within previous 6 months
- Cost remains a barrier to use
- FDA warning regarding use in patients with congestive heart failure

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Johnson S. et al, Clin. Inf. Dis. 2021;73(5):e1029-e1044.

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CDI Clinical Pearls

- Diagnosis should be based on 3 or more liquid stools at presentation then confirmed with a PCR or multi-step algorithm
- Do NOT screen patients for CDI without having signs and symptoms
- Do NOT repeat testing within 7 days of previous positive PCR
- Do NOT routinely recommend antiperistaltic agents (e.g., loperamide)

GERIATRIC PHARMACIST BOOT CAMP

McDonald LC, et. al. Clin. Inf. Dis. 2018;66(7):e1-e48.
Johnson S. et al, Clin. Inf. Dis. 2021;73(5):e1029-e1044.

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CDI Clinical Pearls

- Discontinue the offending antibiotic when possible
- Fidaxomicin is the preferred therapy for non-severe & severe initial or 1st recurrence episode of CDI
- Intravenous metronidazole should be used in combination with oral vancomycin for fulminant cases
- Fecal microbiota transplantation may be considered after 3rd case of CDI

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McDonald LC, et. al. Clin. Inf. Dis. 2018;66(7):e1-e48.
Johnson S. et al, Clin. Inf. Dis. 2021;73(5):e1029-e1044.

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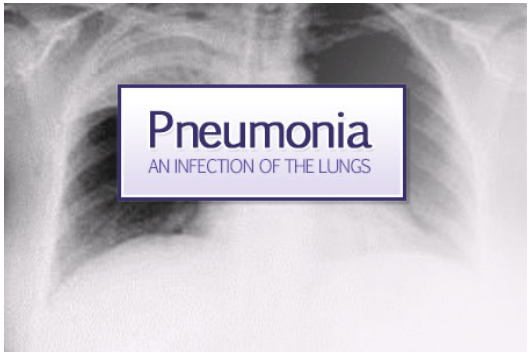
Community Acquired Pneumonia (CAP)
Community Acquired Bacterial Pneumonia (CABP)



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Pneumonia. CDC.gov https://www.cdc.gov/pneumonia Accessed 02/27/2025

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Microbiology

- Common pathogens
  - Viruses
    - Influenza
    - SARS-CoV2
    - Enterovirus/rhinovirus
  - Typical bacteria
    - ***Streptococcus pneumoniae***
    - *Haemophilus influenzae*
  - Atypical bacteria
    - *Legionella pneumophila*
    - *Mycoplasma pneumoniae*
    - *Chlamydophila pneumoniae*
- Uncommon pathogens
  - Methicillin-resistant *Staphylococcus aureus* (MRSA)
  - *Pseudomonas aeruginosa*

GERIATRIC PHARMACIST BOOT CAMP

Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.
Mandell LA, et. al. Clin. Inf. Dis. 2007;44:S27-72.

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Pneumococcal Resistance to Macrolides

- Centers for Disease Control and Prevention Serious Threat
  - USA macrolide resistance 28.7%
- Varied by region and location
  - South Atlantic states and ambulatory sites had the highest rates of respiratory samples resistant to macrolides exceeding 40%
- Avoid macrolide monotherapy in most patients

GERIATRIC PHARMACIST BOOT CAMP

Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.
https://www.cdc.gov/abcs/reports-findings/survreports/spneu18.html

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Diagnostic Considerations

- Chest x-ray
  - Gold standard for diagnosis
  - Known inaccuracy when utilizing symptomology alone for diagnosis
- Sputum and blood cultures are recommended in all patients with **severe disease** or when **suspecting MRSA or *Pseudomonas***
- Urinary antigen tests for *Legionella* and *Streptococcus* antigens are **NOT** routinely recommended
  - Exception: recommended in patients with severe CAP or *Legionella* outbreak

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Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.

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Streamlined Risk Factors

HCAP is gone!

MRSA	*Pseudomonas*
• Prior infection in previous 12 months • Parental antimicrobial therapy in previous 90 days • Hospitalized in previous 90 days	• Prior infection in previous 12 months • IV antibiotics within 90 days • Hospitalization within 90 days • Cystic fibrosis • Bronchiectasis

GERIATRIC PHARMACIST BOOT CAMP

Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.
Kalil AC, et. al. Clin. Inf. Dis. 2016;63(5):e61-e111.

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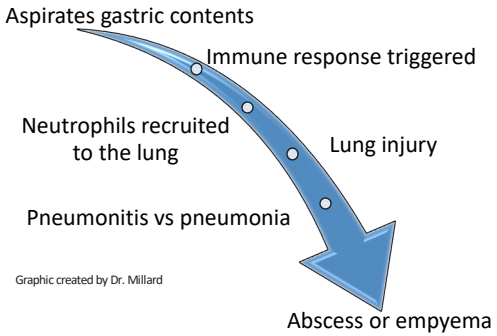
Differential Diagnostic Considerations



Aspiration Risk Factors

- Intoxicants (alcohol, drug overdose, sedatives, procedural sedation, general anesthesia)
- Loss of consciousness (alcohol, drugs, hepatic failure)
- Somnolence
- Supine instead of head at 45° angle
- Enteral nutrition
- Periodontal disease
- Dysphagia and comorbidities often leading to aspiration
- Neurologic disease
- Upper GI tract disease
- Surgery
- Stroke
- Mechanical disruption of glottis closure

GERIATRIC PHARMACIST BOOT CAMP

Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.
Am J Respir Crit Care Med. 2005;171(4):388-416.

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Aspiration Pneumonitis vs Pneumonia

- Aspiration is very common with half of all adults aspirating during sleep
- Patients who aspirate gastric contents are considered to have aspiration pneumonitis
  - Symptoms typically resolve within 48 hours and do **NOT** require antibiotics
- Adding anaerobic antibiotic coverage is **NOT** recommended
  - Exception: evidence of an abscess or empyema on imaging

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Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.

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Criteria for Disease Severity

Major Criteria
Septic shock requiring vasopressors
Respiratory failure requiring mechanical ventilation requirements

One major criteria OR ≥ 3 minor criteria = **Severe CAP**

Minor Criteria
RR ≥ 30 breaths/minute
$Pa_{O2}/Fi_{O2} \leq 250$
Multilobar infiltrates
Confusion/disorientation
Uremia (BUN ≥ 20 mg/dL)
Leukopenia (WBC < 4,000 cells/µL)
Thrombocytopenia (PLT < 100,000/µL)
Hypothermia (core temperature < 36°C)
Hypotension requiring fluid resuscitation

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Mandell LA, et. al. Clin. Inf. Dis. 2007;44:S27-72.

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Clinical Prediction for Prognosis

- PSI/PORT:
  - **P**neumonia **S**everity **I**ndex/ Patient **O**utcomes **R**esearch **T**eam

Points	Class	Mortality rate (%)
	I	0.1
≤ 70	II	0.6
71 to 90	III	0.9
91 to 130	IV	9.3
> 130	V	27.0

- CURB-65:

Features	Points
Confusion	1
Uremia (BUN > 19 mg/dL)	1
Respiratory rate ≥ 30 breaths/minute	1
Blood pressure (Systolic < 90 mmHg or diastolic ≤ 60 mmHg)	1
Age ≥ **65** years	1

- PSI & CURB-65 prediction tools to assess risk of mortality
- PSI & CURB-65 NOT designed to assess level of care needed by a patient
- When compared to CURB-65, PSI identifies larger proportions of patients as low risk and has a higher discriminative power in predicting mortality

GERIATRIC PHARMACIST BOOT CAMP

Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.

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Case Study #2

- TG is a 66 y/o patient who presented with a 2-day history of cough, chills, generalized fatigue, confusion, and increasing SOB. In the ED patient was hypoxic and placed on 2 liters/minute of supplemental oxygen.
- Allergies: cefpodoxime (toxic epidermal necrolysis)
- PMH: COPD, homeless, tobacco use disorder, alcohol use disorder, and PTSD
- PE: T 99.9^{o}F; BP 124/75 mmHg; HR 77 bpm; RR 30 RR
- CXR: suggestive of consolidation and opacification of the right lung base with right pleural effusion
- CrCl is approximately 100 mL/min

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Case Study #2

Which of the following is the most appropriate treatment regimen for TG at this time?

A. Ceftriaxone 1 gram IV q24h and azithromycin 500 mg IV q24h
B. Amoxicillin 500 mg PO q8h
C. Moxifloxacin 400 mg PO q24h
D. Levofloxacin 750 mg IV q24h and Doxycycline 100 mg IV q12h

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Outpatient Treatment

Comorbidities/Risk Factors	Regimen
No comorbidities No IV antibiotics in last 90 days No risk factors for MRSA No risk factors for *P. aeruginosa*	**Amoxicillin** Doxycycline ~~Macrolide~~ (if pneumococcal resistance <25%)
With comorbidities - Alcohol Use Disorder - Type II diabetes - Heart failure - Chronic pulmonary disease - Chronic renal failure - Chronic liver failure - Malignancy - Asplenia	Combination: Amoxicillin/clavulanate or cephalosporin AND **Macrolide** or doxycycline OR Monotherapy: Respiratory fluoroquinolone

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Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.

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Standard Inpatient Regimens

Severity	Generalized Regimen	MRSA Risk Factors Present	*Pseudomonas* Risk Factors Present
Non-severe	β-lactam + anti-atypical* OR Fluoroquinolone	Add MRSA coverage: • Prior isolation, MRSA nares or culture positive Hold MRSA coverage: • MRSA nares negative	Add Pseudomonas coverage and obtain cultures
Severe	β-lactam + macrolide OR Fluoroquinolone	Add MRSA: obtain cultures and MRSA nasal PCR • Consider d/c if MRSA PCR (-)	Add *Pseudomonas* coverage and obtain cultures

MRSA = Methicillin Resistant *Staphylococcus aureus*, Fluoroquinolone = levofloxacin or moxifloxacin, PCR = polymerase chain reaction, d/c = discontinue, *macrolide preferred but if contraindications to macrolides, doxycycline can be substituted

GERIATRIC PHARMACIST BOOT CAMP

Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.

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MRSA Nares PCR

- Recommended for empiric MRSA de-escalation by the guidelines
  - Negative predictive value (NPV) ~ 95%
- Determines if nasal passageway is colonized with MRSA
- Interpretation:
  - Nares positive = patient's airway is likely colonized with MRSA
  - Nares negative = patient's airway is not colonized with MRSA = discontinue anti-MRSA therapy

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Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.

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Anti-MRSA Agents

- Vancomycin
  - Dose: 15 mg/kg IV q12h in patients with normal renal function
  - Current guidelines recommend a target AUC of 400 to 600 mg·h/L
- Linezolid
  - Myelosuppression typically thrombocytopenia, neuropathy when used for a prolonged duration of therapy
  - Serotonin syndrome: when combined with serotonergic agents
- Daptomycin
  - CANNOT be used for pneumonia, inactivated by pulmonary surfactant

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Generalized Overview for the Older Adults

Outpatient with OUT comorbidities	Outpatient with comorbidities	Non-severe without MRSA or *Pseudomonas* Risk Factors	Severe without MRSA or *Pseudomonas* Risk Factors
• Amoxicillin • Doxycycline	• β - lactam + atypical coverage (macrolide or doxycycline)	• β - lactam + macrolide	• β - lactam + macrolide

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Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.

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Duration of therapy

- Minimum of 5 days
  - Clinical stability within 48 to 72 hours
  - No more than 1 clinical sign of instability
- MRSA duration 7 days
- *Pseudomonas* duration 7 days

Criteria for Clinical Stability	Reference
Temperature	< 100.4°F
Heart rate	< 100 bpm
Respiratory rate	< 24 breaths per min
Systolic blood pressure	> 90 mm Hg
Normal mental status	N/A
Ability to maintain oral intake	N/A
Arterial oxygen saturation	> 90%

GERIATRIC PHARMACIST BOOT CAMP

Metlay JP, et. al. Am J Respir Crit Care Med. 2019; 200(7):e45–e67.
Mandell LA, et. al. Clin. Infect. Dis. 2007;44:S27 – 72

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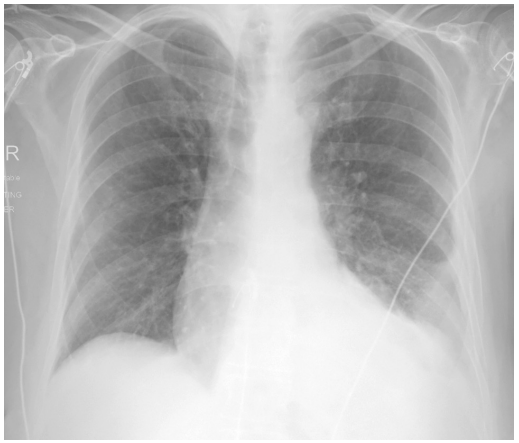
Hospital Acquired Pneumonia (HAP)



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Diagnostic Considerations

- An episode of pneumonia that occurs at least 48 hours after admission and is **NOT** associated with mechanical ventilation

Risk factor for MRSA HAP or MRSA VAP	Risk factor for MDR *Pseudomonas*
Prior intravenous antibiotic use within 90 days	Prior intravenous antibiotic use within 90 days

Risk factor for MDR HAP
Prior intravenous antibiotic use within 90 days

MDR = multi-drug resistant, VAP = ventilator associated pneumonia

GERIATRIC PHARMACIST BOOT CAMP

Kalil AC, et. al. Clin. Inf. Dis. 2016;63(5):e61-e111.

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HAP Empiric Treatment

NOT at high risk of mortality
AND no IV antibiotics in the past 90 days
AND MRSA prevalence ≤20%

Pick one of the following anti-pseudomonal therapies:

Medication*	Dosing	Duration	Comments
Piperacillin-tazobactam	4.5 g IV q6h	At least 7 days	Specific anti-pseudomonal dosing
Cefepime	2 g IV q8h	At least 7 days	Risk of neurotoxicity
Levofloxacin	750 mg IV q24h	At least 7 days	Multiple box warnings
Meropenem	1 g IV q8h	At least 7 days	Lowers seizure threshold Major drug-drug interaction with valproic acid

*All antibiotics require renal adjustments, IV = parental, q = every, h = hours

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Kalil AC, et. al. Clin. Inf. Dis. 2016;63(5):e61-e111.

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HAP Empiric Treatment - 2

NOT at high risk of mortality
AND no IV antibiotics in the past 90 days
AND MRSA prevalence >20%

Pick one anti-pseudomonal therapy from previous slide AND one anti-MRSA agent below:

Medication	Dosing	Duration	Comments
Vancomycin*	15 mg/kg IV q8 – 12 h	At least 7 days	Target trough 15 – 20 mcg/mL, ideally an AUC of 400
Linezolid	600 mg IV q12h	At least 7 days	Risk of thrombocytopenia Critical drug-drug interactions with mental health medications: serotonin syndrome

*Requires renal adjustments, IV = parental, q = every, h = hours

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Kalil AC, et. al. Clin. Inf. Dis. 2016;63(5):e61-e111.

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HAP Empiric Treatment - 3

High risk of mortality, OR IV antibiotics in the past 90 days*, OR structural lung disease

Two anti-pseudomonals agents		plus Anti-MRSA
Piperacillin/tazobactam Ceftazidime Cefepime Imipenem Meropenem	Ciprofloxacin Levofloxacin Gentamicin Tobramycin Amikacin Aztreonam	Vancomycin Linezolid

- *Pertains to likelihood of needing anti-pseudomonal coverage but not necessarily double anti-pseudomonal coverage
- High risk of mortality: septic shock or ventilatory support due to pneumonia
- Structural lung disease: cystic fibrosis or bronchiectasis
- Aztreonam indicated for severe penicillin allergy or as adjunctive in combination with another beta-lactam

Kalil AC, et. al. Clin. Inf. Dis. 2016;63(5):e61-e111.

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Double Anti-pseudomonal Coverage?

- Patients with septic shock or ventilatory support due to pneumonia
- Patients with structural lung disease specifically cystic fibrosis or bronchiectasis
- If facility **without** a primary anti-pseudomonal with susceptibility ≥ 90% or *Pseudomonas* resistance ≥ 10% for all anti-pseudomonal agents on facility antibiogram

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Kalil AC, et. al. Clin. Inf. Dis. 2016;63(5):e61-e111.

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Gram Negative Rods Data are % Susceptible	No. of Strains	Ampicillin	Amp/sulbactam	Pip/tazo	Cefazolin	Ceftriaxone	Ceftazidime	Cefepime	Ertapenem	Imipenem	Ciprofloxacin[e]	Tobramycin	Gentamicin	Trimeth/sulfa	Nitrofurantoin[a]
Acinetobacter baumannii[d]	22[b]	NA	95	91	NA	NA	82	NA	NA	100	82	100	96	NA	NA
Citrobacter freundii	61	NA	NA	82	NA	80	82	98	100	97	88	95	94	91	85
Citrobacter koseri	39	NA	NA	95	87	100	100	100	100	100	95	97	97	95	79
Klebsiella (prev. Enterobacter) *aeroger*	39	NA	100	82	NA	79	79	100	95	79	92	100	100	100	15
Enterobacter cloacae complex	169	NA	NA	79	NA	76	79	92	93	96	94	95	98	90	43
Escherichia coli	924	61	70	96	84	92	97	98	100	100	78	94	94	83	96
Klebsiella oxytoca	114	NA	62	89	42	87	100	100	100	100	94	96	97	88	82
Klebsiella pneumoniae	292	NA	82	95	89	92	94	98	99	100	90	95	97	89	23
Morganella morganii	61	NA	NA	100	NA	89	85	97	98	31	84	98	100	90	NA
Proteus mirabilis	239	84	89	100	69	100	100	100	100	13	86	94	95	83	NA
Pseudomonas aeruginosa	234	NA	NA	94	NA	NA	86	87	NA	87	81	99	92	NA	NA
Serratia marcescens	64	NA	NA	97	NA	92	100	100	100	97	88	88	98	98	NA
Stenotrophomonas maltophilia	29[b]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100	NA

- Aminoglycosides are not recommended as monotherapy due to toxicity

GERIATRIC PHARMACIST BOOT CAMP

Kalil AC, et. al. Clin. Inf. Dis. 2016;63(5):e61-e111.
Modified Graphic created by Dr. Millard's from clinical practice sites

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Gram Negative Organisms	# isolates	Ampicillin	Ampicillin/ Sulbactam	Piperacillin/ Tazobactam	Aztreonam	Cefazolin	Ceftazidime	Ceftriaxone	Cefepime	Levofloxacin	Ciprofloxacin	Gentamicin	Tobramycin	Nitrofurantoin	Trimethoprim/ Sulfamethoxazole
Citrobacter freundii Complex	*56			87	87		85	85	100	100	100	96	98	100	84
Citrobacter koseri	*46			100	100	98	100	100	100	98	100	100	100	87	100
Enterobacter cloacae	57			88	81		79	75	89	96	93	100	98	59	91
Escherichia coli (Urine)	464	62	69	98	95	91	96	94	95	81	80	95	95	98	81
Escherichia coli (Non-Urine)	*29	55	66	100	79	59	83	83	86	76	72	93	93		72
Klebsiella aerogenes	*43			84	84		84	81	100	98	98	100	100	72	100
Klebsiella oxytoca	51		47	92	94	16	98	94	96	98	96	98	98	98	90
Klebsiella pneumoniae	145		83	96	94	94	94	94	94	94	89	99	96	61	86
Klebsiella variicola	*48		98	100	96	83	98	98	100	100	96	96	96	83	98
Proteus mirabilis	110	84	94	100	100	82	100	95	97	74	74	92	95		82
Pseudomonas aeruginosa	82			94	89		98		95	88	84	98	99		
Serratia marcescens	*49			100	100		100	90		88	86	100	98		98

*Denotes organisms with % susceptible based on two years of susceptibility data, 2021 and 2022

*According to CLSI guidelines, organisms with fewer than 30 isolates have less statistical validity. Interpret results with caution.

GERIATRIC PHARMACIST BOOT CAMP

Modified Graphic created by Dr. Millard's from clinical practice sites

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Case Study #3

- DB is a 73 y/o hospitalized patient who is day 5 post left TKA when nursing reports that patient has worsening SOB, mental status, pulse oximetry dropping to 82%, prompting starting of 4 L/minute of supplemental oxygen. Patient has COPD and was treated with a five-day course of ceftriaxone forty-eight days prior to admission for left TKA.
- Allergies: sulfamethoxazole (Stevens-Johnson syndrome)
- PMH: COPD with bronchiectasis, HTN, HLD, OA, DM, Right TKA
- PE: T 100.4^{o}F; BP 89/65 mmHg; HR 111 bpm; RR 22 RR
- Labs: WBCs 14,200; Bands 32%; Lactic acid 3.4
- CXR: New bilateral airspace opacities with large area of consolidation greatest in the right midlung concerning for infiltrates

GERIATRIC PHARMACIST BOOT CAMP

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Case Study #3

- The orthopedics team started ceftriaxone 1gm IV q24h and are currently reviewing records. MRSA prevalence is 54% according to the facility antibiogram.
- Patient records reviewed and show the following at time of admission:
  - CXR at time of admission without cardiopulmonary concerns
  - PE: T 97.4^{o}F; BP 135/71 mmHg; HR 65 bpm; 18 RR
  - Labs: WBCs 7,200; Bands 0%; SCr 1.2 mg/dL

GERIATRIC PHARMACIST BOOT CAMP

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Case Study #3

Which of the following is the most appropriate course of action and/or treatment for DB at this time?

A. Escalate ceftriaxone to levofloxacin 750 mg IV q24h and vancomycin 15 mg/kg IV q12h
B. Escalate ceftriaxone to vancomycin 15 mg/kg IV q12h and cefepime 2gm IV q8h and levofloxacin 750 mg IV q24h
C. Escalate ceftriaxone to meropenem 1 gram q8h and add linezolid 600 mg IV q12h
D. Escalate ceftriaxone to ciprofloxacin 400 mg IV q8h and linezolid 600 mg IV q12h and piperacillin-tazobactam 3.375 gm IV q6h

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Pneumonia Clinical Pearls

- Most common cause of pneumonia is of viral etiology
- Most common cause of bacterial pneumonia is *S. pneumonia*e
- Empiric coverage for anaerobic organisms is not indicated for CABP
- Aspiration pneumonitis does not warrant antibiotic therapy
- MRSA nasal PCR NPV ~95% and if negative may discontinue anti-MRSA therapy for most patients
- Empiric double anti-pseudomonal therapy is always indicated for:
  - Septic shock when caused by pneumonia
  - Patient with pneumonia requires ventilator support

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Immunizations

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https://www.cdc.gov/shingles/index.html

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Immune Response in Older Adults

- Older adults have a lower immune response to vaccines than their younger counterparts
  - Lower antibody concentrations
  - More rapid decrease in antibody titers over time
- Several vaccines are known to be less effective in older adults and those with chronic medical conditions
  - Influenza
  - Pneumococcal
  - Herpes zoster

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Vaccine	Abbreviation(s)	Trade name(s)
COVID-19 vaccine	1vCOV-mRNA	Comirnaty®/Pfizer-BioNTech COVID-19 Vaccine Spikevax®/Moderna COVID-19 Vaccine
	1vCOV-aPS	Novavax COVID-19 Vaccine
Influenza vaccine (inactivated, egg-based)	IIV3	Multiple
	aIIV3	Fluad
	HD–IIV3	Fluzone High–Dose
Influenza vaccine (inactivated, cell–culture)	ccIIV3	Flucelvax
Influenza vaccine (recombinant)	RIV3	Flublok
Influenza vaccine (live, attenuated)	LAIV3	FluMist
Measles, mumps, and rubella vaccine	MMR	M–M–R II, Priorix
Meningococcal serogroups A, C, W, Y vaccine	MenACWY–CRM	Menveo
	MenACWY–TT	MenQuadfi
Meningococcal serogroup B vaccine	MenB–4C	Bexsero
	MenB–FHbp	Trumenba
Meningococcal serogroup A, B, C, W, Y vaccine	MenACWY–TT/ MenB–FHbp	Penbraya
Mpox vaccine	Mpox	Jynneos
Pneumococcal conjugate vaccine	PCV15	Vaxneuvance
	PCV20	Prevnar 20
	PCV21	Capvaxive
Pneumococcal polysaccharide vaccine	PPSV23	Pneumovax 23
Poliovirus vaccine (inactivated)	IPV	Ipol
Respiratory syncytial virus vaccine	RSV	Abrysvo, Arexvy, mResvia
Tetanus and diphtheria vaccine	Td	Tenivac
Tetanus, diphtheria, and acellular pertussis vaccine	Tdap	Adacel, Boostrix
Varicella vaccine	VAR	Varivax
Zoster vaccine, recombinant	RZV	Shingrix

GERIATRIC PHARMACIST BOOT CAMP Recommended Adult Immunization Schedule 2025. CDC.gov https://www.cdc.gov/vaccines/ Accessed 02/27/2025

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Table 1 Recommended Adult Immunization Schedule by Age Group, United States, 2025

Vaccine	19–26 years	27–49 years	50–64 years	≥65 years
COVID-19	1 or more doses of 2024–2025 vaccine (See Notes)			2 or more doses of 2024-2025 vaccine (See Notes)
Influenza inactivated (IIV3, ccIIV3) Influenza recombinant (RIV3)	1 dose annually			1 dose annually (HD–IIV3, RIV3, or aIIV3 preferred)
Influenza inactivated (aIIV3; HD–IIV3) Influenza recombinant (RIV3)	Solid organ transplant (See Notes)			
Influenza live, attenuated (LAIV3)	1 dose annually			
Respiratory syncytial virus (RSV)	Seasonal administration during pregnancy (See Notes)		60 through 74 years (See Notes)	≥75 years
Tetanus, diphtheria, pertussis (Tdap or Td)	1 dose Tdap each pregnancy; 1 dose Td/Tdap for wound management (See Notes)			
	1 dose Tdap, then Td or Tdap booster every 10 years			
Measles, mumps, rubella (MMR)	1 or 2 doses depending on indication (if born in 1957 or later)			For health care personnel (See Notes)
Varicella (VAR)	2 doses (if born in 1980 or later)		2 doses	
Zoster recombinant (RZV)	2 doses for immunocompromising conditions (See Notes)		2 doses	
Human papillomavirus (HPV)	2 or 3 doses depending on age at initial vaccination or condition	27 through 45 years		
Pneumococcal (PCV15, PCV20, PCV21, PPSV23)			See Notes	See Notes
Hepatitis A (HepA)	2, 3, or 4 doses depending on vaccine			
Hepatitis B (HepB)	2, 3, or 4 doses depending on vaccine or condition			
Meningococcal A, C, W, Y (MenACWY)	1 or 2 doses depending on indication (See Notes for booster recommendations)			
Meningococcal B (MenB)	19 through 23 years	2 or 3 doses depending on vaccine and indication (See Notes for booster recommendations)		
Haemophilus influenzae type b (Hib)	1 or 3 doses depending on indication			
Mpox	2 doses			
Inactivated poliovirus (IPV)	Complete 3-dose series if incompletely vaccinated. Self–report of previous doses acceptable (See Notes)			

Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of immunity
Recommended vaccination for adults with an additional risk factor or another indication
Recommended vaccination based on shared clinical decision–making
No Guidance/ Not Applicable

GERIATRIC PHARMACIST BOOT CAMP Recommended Adult Immunization Schedule 2025. CDC.gov https://www.cdc.gov/vaccines/ Accessed 02/27/2025

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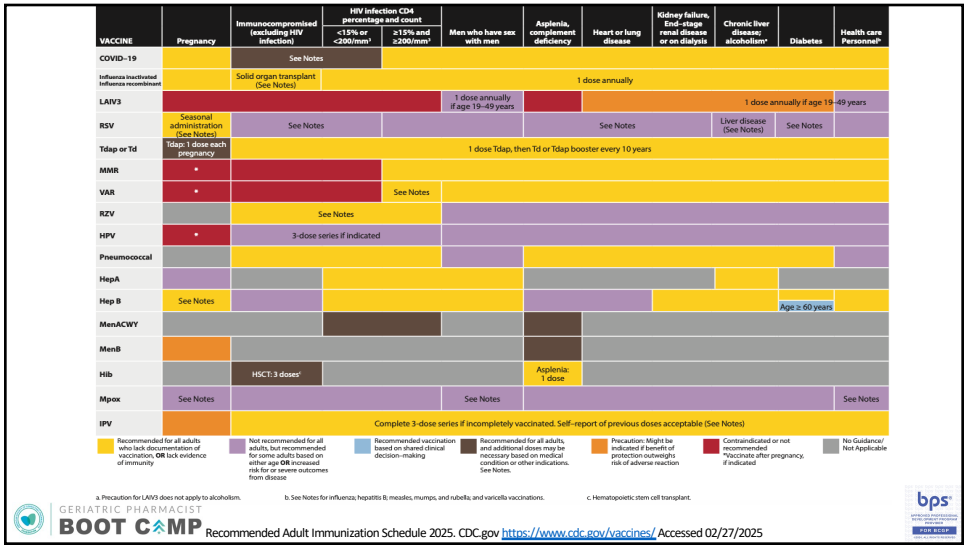

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Vaccines for Older Adults

- Older adults are eligible for a wide variety of vaccines, most importantly:
  - Influenza High Dose (HD)
  - Pneumococcal
  - Herpes zoster
  - COVID-19
  - Hepatitis B*
  - Respiratory syncytial virus
- Other vaccines are more patient specific and depend on risk factors and prior receipt of vaccines:
  - Td/Tdap
  - Meningococcal

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Influenza Vaccines: Contraindications & Precautions

Vaccine Type	Contraindications	Precautions
IIV3 LAIV3	- History of severe allergic reaction to any component of the vaccine or to a previous influenza vaccine	- Moderate or severe acute illness with or without fever - History of Guillain-Barré syndrome within 6 weeks of receipt of influenza vaccine
RIV3	- History of severe allergic reaction to any component of the vaccine	- Moderate or severe acute illness with or without fever - History of Guillain-Barré syndrome within 6 weeks of receipt of influenza vaccine

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Influenza Vaccines: Allergy to Eggs

- Hives only
  - Patients may receive any vaccine recommended for their age without the need for medical monitoring
- Reactions *other* than hives (e.g., anaphylaxis, angioedema)
  - Patients may receive any recommended vaccine for their age
  - Vaccine must be administered in an inpatient or outpatient setting by a healthcare provider who can recognize and manage severe allergic reactions

GERIATRIC PHARMACIST BOOT CAMP Recommended Adult Immunization Schedule 2025. CDC.gov https://www.cdc.gov/vaccines/ Accessed 02/27/2025

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Herpes Zoster Vaccine

	Recombinant Zoster Vaccine (RZV; Shingrix®)
Vaccine type	Lyophilized recombinant VZV surface glycoprotein E antigen
Indication	FDA approved for people aged ≥ 50 years old FDA approved for immunocompromised people aged ≥ **19** years old
Dose	2 doses separated by 2 to 6 months
Route	IM
Storage	Refrigerate between 2°C to 8°C

- Whether or not they report a prior episode of herpes zoster
- Regardless if vaccinated prior with Zostavax (removed from market)
- Not necessary to screen, verbally or by laboratory serology, for evidence of prior varicella exposure

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Herpes Zoster Vaccine Recommendations | CDC
Clinical Considerations for Use of Recombinant Zoster Vaccine (RZV, Shingrix) in Immunocompromised Adults Aged ≥19 Years | CDC

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Herpes Zoster Vaccine

- Dosing schedule
  - Persons who are or will be immunodeficient or immunosuppressed and who would benefit from completing the series in a shorter period, the second dose can be administered 1–2 months after the first dose
  - If the second dose of RZV is given sooner than 4 weeks after the first, a second valid dose should be repeated at least 4 weeks after the dose that was given too early
  - The vaccine series does not need to be restarted if more than 6 months have elapsed since the first dose

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Herpes Zoster Vaccine Recommendations | CDC
Clinical Considerations for Use of Recombinant Zoster Vaccine (RZV, Shingrix) in Immunocompromised Adults Aged ≥19 Years | CDC

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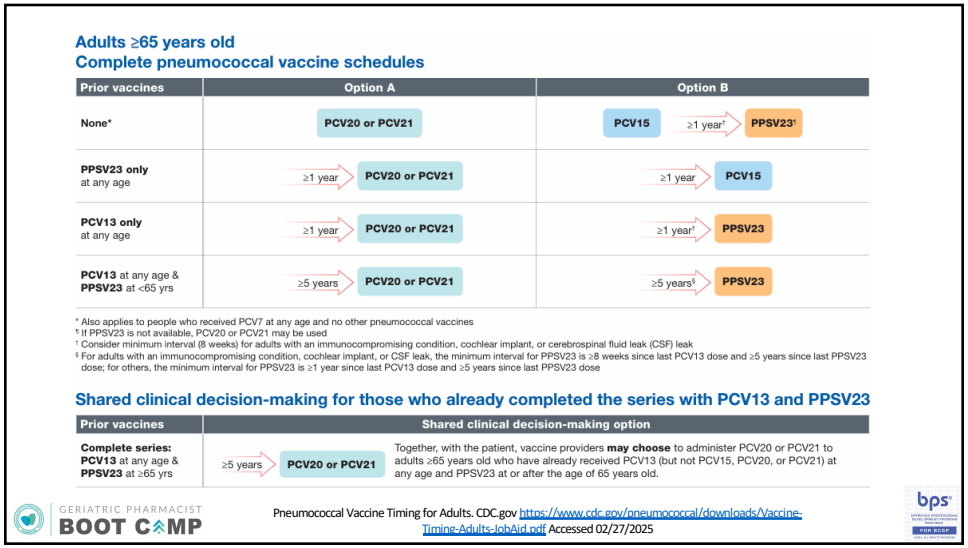

Adults ≥65 years old
Complete pneumococcal vaccine schedules

Prior vaccines	Option A	Option B
None*	PCV20 or PCV21	PCV15 → ≥1 year† → PPSV23‡
PPSV23 only at any age	≥1 year → PCV20 or PCV21	≥1 year → PCV15
PCV13 only at any age	≥1 year → PCV20 or PCV21	≥1 year† → PPSV23
PCV13 at any age & PPSV23 at <65 yrs	≥5 years → PCV20 or PCV21	≥5 years§ → PPSV23

* Also applies to people who received PCV7 at any age and no other pneumococcal vaccines
‡ If PPSV23 is not available, PCV20 or PCV21 may be used
† Consider minimum interval (8 weeks) for adults with an immunocompromising condition, cochlear implant, or cerebrospinal fluid leak (CSF) leak
§ For adults with an immunocompromising condition, cochlear implant, or CSF leak, the minimum interval for PPSV23 is ≥8 weeks since last PCV13 dose and ≥5 years since last PPSV23 dose; for others, the minimum interval for PPSV23 is ≥1 year since last PCV13 dose and ≥5 years since last PPSV23 dose

Shared clinical decision-making for those who already completed the series with PCV13 and PPSV23

Prior vaccines	Shared clinical decision-making option
Complete series: PCV13 at any age & **PPSV23** at ≥65 yrs	≥5 years → PCV20 or PCV21 — Together, with the patient, vaccine providers **may choose** to administer PCV20 or PCV21 to adults ≥65 years old who have already received PCV13 (but not PCV15, PCV20, or PCV21) at any age and PPSV23 at or after the age of 65 years old.

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Pneumococcal Vaccine Timing for Adults. CDC.gov https://www.cdc.gov/pneumococcal/downloads/Vaccine-Timing-Adults-JobAid.pdf Accessed 02/27/2025

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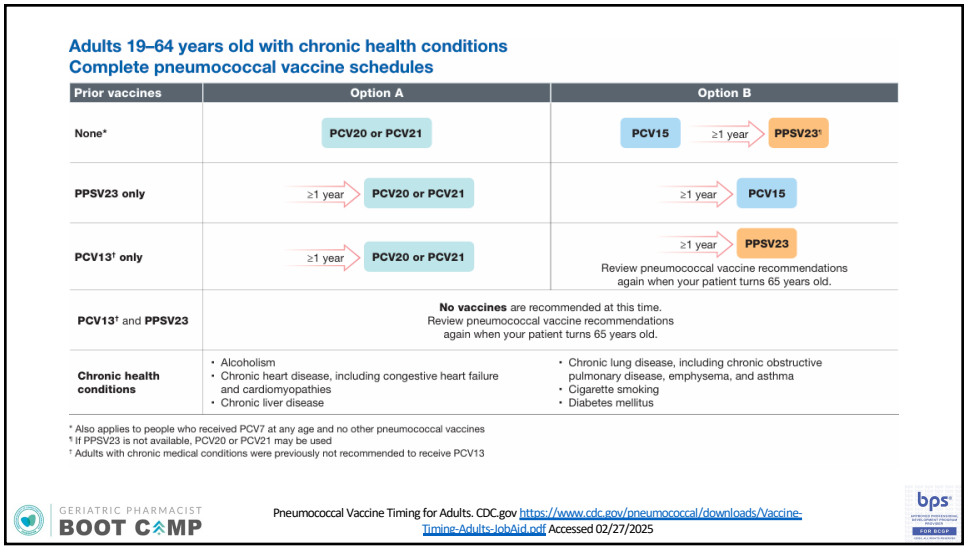

Adults 19–64 years old with chronic health conditions
Complete pneumococcal vaccine schedules

Prior vaccines	Option A	Option B
None*	PCV20 or PCV21	PCV15 → ≥1 year → PPSV23‡
PPSV23 only	≥1 year → PCV20 or PCV21	≥1 year → PCV15
PCV13† only	≥1 year → PCV20 or PCV21	≥1 year → PPSV23 Review pneumococcal vaccine recommendations again when your patient turns 65 years old.
PCV13† and PPSV23	**No vaccines** are recommended at this time. Review pneumococcal vaccine recommendations again when your patient turns 65 years old.	
Chronic health conditions	• Alcoholism • Chronic heart disease, including congestive heart failure and cardiomyopathies • Chronic liver disease	• Chronic lung disease, including chronic obstructive pulmonary disease, emphysema, and asthma • Cigarette smoking • Diabetes mellitus

* Also applies to people who received PCV7 at any age and no other pneumococcal vaccines
‡ If PPSV23 is not available, PCV20 or PCV21 may be used
† Adults with chronic medical conditions were previously not recommended to receive PCV13

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Pneumococcal Vaccine Timing for Adults. CDC.gov https://www.cdc.gov/pneumococcal/downloads/Vaccine-Timing-Adults-JobAid.pdf Accessed 02/27/2025

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Pneumococcal Vaccines: Clinical Considerations

- PCV15, PPSV23, etc. should **NOT** be administered concomitantly
- When both vaccines are indicated, PCV15 should generally be given prior to PPSV23
  - If either vaccine is incorrectly given earlier than at the recommended time, the dose should not be repeated
- PCV15 and PPSV23 **should generally be separated by 1 year** in most immunocompetent patients
  - Minimum interval is 8 weeks for select immunocompromised patients

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Recommended Adult Immunization Schedule 2025. CDC.gov https://www.cdc.gov/vaccines/ Accessed 02/27/2025
Pneumococcal Vaccine Timing for Adults. CDC.gov https://www.cdc.gov/pneumococcal/ Accessed 02/27/2025

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Hepatitis B Vaccine What to Know

- 2024 Recommendations
- All infants, children, and adolescent younger than 19 who have not been vaccinated
- Adulty 19 – 59 years of age
- Adults 60 and older with risk factors for hepatitis B*

*Age 60 years or older with diabetes: Based on shared clinical decision making, 2-, 3-, or 4 dose series

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MMWR. Volume 73, Issue 1 — January 11, 2024 (cdc.gov).

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Respiratory Syncytial Virus Vaccines

	RSV (Arexvy®; Abrysvo®)
Arexvy®	Lyophilized antigen powder to be reconstituted with adjuvant suspension
Abrysvo®	Lyophilized antigen component to be reconstituted with sterile water diluent
mResvia®	Pre-filled syringe that much be thawed prior to administration
FDA Approved	Single dose to all adults ≥ 75 years old, or ≥ 60 with increased risk of severe illness
Dose	Single dose 0.5 mL
Route	IM

- Do not freeze, discard if package has been frozen, **excluding mResvia**
- Abrysvo also FDA approved for pregnant individual at 32 – 36 weeks gestation
- Abrysvo also FDA approved for infants from birth through 6 months of age

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Recommended Adult Immunization Schedule 2025. CDC.gov https://www.cdc.gov/vaccines/ Accessed 02/27/2025

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Risk Factors for Severe Respiratory Syncytial Virus

- Adults aged 60 – 74 years
  - Chronic cardiovascular disease
  - Chronic lung or respiratory disease
  - End-stage renal disease or dependence renal replacement therapy
  - Diabetes complicated by CKD, neuropathy, retinopathy, or other end-organ damage, or requiring treatment with insulin or sodium-glucose cotransporter-2 (SGLT2) inhibitor
  - Neurologic or neuromuscular conditions
  - Chronic liver disease
  - Severe obesity (body mas index ≥ 40 kg/m^2)
  - Moderate or sever immune compromise
  - Residence in a nursing facility

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Recommended Adult Immunization Schedule 2025. CDC.gov https://www.cdc.gov/vaccines/ Accessed 02/27/2025

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Case Study #4

- RS is a 67-year-old person who presents today to his PCP for an annual physical evaluation.
- He is inquiring about the "pneumonia shot." His records indicate that he has received one dose of PCV13 two years ago.
- PMH: Hypertension, type 2 diabetes mellitus, and depression
- Medications: Lisinopril, metformin, insulin NPH, fluoxetine, and aspirin
- Allergies: NKDA
- PE: T 98.9°F; BP 152/90 mmHg; HR 80 beats/minute; RR 20 breaths/minute

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Case Study #4

What is the best recommendation for RS currently?

A. Administer PCV15 only
B. Administer PCV15 and PPSV23 at the same time
C. Administer PCV20 only
D. He is not a candidate for any pneumococcal vaccine because he recently received a pneumonia shot

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Vaccine Clinical Pearls

- Influenza vaccines are recommended for all adults without contraindications
  - **Patients ≥ 65 should receive 1 high dose inactivated version (HD-IIV4)**
- Patients 60 or older with diabetes should be considered for Hepatitis B vaccination if not received before
- **8 weeks** minimum interval between COVID-19 boosters
- Patients with diabetes on insulin or SGLT-2i between 60 – 74 are indicated for the RSV vaccine

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Vaccine Clinical Pearls

- Moderate or severe acute illness, with or without fever?
- mRNA COVID-19 Vaccines
  - Contraindicated severe allergic reaction e.g. anaphylaxis
  - Precaution non-severe allergy (e.g. urticaria beyond injection site), myocarditis or pericarditis within 3 weeks of vaccination
  - Novavax?
- Multiple vaccines at once?
  - Injectable or nasally administered live vaccines
  - mRNA vaccines
- When to give Shingrix when patient has active shingles?

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What to Know About Getting Flu, COVID-19, and RSV Vaccines at the Same Time | NCIRD | CDC

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Vaccine Clinical Pearls

- RZV is the only recommended vaccine for the prevention of herpes zoster in adults aged ≥50 years
  - Patients should receive 2 doses of RZV
- PPSV23 is recommended in patients with specific underlying medical conditions and in adults ≥65 years
  - Many patients require 2 doses, but some may receive up to 3 doses
- One dose of PCV20 or PCV21 may be used if PPSV23 is not available

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