2022 Antibiotic Stewardship Guidebook

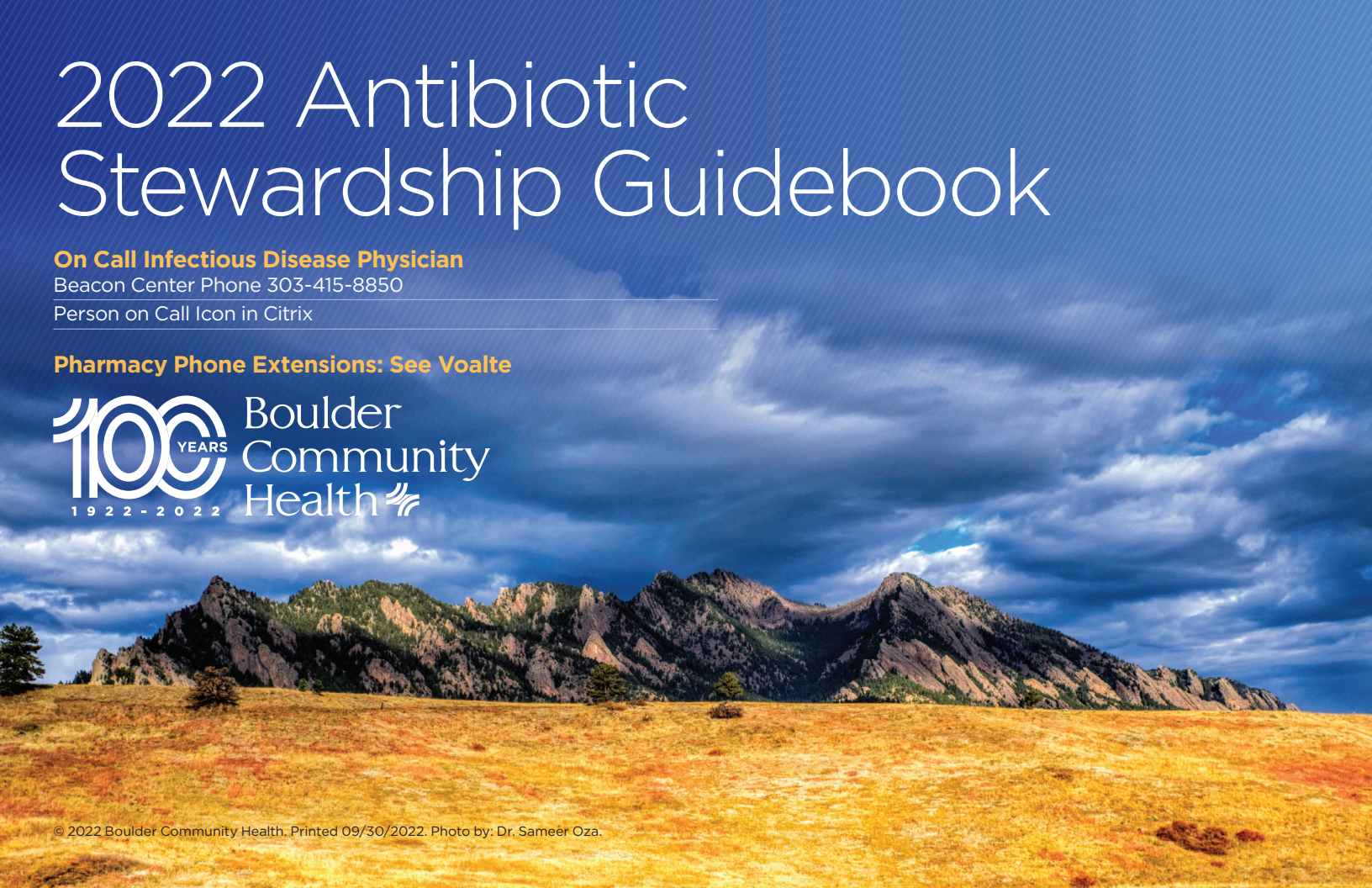
On Call Infectious Disease Physician

Beacon Center Phone 303-415-8850

Person on Call Icon in Citrix

Pharmacy Phone Extensions: See Voalte

100 YEARS 1922-2022 Boulder Community Health



2022 Antibiotic Stewardship Guidebook

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Antibiogram 2021

Species with less than 30 isolates, susceptibilities should be interpreted with caution. Grey boxes indicate organism has intrinsic resistance or susceptibilities are not published to corresponding antimicrobial.

Gram Negative NON-URINE Isolates Inpatient and Emergency Department	**Total # Isolates**	**Ampicillin**	**Ampicillin-Sulbactam**	**Piperacillin Tazobactam**	**Cefazolin**	**Ceftriaxone**	**Ceftazidime**	**Cefepime**	**Ertapenem**	**Meropenem**	**Levofloxacin**	**Trimethoprim Sulfamethoxazole**	**Gentamicin**	**Tobramycin**
Organism	# Results	% Susceptibility												
Acinetobacter spp.	3					67%	100%	100%		100%	100%	100%	100%	100%
Citrobacter spp.[1]	13		38%	85%	38%	83%		92%	100%	100%	92%	92%	92%	100%
Enterobacter spp.[1,2]	26			73%		69%		77%	77%	100%	96%	88%	100%	100%
Escherichia coli	111	60%	68%	98%	86%	89%		91%	99%	100%	77%	70%	93%	91%
Klebsiella spp.	58		60%	91%	71%	90%		91%	100%	100%	97%	88%	93%	93%
Klebsiella spp excluding K. aerogenes	52		66%	91%	77%	89%		90%	100%	100%	98%	87%	92%	92%
K. aerogenes[1]	6		0%	100%		100%		100%	100%	100%	83%	100%	100%	100%
Proteus vulgaris group	5			100%				100%	100%	60%	100%	100%	80%	80%
Proteus mirabilis	16	88%	94%	100%	87%	100%		100%	100%		75%	94%	81%	80%
Pseudomonas aeruginosa	26			88%			88%	88%		92%	85%		100%	100%
Serratia spp.[1]	11			100%		100%		100%	100%	100%	100%		100%	100%
Stenotrophomonas maltophilia (all locations)	10						30%				80%	90%		

1. Enterobacter, Klebsiella (formerly Enterobacter) aerogenes, and Citrobacter fruendii have the potential to induce AmpC beta-lactamase production and become resistant to 3rd generation cephalosporins, aztreonam, piperacillin-tazobactam while on therapy. Use those agents with caution. Failure rates appear highest with Enterobacter>>Citrobacter. Cefepime and carbapenems appear to be stable. (REF: Tamma, PD et al. IDSA Guidance for treatment of GNR bacteria, 3/31/22)
2. Among enterobacter resistant to ertapenem, none were identified as true CRE by CDPHE.

Haemophilus influenzae beta-lactamase positive 15%, total isolates n=13
Carbapenem Resistant Ps. aeruginosa (CRPA) rate Inpatient/ED: 1) NON-URINE 8%, 2) URINE 11%; Outpatient: 1) NON-URINE 5%, 2) URINE 2%
ESBL (E.coli and Klebsiella) rate Inpatient/ED: 1) NON-URINE 5%, 2) URINE 4%; Outpatient: 1) NON-URINE 5%, 2) URINE 4%

% Susceptible

80% or better

70-79%

≤69%

Antibiogram 2021

Species with less than 30 isolates, susceptibilities should be interpreted with caution. Grey boxes indicate organism has intrinsic resistance or susceptibilities are not published to corresponding antimicrobial.

Gram Positive NON-URINE Isolates Inpatient and Emergency Department	**Total # Isolates**	**Penicillin G**	**Penicillin G (meningitis)**	**Oxacillin[3]**	**Ceftriaxone**	**Ceftriaxone (meningitis)**	**Clindamycin**	**Levofloxacin**	**Trimethoprim Sulfamethoxazole**	**Vancomycin**	**Gentamicin synergy**	**Tetracycline**	**Erythromycin**
Organism	# Results	% Susceptibility											
Enterococcus spp.[1]	54	93%								94%	83%		
E. faecalis	47	100%								100%	85%		
E. faecium	7	43%								57%	71%		
Streptococcus pneumoniae (all locations)[2]	17	94%	59%		100%	100%	81%	94%	65%	100%			38%
Viridans Strep (includes S.anginosus)[4]	25	76%			100%		X	X		100%			
Streptococcus pyogenes (Group A)	23	100%			100%		52%			100%			52%
Streptococcus agalactiae (Group B)	8	100%			100%		50%			100%			50%
Staphlococcus aureus all locations	695			81%			81%		99%	100%		94%	
Inpatient/ED	237			70%			80%		98%	100%		93%	
Outpatient only	481			86%			81%		99%	100%		93%	
Staphylococcus epidermidis	19			37%			63%		*	100%		79%	
Staphylococcus lugdunensis (all locations)	39			100%			87%		*			97%	

1. Enterococci susceptible to penicillin are predictably susceptible to ampicillin, amoxicillin, ampicillin-sulbactam, amoxicillin-clavulanate and pip/tazo.
2. CLSI requires publication of two breakpoints for all pneumococcal isolates designated: meningitis and non-meningitis. There were 8 blood/CSF & 9 Respiratory/Wound pneumococcal isolates.
3. Oxacillin results can be applied to other anti-staph penicillins and β-lactam/β-lactamase inhibitors, cephalosporins and carbapenems.
4. Viridans Strep non-susceptible to penicillin 100% (n=9) were intermediate (MIC 0.25-2.0).

X=not recommended
*In house testing not available

MRSA rate: Inpatient/ED: 1) NON-URINE 30% 2) URINE 25%; Outpatient: 1) NON-URINE 14%, 2) URINE 19%
VRE rate: Inpatient/ED: 1) NON-URINE 6%, 2) URINE 0%; Outpatient URINE 0%

% Susceptible

80% or better

70-79%

≤69%

Antibiogram 2021

Species with less than 30 isolates, susceptibilities should be interpreted with caution. Grey boxes indicate organism has intrinsic resistance or susceptibilities are not published to corresponding antimicrobial.

URINE Isolates Inpatient and Emergency Department	Total # Isolates	Penicillin G	Ampicillin	Ampicillin Sulbactam	Oxacillin	Piperacillin Tazobactam	Cefazolin	Ceftriaxone	Ceftazidime	Cefepime	Ertapenem	Meropenem	Levofloxacin	Trimethoprim Sulfamethoxazole	Vancomycin	Nitrofurantoin	Tetracycline
Organism	# Results	% Susceptibility															
Acinetobacter species	0																
Citrobacter spp	16					81%		81%		100%	88%	100%	100%	88%		81%	88%
Enterobacter cloacae	23					83%		74%		94%	83%	100%	100%	91%		30%	96%
E.coli	411		64%	67%		99%	88%	93%		94%	100%	100%	84%	80%		98%	77%
Klebsiella spp.																	
Klebsiella excluding K.aerogenes	84			79%		96%	94%	96%		96%	99%	100%	93%	89%		62%	85%
K.aerogenes	9			0%		100%	0%	100%		100%	100%	100%	100%	100%		44%	89%
Proteus spp.																	
P. mirabilis	26		65%	81%		100%	96%	100%		100%	100%		58%	73%			
P. vulgaris group	5					60%				100%	100%	100%	60%	80%			
Ps. aeruginosa	35					83%			83%	97%		89%	83%				
Serratia marcescens	4					100%		100%		100%	100%	100%	100%				
Stenotrophomonas (All Locations)	2								50%				50%	0%			
Enterococcus spp. total	68	97%	97%												100%	100%	38%
E. faecalis	64	100%	100%												100%	100%	36%
E. faecium	4	50%	50%												100%	*	50%
Staphylocccus aureus	44				75%									100%	100%	100%	86%
Staph species not aureus	23				65%									*	100%	100%	74%

Enterococci susceptible to penicillin are predictably susceptible to ampicillin, amoxicillin, ampicillin-sulbactam, amoxicillin-clavulanate and pip/tazo.

*In house testing not available

% Susceptible

80% or better

70-79%

≤69%

Antibiogram 2021

Species with less than 30 isolates, susceptibilities should be interpreted with caution. Grey boxes indicate organism has intrinsic resistance or susceptibilities are not published to corresponding antimicrobial.

URINE Isolates Outpatient	Total # Isolates	Penicillin G	Ampicillin	Ampicillin Sulbactam	Oxacillin	Cefazolin	Ceftriaxone	Ceftazidime	Cefepime	Meropenem	Levofloxacin	Trimethoprim Sulfamethoxazole	Vancomycin	Nitrofurantoin	Tetracycline
Organism	# Results	% Susceptibility													
Acinetobacter baumanii	3			100%			67%	100%	67%	100%	100%	100%			
Citrobacter spp.	56			54%		45%	91%			100%	93%	88%		79%	84%
Enterobacter cloacae complex	37						84%			100%	89%	86%		41%	89%
E.coli	1484		67%	71%		92%	95%			100%	87%	83%		99%	80%
Klebsiella spp.															
Klebsiella excluding K. aerogenes	236			78%		86%	94%			100%	94%	93%		63%	87%
K. aerogenes	21			0%		0%	90%			100%	100%	95%		38%	100%
Proteus spp.															
P. mirabilis	63		90%	95%		94%	95%				89%	92%			
P. vulgaris group	5					0%	20%				60%	100%			
Ps. aeruginosa	41							98%	98%	100%	93%				
Serratia marcesens	4						100%			100%	100%	*			
Enterococcus spp.	115	100%	100%										100%	100%	27%
E. faecalis	111	100%	100%										100%	100%	24%
E. faecium	4	100%	100%										100%	*	100%
Staphylocccus aureus	67				81%							100%	100%	100%	96%
Staph species not aureus	55				69%							*	100%	100%	82%

*In house testing not available.

% Susceptible

80% or better

70-79%

≤69%

Antibiogram 2021

Species with less than 30 isolates, susceptibilities should be interpreted with caution.

Yeast All locations[1]	Total # Isolates	Fluconazole	Micafungin	Voriconazole
Organism	# Results	% Susceptibility		
Candida albicans	12	100%	100%	100%
Candida glabrata	4	75%	100%	
Candida krusei[2] (Pichia kudriavzevii)	1	0%	100%	100%
Candida tropicalis	0			
Candida parapsilosis	1	100%	100%	100%
Overall	18	89%	100%	100%

1. Testing performed at Mayo Laboratories
2. Intrinsically resistant to Fluconazole

Isolate sources:
Peritoneal n=8, Bone/Joint n=1, Urine n=4, Blood n=5

% Susceptible

80% or better	
70-79%	
≤69%	
Dose dependent susceptibility.	

Empiric Antimicrobial Guidelines for Hospitalized Adults

Suggested initial therapies based on guidelines[1-9] and local resistance patterns, these guidelines are *not* a substitution for an ID consult.

Indication	Likely Pathogens	Empiric Therapy	Alternative Therapy	TOTAL Duration (inpatient + outpatient)	Oral Empiric Step Down
Community Acquired Pneumonia[1]	Respiratory viruses, S. pneumo., H. flu, Mycoplasma, C. pneumoniae, Legionella, S. aureus ***PEARL:*** *Respiratory viruses are the most common cause of pneumonia. Testing for respiratory viruses recommended on all admissions for pneumonia.* *Blood and respiratory cultures recommended if sepsis. If severe pneumonia send legionella urinary antigen.*	Ceftriaxone 1-2 gm IV Q24h + Azithromycin 500 mg PO/IV Q24h **OR** Levofloxacin 750 mg PO/IV Q24h ICU admit + Risks for MDRO: consider HAP antibiotic recs +/- Levofloxacin 750 mg IV Q24h	**Severe β lactam allergy** Levofloxacin 750 mg PO/IV Q24h **Risk for Prolonged QT** Use Doxycycline 100 mg IV/PO Q12h for atypical coverage	5-7 days If abscess or empyema is present, ID consult recommended	• Amox/Clav + Azithromycin • 3rd gen PO Cephalosporin +Azithromycin • Levofloxacin
HCAP	Treat as CAP unless specific risks for MDRO then HAP recommendations	MDRO Risks: prior IV antibiotic use last 90 days, past cultures demonstrating MDRO or MRSA risk factors			
HAP/VAP[2]	Enteric GNR, Pseudomonas, MRSA *BAL or tracheal aspirate recommended, although detected pathogens may be either colonizing or invading.*	Cefepime 2 gm IV Q8h **OR** Pip/taz 3.375 gm IV Q8h extended infusion +/- Vancomycin IV	**Severe β lactam allergy** Consult ID	7 days	Depends on microbiologic data
Aspiration PNA[1,2,8]	Streptococcus, H flu, S. Aureus, Enterobacteraciae. Anaerobes considered less common *1) Clear CXR + mild to moderate illness consider withholding antibiotics and monitoring* *2) If no evidence of infection after 2 days following witnessed aspiration in the hospital, consider discontinuation of antibiotics*	**Community acquired** Amp/Sulbactam 3 gm IV Q6h **OR** Ceftriaxone 2 gm IV Q24h **Hospital acquired** ***Low risk:*** same as community acquired listed above ***High risk:*** antibiotics in last 90 days and/or hospitalized 5 days or more Pip/taz 3.375 gm IV Q8h extended infusion	**Severe β lactam allergy** Moxifloxacin 400 mg PO Q24h	5-7 days If abscess or empyema is present, ID consult recommended	• Amox/Clav • Moxifloxacin • PCN + Metronidazole

NOTE: Antibiotic dosing in this chart does not take into account renal or liver dysfunction.

Empiric Antimicrobial Guidelines for Hospitalized Adults

Suggested initial therapies based on guidelines[1-9] and local resistance patterns, these guidelines are *not* a substitution for an ID consult.

Indication	Likely Pathogens	Empiric Therapy	Alternative Therapy	TOTAL Duration (inpatient + outpatient)	Oral Empiric Step Down
Community Acquired Intra-abdominal Infection[3]	E coli, other enteric GNR, Enteric streptococci, Bacteroides, anaerobes	Ceftriaxone 2 gm IV Q24h + Metronidazole 500 mg IV Q8h	**Severe β lactam allergy** Levofloxacin 750 mg IV Q24h + Metronidazole 500 mg IV Q8h *23% local non-urine E coli resistance to Levofloxacin*	5-7 days with source control	Based on cultures Empiric • Amox/Clav • Levofloxacin + Metronidazole
Severe Sepsis with Peritonitis or Hospital Acquired Intra-abdominal Infection[3]	ESBL E coli, Pseudomonas, streptococcus sp, enterococcus, staphylococcus, MRSA, yeast	Pip/taz 3.375 gm IV Q8h extended infusion +/- Vancomycin IV (MRSA colonized or failing current therapy) Consider yeast coverage	**β lactam allergy** Meropenem 1 gm IV Q8h **Severe β lactam allergy** Consult ID	5-14 days depending on source control ID Consult Recommended	Based on cultures Empiric • Levofloxacin + Metronidazole
Febrile Neutropenia[4]	Enteric gram neg, Pseudomonas, Streptococcus sp, Staphylococcus	Cefepime 2 gm IV Q8h +/- Vancomycin IV (cath related, SSTI, PNA, unstable) +/- Metronidazole 500 mg IV Q8h (abdominal symptoms) **OR** Meropenem 1 gm IV Q8h +/- Vancomycin IV (cath related, SSTI, PNA, unstable)	**Severe β lactam allergy** Consult ID	Depends on clinical response/ source/count recovery	• Levofloxacin • Amox/Clav
Meningitis[5]	Viral (enterovirus, HSV, VZV, West Nile), S. pneumo., N. meningitis, Listeria *Consult ID for bacterial or herpes virus meningitis.*	Ceftriaxone 2 gm IV Q12h + Vancomycin IV +/- Ampicillin 2 gm IV Q4h (Listeria, consider if >50y/o, preg, immunocompromised) +/- Dexamethasone 0.15 mg/kg IV Q6h administered 10–20 min before, or concomitant with, 1st dose of antibiotics with suspected/proven pneumococcal meningitis	**Nosocomial/post-neurosurgical** Cefepime 2 gm IV q8h + Vancomycin IV AND consult ID **Severe β lactam allergy** Consult ID	7-21 days depending on pathogen: consult ID	Not applicable

NOTE: Antibiotic dosing in this chart does not take into account renal or liver dysfunction.

Empiric Antimicrobial Guidelines for Hospitalized Adults

Suggested initial therapies based on guidelines[1-9] and local resistance patterns, these guidelines are *not* a substitution for an ID consult.

Indication	Likely Pathogens	Empiric Therapy	Alternative Therapy	TOTAL Duration (inpatient + outpatient)	Oral Empiric Step Down
Skin and Soft Tissue Infections	**Erysipelas, Non-purulent[6]** Streptococcus	Cefazolin 2 gm IV Q8h	**Severe β lactam allergy** Vancomycin IV *If vancomycin allergy or not clinically appropriate, **Consult ID.** Clindamycin may not be appropriate due to high levels of GBS and GAS resistance.*	5-7 days	• Dicloxacillin • Cephalexin
	Purulent/abscess[6] Staphylococcus sp • Consider Surgical consult for I&D • Obtain culture	Vancomycin IV	**Allergy to Vancomycin IV** Consult ID	Variable, if abscess evacuated consider shorter 5-7 days	**Empiric or MRSA** TMP/SMX or Doxycycline **MSSA** Dicloxacillin or Cephalexin
	Necrotizing Fasciitis[6] Type 1 Polymicrobial Type 2 S. pyogenes (GAS) *Immediate Surgical and ID consult recommended.*	Vancomycin IV +Pip/taz 3.375 gm IV Q8h extended infusion +/- Linezolid, Call ID for approval, use is recommended if high concern S. pyogenes	**Severe β lactam allergy** Consult ID	Variable	Not applicable
Diabetic Foot Infection[7]	Polymicrobial: Staphylococcus, Streptococcus predominant Review past culture data and antibiotic use to assess risk of ESBL, Pseudomonas, anaerobes. *Recommend culture from deep tissue, obtained by biopsy or curettage after the wound cleansed and debrided.*	Amp/sulbactam 3 gm IV Q6h **OR** Ceftriaxone 2 gm IV Q24h + metronidazole 500 mg PO/IV Q8h +/- Vancomycin IV	**Concern for Pseudomonas** Pip/taz 3.375 gm IV Q8h extended infusion **Severe β lactam allergy** Meropenem 1 gm IV Q8h +/-Vancomycin IV	Variable	Based on cultures

Empiric Antimicrobial Guidelines for Hospitalized Adults

Suggested initial therapies based on guidelines[1-9] and local resistance patterns, these guidelines are *not* a substitution for an ID consult.

Indication	Likely Pathogens	Empiric Therapy	Alternative Therapy	TOTAL Duration (inpatient + outpatient)	Oral Empiric Step Down
Urinary Tract Infection[8,9]	See pages 11-12				

Infectious Diseases consult available for any ID condition, but strongly recommended for bacteremia, fungemia, meningitis, necrotizing fasciitis, severe intra-abdominal infection and endocarditis

NOTE: Antibiotic dosing in this chart does not take into account renal or liver dysfunction.

REFERENCES:

1 CID 2007; 44:S27–72 & NEJM 2015; 373:415
2 CID 2016; 63(5):e61
3 CID 2010; 50:133–64 & Surg Infect 2017: 18:1-56
4 CID 2011; 52(4):e56–e93
5 CID 2004; 39:1267–84
6 CID 2014 Jul 15; 59(2):147-59
7 CID 2012; 54(12):132–173
8 CID 2011; 52(5):e103–e120 & NEJM 2019; 380:651-63
9 CID 2010; 50:625–663

PEARLS:

- Penicillin allergy: Recommend review of Antibiotic Allergy Tip Sheet and Chart on Cross Reactivity between Penicillins and Cephalosporins, page 23-24.
- 30% of non-urine staphylococcus aureus isolates are MRSA.
- Rate of non-urine ESBL is 5% among E coli, Klebsiella and Proteus.

BCH Empiric Antibiotic Therapy for Sepsis and Septic Shock of ***Unknown*** Source

Risk Factors for Resistant Organisms
Hospitalized previous 90 days
Long term HD
Immunosuppressed
Broad spectrum antibiotics in last 90 days
NH or LTC
Known MDRO organism
Concern for Pseudomonas

NO

Ceftriaxone 2 gm IV Q24h
(Q12h for CNS)
+/-
Vancomycin IV
(IF suspect MRSA or resistant S. pneumoniae)

OPTIONAL TREATMENT

Atypical CAP coverage:
Azithromycin 500 mg Q24h

Anaerobic coverage : Metronidazole
IV/PO 500 mg Q8h

Broad-spectrum empiric therapy used while cultures are pending i.e. first 48-72 hours. Antibiotic regimen should be evaluated daily and streamlined based on culture data.

YES

Zosyn 3.375 gm IV Q8h extended infusion
OR
Meropenem 1 gm IV Q8h
+/-
Vancomycin IV
+/-
Atypical CAP coverage:
Azithromycin 500 mg Q24h

SEVERE BETA LACTAM ALLERGY

Aztreonam 2 gm IV Q8h
OR
Levofloxacin 750 mg IV Q24h
+
Vancomycin IV
+/-
Anaerobic coverage: Metronidazole
IV 500 mg Q8h

NOTE: If Septic Shock: initial use of broader spectrum antibiotics may be appropriate, even in the absence of risk factors for resistant organisms, and is left to clinical judgment.

1. Refer to specific sections in antibiotic guidelines for specific sources of infection. Sepsis treatment should be targeted at the specific source whenever possible.
2. Review prior microbiology data.
3. Blood cultures should be collected **PRIOR** to antibiotics.
4. **Consider viral etiologies.**

NOTE: Dosing below assumes Normal Renal Function

Guidelines for Management of Urinary Tract Infection in the Inpatient and Outpatient Setting

GENERAL RULE: Limit overuse of antibiotics and development of resistant bacteria by ONLY using antibiotics when ALL three things exist: 1. New or Different Symptoms, 2. Abnormal urinalysis, 3. Positive urine culture (>10^5 CFU/mL of 1 organism in clean catch or 10^3 CFU/mL in catheterized specimen)

*See 2021 inpatient and outpatient urine antibiogram for BCH patterns of resistance

Typical Symptoms of an Infection along the Urinary Tract	Symptoms NOT Indicative of UTI in the *Absence* of Typical Symptoms
• Dysuria, frequency, urinary urgency, urinary retention, acute hematuria • Pelvic pain, suprapubic pain, flank pain • Complicated UTI: Localizing urinary symptoms with new onset or worsening fever, rigors, or AMS without other identifiable cause. • Spinal cord injury: increased spasticity, autonomic dysreflexia	Foul smelling urine, dark urine, cloudy urine, sediment in urine

	Definition / Comments	Organisms	Inpatient Treatment	Outpatient Treatment
Asymptomatic Bacteriuria	10^5 bacteria in the urine without symptoms ***PEARL:*** *PPV of pyuria for infection is between 30 to 56, therefore has limited use a predictor of UTI.*		No antibiotic treatment recommended (exceptions: pregnancy, planned urinary instrumentation, or 1st month following renal transplant)	
Uncomplicated Cystitis	Guidelines suggest that UA/Culture not needed with uncomplicated UTI in women, but with increasing resistance rates, may be clinically justified outside of culture guidelines below. Indications for culture: • Male • History of MDR positive culture, inpatient stay at health care facility or broad spectrum antibiotic use in last 90 days • Recent travel to areas with high rates of MDR (eg, India, Israel, Spain, Mexico)	E. coli, Klebsiella, Proteus S. saprophyticus (women) r/o STIs in sexually active individuals	N/A	**First Line** Nitrofurantoin 100 mg PO BID x 5 days[1] Fosfomycin 3 gm PO x1 dose[1,2] Bactrim DS 1 PO BID x 3-5 days Cephalexin 500 mg PO BID x 5 days *Men should receive 7 days **Second Line** Cipro 250 or 500 mg PO BID x 3 days *Men should receive 5 days of therapy **GC/Chlamydia therapy[3]** Ceftriaxone 500 mg IM x1 PLUS Doxycycline 100 mg PO BID x 7

PPV = positive predictive value, MDRO = multi-drug resistant organisms

Renal dose adjustments not included in this chart, see pages 15 to 18.

	Definition / Comments	Organisms	Inpatient Treatment	Outpatient Treatment
Complicated UTI including pyelonephritis	Defined as evidence that infection extends beyond the bladder including fever, flank pain, CVA tenderness, pelvis/perineal pain. ***PEARL:*** *May need to order Urine Culture separately if suspicious of pyelonephritis as pyuria may not be present.*	E. coli, Klebsiella, Enterococcus, Pseudomonas	**General admit** Ceftriaxone 1-2 gm IV Q24h **Moderate to severe illness and/or Concern for Pseudomonas** Cefepime 1-2 gm IV Q12h **OR** Pip/taz 3.375 gm IV Q8h extended infusion +/- Vancomycin IV **H/O MDRO:** Ertapenem 1 gm IV Q24h	Specific antibiotic guided by cultures from inpatient. Total duration of therapy 5 to 14 days depending on rapidity of response and antibiotic used to complete therapy. Recommend total duration of therapy for fluoroquinolones 5-7 days, TMP-SMX 7-10 days, beta-lactams 10-14 days. **Therapy for Pyelonephritis Started as Outpatient** *Obtain Urine culture* Levofloxacin 750 mg PO daily x 5-7 days Consult ID for Ceftriaxone 1-2 gm IV Q24h x 7d
CAUTI	Evaluation of urinary catheter placed during hospitalization as source of fever should only be undertaken if additional factors present: 1) clinical signs: suprapubic pain or CVA tenderness, **AND/OR** 2) risk factors such as: kidney transplant, recent GU surgery, evidence of obstructive uropathy, profound immunosuppression or neutropenia. ***PEARL:*** *Urinary tract infection is rarely a cause of fever in hospitalized patient.* ***PEARL:*** *PPV of pyuria is low for infection in catheterized patients (15 to 28%)*	E. coli, Klebsiella, Staphylococcus, Enterococcus, Pseudomonas	Change or discontinue Foley **Uncomplicated** Ceftriaxone 1-2 gm IV Daily **Antibiotics in last 90 days/ Severe sepsis/ Concern for Pseudomonas or MDRO** Cefepime 2 gm IV Q12h **OR** Meropenem 1 gm IV Q8h +/- Vancomycin IV	Based on cultures
Acute Prostatitis	Symptoms of cystitis **PLUS** fever, chills, malaise, myalgias, pelvic or perineal pain, or obstructive symptoms. Swollen, tender prostate on exam. ***PEARL:*** *Only instance when urine culture appropriate to repeat after approximately 7 days of antibiotics to assure clearance of bacteriuria.*	E. coli, Klebsiella, Enterococcus, Pseudomonas Consider evaluation of STIs in sexually active individuals	**Moderate disease** Ceftriaxone 1 gm IV Q24h **ICU admission/Concern for Pseudomonas** Cefepime 2 gm IV Q8h	**Based on cultures, possible empiric therapy:** Bactrim DS 1 PO BID **OR** Cipro 500 mg PO BID Duration 14 days to 6 weeks Consider empiric Rx for GC/Chlamydia[3] if at risk, therapy listed above. Consider urology referral

PPV = positive predictive value, MDRO = multi-drug resistant organisms

Renal dose adjustments not included in this chart, see pages 15 to 18.

1. Not recommended if concern for pyelonephritis. Short term use of Macrobid okay for CrCl >30.
2. One study did show Fosfomycin inferior to Macrobid for cystitis (JAMA. 2018; 319(17):1781-1789). BCH microbiology does not provide Fosfomycin testing, but Fosfomycin can be used empirically without testing.
3. Ceftriaxone 1000mg IM if greater than 150kg. Azithromycin no longer recommended as first line therapy. If serious β lactam allergy call ID.

Severe β lactam allergy: Consult ID and/or review Recommend review of Antibiotic Allergy Tip Sheet and Chart on Cross Reactivity between Penicillins and Cephalosporins, page 23-24.

REFERENCES:

O'Grady, et al Crit Care Med 2008 (36): 1330; Mody, et al., JAMA 2014 (311):844; Gupta, et al., CID 2011;52(5):e103–e120; Hooton, et al., CID 2010; 50:625–663;
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Ambulatory Management of Upper Respiratory Tract Infections in Adults

Testing for SARS-CoV-2 (year-round) and influenza (in fall and winter) remains an important part of standard practice when evaluating sinusitis, pharyngitis, and acute bronchitis in adults. Identifying and isolating individuals with respiratory viruses is an important measure and testing may identify individuals who may be candidates for specific antiviral therapies.

	Definition / Comments	Organisms	Non-Antibiotic Treatments	Antibiotics[1]
Acute Rhinosinusitis	90-98% of cases are viral Criteria to consider antibiotics: • **Persistent:** >10 days without improvement • **Worsening:** 3-4 days • **Symptoms:** Fever >38°C, facial/tooth pain	Respiratory viruses Less Common: S. pneumoniae, H. influenzae, M. catarrhalis, S. aureus	Acetaminophen/NSAIDs Nasal saline Nasal steroid Decongestants	ONLY IF meets criteria for bacterial sinusitis, Rx 5-7 days: **Augmentin:** 500 mg Q8h or 875 mg Q12h **Doxycycline:** 100 mg Q12h **Cefpodoxime:** 200 mg Q12h Risk for resistance or severe β-lactam allergy[1]: Respiratory fluoroquinolone[2]
Pharyngitis	**Respiratory viruses are the most common cause of acute pharyngitis.** Signs and symptoms more suggestive of viral etiology: fatigue, nasal congestion, cough, conjunctivitis, sneezing, hoarseness, ear pain, sinus discomfort, oral ulcers. Low grade fever also typical, but may be higher if COVID-19 is etiology. ***PEARL:*** *SARS-CoV-2 can cause an isolated sore throat.* **Group A Streptococcus (GAS) is cause: 5-15%** Signs and symptoms more suggestive of GAS: fever, tonsillar exudates, tender cervical lymphadenopathy, absence of additional symptoms listed for viral infection above. ***PEARL:*** *Known exposure to individual with GAS makes diagnosis of GAS more likely.*	SARS-CoV-2, adenovirus, rhinovirus, and other coronaviruses. Less Common: GAS, Fusobacterium	Acetaminophen/NSAIDs Lozenges	**Penicillin V:** 500 mg Q12h x10 days **Amoxicillin:** 500 mg Q12h x10 days **Cephalexin:** 500 mg Q12h x10 days Anaphylaxis to penicillin or cephalosporin can consider **Clindamycin** 300 mg PO TID x 10 days.[3] ***PEARL:*** *Macrolides are NOT recommended to treat GAS due to high levels of resistance.*

	Definition / Comments	Organisms	Non-Antibiotic Treatments	Antibiotics[1]
Acute Uncomplicated Bronchitis	Cough is the cardinal symptom, lasting 1-3 weeks. ***PEARL:*** *Cough caused by COVID-19 may persist for longer duration.* **Mostly viral or non-infectious cause** • Colored sputum does not indicate bacterial infection • Consider further work up if concern for pneumonia, underlying lung disease, or if pertussis in Ddx Case series suggest bacteria is cause : 6% In addition to testing for COVID-19, testing for influenza should also be considered	Influenza A & B, Parainfluenza, Coronaviruses, SARS-CoV-2, Rhinovirus, RSV, Human metapneumovirus Less Common: M. pneumoniae B. pertussis C. pneumoniae ***PEARL:*** *no convincing evidence that pneumococcus, staph, H. flu or Moraxella cause acute bronchitis in the absence of instrumentation or COPD*	Cough suppressants Antihistamines Decongestants Beta-agonists	Rarely recommended regardless of cough duration

1. Recommend reviewing Antibiotic Allergy Tip Sheet and Chart on Cross Reactivity between Penicillins and Cephalosporins, page 23-24.

2 Risk of fluoroquinolones generally outweighs benefits for sinusitis. Levofloxacin 750 mg Q24h or moxifloxacin 400 mg Q24h can be used but should be reserved for those who: (a) cannot tolerate other antibiotic options, (b) have risks for resistance (e.g. hospitalization last 5 days, antibiotic use in last month, immune compromise), or (c) have severe disease with systemic toxicity.

3 Patients prescribed clindamycin for pharyngitis should have scheduled follow-up to assess resolution due to high rates of GAS resistance.

Antimicrobial Dosing Guidelines

Suggested initial doses, these guidelines are *not* a substitution for an ID or Pharmacy consult.

Antibiotic category	Antibiotic	Route	Dose for normal renal function	Reduced renal function mL/min	Hemodialysis (HD)
PENICILLIN	Amoxicillin/clavulanate	PO	500-875 mg BID or 500 mg TID	**11-29:** 250-500 mg BID **≤10:** 250-500 mg Q24h	500 mg Q24h, post HD
	Amoxicillin	PO	500 mg TID	**11-29:** 500 mg Q12h **≤10:** 250-500 mg Q24h	500 mg Q24h, post HD
	Ampicillin/sulbactam	IV	1.5-3 gm Q6h	**30-49:** 1.5-3 gm Q6-8h **15-29:** 1.5-3 gm Q12h **≤14:** 1.5-3 gm Q24h	1.5-3 gm Q24h, post HD
	Ampicillin	IV	2 gm Q4h	**11-49:** 2 gm Q6h **≤10:** 2 gm Q12h	1- 2 gm Q24h, post HD
	Dicloxacillin	PO	250-500 mg Q6h	No adjustment	No adjustment
	Penicillin G	IV	2-4 MU Q4-6h, max 24 MU/day	High KCl, cautious use in renal failure **11-49:** 1-2 MU Q6-8h **≤10:** 1-2 MU Q8-12h	1-2 MU Q8-12h post HD
	Penicillin VK	PO	250-500 mg Q6h	**<10:** 250-500 mg TID	250-500 mg TID post HD
	Nafcillin	IV	1-2 gm Q4-6h	No adjustment	No adjustment
	Piperacillin/tazobactam	IV	3.375 gm Q8h extended infusion	**<20:** 3.375 gm Q12h extended infusion	3.375 gm Q12h extended infusion
CARBAPENEM	Ertapenem	IV	1 gm Q24h	**<30:** 0.5 gm Q24h	0.5 gm Q24h post HD
	Meropenem	IV	1 gm Q8h *higher doses may be needed for severe infection or meningitis, **Consult ID**	**26-50:** 1 gm Q12h **10-25:** 0.5 gm Q12h **<10:** 0.5 gm Q24h	0.5 gm Q24h after HD
CEPHALOSPORIN					
1st	Cefazolin	IV	**Mild to Moderate Infection** 1 gm Q8h	**11-49:** 1 gm Q12h **≤10:** 1 gm Q24h	1 gm 3x/week post HD
			Severe Infections 2 gm Q8h	**11-49:** 2 gm Q12h **<10:** 2 gm Q24h	2 gm 3x/week post HD
	Cephalexin	PO	500 mg – 1000 mg TID to QID	**31-49:** 250-500 mg TID **11-30:** 250-500 mg BID **≤10:** 250 mg BID	250 mg BID post HD

¥ Oral and IV dosing is equivalent.
Pharmacy should be consulted if reduced renal function or hemodialysis.

Antimicrobial Dosing Guidelines

Antibiotic category	Antibiotic	Route	Dose for normal renal function	Reduced renal function mL/min	Hemodialysis (HD)
2nd	Cefoxitin	IV	1-2 gm Q6-8h	**30-50:** 1-2 gm Q8-12h **10-29:** 1-2 gm Q12-24h **≤10:** 1 gm Q24h	1-2 gm Q24h post HD
	Cefuroxime	IV	0.75-1.5 gm Q8h	**10-20:** 0.75-1.5 gm Q12h **<10:** 0.75-1.5 gm Q24h	0.75-1.5 gm Q24h post HD
		PO	250-500 mg BID	**30-10:** 250-500 mg Q24h **<10:** 250-500 mg Q48h	250-500 mg Q24h post HD
3rd	Ceftriaxone	IV	**Standard dose** 1-2 gm Q24h	No adjustment	No adjustment
			Bacteremia, Endocarditis, Osteomyelitis 2 gm Q24h *Consult ID*		
			Meningitis 2 gm Q12h		
	Cefdinir	PO	300 mg Q12h	**<30:** 300 mg Q24h	300 mg Q48h
4th	Cefepime	IV	**Mild to Moderate Infection** 1-2 gm Q12h	**30-59:** 1 gm Q24h or 1 gm Q12h **11-29:** 0.5-1 gm Q24h **<10:** 0.5 gm Q24h	0.5 gm Q24h post HD
			Severe Infection (Pneumonia, Pseudomonas, Neutropenia) 2 gm Q8h *Consult ID*	**30-59:** 2 gm Q12h **11-29:** 2 gm Q24h **<10:** 1 gm Q24h	1 gm Q24h post HD
FLUORO-QUINOLONES	Ciprofloxacin	PO	**Mild to Moderate Infection, Uncomplicated cystitis** 250-500 mg BID **Severe Infection** 750 mg BID	**<30:** same dose Q24h	Same dose as for <30, post HD
		IV	**Mild to Moderate Infection** 400 mg Q12h **Severe Infection (OM, neutropenic fever, nosocomial PNA)** 400 mg Q8h	**<30:** same dose Q24h	Same dose as for <30, post HD
	Levofloxacin¥	PO/IV	**Mild to Moderate Infection** 500 mg Q24h	**20-49:** 500 mg load then 250 mg Q24h **<20:** 500 mg load then 250 mg Q48h	Same dose as for <20, post HD
			CAP, Severe Infection 750 mg Q24h	**20-49:** 750 mg load then 750 mg Q48h **<20:** 750 mg load then 500 mg Q48h	

¥ Oral and IV dosing is equivalent.
Pharmacy should be consulted if reduced renal function or hemodialysis.

Antimicrobial Dosing Guidelines

Antibiotic category	Antibiotic	Route	Dose for normal renal function	Reduced renal function mL/min	Hemodialysis (HD)
TETRACYCLINE	Doxycycline¥	PO/IV	100 mg Q12h	No adjustment	No adjustment
MACROLIDE	Azithromycin¥	PO/IV	250-500 mg Q24h	**<10:** use with caution	Consult ID or pharmacy
MISC	Daptomycin *For obese patients, use adjusted body weight* ****ID restricted**	IV	**Cystitis (including VRE)** 250 mg Q24h	**<30:** 250 mg Q48h	250 mg Q48h
			Pyelonephritis/Cellulitis 4 mg/kg Q24h	**<30:** 4 mg/kg Q48h	4 mg/kg Q48h
			Uncomplicated Bacteremia/ Right-Sided Endocarditis (NOT VRE) 6 mg/kg Q24h	**<30:** 6 mg/kg Q48h	6 mg/kg Q48h
			Osteomyelitis, Prosthetic Joint Infection, VRE Bacteremia (source control adequate) 8 mg/kg Q24h	**<30:** 8 mg/kg Q48h	8 mg/kg Q48h
			Refractory MRSA bacteremia, Left-Sided Endocarditis, VRE infection/bacteremia (inadequate source control) 10-12 mg/kg Q24h	**<30:** 10-12 mg/kg Q48h	10-12 mg/kg Q48h
	Linezolid¥ ****ID restricted**	PO/IV	600 mg Q12h	No adjustment	No adjustment
	Vancomycin	IV	See Nomogram		
	Vancomycin	PO	125 mg Q6h *(Only for C. diff)*	No adjustment, not absorbed	No adjustment
	Trimethoprim/ Sulfamethoxazole (TMP/Sulfa)	IV	*Consult ID if using IV*		
		PO	1-2 DS tab BID (5-8 mg TMP/kg/day total) *Severe infection or PJP suspect, Consult ID*	**Consult ID**	
	Clindamycin	PO	300 mg QID or 450 mg TID	No adjustment	No adjustment
		IV	600-900 mg Q8h	No adjustment	No adjustment
	Metronidazole¥	PO/IV	500 mg Q8h	No adjustment	No adjustment

¥ Oral and IV dosing is equivalent.
Pharmacy should be consulted if reduced renal function or hemodialysis.

Antimicrobial Dosing Guidelines

Antibiotic category	Antibiotic	Route	Dose for normal renal function	Reduced renal function mL/min	Hemodialysis (HD)
ANTIFUNGAL	Fluconazole¥	PO/IV	**Mild to Moderate Infection** 200-400 mg Q24h *Severe infection, Consult ID*	**<50:** 200-400 mg load, then 100-200 mg Q24h	Consult ID or pharmacy
	Micafungin ****ID restricted**	IV	100-150 mg Q24h	No adjustment	No adjustment
ANTIVIRAL	Acyclovir	PO	**Shingles** 800 mg 5 times daily	**10-25:** 800 mg TID <**10:** 800 mg BID	800 mg BID post HD
	Acyclovir *Dose based in ideal body weight.*	IV	**HSV skin lesions in immunocompromised/ICU** 5 mg/kg IV Q8h	**25-49:** 5 mg/kg Q12h **11-24:** 5 mg/kg Q24h **<10:** 2.5 mg/kg Q24h	2.5mg/kg IV q24h, give after HD on HD days
			HSV encephalitis, Primary varicella, or shingles >1 dermatome, disseminated 10 mg/kg IV Q8h *Consult ID*	**25-49:** 10 mg/kg Q12h **11-24:** 10 mg/kg Q24h **<10:** 5 mg/kg Q24h	5mg/kg IV q24h, give after HD on HD days
	Valacyclovir	PO	**Shingles** Valacyclovir 1000 mg TID x 7 days	**30-49:** 1 gm BID **10-29:** 1 gm Q24h **<10:** 500 mg Q24h	500 mg Q24h post HD
	Remdesivir	IV	**Hospitalized Patients:** 200 mg load, followed by 100 mg Q24h x 4 doses	Consult ID or Pharmacy	Consult ID or Pharmacy
			Nonhospitalized Patients: 200 mg load, followed by 100 mg Q24h x 2 doses		

¥ Oral and IV dosing is equivalent.
Pharmacy should be consulted if reduced renal function or hemodialysis.

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Recommended Prophylactic Antibiotics by Procedure

Surgical Procedure	Organisms	Recommended IV Antibiotics[1]	Dosing	Redosing Hours[2]
Plastic				
Plastic surgery with risk factors, breast surgery	*Staphylococcus aureus, S. epidermidis, streptococcus*	Cefazolin	<120 kg: 2 gm IV ≥120 kg: 3 gm IV	4
		OR Severe β lactam allergy Vancomycin	15 mg/kg IV (max 2 gm). Start 60 to 120 min prior to procedure.	—
Cardiovascular				
Cardiovascular, thoracic, cardiac device insertion	*Staphylococcus & streptococcus*	Cefazolin	<120 kg: 2 gm IV ≥120 kg: 3 gm IV	4
		OR Cefuroxime (Recommended for MitraClip)	1.5 gm IV	4
		OR Severe β lactam allergy Vancomycin	15 mg/kg IV (max 2 gm). Start 60 to 120 min prior to procedure.	—
Gastroduodenal, Biliary[3], Colorectal[4] and Other General Surgery				
Appy, biliary[3], colon[4], gastroduodenal	Enteric GNR, anaerobes, *enterococcus*	Ceftriaxone[5] + metronidazole	Ceftriaxone 1-2 gm IV	—
			Metronidazole 500 mg IV	—
		OR Cefoxitin	2 gm IV	2
		OR Severe β lactam allergy Vancomycin + Cipro + metronidazole	Vanco 15 mg/kg IV (max 2 gm). Start 60 to 120 min prior to procedure.	—
			Cipro 400 mg IV	—
			Metronidazole 500 mg IV	—
Hernia	*Staphylococcus & streptococcus*	Cefazolin	<120 kg: 2 gm IV ≥120 kg: 3 gm IV	4
		OR Severe β lactam allergy Vancomycin	15 mg/kg IV (max 2 gm). Start 60 to 120 min prior to procedure.	—
Head and Neck				
Head and neck surgery	*Staphylococcus aureus, S. epidermidis, streptococci.* Sometimes: GNR, anaerobes	Cefazolin	<120 kg: 2 gm IV ≥120 kg: 3 gm IV	4
		PLUS Metronidazole (for contaminated case)	500 mg IV	—
		OR Ampicillin-sulbactam (for contaminated case)	3 gm IV	2
		OR Severe β lactam allergy Clindamycin	900 mg IV	6

Recommended Prophylactic Antibiotics by Procedure

Surgical Procedure	Organisms	Recommended IV Antibiotics[1]	Dosing	Redosing Hours[2]
Neurosurgery and Orthopedic				
Spinal, hip fracture, internal fixation, total joint replacement	*Staphylococcus & streptococcus*	Cefazolin	<120 kg: 2 gm IV ≥120 kg: 3 gm IV	4
		OR Severe β lactam allergy Vancomycin	15 mg/kg IV (max 2gm). Start 60 to 120 min prior to procedure.	—
Ob-Gyn				
C section without suspected infection	Staphylococcus & streptococcus	Cefazolin	<120 kg: 2 gm IV ≥120 kg: 3 gm IV	4
		PLUS Azithromycin (only for non-elective C-sections)	500 mg IV	—
		OR Severe β lactam allergy Vancomycin + Gentamicin[6]	Vancomycin 15 mg/kg IV (max 2 gm). Start 60 to 120 min prior to procedure	—
			Gentamicin 5 mg/kg IV (use IBW)	—
C-section with intraamniotic infection suspected	*Staphylococcus, streptococcus, genital mycoplasma, gardnerella, bacteroides, Enteric GNRs*	Ampicillin + Gentamicin[6]	Ampicillin 2 gm IV Q6h	Typically patient receives 1 additional dose of antibiotic unless has bacteremia or persistent fever, then antibiotics may be continued.
			Gentamicin 5 mg/kg IV Q24h (use IBW)	
		OR Non-Severe β lactam allergy Cefazolin + Gentamicin[6]	Cefazolin <120 kg: 2 gm IV Q8h Cefazolin ≥120 kg: 3 gm IV followed by 2 gm IV Q8h	
			Gentamicin 5 mg/kg IV Q24h (use IBW)	
		OR Severe β lactam allergy Vancomycin + Gentamicin[5]	Vancomycin 15 mg/kg IV (max 2 gm). Start 60 to 120 min prior to procedure	
			Gentamicin 5 mg/kg IV Q24h (use IBW)	
		PLUS Metronidazole for anaerobic coverage	Metronidazole 500 mg IV once **OR** Clindamycin 900 mg IV once	
		PLUS Azithromycin (only for non-elective C-sections)	500 mg IV Q24h	—
Hysterectomy	Enteric GNR, anaerobes, GBS, enterococcus	Cefazolin	<120 kg: 2 gm IV ≥120 kg: 3 gm IV	4
		OR Severe β lactam allergy Vancomycin + Cipro	Vancomycin 15 mg/kg IV (max 2gm). Start 60 to 120 min prior to procedure. Cipro 400 mg IV	—
Uterine evacuation (suction D&C/D&E)	GP, GN aerobic and anaerobic	Doxycycline	200 mg PO/IV 60 min prior to procedure	—

Recommended Prophylactic Antibiotics by Procedure

Surgical Procedure	Organisms	Recommended IV Antibiotics[1]	Dosing	Redosing Hours[2]
Urologic[7]				
Cystoscopy with manipulation or upper tract instrumentation	Enteric GNR, enterococcus	Cefazolin	<120 kg: 2 gm IV ≥120 kg: 3 gm IV	4
		OR Cipro	400 mg IV or 500 mg PO	—
		OR Bactrim DS	160 mg TMP/800 mg SMX PO/IV	—
Laparoscopic or Open GU	Enteric GNR, enterococcus	Cefazolin	<120 kg: 2 gm IV ≥120 kg: 3 gm IV	4
		PLUS Metronidazole (for obstruction or entry into intestine)	500 mg IV	—
		OR Cefoxitin	2 gm IV	2
		OR Severe β lactam allergy Vancomycin + Cipro	Vanco 15 mg/kg IV (max 2 gm). Start 60 to 120 min prior to procedure	—
			Cipro 400 mg IV	—
Prostate Biopsy	Enteric GNR, enterococcus Sometimes skin flora	Cipro	400 mg IV or 500 mg PO	12
		OR Bactrim DS	160 mg TMP/800 mg SMX PO 60 min prior to procedure	12

1. Additional pre-op antibiotic not needed for patients already on systemic antibiotics which would provide protection against expected surgical pathogens.
2. Indicates timing of re-dosing antibiotics based on length of surgery and half-life of antibiotic. Re-dosing also recommended if loss 1500cc blood or more
3. ERCP: No antibiotics needed if no obstruction
4. Neomycin PLUS erythromycin base or metronidazole on Pre-Op day for elective colon procedures.
5. Ceftriaxone preferred over guideline-recommended cefazolin due to local Klebsiella resistance rates
6. Gentamicin should be dosed using ideal body weight (IBW).
7. Treat patients with UTI prior to procedure using an antimicrobial active against pathogen isolated via pre-operative urine culture.

Vancomycin is preferred over clindamycin for severe β lactam allergy for prevention of Group A and B streptococcus due to higher levels of resistance to clindamycin locally. Vancomycin should also be considered if known history of MRSA. Other risk factors for use of vancomycin: High risk patient with recent hospital stay, high risk patient from nursing home, dialysis, transfer from another hospital in the last three days.

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Preventive Antibiotic Regimens for Patients with Open Fractures

Type of Open Fracture by Gustilo-Anderson Classification[1]	Duration of Antibiotics from Wound Closure (hours)	Absence of Soil or Water Contamination	Soil Contamination Present	Water Contamination Present	
				Fresh Water	Sea Water
Type 1 or 2	24	Cefazolin 2 gm IV Q8h	ADD Metronidazole 500 mg IV Q8h	No change	No change
Type 1 or 2 **AND** Severe Beta Lactam Allergy[2]	24	Vancomycin 15 mg/kg IV once followed by pharmacy to dose consult	ADD Metronidazole 500 mg IV Q8h	No change	No change
Type 3	72	Ceftriaxone 2 gm IV Q24h	**ADD** Metronidazole 500 mg IV Q8h	**CHANGE TO** Piperacillin/tazobactam 3.375 gm Q8h extended infusion	**CHANGE TO** Piperacillin/tazobactam 3.375 gm Q8h extended infusion **AND** Doxycycline 100mg PO/IV Q12h
Type 3 **AND** Severe Beta Lactam Allergy[2]	72	Vancomycin 15 mg/kg IV once followed by pharmacy to dose consult[3]	**ADD** Levofloxacin 750 mg IV Daily (preferred) **OR** Gentamicin 5 mg/kg IV Q24h[4]	**CHANGE TO** Meropenem 1 gm IV Q8h	**CHANGE TO** Meropenem 1 gm IV Q8h **AND** Doxycycline 100mg PO/IV Q12h

1. Tetanus vaccination should be given as prophylaxis in all patients without vaccination in the last 10 years or with unknown vaccination status.
2. Recommend reviewing Antibiotic Allergy Tip Sheet and Chart on Cross Reactivity between Penicillins and Cephalosporins, pages 23-24 or review reaction with pharmacy.
3. Standard guidelines recommend use of Clindamycin, but due to high levels of local GAS and GBS resistance, vancomycin is considered better empiric coverage.
4. Gentamicin should be used cautiously as synergistic renal toxicity with vancomycin.

Antibiotic Allergy Tip Sheet

Examples of Reactions to Antibiotics & What to Do

Penicillins/β-Lactams		Vancomycin	Azithromycin/ Sulfa	Azithromycin/ Levofloxacin
Childhood reactions, family history, intolerance (GI symptoms, fatigue, headache, limited rash, isolated itching)	Anaphylaxis: throat tightness, SOB severe rash required treatment	Flushing during infusion (Vanco flushing syndrome)	Maculopapular rash without systemic symptoms	Arrhythmias and other cardiac issues
Not allergy	Type 1 hypersensitivity/ anaphylaxis incidence is <1%	Pseudoallergy	Delayed T-cell mediated reaction without systemic symptoms	Significant adverse reaction
Remove from allergy list	Add/keep on allergy list	Give antibiotic, slow down rate and/or premedicate	Add to allergy list with details. Sometimes given again under ID guidance	Add to allergy list and avoid unless arrhythmia was related to co-administration of another medication

Don't accept penicillin or other antibiotic allergy without getting more information. Use these questions to obtain history to document accurate allergy label in EPIC.

- Do you have allergies to medications?
- What was your reaction?
- How long ago did the reaction take place? (age, onset of reaction)
- Did you require medical treatment, hospitalization or medications for the reaction?
- Why was the medication being used?
- Have you received a similar medication since that reaction?

PEARL: Uncommon causes of allergy: inactive ingredients in medications (i.e. fillers and dyes)

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How to Give a Different β-Lactam Antibiotics with an Existing β-Lactam Allergy

Cross reactivity between penicillins and cephalosporins is not a class effect, but an allergic reaction to an antibiotic with a similar side chain. This chart shows which β-lactams are safe to administer based on a patient's allergy history and β-lactam side chains. This does not need to be considered in the setting of symptoms that likely do not reflect true allergy (e.g. isolated mild rashes, GI symptoms, etc.). Call Pharmacy or Infectious Diseases providers for questions.

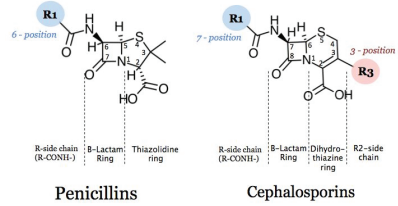
Antibiotic class		Penicillins				1			2		3			4	
		Amoxicillin	Ampicillin	Penicillin	Piperacillin	Cefazolin	Cephalexin	Cefadroxil	Cefoxitin	Cefuroxime	Cefotaxime	Ceftazidime	Ceftriaxone	Cefepime	Carbapenems
Penicillins	Amoxicillin		X	X	X		X	X							
	Ampicillin	X		X	X		X	X							
	Penicillin	X	X		X			X	X						
	Piperacillin	X	X	X			X	X							
1	Cefazolin														
	Cephalexin	X	X		X			X							
	Cefadroxil	X	X	X	X		X								
2	Cefoxitin			X						X					
	Cefuroxime								X		X	X	X	X	
3	Cefotaxime									X		X	X	X	
	Ceftazidime									X	X		X	X	
	Ceftriaxone									X	X	X		X	
4	Cefepime									X	X	X	X		
	Carbapenems														

Key

- High cross reactivity, do not give
- Low cross reactivity, can give
- Same medication

What is a side chain?

Chemical group attached to the main molecular structure



Penicillins Cephalosporins

AVOID ALL β-lactams if administration of any β-lactam caused:

- ICU admission related to allergy
- Interstitial nephritis
- Severe hepatitis
- Hemolytic anemia
- Steven-Johnson Syndrome
- Toxic Epidermal Necrolysis
- Acute Generalized Exanthematous Pustulosis
- DRESS

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Testing Algorithm for *Clostridioides difficile (C. diff).* **New Antigen testing starts Nov 2022**

Hospitalized patient with clinically-significant diarrhea (3 or more loose/liquid stools per day for at least 1-2 days)

NO → Observe for 24 hours to assess for persistence of symptoms. Do not order test for C. diff.

YES ↓

Has patient received laxatives, tube feedings, or oral contrast over the past 24-48 hours?

YES → Stop medication and gauge clinical response for ≥ 24 hrs PRIOR to ordering C. diff testing.

NO ↓

Does patient meet clinical criteria for C. diff colitis:

- Risk factor: recent antibiotic exposure
- Symptoms & Signs: fever, dehydration, abdominal distension/pain, ileus, unexplained white count

NO → Consider alternate diagnosis for diarrhea.

YES ↓

Order test: **C. diff PCR** → *C. diff order will automatically cancel after 24 hours if not collected.*

↓

C. diff PCR positive? Test will automatically reflex to Toxin A/B Antigen test.

NO → Consider alternate diagnosis for diarrhea.

YES ↓

Is Toxin A/B Antigen test positive?

NO → Positive C. diff PCR but negative Toxin A/B Antigen may reflect colonization with C. diff, consider alternate diagnosis for diarrhea. **If still concern about C. diff colitis, recommend giving Vancomycin PO while evaluate further.**

YES ↓

Start Vancomycin 125mg PO QID.

Do not send C. diff PCR as test of cure.

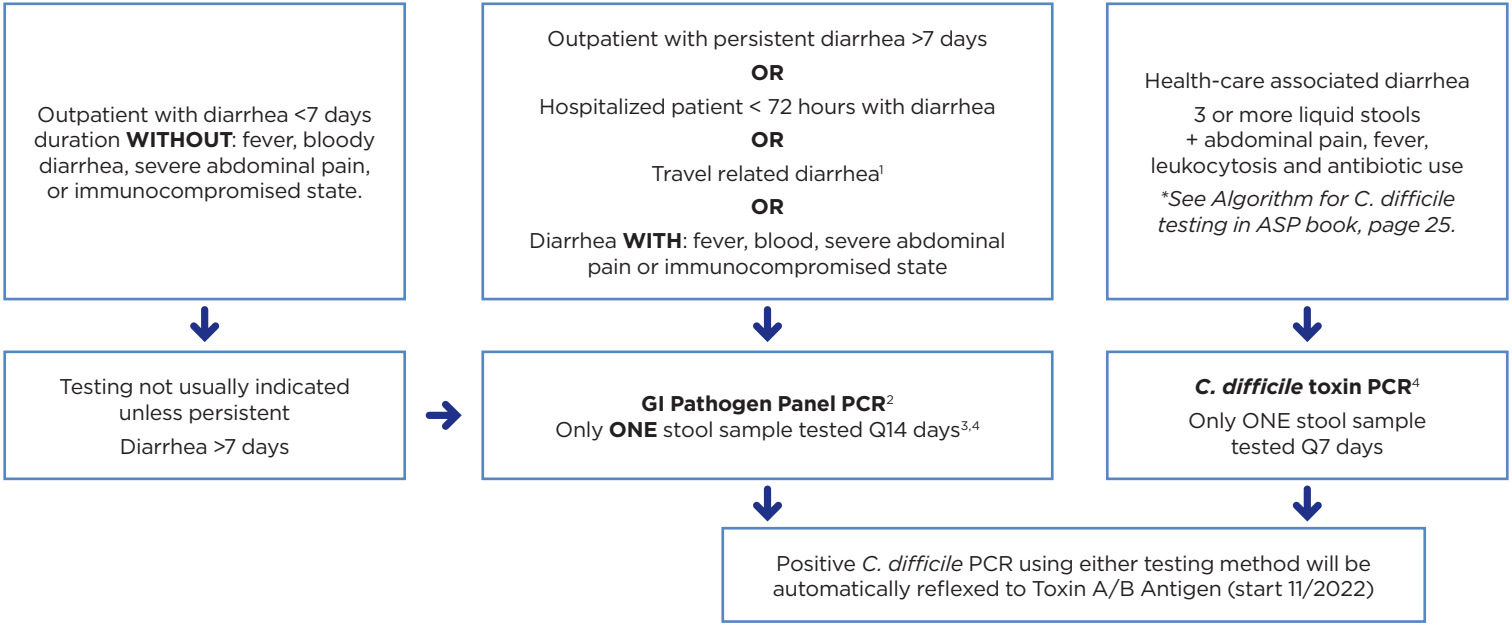
* Patients with a positive C. diff test should be put into **Contact Isolation** for 30 days.

Questions about isolation precautions or discontinuation of isolation can be directed to Infection Prevention or Infectious Disease Physicians.

GI Pathogen Panel PCR (GIP) Testing Algorithm

Specimen: ONE unformed stool submitted in:

(1) Orange ParaPak C&S transport OR (2) Raw stool received within 2 hrs. of collection



1. Only if clinically indicated; GI illness often self-limited.
2. IF GIP negative in patient with persistent diarrhea >2 weeks consider: Ova and Parasite Exam in traveler, Microsporidium and Cystoisospora belli for immunocompromised patient, non-infectious cause, and/or GI or Infectious Diseases Consult.
3. Repeat GIP is not performed less than 14 days from previous sample tested. If you think it is indicated, please call ID on call for approval (Person on Call App or 303-415-8850). *Approval request will only be taken during regular business hours 7 am to 7 pm.*
4. **GI pathogen panel PCR or C. difficile PCR should NOT be used for test of cure.**

Recommended Interpretation and Management of GI Pathogen Panel PCR (GIP) Results

At BCH, total number of GIPs run in 2021 was 1,234, lower than 2020 (n=1,404) and 2019 (n=2,272). A little over one-third (36%) of GIPs run were positive for an organism in 2021. Among positive results, EPEC, EAEC, and ETEC together were the most common pathogens detected (17%), followed by *C. difficile* (13%) and viruses (10%).

This nested PCR technology (BioFire Diagnostics) has a high sensitivity (98.5%) and specificity (99.2%). See page 26 for appropriate clinical context to order this test. Specific management pearls listed below, but due to sensitivity of PCR technology, it is not uncommon for the results to indicate multiple organisms and results should be interpreted with careful attention to clinical context and severity of symptoms.

	Pathogen/Result	Clinical Significance	BCH Prevalance 2021 – Avg % of positive panels	Treatment and Clinical Guidance
Bacteria	Campylobacter	Major cause of acute diarrhea worldwide; associated with raw poultry, unpasteurized dairy, and untreated water	3%	Azithromycin 500 mg PO daily x 3 days
	C. difficile toxin A/B	Related to healthcare, antibiotic usage	13%	When detected in the presence of other pathogens, can reflect colonization. Starting Nov 2022, positive *C. difficile* testing will be reflexed to antigen test to assist in interpretation.
	Plesiomonas shigelloides	Typically waterborne (freshwater), fish, shellfish	0.6%	Mild to moderate, immunocompetent: supportive care Severe: Carbapenem IV or Ciprofloxacin 750 mg PO BID or 400 mg IV BID, consult ID
	Salmonella spp.	Contaminated foods, animal or person-to-person Typhoid common cause fever in returning travelers	2.5%	Non-typhoid, immunocompetent patients (ages 1-50) w/ mild or moderate disease = No treatment **Treatment recommended:** severe infection, typhoid, age > 50 yrs or <1 year, joint prosthesis, endocarditis risk (valvular heart disease/prosthetic valve/endovascular stents), uremia, sickle cell, significant immune compromise. Uncomplicated (GI manifestations only): Ciprofloxacin 500 mg BID or 750 mg Q24h for 7 days **OR** Azithromycin 1 gm PO x 1 then 500 mg PO daily for 5-7 days Complicated: consult ID
	Vibrio/V. cholerae	Marine source, contaminated water, shellfish	<0.5%	**Vibrio:** Supportive care only **V. cholerae:** moderate to severe hypovolemia Azithromycin 1 gm PO x1 dose Alternative, but resistance reported: Doxycycline 300 mg PO x 1 dose **OR** Ciprofloxacin 1 gm PO x 1 dose

	Pathogen/Result	Clinical Significance	BCH Prevalance 2021 – Avg % of positive panels	Treatment and Clinical Guidance
Bacteria	Yersinia enterocolitica	Uncooked pork, contaminated food; associated with cecitis, pseudoappendicitis	<1%	Typically self-limiting. Severe infection or severely immunocompromised: Bactrim DS 1 tab PO BID, Doxycycline 100 mg PO BID **OR** Ciprofloxacin 500 mg PO BID x 5 days
	Enteropathogenic E. coli (EPEC)	Common cause of gastroenteritis; ETEC associated with traveler's diarrhea	17%	Usually supportive care only for mild disease. Bismuth or loperamide can be given. **Moderate ETEC:** Azithromycin 1 gm PO x 1 dose **Severe ETEC:** Azithromycin 500 mg PO daily x 3 days **Alternate:** Ciprofloxacin 750mg PO x 1-3 days
	Enteroaggregative E. coli (EAEC)			
	Enterotoxigenic E. coli (ETEC),			
	Shiga-like toxin producing E. coli (STEC) and E coli 0157	Contaminated meat, dairy, produce, water, human-to-human	2.4%	Supportive care only. Try to avoid antibiotics: can increase risk for hemolytic uremic syndrome (HUS).
	Enteroinvasive E. coli (EIEC)*	Closely related to Shigella	1%	Azithromycin 1 gm PO x 1 dose or 500 mg daily x 3 days
Parasites	Cryptosporidium	Food/water-borne outbreaks; diarrhea in AIDS and immunocompromised patients	1.5%	Supportive care if immunocompetent Severely immunocompromised patients, consult ID
	Cyclospora cayetanensis	Travel in tropical regions; imported fresh produce	<1%	For severe symptoms, Bactrim DS PO BID x 7-10 days, longer if immune compromised, consult ID
	Entamoeba histolytica	Most commonly seen in tropical areas with poor sanitary conditions; highly contagious person-to-person; can be associated with invasive colitis	<1%	**Asymptomatic** Paromomycin 25-35 mg/kg/day PO divided into 3 doses x 7 days **Diarrhea** Metronidazole 500-750 mg PO TID x 7-10 days Followed by Paromomycin 25-35 mg/kg/day PO divided into 3 doses x 7 days Risk of invasive disease, consult ID.
	Giardia duodenalis (lamblia)*	Drinking contaminated water; camping/backpacking or travel-related	2.5%	Tinidazole 2 gm PO x 1 dose Alternative: Metronidazole 500 mg PO BID x 5-7 days
Viruses	Adenovirus F 40/41	Fecal-oral transmission; contaminated foods/water, poor sanitation	10%	Supportive care only, fluid replacement
	Astrovirus			
	Norovirus GI/GII			
	Rotavirus A			
	Sapovirus			

*These organisms can be associated with sexual transmission. If concern based on patient history, consider work-up for other STIs (chlamydia, HIV, etc.)
Definitions of disease severity: 1) **Moderate disease:** distressing or interferes with activities, 3 to 5 unformed BMs daily; 2) **Severe disease:** incapacitating, bloody BMs, greater than 6 to 9 BMs daily

BCH Relative Antimicrobial Cost Information

Relative medication acquisition cost information does not include nursing, administration supplies, or laboratory costs.

Medication	Route	Relative Cost/Day
Acyclovir	IV	$$
Acyclovir	PO	$
Amoxicillin	PO	$
Ampicillin	IV	$
Augmentin	PO	$
Azithromycin	IV	$
Azithromycin	PO	$
Bactrim	IV	$$$$
Bactrim	PO	$
Cefazolin 2 gm	IV	$$
Cefazolin 1 gm	IV	$$
Cefdinir	PO	$
Cefepime	IV	$$
Cefoxitin	IV	$$
Ceftriaxone	IV	$$
Cephalexin	PO	$
Ciprofloxacin	IV	$

Medication	Route	Relative Cost/Day
Ciprofloxacin	PO	$
Clindamycin 600 mg	IV	$
Clindamycin 900 mg	IV	$$
Clindamycin	PO	$
Daptomycin	IV	$$$
Dicloxacillin	PO	$
Ertapenem	IV	$$$
Fluconazole	IV	$$
Fluconazole	PO	$
Levofloxacin	IV	$
Levofloxacin	PO	$
Linezolid	IV	$$$
Linezolid	PO	$$
Meropenem	IV	$$
Metronidazole	IV	$
Metronidazole	PO	$
Micafungin	IV	$$$

Medication	Route	Relative Cost/Day
Nafcillin	IV	$$$
Penicillin G	IV	$$
Penicillin VK	PO	$
Remdesivir	IV	$$$$
Unasyn	IV	$$
Valacyclovir	PO	$
Vancomycin	IV	$$
Vancomycin 125 mg	PO	$
Zosyn 3.375 mg	IV	$$$
Zosyn 4.5 mg	IV	$$

Daily Cost	Relative Cost Key
<$5	$
$5-25	$$
$25-50	$$$
>$50	$$$$

Adult Vancomycin Dosing and Monitoring Guidelines.

***Please contact pharmacy or get ID consult if concerns about vancomycin dosing. It is important to consider if other renal toxic agents are being co-administered when dosing vancomycin.**

Goal Trough (mcg/mL)	Indication	
10-15	UTI, Cellulitis	**PTD**
	MRSA MIC <1	
15-20	Bacteremia, Osteomyelitis, Endocarditis, Meningitis, PNA, Febrile neutropenia, Severe SSTI	**CONSULT ID**
	Any infection with MRSA MIC ≥ 1	
Suggest alternative therapy for any infection with MRSA MIC ≥ 2		

Vancomycin Loading Doses (actual body weight)	
Non-critically ill	15-20 mg/kg
Complicated infections in seriously ill	25 mg/kg
Renal Impairment, CRRT, IHD, PD	15-25 mg/kg
Preoperative antimicrobial prophylaxis	15 mg/kg
Maximum of 2 grams per dose	

Vancomycin Maintenance Dosing in Dialysis	
IHD level < 10-15	500-1000 mg (5-10 mg/kg) after each session
PD level < 10-15	500-1000 mg Q48-72h
CRRT level < 1-15	1000 mg (10-15 mg/kg) daily dose may vary by type of CRRT and rate of filtration

Vancomycin Maintenance Doses: Goal 10-15 mg/L ~15 mg/kg per Dose

	Creatinine Clearance (mL/min)									
Actual Body Weight (kg)		20	30	40	50	60	70	80	90	≥100
	50	750 mg Q48h	500 mg Q24h	750 mg Q24h	750 mg Q24h	1000 mg Q24h	1000 mg Q24h	500 mg Q12h	750 mg Q12h	1000 mg Q12h
	60	750 mg Q48h	750 mg Q24h	750 mg Q24h	1000 mg Q24h	1250 mg Q24h	750 mg Q12h	750 mg Q12h	1000 mg Q12h	1000 mg Q12h
	70	1000 mg Q48h	750 mg Q24h	1000 mg Q24h	1250 mg Q24h	1500 mg Q24h	750 mg Q12h	750 mg Q12h	1000 mg Q12h	1250 mg Q12h
	80	1250 mg Q48h	750 mg Q24h	1000 mg Q24h	1250 mg Q24h	1500 mg Q24h	750 mg Q12h	1000 mg Q12h	1250 mg Q12h	1250 mg Q12h
	90	1250 mg Q48h	1000 mg Q24h	1250 mg Q24h	1500 mg Q24h	1750 mg Q24h	1000 mg Q12h	1250 mg Q12h	1250 mg Q12h	1500 mg Q12h
	100	1500 mg Q48h	1000 mg Q24h	1250 mg Q24h	1500 mg Q24h	1000 mg Q12h	1000 mg Q12h	1250 mg Q12h	1500 mg Q12h	1500 mg Q12h
	110	1750 mg Q48h	1000 mg Q24h	1500 mg Q24h	1750 mg Q24h	1000 mg Q12h	1000 mg Q12h	1250 mg Q12h	1500 mg Q12h	1250 mg Q8h
	120	1750 mg Q48h	1250 mg Q24h	1500 mg Q24h	1750 mg Q24h	1000 mg Q12h	1250 mg Q12h	1500 mg Q12h	1500 mg Q12h	1250 mg Q8h
	130	2000 mg Q48h	1250 mg Q24h	1500 mg Q24h	1000 mg Q12h	1000 mg Q12h	1250 mg Q12h	1500 mg Q12h	1250 mg Q8h	1250 mg Q8h
	140	2000 mg Q48h	1500 mg Q24h	1750 mg Q24h	1000 mg Q12h	1250 mg Q12h	1500 mg Q12h	1500 mg Q12h	1250 mg Q8h	1250 mg Q8h
	150	1000 mg Q24h	1500 mg Q24h	1750 mg Q24h	1000 mg Q12h	1250 mg Q12h	1500 mg Q12h	1250 mg Q8h	1250 mg Q8h	1250 mg Q8h
Consult ordering provider for alternative therapy if required calculated daily dose exceeds 4 grams										

Vancomycin Maintenance Doses: Goal 15-20mg/L ~20mg/kg per Dose

Infectious Diseases Team will be notified for:

- Any indication with a goal trough of 15-20
- Any order with a goal trough of 15-20
- Any MRSA with an MIC of 2 or greater
- Any patient requiring greater than or equal to 3 grams vancomycin total per day

Pharmacists may order the first dose(s) of vancomycin to goal trough of 15 to 20 for listed indications.

Adult Vancomycin Dosing and Monitoring Guidelines.

***Please contact pharmacy or get ID consult if concerns about vancomycin dosing. It is important to consider if other renal toxic agents are being co-administered when dosing vancomycin.**

Timing of First Vancomycin Trough or Level	
Dosing Interval	**Timing**
Q8h	Trough 30 min prior to 4th or 5th dose
Q12h	
Q24h	Trough 30 min prior to 3rd or 4th dose
Q48h	Random level w/in 24 hours of first dose **Begin maintenance dose if random is <15**
CrCl <20, ARF, IHD, CRRT	Random level prior to re-dose **Wait at least 4-6 hours after IHD before drawing level**

Additional Monitoring Labs which can be initiated following a PTD order	
Renal function	SCr, BUN, urine output
Response to therapy	WBC, Segs/Bands, ANC, TMax
Appropriateness of therapy	Culture, Sensitivity, Levels
Toxicity	Alb/Tbili, Platelets

Frequency of Trough Monitoring	
Stable patient following trough at goal	At least once weekly
Following change in dose	Trough prior to 3rd or 4th dose
Change in renal function SCr increase ≥ 0.3, decreased urine output	Trough prior to next dose
Change in renal function SCr increase ≥ 0.5 **OR** ≥ 50% from baseline	Hold vancomycin **AND** trough prior to next dose *Contact provider*
Obese patients (BMI > 30)	Trough every 3 days to avoid risk of supra-therapeutic levels due to accumulation
CrCl < 20, ARF, IHD, CRRT	Random level prior to dose
Hemodynamically unstable **OR** rapidly changing renal function	Daily troughs may be warranted

General Recommendation for Dose Adjustment Based on Levels		
Actual Trough	Target Trough	Recommendation
≤ 5	10-15	Decrease dosing interval **AND** keep TDD same
	15-20	Decrease dosing interval
6-9	10-15	Increase dose by 250 mg
	15-20	Decrease dosing interval **OR** increase dose by 500 mg
10-15	10-15	No change required
	15-20	Increase dose by 250 mg
15-20	10-15	Decrease dose by 250 mg
	15-20	No change required
> 20	10-15	Increase dosing interval **OR** decrease dose by 500mg
	15-20	Decrease dose by 250 mg
General Calculation Strategy if Interval Remains the Same: (Current vancomycin dose)/(Vancomycin trough) = (New vancomycin dose)/(Desired trough)		

References: see online document on Scoop

For more information about the Infectious Diseases Team at BCH see:

bch.org/beaconcenter

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