UPMC | PRESBYTERIAN SHADYSIDE

Antibiotic
Stewardship
Program

Guide to Antimicrobial Chemotherapy

2020–2021, Tenth edition

UPMC PRESBYTERIAN GUIDE TO ANTIMICROBIAL CHEMOTHERAPY

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The Antibiotic Management Program is a patient safety initiative and was developed to address infections related to *C. difficile*, increasing antimicrobial resistance in nosocomial Gram-negative organisms, and to promote antimicrobial stewardship. The program is endorsed by the Medical Executive and Pharmacy and Therapeutics committees of UPMC for implementation at UPMC Presbyterian. To see the impact the Antibiotic Management Program in conjunction with Infection Control has had on *C. difficile* at UPMC Presbyterian, review Clin Infect Dis 2007;45:1266-73.

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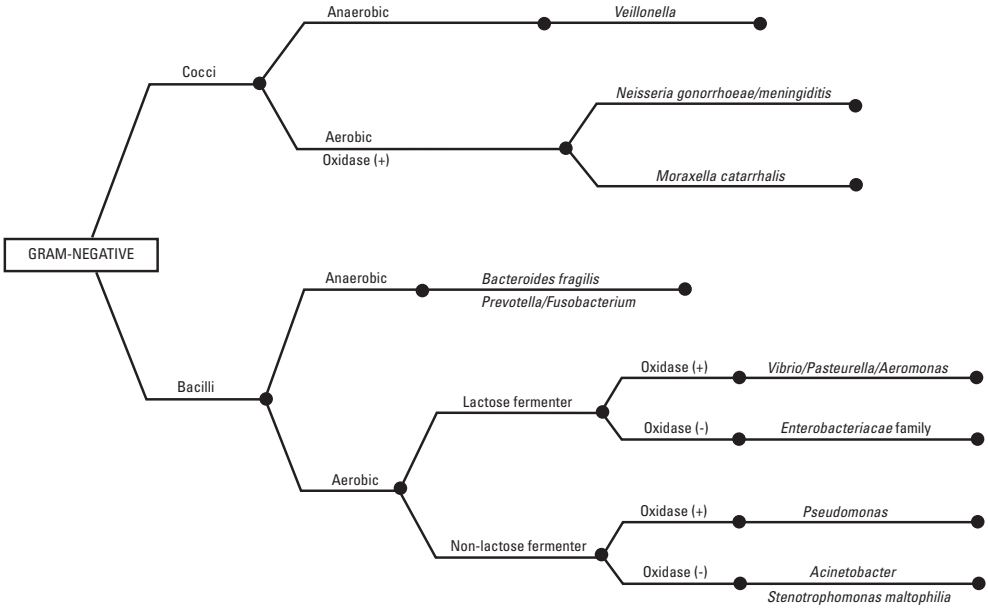
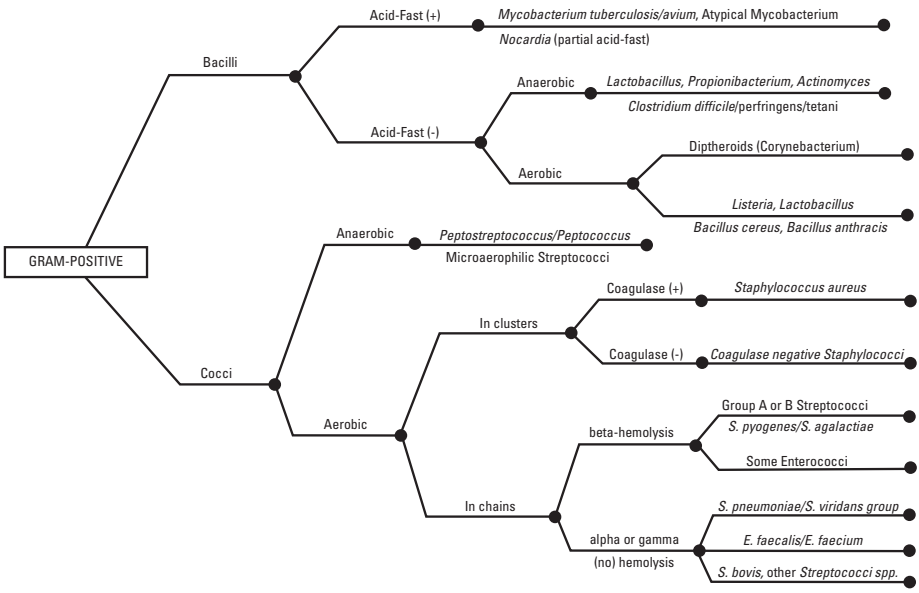
ORGANISM IDENTIFICATION

ORGANISM IDENTIFICATION THROUGH GRAM STAIN (NOT COMPREHENSIVE)



MICRO-ORGANISM IDENTIFICATION THROUGH GRAM STAIN (NOT COMPREHENSIVE)



ANTIBIOTIC BY CLASS AND RESTRICTION

SELECTED FORMULARY ANTIMICROBIALS BY CLASS [R]=RESTRICTED AT UPMC PRESBYTERIAN HOSPITAL [NF]= NON FORMULARY

<table>
<tr>
<td>Penicillins
Penicillin
Ampicillin
Amoxicillin
Nafcillin
Oxacillin
Dicloxacillin
Amoxicillin/Clavulanate
Ampicillin/Sulbactam
Piperacillin/Tazobactam [R]</td>
<td>Cephalosporins
Cefazolin
Cefuroxime
Cephelexin
Cefoxitin
Cefpodoxime
Cefepime [R]
Ceftaroline [R]
Ceftazidime [R]
Ceftriaxone [R]</td>
<td>Carbapenems
Ertapenem [R]
Imipenem/Cilastatin [R]
Meropenem [R]

Macrolides
Azithromycin
Clarithromycin
Erythromycin</td>
<td>β-LACTAM/ β-LACTAM INHIBITOR COMBINATIONS
Ceftolozane/Tazobactam [R]
Ceftazidime/Avibactam [R]
Meropenem/Vaborbactam [R]
Imipenem/Cilastatin/Relebactam [R]

POLYMYXIN
Colistin [R]
Polymyxin B [R]</td>
</tr>
<tr>
<td>LIPOGLYCOPEPTIDES
Telavancin [R]
Dalbavancin [R –outpatient location]
Oritavancin [R-outpatient location]</td>
<td>FLUOROQUINOLONES
Ciprofloxacin [R]
Delafloxacin [NF]
Levofloxacin [R]
Moxifloxacin [NF]</td>
<td>AMINOGLYCOSIDES
Amikacin
Gentamicin
Plazomicin [NF]
Tobramycin</td>
<td>TETRACYCLINE
Doxycycline
Eravacycline [R]
Minocycline [IV is R]
Tetracycline
Tigecycline [R]</td>
</tr>
<tr>
<td>Oxazolidinone
Linezolid [R]
Tedizolid [R]</td>
<td>LINCOSAMIDE
Clindamycin [R]</td>
<td>MONOBACTAM
Aztreonam [R]</td>
<td>GLYCOPEPTIDES
Vancomycin [PO dose >125mg]</td>
</tr>
<tr>
<td>POLYENES
Amphotericin B Deoxycholate [R]
Amphotericin B Liposomal [R]

ECHINOCANDIN
Caspofungin [R] preferred
Micafungin [R]
Anidulafungin [R]

OTHER ANTIFUNGALS
Flucytosine [R]</td>
<td>AZOLES
Fluconazole
Isavuconazole [R]
Itraconazole
Posaconazole [R]
Voriconazole [R]

ANTI-CMV AGENTS
Cidofovir
Foscarnet
Ganciclovir
Letermovir [R]
Valganciclovir</td>
<td colspan="2">ANTIMICROBIALS
Bezlotoxumab [R]
Bedaquiline [R]
Cobicistat*
Cefiderocol [R]
Daptomycin [R]
Fidaxomicin [R]
Fosfomycin
Lefamulin [NF]

OTHER ANTIMICROBIALS
Metronidazole
Nitrofurantoin
Peramivir [R]
Pretomanid [R]
Pyrimethamine [R]
Ribavirin [R]
Quinupristin/dalfopristin [R]
Trimethoprim/sulfamethoxazole</td>
</tr>
</table>

Restriction process and agents may differ based on UPMC institution- please refer to local process and procedure.
Please note that the dose recommendations in the specific disease state management sections are based on patients with estimated creatinine clearance of >50mL/min.
For patients with renal insufficiency or renal replacement therapy, please see the Renal Dosing Recommendations section of this handbook (pages 84-106).
**Confirm indication within 24 hours admission with PACT clinic or General ID Team.*

SELECTED FORMULARY AND NONFORMULARY ANTIMICROBIALS ([R] = RESTRICTED)

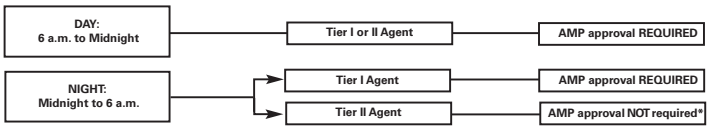
Restricted agents:
In the following tables, antimicrobials are recommended that may be restricted. Although a restricted antimicrobial may be recommended in this guide, a call to the Antibiotic Management Program still is required.

Restricted agents that have exceptions:
Piperacillin/tazobactam[R] (Zosyn™), ceftriaxone [R], and cefepime[R] (Maxipime™) do not require prior approval from the AMP in Presbyterian campus ICU units and the bronchoscopy suite. These units include CTICU, SICU, 3F, 4F, 4G, 5F, 6F/G, MICU (9F, 10F, 10C, 11F), TICU (5S).
NOTE: Carbapenems (ertapenem, meropenem, imipenem) and quinolones (ciprofloxacin, moxifloxacin, and levofloxacin) are not exempt from prior approval in ICUs.

Patients with renal insufficiency:
Please note that the dose recommendations below are based on patients with estimated creatinine clearances of > 50ml/min. For patients with moderate to severe renal impairment, including hemodialysis, please see the Renal Dosing Recommendations section of this handbook.

Note: Colistin is administered as the prodrug colistin methanesulfonate, and dosing is expressed as colistin base activity. See page 91 for dosing.

UPMC PRESBYTERIAN CAMPUS
PROCEDURE FOR AMP-RESTRICTED AGENTS



AMP PHONE: (412) 225-7866; PAGER #14131

*For Tier II orders entered between midnight and 6AM, AMP team will follow up the next day to determine appropriateness. Callers should be ready to provide rationale for the use of the restricted agent, regardless of the time of day.

TIER I ANTIMICROBIALS

Broad Spectrum Gram Positive Agents:
- Daptomycin
- Quinuprostin/Dalfopristin
- Tedizolid (IV/PO)
- Telavancin
- Ceftaroline

Lipoglycopeptides for outpatient location administration only
- Dalbavancin
- Oritavancin

Antifungals:
- Amphotericin B deoxycholate (IV)
- Amphotericin B liposomal (IV)
- Isavuconazole (IV/PO)
- Posaconazole (IV/PO)

Other
- Bezlotoxumab
- Bedaquiline
- Cefiderocol
- Lefamulin
- Ribavirin (inhaled only)
- Peramivir
- Plazomicin
- Pretomanid
- Colistin and Polymyxin B (IV)
- Pyrimethamine
- Ethyl Alcohol Line Lock Therapy
- Eravacycline
- Fidaxomicin
- Letermovir (IV/PO)
- Flucytosine

B-Lactam/B-Lactamase Combos
- Ceftazidime/Avibactam
- Meropenem/Vaborbactam
- Ceftolozane/Tazobactam
- Imipenem/Cilastatin/ Relebactam

TIER II ANTIMICROBIALS

Fluoroquinolones
- Ciprofloxacin (IV/PO)
- Levofloxacin (IV/PO)

Carbapenems
- Ertapenem
- Meropenem
- Imipenem/Cilastatin

Antifungals
- Voriconazole IV/PO

Lung transplant and high-risk heart/liver transplant excluded. Prescribers to document "post-transplant protocol" in special instructions

- Piperacillin/Tazobactam, Ceftriaxone, and Cefepime**

Other
- Aztreonam
- Linezolid (IV/PO)
- Ceftazidime
- Tigecycline
- Caspofungin (and other echinocandins)
- Clindamycin (IV/PO)
- Minocycline IV
- Vancomycin PO doses GREATER than 125mg only

**Piperacillin/tazobactam, cefepime, and ceftriaxone exclusions:
- All three: ICU's excluded
- Cefepime: 1st dose for sepsis
- Pip/tazo: GI lab and ERCP
- "CYSTIC" code accepted in lieu of AMP code for CF population

General AMP Exclusions:
- Emergency Department-one time doses (Orders for patients boarding in the ED/ scheduled orders require AMP approval)
- Topical agents
- Antiretrovirals
- Intra-operative and PACU antimicrobials

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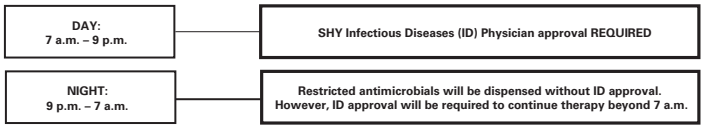
Please note that the dose recommendations in the specific disease state management sections are based on patients with estimated creatinine clearance of >50mL/min. For patients with renal insufficiency or renal replacement therapy, please see the Renal Dosing Recommendations section of this handbook (pages 84-106).

UPMC SHADYSIDE CAMPUS
PROCEDURE FOR AMP-RESTRICTED AGENTS



UPMC Shadyside ID approval numbers

ID Associates of Western PA: (412) 864-7992

Weber & Associates: (412) 578-9747

Shadyside Transplant ID: (412) 647-PAGE #37128

Anidulafungin (Eraxis®)*	Ertapenem (Invanz®)	Peramivir (Rapivab™) – Approval not required if ordered by Critical Care attending
Amphotericin B (Fungizone®)	EtOH lock – *Approval not required if ordered by Nutrition Support*	Pretomanid
Amphotericin B Liposome (Ambisome®)	Fidaxomicin (Dificid®)	Pyrimethamine (Daraprim®)
Aztreonam (Azactam® / Cayston ®)	Fluconazole IV (Diflucan®)*	Polymyxin B
Caspofungin (Cancidas®)*	Flucytosine (Ancobon®)	Posaconazole (Noxafil®)*
Cefiderocol (Fetroja™)	Imipenem/Cilastatin (Primaxin®)	Quinupristin/dalfopristin (Synercid®)
Ceftaroline (Teflaro™)	Imipenem/Cilastatin/Relebactam (Recarbrio™)	Ribavirin aerosolized (Virazole®)
Ceftazidime/avibactam (Avycaz™)	Isavuconazonium (Cresemba®)	Tedizolid (Sivextro®)
Ceftolozane/tazobactam (Zerbaxa™)	Letermorvir (Prevymis™)*[1]	Telavancin (Vibativ®)
Clindamycin (Cleocin®)	Linezolid (Zyvox®)	Tigecycline (Tygacil®)
Cobicistat (Tybost™) – *Approval not required if ordered OR approved by PACT service*	Meropenem (Merrem®)	Vancomycin ENTERAL - Approveal required for doses GREATER THAN 125mg
Colistin	Meropenem/Vaborbactam (Vabomere™)	Vancomycin IV – Approval required for doses 4 grams / 24 hours or more
Dalbavancin (Dalvance™)**	Micafungin (Mycamine®)*	Voriconazole (Vfend®)*
Daptomycin (Cubicin®)	Minocycline IV (Minocin®)	
Eravacycline (Xerava™)	Oritavancin (Orbactiv®)**	

*SHY ID physician approval not required if ordered by Hematology/Oncology Attending, Fellow, or Mid-level Confirm indication within 24 hours of admission with PACT clinic OR General ID team.

**Outpatient administration only; not for perioperative use

[1]for prophylaxis of CMV infection and disease in adult CMV-seropositive recipients [R+] of an allogeneic hematopoietic stem cell transplant (HSCT)

Restriction process and agents may differ based on UPMC institution- please refer to local process and procedure.
Please note that the dose recommendations in the specific disease state management sections are based on patients with estimated creatinine clearance of >50ml/min. For patients with renal insufficiency OR renal replacement therapy, please see the Renal Dosing Recommendations section of thus handbook (pages 84-106).

ANTI-INFECTIVE AGENTS THAT SHOULD NOT BE CRUSHED

ORAL ANTIMICROBIAL AGENTS THAT SHOULD NOT BE CRUSHED[1]

Brand Name	Generic Name	Rationale
Augmentin XR	Amoxicillin/clavulanic acid extended release	Extended release tablet
Biaxin-XL	Clarithromycin extended release	Extended release tablet
Cipro XR (Proquin XR)	Ciprofloxacin extended release	Extended release tablet
Ery-Tab	Erythromycin delayed release	Delayed release tablet
E-Mycin	Erythromycin base/stearate	Enteric coated tablet
Valcyte	Valganciclovir	Teratogenic and irritant potential
Noxafil	Posaconazole	Delayed-release tablet and manufacturer rec.
Flagyl ER	Metronidazole extended-release	Extended release tablet
Rifadin	Rifampin	Hazardous medication policy

Reference UPMC Presbyterian Shadyside CP-77 Hazardous Drugs Policy for recommendations regarding the handling of hazardous drugs.

VANCOMCYIN APPROPRIATE USE

WHY IS VANCOMYCIN NOT RESTRICTED?

The majority of Coagulase-negative Staphylococci (~70%) and *Staphylococcus aureus* (~50%) at this institution are resistant to methicillin. Thus, preapproval calls for vancomycin would be overwhelming. Those prescribing vancomycin should be aware that the CDC has published a document with recommendations for its prudent use. The following table illustrates instances when its use is appropriate and those when it should be discouraged†.

When vancomycin is appropriate:	When vancomycin is inappropriate:
1. Treatment of serious infections due to beta-lactam resistant Gram-positive micro-organisms. 2. Treatment of Gram-positive infections in patients with severe allergies to beta-lactam antimicrobials. 3. For treatment of *C. difficile* colitis (PO vancomycin only) 4. Prophylaxis, as recommended by the American Heart Association, for endocarditis after certain procedures in patients at high risk for endocarditis. 5. Prophylaxis for surgical procedures involving implantation of prosthetic materials OR devices at institutions with a high rate of infections due to *MRSA* OR MRSE. 6. Surgical prophylaxis in patients with severe PCN allergy.	1. Routine surgical prophylaxis. 2. Empiric antimicrobial therapy for a febrile neutropenic patient, unless there is strong evidence that the patient has an infection due to a beta-lactam resistant Gram-positive organism. 3. Treatment in response to a single blood culture positive for coagulase-negative Staphylococci, if other blood cultures drawn in the same time frame are negative (contamination). 4. Continued empiric use for presumed infections in patients whose cultures are negative for beta-lactam resistant Gram-positive micro-organisms. 5. Systemic OR local prophylaxis for infection OR colonization of indwelling central OR peripheral intravascular catheters OR vascular grafts. 6. Selective decontamination of the digestive tract. 7. Eradication of *MRSA* colonization. 8. Routine prophylaxis for infants with very low birth weights. 9. Routine prophylaxis for patients on continuous ambulatory peritoneal dialysis. 10. Routine PO prophylaxis for *C. difficile* colitis.

† Federal Register 1994; 59:25758-63

COMMUNITY-ASSOCIATED METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* (CA-MRSA)

Infections due to CA-MRSA are increasing in frequency. Here are some relevant points worth noting: Risk factors classically associated with CA-MRSA (although the organism has now spread throughout the USA to include patients without these defined risk factors) include

a. Children

b. Incarcerated persons

c. Alaskan natives, Native Americans, Pacific Islanders

d. Sports participants, specifically with:

i. Abrasions and lacerations

ii. Physical contact

iii. Equipment sharing (e.g. towels, uniforms, razors, etc.)

e. Military personnel

Patients may attribute their skin infections incorrectly to a "spider bite"

The role of antimicrobial therapy for the treatment of uncomplicated CA-MRSA skin infections (<5cm) is unclear. However, in one of the largest studies to date, the use of an inactive antimicrobial agent was an independent predictor of treatment failure1. An incision and drainage (I+D) procedure was performed in the majority of patients. In those patients who have an I+D performed, culture and Gram stain of the drained material is of value in directing therapy.

If antibiotic therapy is desired and the patient can tolerate, initiate trimethoprim/sulfamethoxazole 1 to 2 double strength tablet(s) PO q12h.[2] Other antibiotic options include the following: a tetracycline (doxycycline or minocycline), clindamycin, and linezolid.[3]

See table below for comparison of CA-MRSA and health care-associated MRSA (HA-MRSA).[4]

Drug Susceptibility	CA-MRSA	HA-MRSA
Doxy/minocycline[A]	Usually susceptible	Usually susceptible
Erythromycin	Usually resistant	Usually resistant
TMP/SMX[B]	Usually susceptible	Usually susceptible
Fluoroquinolone[C]	Geographic variability (not reliable)	Usually resistant
Clindamycin[D]	Variable susceptibility (Not reliable empirically)[D]	Usually resistant
Linezolid/Tedizolid	Usually susceptible	Usually susceptible

Invasive infections due to CA-MRSA such as septic arthritis, endocarditis, and pneumonia are well described. A variety of agents can be used to treat these infections. A partial list is included to help guide therapy selection. If further guidance is needed, an Infectious Diseases consult should be obtained.

Antimicrobial	Dose	Route	Notes
Vancomycin	15-20mg/kg q12h	IV	Dose adjust in renal insufficiency. See pages 156-161 for dosing recommendations.
Daptomycin	6-8mg/kg q24h	IV	Do not use for the treatment of pneumonia. Dose adjust in renal insufficiency.
Linezolid	600mg q12h	IV/PO	Caution with serotonergic drugs (e.g. SSRI) given risk of serotonin syndrome. Limit courses to <14 days.
Telavancin	7.5-10mg/kg q24h	IV	Caution as data in *MRSA* bacteremia is limited. Dose adjust in renal insufficiency.
Ceftaroline	600mg q8-12h	IV	Not first line, often used in combination for salvage therapy. Dose adjust in renal insufficiency

[1] Ruhe JJ, et al. Clin Infect Dis 2007;44:777-842
[2]Talan DA, et al. N Engl J Med 2016;374:823-32.3
[3]Liu C, Bayer A, Cosgrove SE et al. Clin Infect Dis. 2011 Feb 1;52(3):e18-55.
[4] Weber JT. Clin Infect Dis 2005;41 S269-72
AIn 2018 approximately 1859 S. aureus *isolates at UPMC Presbyterian were tested to doxycycline and 93% were susceptible*
BTMP/SMX (Trimethoprim/sulfamethoxazole). In 2018, approximately 1859 S. aureus *isolates at UPMC Presbyterian were tested to TMP/SMX and 99% were susceptible.*
C Ciprofloxacin should not be thought of as an agent with reliable Gram-positive activity
D In 2018, approximately 1859 S. aureus *isolates at UPMC Presbyterian were tested to clindamycin and 66% were susceptible*

MICROBIOLOGY AND DOSE OPTIMIZATION PEARLS

What is an "MIC" and how do I interpret it?
"MIC" stands for Minimum Inhibitory Concentration. On susceptibility reports, it denotes the minimum concentration of an antibiotic needed to inhibit growth of an organism. Knowing the MIC of an organism to a given antibiotic can help the clinician optimally dose the antibiotic and/or determine if that antibiotic is the most appropriate choice. Importantly, since antibiotics achieve different concentrations at different doses and have different pharmacodynamics characteristics (properties that result in optimal killing), MICs cannot be compared directly between different antimicrobial classes. Indeed, it is possible that the antibiotic with the lowest MIC may not be the most optimal choice.

What is susceptible dose-dependent (SDD)?
Susceptible-dose dependent (SDD) implies that susceptibility of an isolate depends on the dosing regimen used for the infection. Essentially, higher exposures of the antimicrobial agent are necessary to be clinically effective. Higher exposures can be achieved by administering antimicrobials at higher doses, more frequent intervals, or both. This category is used for organisms where higher doses are safe and supported by the literature, widely used clinically and/or approved.

At UPMC Presbyterian and Shadyside hospitals, dosing for SDD isolates is as follows:

Antimicrobial	MIC	Dose
Cefepime	SDD: 4-8 µg/mL	2g IV q8h over 3h infusion
Ceftaroline (for *S. aureus* only)	SDD: 2-4 µg/mL	600mg IV q8h over 2h infusion
Daptomycin (for *E. faecium* only)	SDD: ≤ 4 µg/mL	8-12 mg/kg/day
Fluconazole:		
C. albicans, parapsilosis, tropicalis	SDD: 4 µg/mL	In GENERAL, Dose/MIC ~50-100
C. glabrata	SDD: ≤ 32 µg/mL	In GENERAL, Dose/MIC ~50-100

Why are antipseudomonal beta-lactam antibiotics (e.g., cefepime, meropenem) infused over 3 hours?
The pharmacodynamic (PD) parameter best associated with bacterial killing in beta-lactam antibiotics is the time the free concentration of the antibiotic is above the minimum inhibitory concentration (MIC) of the bacterial pathogen. This is otherwise referred to as fT>MIC. Infusing beta-lactam antibiotics over extended intervals (i.e., 3 hours) maximizes this efficacy parameter and therefore optimizes the antibacterial effect of the antibiotics. Additionally, data demonstrate extended-infusion beta-lactams are associated with decreased mortality, shortened hospital length of stay, and improved clinical cure.

At UPMC Presbyterian and Shadyside hospitals, cefepime, ceftazidime, ceftolozane/tazobactam, ceftazidime/avibactam, meropenem, meropenem/vaborbactam, and piperacillin/tazobactam are all infused over 3 hours.

ANTIBIOTIC AND ETHYL ALCOHOL LOCK THERAPY

Central line associated bloodstream infection (CLABSI) remains one of the most devastating complications associated with vascular access devices, especially with long-term total parenteral nutrition administration. Central venous catheters (CVCs) are expensive and difficult to implant and remove, and vascular access sites may be limited. Line lock therapy with select antimicrobials or ethyl alcohol has been proposed as a means of salvage therapy or prevention of catheter-related infection (CRI), respectively. Lock therapy consists of filling and closing a catheter lumen with a specific concentration of solution, allowing the solution to dwell in the lumen while the catheter is not in use, and subsequent removal of solution from the line (ie. solution is NOT administered systemically). Safety concerns are associated with utilization of these therapies and careful consideration of indication should be utilized. Variation of lumen volumes is notable and unpredictable- every effort should be taken to confirm lumen volume for dwell volume to avoid inadvertent systemic administration.

ANTIBIOTIC LOCK THERAPY[1]

The 2009 guidelines by the Infectious Diseases Society of America on the management of catheter-related infection state that antibiotic lock therapy may be considered in combination with systemic antimicrobial therapy for patients with catheter-related infection involving long-term catheters with no signs of exit site or tunnel infection for whom catheter salvage is the goal. Catheter removal is strongly recommended for infections due to *S. aureus* and Candida species. The addition of an anticoagulant to the antimicrobial lock solution is recommended unless otherwise contraindicated for patients. Antimicrobial lock formulation utilized should have spectrum of activity that includes common pathogens associated with CLASI and/or targeted pathogens.

The following therapies are standard and available at UPMC:

Cefazolin 5mg/mL + heparin 2,500 Units/mL	Gentamicin 1mg/mL + heparin 2,500 Units/mL	Vancomycin 5mg/mL
Vancomycin 5mg/mL + heparin 1,000 Units/mL		Gentamicin 1mg/mL

ETHYL ALCOHOL LOCK THERAPY[2]

Ethyl alcohol lock therapy may be utilized as an option for prophylaxis in patient who have experienced multiple CLABSIs and who have limited remaining access sites. Ethyl alcohol lock therapy is a designated Tier I restricted antimicrobial and patients must meet specific criteria prior to initiation of this therapy (including documentation of a catheter compatible with ethanol, are not receiving concomitant heparin therapy, and are not receiving an agent that interacts with ethyl alcohol).

Standard ethyl alcohol 74% solution is available at UPMC..

References:
[1] *Mermel LA, Allen M, Bouza E, et al. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 update by the infectious diseases society of America. Clin Infect Dis 2009;49:1-45.*
[2] *Maiefski M, Rupp ME, Hermsen ED. Ethanol lock technique: review of the literature. Infect Control Hosp Epidemiol 2009;30:1096- 1108.*

ANTIBIOTICS OF CHOICE BY ORGANISM

Organism	Antibiotic of Choice (If Susceptible)	Notes
Methicillin Sensitive *Staphylococcus aureus* (MSSA)	Oxacillin (preferred)[1] Or Cefazolin	Data demonstrate greater anti-staphylococcal activity and less toxicity for B-lactams compared to vancomycin
Methicillin Resistant *Staphylococcus aureus* (*MRSA*)	Vancomycin	Infectious Diseases consult is associated with decreased mortality in patients with *MRSA* bacteremia. Consider Linezolid as an alternate therapy for pneumonia. Consider daptomycin in patients persistently bacteremic with *MRSA* in the absence of infection focus despite therapeutic level of vancomycin.
Group A Streptococci (*Streptococcus pyogenes*)	Penicillin	Clindamycin OR linezolid may be added in necrotizing fasciitis
Listeria monocytogenes	Ampicillin	TMP/SMX is the alternative for true penicillin allergy
Enterococcus spp. (ampicillin susceptible)	Ampicillin	Gentamicin OR Ceftriaxone may be added for synergy for endocarditis or meningitis.
Enterococcus spp. (vancomycin resistant, ampicillin resistant)	Linezolid	Fosfomycin and doxycycline can be used for cystitis. Vancomycin resistance in enterococcus does not predict ampicillin resistance. Other agents, including daptomycin and tigecycline may have activity. Consider Infectious Diseases consultation.
Stenotrophomonas maltophilia	TMP/SMX	Alternative agents include ceftazidime and levofloxacin, yet resistance rates for these agents are higher than TMP/SMX at Presbyterian and Shadyside campuses.
Extended Spectrum beta-lactamase (ESBL) producing bacteria	Meropenem OR Ertapenem	Alternatives are fluoroquinolones OR TMP/SMX if susceptible for non-severe infections.
Pseudomonas aeruginosa	Cefepime OR Piperacillin/ tazobactam	Meropenem[R] OR Ceftolozane/tazobactam are alternatives

[1] Oxacillin has been associated with a lower rate of adverse events and treatment discontinuation as compared to nafcillin among adult, hospitalized patients at UPMC Presbyterian Shadyside. (Viehman JA, et al. Antimicrob Agents Chemther. 2016; 60:3090-5.)
[2] TMP/SMX doses for pneumonia caused by Stenotrophomonas *are not as high as those seen for Pneumocystis pneumonia. In patients without renal insufficiency, dose TMP/SMX at 5mg/kg (of the trimethoprim component) IV q12h for* Stenotrophomonas *pneumonia (Clin Infect Dis 1996; 22:508-12).*

DURATION OF ANTIBIOTIC TREATMENT FOR BLOODSTREAM INFECTIONS

Infection	Recommended Duration	Comment
Bacteremia; *Staphylococcus aureus*	Frequently 4-6 weeks (minimum 14 days, but only in low-risk patients with uncomplicated infection)	Strongly suggest ID consult for all *S. aureus* bacteremia to determine duration[1-2]
Bacteremia; Coagulase-negative *Staphylococcus*	5-7 days for line-related bacteremia if lines have been changed and bacteremia has cleared	This is frequently a contaminant.
Bacteremia; *Enterobacterales* (e.g. *E. coli*, *K. pneumoniae*, *Proteus*)	Low-risk (source control, rapid improvement and clearance): 7 days Not low-risk: Usually 10-14 days; depends on focus of infection	
Bacteremia; Other Gram-negative bacilli (e.g. *Pseudomonas*, *Acinetobacter*)	Usually 7-14 days; depends on focus of infection and organism	
Candidemia	14 days minimum from date of documented clearance of blood cultures	Suggest Infectious Diseases and Ophthalmology consults
Endocarditis	Usually requires prolonged therapy	Suggest ID consult, see endocarditis section for specifics

[1] Clin Infect Dis. 1998; 27: 478-486
[2] Clin Infect Dis. 2015; 60(10):1451-61

PENICILLIN ALLERGY BACKGROUND

Penicillin is the most common drug allergy reported in the United States with approximately 10% of the population reporting some type of penicillin allergy. Importantly, more than 95% of patients with reported allergies do not experience immediate IgE-mediated Type I hypersensitivity reactions and may be able tolerate exposure to beta-lactam antibiotics.

Withholding beta-lactam antibiotics and administering second-line agents (vancomycin, clindamycin, and fluoroquinolones) is associated with substantial patient harm, including increased:

- Mortality
- Hospital length of stay
- Antibiotic-related toxicities
- Treatment failure
- Colonization with drug-resistant organisms (e.g., VRE, MRSA)
- Surgical site infections

Key components of a penicillin allergy evaluation and management pathway include the following and are further detailed on subsequent pages:

- Thorough medication allergy history, including historic β-lactam use
  - › Clarifies 80-90% of cases
- Cross-reactivity chart
  - › Cefazolin does not share a side-chain with any other beta-lactam antibiotic. The rate of reaction to cefazolin in patients with a confirmed penicillin allergy is 1.4%; this is too low to call the relationship cross-reactive and instead most likely represents patients who have 2 independent allergies.
- Graded challenge, or "test dose" procedure
  - › Generally administered to patients who are considered low or moderate risk for developing an IgE-mediated hypersensitivity reaction.
  - › This procedure consists of administering 1-2 test doses: for example, 10% of the intended dose, followed by the full dose of the medication. Unlike desensitization, a graded-challenge aims to rule-out the presence of IgE-mediated hypersensitivity reaction.
- Desensitization, or the induction of the temporary drug tolerance,
  - › Typically performed on those patients who are considered at high risk for developing a systemic IgE-mediated hypersensitivity reaction.
  - › This procedure consists of administering the offending agent at a concentration and rate that will cause drug-specific IgE-armed mast cells to degranulate at low rates without causing an allergic reaction, and ultimately allow for the drug to be administered at a full therapeutic dose.

BETA-LACTAM ALLERGY DOCUMENTS

BETA-LACTAM ALLERGY ASSESSMENT QUESTIONNAIRE

Step 1. Review Cerner PowerChart, External Rx History, and EPIC before conducting the patient interview to help prompt recall of historic beta-lactam utilization

- PowerChart: Med Review › Time Scale (top banner bar) › Interval › 1 Day › Group › Change Search Criteria (right click gray date range banner in Med Review) › Clinical Range › From 01/01/2010
- External Rx History: Orders › External Rx History › View › Rx history display (All) › Show More Medications (until grayed out)
- EPIC: Meds › Uncheck Current Meds Only

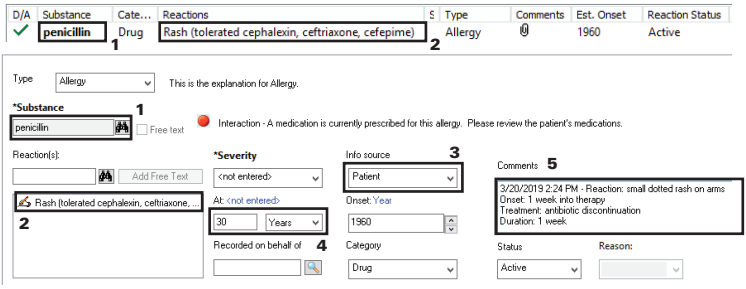
Step 2. Conduct patient beta-lactam allergy interview

IPatient Interview Questions	Response
1. What is the name of the medication you are allergic to?	
2. How old were you when the reaction occurred?	
3. Please describe what happened when you took the medication. If hives ask… *"Was your reaction itchy, raised welts/wheels that occurred right after starting the medication and went away 1-2 days after stopping the medication?"*	REACTION
4. After how many days of treatment did the reaction occur? (prompt for "immediate/>24 hours")	ONSET
5. How was the reaction treated? Prompt if required medical treatment for the reaction (e.g. drug discontinuation, benadryl, epinephrine, urgent medical care/hospitalization)	TREATMENT
6. How long did the reaction last?	DURATION
7. Have you ever taken drugs similar to penicillins? If yes, what happened with those? *Prompt Augmentin, Keflex, Omnicef, ceftriaxone (Rocephin), cefepime (Maxipime)* *Prompt for specific beta-lactam previously documented as received in eRecord*	OTHER BETA-LACTAMS TOLERATED SINCE

BETA-LACTAM ALLERGY DOCUMENTATION

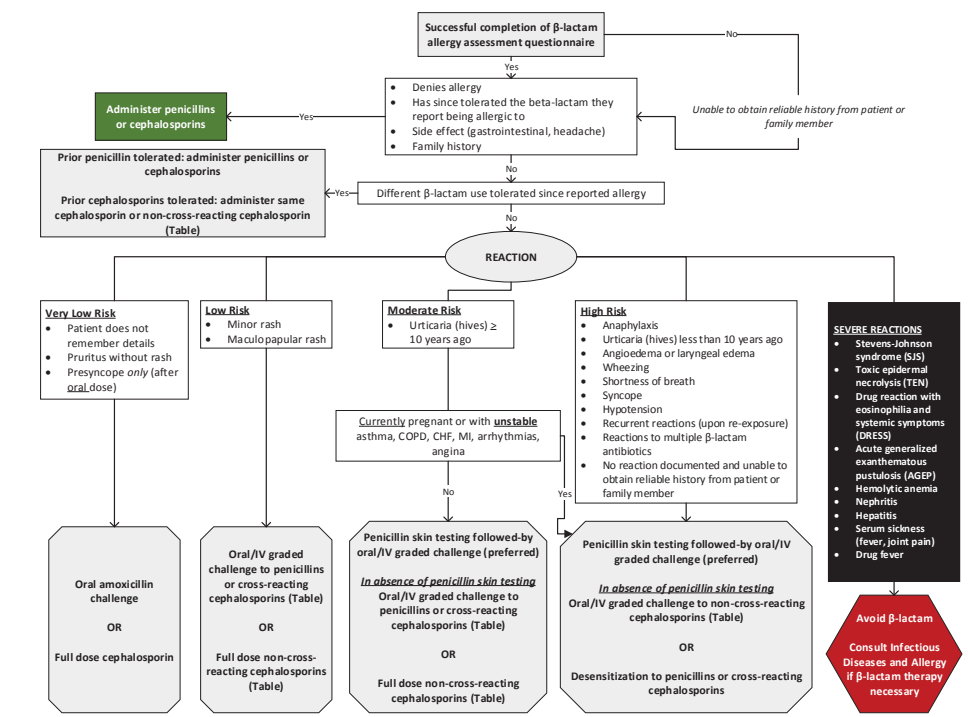
Step 3. Update Beta-Lactam Allergy Documentation in eRecord

Substance: Add medication patient is allergic to (if not already entered)



1. Reaction: Add reaction and beta-lactam(s) tolerated since the event
2. Will need to add this using "Add Free Text" feature
3. Info source: Document source of history (i.e. patient)
4. At: Document approximate age when reaction occurred
5. Comments: Document specifics of allergy history including
   - Reaction:
   - Onset (in relation to starting medication):
   - Treatment:
   - Duration:
   - Which other beta-lactams have been tolerated since reaction (as applicable)

Step 4. If beta-lactam therapy is indicated, please refer to pathway for evaluation and management of beta-lactam allergies



ANTIMICROBIAL RECOMMENDATIONS IN PULMONARY DISEASE

Reference CP-72 Desensitization and Graded Challenges and Beta-lactam Allergy Assessment Pathway on pages 32-35.

Diagnosis (Modifying Factors)	Likely Pathogens	First Line Therapy	Alternative	Comments
Aspiration pneumonitis "Mendelson's syndrome"	None (sterile gastric contents)	None	None	Aspirated gastric contents acutely causes lung injury with subsequent immune response.
COPD exacerbation	*S. pneumoniae*, *H. influenzae*, viral, other	**Doxycycline 100mg PO q12h OR Amoxicillin 500mg PO q8h**	Azithromycin 500mg PO q24h OR Levofloxacin 500mg PO q24h	Azithromycin duration of therapy is 3 days, other therapies are 5 days in duration
Aspiration pneumonia (Community acquired OR hospitalized < 5 days)	Viridans Streptococci, Micrococci, oral anaerobes, Gram-negative rods	**Ampicillin/sulbactam 3g IV q6h** (See comment)	Levofloxacin 750mg PO/IV q24h (see comment)	Patients who have aspirated and who are suspected to have upper airway colonization with nosocomial bacteria should be treated using the pathway in the row below. (Aspiration pneumonia, hospitalized ≥ 5 days) Duration:5-7 days
Aspiration pneumonia (Hospitalized ≥ 5 days)	*E. coli, H. influenzae, Klebsiella spp., Proteus spp., Serratia marcescens, S. pneumoniae, S. aureus Pseudomonas, Acinetobacter spp.*	**Cefepime 2g IV q8h OR Piperacillin/tazobactam 4.5g IV q6h +/- Vancomycin (see Vancomycin dosing recommendations on pages 156-161)**	Ciprofloxacin 400mg IV q8h PLUS Vancomycin‡ (vancomycin dosing recommendations, pages 156-161)	

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ANTIMICROBIAL RECOMMENDATIONS IN PULMONARY DISEASE (CONTINUED)

Diagnosis (Modifying Factors)	Likely Pathogens	First Line Empiric Therapy	Alternative	Comments
Community Acquired Pneumonia (CAP)* * (including ICU without *Pseudomonas* risk factors)	*S. pneumoniae, H. influenzae, Legionella, Mycoplasma, Chlamydia pneumoniae*	**Ampicillin/sulbactam 3g IV q6h (first line therapy) OR Ceftriaxone 1g (non-ICU), 2g (ICU) IV q24h PLUS Azithromycin 500mg IV q24h x 2 doses, then 500mg IV/PO q24h**	Levofloxacin 750mg IV/PO q24h	Switch to PO when tolerated. Duration (azithromycin >=3 days) Duration (non-azithromycin) 5-7 days Add Vancomycin IV (see pages 156-161 for dosing recommendations) for prior respiratory isolation of *MRSA*, and in patients with hospitalization and receipt of parenteral antibiotic treatment course in the last 90 days OR other risk factors for *MRSA*
CAP in ICU WITH *Pseudomonas* risk factors: 1. Recent ICU stay 2. Multiple HC facility admissions in last 3 months 3. Multiple antibiotic courses in last 30 days 4. Bronchiectasis 5. Structural lung disease with long term/chronic systemic corticosteroid use within the last 3 months	*S. pneumoniae, Legionella, S. aureus, Mycoplasma, Chlamydophila pneumoniae, Pseudomonas*	**Cefepime 2g IV q8h +/- Tobramycin IV (see page 150-153 for dosing recommendations) PLUS Azithromycin 500mg IV q24h x 2 doses, then 500mg PO q24h**	Levofloxacin 750mg IV q24h +/- Vancomycin IV (see page 156-161 for dosing recommendations) +/- Tobramycin IV (see page 150-153 for dosing recommendations)	Switch to PO when tolerated Add Vancomycin IV (see pages 156-161 for dosing recommendations) for prior respiratory isolation of *MRSA*, and in patients with hospitalization and receipt of parenteral antibiotic treatment course in the last 90 days OR other risk factors for *MRSA*

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ANTIMICROBIAL RECOMMENDATIONS IN PULMONARY DISEASE (CONTINUED)

Diagnosis (Modifying Factors)	Likely Pathogens	First Line Empiric Therapy	Alternative	Comments
Hospital-Acquired Pneumonia (HAP) Note: Excludes patients with immunosuppression.	*E. coli,H. influenzae, Klebsiella spp., Proteus spp., Serratia marcescens, S. pneumoniae, S. aureus , MRSA, Pseudomonas, Acinetobacter spp.*	**Cefepime 2g IV q8h OR Piperacillin/ tazobactam 4.5g IV q6h OR Meropenem 2g IV q8h PLUS Vancomycin (see page 156-161 for dosing recommendations) +/- Aminoglycoside [See page 150-153 for dosing recommendations]**	Ciprofloxacin 400mg IV q8h PLUS Vancomycin (see page 156-161 for dosing recommendations) +/- Aminoglycoside OR Aztreonam 2g IV q6h PLUS Vancomycin (see page 156-161 for dosing recommendations) +/- Aminoglycoside [See page 150-153 for dosing recommendations]	Therapy duration in the majority of cases should be limited to 7 days. For patients with a NEGATIVE *MRSA* nares swab within 7 days, the likelihood of *MRSA* pneumonia is <5%. Clin Infect Dis 2018;67:1-7
Ventilator Associated Pneumonia (VAP)	*Pseudomonas, Enterobacter, S. marcescens, Klebsiella spp., Acinetobacter,S.aureus, MRSA*	**Cefepime 2g IV q8h OR Piperacillin/ tazobactam 4.5g IV q6h OR Meropenem 2g IV q8h PLUS Vancomycin (see page 156-161 for dosing recommendations) PLUS Aminoglycoside [See page 150-153 for dosing recommendations]**	Ciprofloxacin 400mg IV q8h + Vancomycin (see page 156-161 for dosing recommendations) + Aminoglycoside OR Aztreonam 2g IV q6h + Vancomycin 15-20mg/kg IV q12h + Aminoglycoside [See page 150-153 for dosing recommendations]	See NOTE below this table. Therapy duration in the majority of cases should be limited to 7 days. Call AMP OR ID consult in the setting of vancomycin failure. For patients with a NEGATIVE *MRSA* nares swab within 7 days, the likelihood of *MRSA* pneumonia is <5%. Clin Infect Dis 2018;67:1-7

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NOTE: If HAP/VAP develops during or shortly after antibiotic treatment for a different infection, empiric therapy should involve an agent from a different antibiotic class. Use meropenem in place of cefepime or piperacillin/tazobactam if patient has a history of ESBL or received more than 14 days of cefepime or piperacillin/tazobactam in last 30 days. In HAP add aminoglycoside if patient received IV antibiotics in last 90 days, requires ventilatory support due to pneumonia, has septic shock, structural lung diseases or respiratory sample gram stain with numerous and predominant gram-negative rods. In VAP aminoglycosides are recommended due to antipseudomonal resistance for cefepime, piperacillin/tazobactam, ciprofloxacin, aztreonam, and meropenem of more than 10% (See pages 5-12, 14-16 for Antibiogram); otherwise recommended for patients with: ARDS or acute renal replacement preceding VAP, receipt of IV antibiotic course in last 90 days, hospitalization for 5 or more days before VAP, or structural lung disease.

ANTIMICROBIAL RECOMMENDATIONS IN PULMONARY DISEASE (CONTINUED)

Diagnosis (Modifying Factors)	Likely Pathogens	First Line Empiric Therapy	Alternative	Comments
Pneumocystis Pneumonia (PCP)[7]	*Pneumocystis jiroveci* (Previously known as *Pneumocystis carinii*)[7]	**IV/PO Therapy (IV preferred): TMP/SMX 5mg/kg[8] IV q8h x 21 days PLUS Adjunctive steroid therapy[6]** (see Notes in Comments section see dosing table below)	Consult Infectious Diseases	Note: Adjunctive steroid therapy typically reserved for sicker patients (PaO2 < 70mmHg OR Aa gradient >35mmHg).[6] Note: Start adjunctive steroid therapy as early as possible for maximal benefit, but definitely within 24 to 72 hours of antipneumocystis therapy[6]

PCP Adjunctive Therapy (Route)	Days 1 through 5	Days 6 through 10	Days 11 through 21
Prednisone (PO)	40mg PO q12h	40mg PO q24h	20mg PO q24h
Methylprednisolone (IV)	30mg IV q12h	30mg IV q24h	15mg IV q24h

Note: *If patient can tolerate PO administer prednisone; if not, administer methylprednisolone.*

TMP/SMX = Trimethoprim/sulfamethoxazole
** Please use the CAP PowerChart care set.*
[1] CAP: Community-acquired pneumonia; HAP: Hospital-acquired pneumonia; VAP Ventilator-associated pneumonia
[1] ATS/IDSA Guidelines for CAP in Adult. Clin Infect Dis 2007; 44:S27-72.
[2] Am J Respir Crit Care Med 2005;171:388-416.
[3] Patients with CAP caused by penicillin susceptible S. pneumoniae (using non-meningitis criteria for susceptibility when meningitis is not a concern) should be treated with penicillin whenever possible.
[4] Necrotizing or cavitary pneumonia is a risk for community-acquired methicillin-resistant staphylococus aureus (CA-MRSA). Add vancomycin to the antibiotic regimen in this setting. Sputum samples should be obtained, but preferably quantitative broncheoalveolar lavage.
[5] JAMA 2003; 290:2588-98.
[6] New Engl J Med 1990;323:1500-4.
[7] Despite the nomenclature change from Pneumocystis carinii *to* Pneumocystis jiroveci *to reflect its proper classification as a fungus and not a protozoa, the acronym "PCP" has been retained and can still be used when referring to the disease. The interested reader is directed to: Emerg Infect Dis 2002;8:891-6.*
[8] Dosing of IV TMP/SMX as mg per kg is based on the trimethoprim component. One TMP/SMX double strength (DS) tablet contains 160mg of the trimethoprim component

ANTIMICROBIAL RECOMMENDATIONS IN GASTROINTESTINAL INFECTIONS

Reference CP-72 Desensitization and Graded Challenges and Beta-lactam Allergy Assessment Pathway on pages 32-35.

Diagnosis (Modifying Factors)	Likely Pathogens	First Line Empiric Therapy	Alternative	Comments
Prophylaxis of spontaneous bacterial peritonitis (SBP)	*E. coli, Klebsiella spp., Streptococcal spp., Enterobacter spp, Enterococcus spp.,* and potential for other nosocomial Gram negatives	TMP/SMX DS one tablet PO q24h	TMP/SMX DS one tablet PO q24h	Ciprofloxacin 500mg PO q24h after TMP/SMX prophylaxis failure OR in clinical considerations (unable to tolerate TMP/SMX, etc.)
Peritonitis prophylaxis after large GI bleed in patients with cirrhosis	*E. coli, Streptococcus* spp., *Klebsiella spp.*	Ceftriaxone 1g IV q24h	Ciprofloxacin 400mg IV q12h	When able to take PO, consider switching to TMP/SMX 1 DS q12h OR Ciprofloxacin 500mg PO q12h.
Spontaneous Bacterial Peritonitis	*E. coli, Streptococcus* spp., *Klebsiella spp.*	Ceftriaxone 2g IV q24h	Tigecycline 100mg IV x 1, then 50mg IV q12h	Fluoroquinolones should be avoided In patients that failed ciprofloxacin prophylaxis for SBP See Ref. 1 bottom of this table for indications for antifungal therapy. Duration of therapy for most patients is 5 days.
Mild to moderate severity Community-acquired Intra-abdominal infection	*E. coli, Klebsiella spp., Streptococcal spp., anaerobes*	Ceftriaxone 1g IV q24h PLUS Metronidazole 500mg IV q8h	Tigecycline 100mg IV x 1, then 50 mg IV q12h	Patients undergoing cholecystectomy for acute cholecystitis should have antimicrobial therapy discontinued within 24 hours unless evidence of infection outside the wall of the gallbladder. In patients with complicated intraabdominal infections with adequate source control, outcomes after 4 days of antimicrobial therapy were no different than longer courses (STOP-IT trial)[2]. Minimum 7 days if bacteremia. See Ref. 1 below regarding indications for antifungal therapy.

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Diagnosis (Modifying Factors)	Likely Pathogens	First Line Empiric Therapy	Alternative	Comments
High risk/severity Community-acquired OR Healthcare-associated intra-abdominal infection	*E. coli*, *Klebsiella spp.*, *Streptococcal spp.*, *Enterobacter spp*, *Enterococcus spp.*, and potential for other nosocomial Gram negatives, anaerobes	Cefepime 2g IV q8h PLUS Metronidazole 500mg IV q8h OR Piperacillin/ Tazobactam 4.5g IV q6h PLUS Vancomycin IV (see page 156-161 for dosing recommendations) OR Linezolid 600mg IV q12h if VRE coverage indicated	Aztreonam 2g IV q8h PLUS Metronidazole 500mg IV q8h PLUS Vancomycin (see page 156-161 for dosing recommendations) OR Linezolid 600mg IV q12h if VRE coverage indicated +/- gentamicin (see page 150-153 for dosing recommendations) OR Ciprofloxacin 400mg IV q8h PLUS Metronidazole 500mg IV q8h PLUS vancomycin IV (see page 156-161 for dosing recommendations) OR Linezolid 600mg IV q12h if VRE coverage indicated PLUS tobramycin IV (see comment)	High severity defined as severe physiologic disturbance, advanced age, or immunocompromised status. In patients with complicated intraabdominal infections with adequate source control, outcomes after 4 days of antimicrobial therapy were no different than longer courses (STOP-IT trial)[2]. Minimum 7 days if bacteremia. See Ref. 1 below regarding indications for antifungal therapy.
Crohn's disease flare (ileitis, colitis, perineal, OR perianal disease)		Metronidazole 500mg PO q8h OR Ciprofloxacin 500mg PO q12h PLUS Metronidazole 500mg PO q8h		Data showing efficacy limited. Reasonable when abscess accompanies flare.
C. difficile disease	*C. difficile*	See Treatment Recommendations in *C. difficile* section on Pgs 139-142		

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[1] Empiric antifungal therapy for Candida is not recommended in patients with community acquired intra-abdominal infections. Candida albicans or other fungi are cultured from ~20% of patients with acute perforations of the GI tract. Even when fungi are recovered, antifungal agents are unnecessary in adults unless the patient recently has received immunosuppressive therapy for neoplasm or has a perforation of a gastric ulcer on acid suppression, or malignancy, transplantation, or inflammatory disease, or has postoperative or recurrent intra-abdominal infections. In these settings, fluconazole should be selected unless the patient is critically ill, in which case choose caspofungin (Clin Infect Dis 2010;50:133-64; Surgery 1980;88:524-30; Lancet 1989;2:1437-40).

[2] N Engl J Med 2015; 372:1996-2005. Trial of Short-Course Antimicrobial Therapy for Intraabdominal Infection.

ANTIMICROBIAL RECOMMENDATIONS IN SKIN/SOFT TISSUE INFECTIONS (SSTI)

Reference CP-72 Desensitization and Graded Challenges and Beta-lactam Allergy Assessment Pathway on pages 32-35.

SSTI Infection severity

Systemic signs/symptoms of infection include temperature > 38 C, heart rate >90bpm, respiratory rate >24bpm, WBC >12,000 (or >10% bands), fluctuance, crepitus, lymphadenopathy, rapid progression, and excessive tenderness.

- Mild: surface area less than 75cm^2 or ~12in^2 (approximate size of standard smartphone) without systemic signs of infection and without documented failure of oral antibiotics
- Moderate: minimum surface area 75cm^2 or ~12in^2 (approximate size of standard smartphone) with systemic signs/symptoms of infection
- Severe (non-necrotizing): minimum surface area 75cm^2 or ~12in^2 (approximate size of standard smartphone) with 2 or more systemic signs/symptoms of infection and documented failure of oral antibiotics and irrigation and debridement (purulent infections), or who are: immunocompromised, or those with clinical signs of deeper infection such as bullae, skin sloughing, hypotension, or evidence of organ dysfunction

ANTIMICROBIAL RECOMMENDATIONS IN SKIN/SOFT TISSUE INFECTIONS (SSTI) (CONTINUED)

	Likely Pathogens	First Line Empiric Therapy	Alternative	Comments
Non-purulent SSTI[1] (cellulitis)	Streptococci	Mild infection: PO therapy: Cephalexin 500mg PO q6h OR Dicloxacillin 500mg PO q6h Moderate Infection: IV therapy: Oxacillin 2g IV q4h OR Cefazolin 1g IV q8h Severe Infection (non-necrotizing): Vancomycin (see page 156-161 for dosing recommendations) +Cefepime 1g IV q6h	Mild Infection: PO therapy: TMP/SMX DS 1-2 tablets q12h Moderate Infection: IV therapy: Vancomycin (see page 156-161 for dosing recommendations) Severe Infection (non-necrotizing): Vancomycin (see page 156-161 for dosing recommendations) + Aztreonam 2g IV q8h	Cellulitis rarely presents with involvement of bilateral limbs. Bilateral erythema is likely indicative of another process (e.g. venous stasis). Duration depends on clinical response. Note: resolution of erythema often occurs after improvement in fever and systemic symptoms uncomplicated: 5 days complicated: 7-10 days Additional Management: Elevate affected area as much as possible. For non-purulent SSTI, outline area of erythema at time of diagnosis to evaluate for improvement OR worsening of cellulitis after starting antibiotic therapy (note that cutaneous inflammation may worsen slightly despite appropriate antibiotic therapy). If patient fails to improve after 72 hours of treatment, consider ID consult and/or addition of *MRSA* coverage if not provided by current therapy (See section on CA-*MRSA* on pages 26-27)
Purulent SSTI[1] (furuncle, carbuncle, abscess) Perform I&D AND send for culture and susceptibility	*S. aureus*	Mild Infection: Small cutaneous abscess may be treated with I&D alone Moderate Infection: I&D + PO therapy: TMP/SMX DS 1-2 tablets q12h OR Doxycycline 100 mg q12h Severe Infection (non-necrotizing): I&D + IV therapy: Vancomycin (see page 156-161 for dosing recommendations)	Empiric options listed are safe for use in setting of PCN allergy	

ANTIMICROBIAL RECOMMENDATIONS IN SKIN/SOFT TISSUE INFECTIONS (SSTI) (CONTINUED)

Necrotizing soft tissue infections *refer to NSTI PowerPlan*	Group A Strep; Polymicrobial (Aerobic and Anaerobic Gram-negative and Gram-positive)	Piperacillin/tazobactam 4.5g IV q6h PLUS Linezolid 600mg IV/PO q12h If Group A Strep is Known Sole Pathogen: Penicillin G 4 million units IV q4h PLUS Linezolid 600mg IV q12h	Aztreonam 2g IV q8h PLUS Linezolid 600mg IV/PO q12h PLUS Metronidazole 500mg IV q8h If Group A Strep is Known Sole Pathogen: linezolid 600mg IV q12h	If history of colonization OR infection with multi-drug resistant Gram-negatives consider ID consult. If history of contact with freshwater, seawater, OR raw seafood ADD Doxycycline 100mg IV q12h and consider ID consult. Surgical intervention is essential in patient management. Contraindications for use of Linezolid: platelets <25,000, OR possible exposure to 2 or more scheduled serotonergic medications within past 14 days. Refer to the NSTI PowerPlan for alternative regimens.
Wound infection (nontraumatic)	*S. aureus*	IV therapy: Oxacillin 2g IV q4h OR Cefazolin 1g IV q8h PO therapy: Cephalexin 500 mg PO q6h OR Dicloxacillin 500mg PO q6h OR TMP/SMX 1-2 DS PO q12h	IV therapy: Vancomycin (see page 156-161 for dosing recommendations) PO therapy: TMP/SMX DS 1-2 tablets q12h OR doxycycline 100mg q12h	If wound is of the perineum OR in setting of operation on the GI tract, axilla, OR female genital tract ADD metronidazole 500mg IV q8h for anaerobic coverage.
Wound infection (traumatic and/or severe)	Polymicrobial	Ampicillin/sulbactam 3g IV q6h Severe: Piperacillin/Tazobactam 4.5g IV q6h	Aztreonam 2g IV q8h PLUS Metronidazole 500mg IV 8h PLUS Vancomycin (see page 156-161 for dosing recommendations)	If wound is of the perineum OR in setting of operation on the GI tract, axilla, OR female genital tract ADD metronidazole 500mg IV q8h for anaerobic coverage.

ANTIMICROBIAL RECOMMENDATIONS IN SKIN/SOFT TISSUE INFECTIONS (SSTI) (CONTINUED)

Mediastinitis	*S. aureus,* *S. epidermidis*, Enteric Gram-negatives	Vancomycin (see page 156-161 for dosing recommendations) PLUS Cefepime 2g IV q8h OR Piperacillin /tazobactam 4.5g IV q6h	Vancomycin (see page 156-161 for dosing recommendations) PLUS Ciprofloxacin 400mg IV q8h	Candidal mediastinitis is rare[1,2] Debridement and subsequent deep sternal wound cultures should guide definitive therapy.
Diabetic foot Definitive antibiotic regimen should be based on culture results, images, other investigations, and the initial clinical response	Early: Gram-positives Late: Gram-positives, Enteric Gram-negatives, and anaerobes	Moderate Infection Ampicillin/Sulbactam 3g IV q6h Severe Infection Piperacillin/Tazobactam 4.5g IV q6h PLUS Vancomycin (see page 156-161 for dosing recommendations)	Ciprofloxacin 400mg IV q8h PLUS Metronidazole 500mg IV q8h PLUS Vancomycin (see page 156-161 for dosing recommendations)	If *MRSA* is proven or likely, add Vancomycin (see page 156-161 for dosing recommendations) Culturing clinically uninfected lesions is unnecessary. Superficial cultures are useless. Infection should be diagnosed clinically based on the presence of purulent secretions, OR at least two of the cardinal manifestations of inflammation (redness, warmth, swelling OR induration and pain OR tenderness).

ANTIMICROBIAL RECOMMENDATIONS IN SKIN/SOFT TISSUE INFECTIONS (SSTI) (CONTINUED)

Bite wounds (cat/dog)[1,4]	*Pasteurella spp., S. aureus, Bacteroides tectum, Fusobacterium, Capnocytophaga, Porphyromonas spp.*	PO therapy: Amoxicillin/ clavulanate 875mg/125mg IR PO q12h OR Cefuroxime 500mg PO q12h + Metronidazole 500mg PO q8h IV therapy: Ampicillin/sulbactam 3g IV q6h OR Cefuroxime 1.5g IV q8h + Metronidazole 500 mg IV q8h	PO therapy: Doxycycline 100mg PO q12h OR TMP/SMX DS 1 tablet PO q12h + Metronidazole 500mg PO q8h IV therapy: Doxycycline 100mg IV q12h OR Levofloxacin 500mg IV q24h + Metronidazole 500 mg IV q8h	Length of treatment is shorter for prophylaxis (5 days) vs. active infection (14 days). Dog bites are usually crush injuries and cat bites are typically puncture wounds. TMP/SMX and doxycycline have variable activity against streptococci. Cefuroxime may not cover *Eikenella spp.*, and ceftriaxone can be considered to treat this type of infection.
Bite wounds [1, 3, 4] (human)	*Streptococcus* spp., *Staphylococcus spp., Fusobacterium* spp., *Eikenella spp., Peptostreptococcus spp., Prevotella spp., Porphyromonas spp.*	PO therapy: Amoxicillin/ clavulanate 875mg/125mg PO q12h IV therapy: Ampicillin/sulbactam 3g IV q6h OR Cefuroxime 1.5g IV q8h + Metronidazole 500 mg IV q8h	PO therapy: TMP/SMX DS 1 tablet PO q12h + Metronidazole 500mg PO q8h OR Doxycycline 100 mg PO q12h IV Therapy: Levofloxacin 500mg IV q24h + Metronidazole 500mg IV q8h	

[1]*Clin Infect Dis 2014; 59 (2): e10-52*
[2]*Clin Infect Dis 1997:25:608-13*
[3]*Lancet 2005;366:1695-1703.*
[4] *Int J Antimicrob Agents 2006;27:290-293.*

ANTIBIOTIC RECOMMENDATIONS IN MENINGITIS[§]

Reference CP-72 Desensitization and Graded Challenges and Beta-lactam Allergy Assessment Pathway on pages 32-35.

Diagnosis (Modifying Factors)	Likely Pathogens	First Line Empiric Therapy	Alternative	Comments
Meningitis (Adults >18 y/o and < 50 y/o)	*S. pneumoniae*, Meningococcus	Ceftriaxone 2g IV q12h PLUS Vancomycin (see page 156-161 for dosing recommendations) **AND** **see comment column**	Meropenem 2g IV q8h PLUS Vancomycin (see page 156-161 for dosing recommendations) **AND** **see comment column**	Add dexamethasone 0.15mg/kg IV q6h x 4days with the first dose administered 10–20 minutes before OR at least concomitant with the first dose of antimicrobial therapy.[2] If the CSF culture grows an organism otherthan *S. pneumoniae*, d/c the dexamethasone. An aminoglycoside OR TMP/SMX may be added for synergy with ampicillin in *Listeria meningitis*. However, due to the minimal penetration into the meninges, the utility of aminoglycosides in this situation is debatable.[1]
Meningitis (>50y/o)	*S. pneumoniae*, *Listeria*, Gram-negative bacilli	Ceftriaxone 2g IV q12h PLUS Ampicillin 2g IV q4h PLUS Vancomycin (see page 156-161 for dosing recommendations)	TMP/SMX[4] 5mg/kg IV q8h PLUS Vancomycin (see page 156-161 for dosing recommendations) PLUS Meropenem 2g IV q8h **AND** **see comment column**	
HEAD TRAUMA				
Basilar skull fracture[3]	*S. pneumoniae*, *H. influenza*, group A beta-hemolytic streptococci	Ceftriaxone 2g IV q12h PLUS Vancomycin (see page 156-161 for dosing recommendations)	Ciprofloxacin 400mg IV q8h OR Meropenem 2g IV q8h PLUS Vancomycin (see page 156-161 for dosing recommendations)	Consider Infectious Diseases Consult

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ANTIBIOTIC RECOMMENDATIONS IN MENINGITIS[§] (CONTINUED)

Diagnosis (Modifying Factors)	Likely Pathogens	First Line Empiric Therapy	Alternative	Comments
Penetrating trauma[3]	*S. aureus*, coagulase-negative *staphylococci*, aerobic gram-negative bacilli (including *P. aeruginosa*)	Cefepime 2g IV q8h PLUS Vancomycin IV (see page 156-161 for dosing recommendations)	Ciprofloxacin 400mg IV q8h OR Meropenem 2g IV q8h PLUS Vancomycin IV (see pages 156-161 for dosing recommendations)	Consider Infectious Diseases Consult
Post-neurosurgery[3] or CSF shunt	Aerobic gram-negative bacilli (including *P. aeruginosa*), *S. aureus*, coagulase-negative *staphylococci*	Cefepime 2g IV q8h PLUS Vancomycin IV (see page 156-161 for dosing recommendations)	Ciprofloxacin 400mg IV q8h OR Meropenem 2g IV q8h PLUS Vancomycin IV (see pages 156-161 for dosing recommendations)	Consider Infectious Diseases Consult

[§] New Engl J Med 1997;336:708-16, Clin Infect Dis 2004;39:1267-84
[1] Eur J Clin Microbial Infect Dis 1990;9:206-9
[2] N Engl J Med 2002;347:1549-56
[3] N Engl J Med 2010;362:146-52
[4] mg/kg dosing of TMP/SMX based on the trimethoprim component
[5] Clin Infect Dis 2017;00:1-32

ANTIBIOTIC RECOMMENDATIONS IN ENDOCARDITIS[§]

Reference CP-72 Desensitization and Graded Challenges and Beta-lactam Allergy Assessment Pathway on pages 32-35.

Pathogen specific	Diagnosis (Modifying Factors)	Targeted therapy	Alternative	Comments
Highly penicillin susceptible viridans group streptococci (VGS), *Streptococcus gallolyticus* (bovis), other streptococci with an MIC to pcn ≤ 0.12mcg/ml	Endocarditis (native valve)	**Penicillin G 12-18 million units IV either as a continuous infusion over 24h or in 4 or 6 equally divided doses OR Ceftriaxone 2g IV q24h for 4 weeks OR Penicillin G 12-18 million units IV either as continuous infusion or divided q4h OR Ceftriaxone 2g IV q24h PLUS Gentamicin 3mg/kg IV q24h x 2 weeks.**	Vancomycin (see page 156-161 for dosing recommendations) for 4 weeks. Target vancomycin trough concentration is 10-15mcg/mL. (Consider Infectious Diseases consult for desensitization.)	2-wk regimen not intended for patients with known cardiac or extracardiac abscess or for those with creatinine clearance < 20mL/min, impaired 8th cranial nerve fxn, or *Abiotropha, Granulicatella*, or *Gemella spp.* infection.
	Endocarditis (prosthetic valve)	**Penicillin G 24 million units IV either as a continuous infusion over 24 hours, or in 4 or 6 equally divided doses OR Ceftriaxone 2g IV q24h for 6 weeks, +/- Gentamicin 3mg/kg IV q24h x 2 weeks**	Vancomycin (see page 156-161 for dosing recommendations) for 6 weeks. Target vancomycin trough concentration in this case is 10-15mcg/mL. (Consider Infectious Diseases consult for desensitization.)	Vancomycin is reasonable only for patients unable to tolerate penicillin or ceftriaxone. Gentamicin therapy in this specific setting is not recommended for patients with creatinine clearances <30mL/min.
Native valve endocarditis caused by VGS and *Streptococcus gallolyticus* (bovis) with penicillin MIC of >0.12 to <0.5mcg/mL.		**Penicillin G 24 million units IV either as a continuous infusion over 24 hours, or in 4 or 6 equally divided doses for 4 weeks plus Gentamicin 3mg/kg IV q24h**	Vancomycin (see page 156-161 for dosing recommendations) for 4 weeks. Target vancomycin trough concentration in this case is 10-15mcg/mL. (Consider Infectious Diseases consult for desensitization.)	Ceftriaxone 2g IV q24h monotherapy x 4 weeks may be a reasonable alternative treatment option for VGS isolates that are susceptible to ceftriaxone. Vancomycin is reasonable only for patients unable to tolerate penicillin or ceftriaxone.

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ANTIBIOTIC RECOMMENDATIONS IN ENDOCARDITIS[§] (CONTINUED)

Pathogen specific	Diagnosis (Modifying Factors)	Targeted therapy	Alternative	Comments
Prosthetic valve endocarditis caused by VGS and *Streptococcus gallolyticus* (bovis) with penicillin MIC > 0.12mcg/mL.		**Penicillin G 24 million units IV either as a continuous infusion over 24 hours, or in 4 or 6 equally divided doses OR Ceftriaxone 2g IV q24h for 6 weeks, either of the above PLUS Gentamicin 3mg/kg IV q24h x 6 weeks.**	Vancomycin (see page 156-161 for dosing recommendations) for 6 weeks. Target vancomycin trough concentration in this case is 10-15mcg/mL. (Consider Infectious Diseases consult for desensitization.)	Vancomycin is reasonable only for patients unable to tolerate penicillin or ceftriaxone. See NOTE at the bottom of this table regarding gentamicin serum concentration monitoring.
Viridans group streptococci (VGS) with penicillin MIC ≥ 0.5mcg/ml, and Enterococci susceptible to ampicillin/penicillin G, vancomycin, and gentamicin	Endocarditis (native valve)	**Ampicillin 2g IV q4h for 4-6 weeks (see comment) PLUS Gentamicin 1mg/kg IV q8h x 4-6 weeks. Alternatively, for Enterococcal endocarditis in this row, double beta-lactam therapy for patients with creatinine clearance <50mL/min: Ampicillin 2g IV q4h (renally dosed) PLUS Ceftriaxone 2g IV q 12h**	Vancomycin (see page 156-161 for dosing recommendations) PLUS Gentamicin 1mg/kg IV q8h x 6 weeks (Consider Infectious Diseases consult for desensitization.)	For beta-lactam based therapy, 4 weeks therapy recommended for patients with symptoms of illness < 3 months; 6 weeks therapy recommended for patients with symptoms > 3 months. See NOTE at the bottom of this table regarding gentamicin serum concentration monitoring.
Enterococci susceptible to ampicillin/penicillin G, vancomycin, and gentamicin	Endocarditis (prosthetic valve)	**Ampicillin 2g IV q4h for 4-6 weeks. PLUS Gentamicin 1mg/kg IV q8h x 4-6 weeks. Alternatively, double beta-lactam therapy for patients with creatinine clearance <50mL/min: Ampicillin 2g IV q4h (renally dosed) PLUS Ceftriaxone 2g IV q 12h**	Vancomycin (see page 156-161 for dosing recommendations) PLUS Gentamicin 1mg/kg IV q8h x 6 weeks (Consider Infectious Diseases consult for desensitization.)	See NOTE at the bottom of this table regarding gentamicin serum concentration monitoring.
Enterococci susceptible to penicillin and resistant to Aminoglycosides	Endocarditis (native OR prosthetic valve)	**Ampicillin 2g IV q4h (renally dosed) PLUS Ceftriaxone 2g IV q12h x 6 weeks**	Consult Infectious Diseases for alternative therapy	

NOTE: Although it is preferred that gentamicin (3mg/kg) be given as a single daily dose to adult patients with endocarditis, as a second option, gentamicin can be administered in 3 equally divided doses. When 3 divided doses are used, the dose and/or frequency should be adjusted to achieve peak serum conctentrations of 3-4mcg/mL and trough concentrations of < 1mcg/mL. There are no optimal drug concentrations for single daily dosing.

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ANTIBIOTIC RECOMMENDATIONS IN ENDOCARDITIS[§] (CONTINUED)

Pathogen specific	Diagnosis (Modifying Factors)	Targeted therapy	Alternative	Comments
Enterococcus spp. resistant to penicillin and ampicillin, yet susceptible to vancomycin and gentamicin	Endocarditis (native OR prosthetic valve)	**Vancomycin (see page 156-161 for dosing recommendations) PLUS gentamicin 1mg/kg IV q8h x 6 weeks (See comment)**	If true vancomycin allergy, consult Infectious Diseases for appropriate alternatives.	Consider Infectious Diseases consultation. Adjust gentamicin frequency for renal insufficiency. Target peaks 3-4mcg/ml; targets troughs < 1mcg/ml.
Enterococcus spp. resistant to penicillin, ampicillin, and gentamicin; susceptible only to vancomycin and streptomycin	Endocarditis (native OR prosthetic valve)	**Consult Infectious Diseases**	Consult Infectious Diseases for alternative therapy options.	
Enterococcus spp. resistant to penicillin, ampicillin and vancomycin	Infectious Diseases consultation recommended as therapy options and data are limited			

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ANTIBIOTIC RECOMMENDATIONS IN ENDOCARDITIS[§] (CONTINUED)

Pathogen specific	Diagnosis (Modifying Factors)	Targeted therapy	Alternative	Comments
MSSA	Endocarditis (native valve)	**Oxacillin 12g IV either as a continuous infusion over 24 hours, or in 4-6 equally divided doses for 6 weeks**	Daptomycin 6mg/kg IV q24h x 6 weeks OR Vancomycin (see page 156-161 for dosing recommendations) x 6 weeks (See comment regarding cefazolin therapy.)	Cefazolin 2g IV q8h is an alternative in patients with nonanaphylactoid-type penicillin allergy, however cefazolin should not be used in the setting of brain abscess resulting from MSSA IE due to inadequate blood-brain barrier penetration. Consult with infectious diseases regarding the most appropriate daptomycin dose.
	Endocarditis (prosthetic valve)	**Oxacillin 12g IV either as a continuous infusion over 24 hours, or in 6 equally divided doses for at least 6 weeks PLUS Rifampin 300 mg IV/PO q8h for at least 6 weeks plus Gentamicin 3mg/kg IV q24h for 2 weeks**	Vancomycin (see page 156-161 for dosing recommendations) PLUS Rifampin 300 mg IV/PO q8h for 6 weeks PLUS Gentamicin 3mg/kg IV q24h x 2 weeks. (Consider Infections Diseases consult for desensitization.)	Gentamicin should be administered in close proximity to oxacillin or vancomycin dosing.
	Endocarditis (Uncomplicated right-sided and IV drug user) Native valve only	**Oxacillin 12g IV either as a continuous infusion over 24 hours, or in 4-6 equally divided doses for 2 weeks.**	Consider Infectious Diseases consult for desensitization OR Daptomycin 6mg/kg IV q24h x 14-28 days	

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ANTIBIOTIC RECOMMENDATIONS IN ENDOCARDITIS[§] (CONTINUED)

Pathogen specific	Diagnosis (Modifying Factors)	Targeted therapy	Alternative	Comments
MRSA	Endocarditis (native valve)	**Vancomycin (see page 156-161 for dosing recommendations) x 6 weeks**	Daptomycin 6-8mg/kg IV q24h x 6 weeks OR Vancomycin (see page 156-161 for dosing recommendations) x 6 weeks	Consult Infectious Diseases for most appropriate daptomycin dose.
	Endocarditis (prosthetic valve)	**Vancomycin (see page 156-161 for dosing recommendations) PLUS Rifampin 300mg IV/PO q8h for at least 6 weeks PLUS Gentamicin 3mg/kg IV q24h for 2 weeks**	Vancomycin (see page 156-161 for dosing recommendations) PLUS Rifampin 300mg IV/PO q8h for at least 6 weeks PLUS Gentamicin 3mg/kg IV q24h x 2 weeks	See NOTE at the bottom of this table regarding gentamicin serum concentration monitoring.
HACEK Organisms[2]	Endocarditis (native valve)	**Ceftriaxone 2g IV q24h x 4 weeks**	Consult Infectious Diseases	Desensitization may be necessary in patients with severe PCN allergy.
	Endocarditis (prosthetic valve)	**Ceftriaxone 2q IV q24h x 4 weeks**	Consult Infectious Diseases	Desensitization may be necessary in patients with severe PCN allergy.
Gram-negative	Endocarditis (native OR prosthetic valve)	Consult Infectious Diseases	Consult Infectious Diseases	

[§] N Engl J Med 2001;345:1318-30 Circulation 2015;132:1435-86.

NOTE: Although it is preferred that gentamicin (3mg/kg) be given as a single daily dose to adult patients with endocarditis, as a second option, gentamicin can be administered in 3 equally divided doses. When 3 divided doses are used, the dose and/or frequency should be adjusted to achieve peak serum conctentrations of 3-4mcg/mL and trough concentrations of < 1mcg/mL. There are no optimal drug concentrations for single daily dosing.

[1] Vancomycin troughs should be targeted at 15-20mg/L. based on recommendations from Am J Health-Syst Pharm 2009;66:82-98. It should be noted, however, that the endocarditis guidelines recommend vancomycin troughs of 10-20mcg/ml when Staphylcoccus is the infecting pathogen.

[2] HACEK organisms include: Haemophilus aphrophilus; Haemophilus parainfluenzae; Actinobacillus actinomycetemcomitans; Cardiobacterium hominis; Eikenella corrodens; Kingella kingae.

ANTIBIOTIC RECOMMENDATIONS IN URINARY TRACT INFECTIONS

Reference CP-72 Desensitization and Graded Challenges and Beta-lactam Allergy Assessment Pathway on pages 32-35.

Diagnosis	Likely Pathogens	Empiric Therapy	Alternative	Comments
Asymptomatic Bacteriuria (ASB): A) Growth of ≥1 bacteria spp. ≥105 CFU/ml B) Lack of symptoms: dysuria, suprapubic pain, hematuria, CVA tenderness, new urgency/frequency/ incontinence C) Regardless of pyuria, cloudy OR foul-smelling urine OR recent fall/ functional decline (these are not specific for UTI vs ASB)	*E. coli*, *Enterococcus spp.* (including VRE), *Klebsiella*, Proteus	No therapy indicated[1] EXCEPT: 1. Pregnancy 2. Renal Transplant within 30 days 3. Planned endoscopic urologic procedure (with mucosal trauma) If treatment indicated, treat as per acute cystitis OR with definitive therapy based on culture data. For those with endoscopic urology procedure planned, 1-2 doses of therapy is adequate		ALTERED MENTAL STATUS: Delirium or altered mental status in older adults (without genitourinary symptoms, fevers or hemodynamic instability) should be assessed for other causes and observed, rather than treated for ASB/UTI INDWELLING CATHETERS: Patients with chronic indwelling catheters are at high risk of ASB. Catheters should be changed at least monthly if possible and ASB should not be screened for or treated. If UTI suspected, change the catheter before UA, Urine culture and antibiotics SPINAL CORD INJURY (SCI) PATIENTS SCI patients who present with recent onset or change in fever, malaise, sense of unease, change in urinary incontinence/leaking around catheter, spasticity, back pain, and/or autonomic dysreflexia with no other obvious cause, and in the setting of bacteriuria and pyuria, may have a symptomatic UTI and should be offered treatment.

ANTIBIOTIC RECOMMENDATIONS IN URINARY TRACT INFECTIONS (CONTINUED)

Diagnosis	Likely Pathogens	Empiric Therapy	Alternative	Comments
Acute simple cystitis (No evidence of upper urinary tract involvement, obstruction, anatomic abnormalities, or recent instrumentation)	*E. coli* (~85%), *S. saprophyticus* (10-15%), *enterococci* and other *Enterobacteriaceae*	Nitrofurantoin , macrocrystals 100mg PO q12h x 5d (CrCl≥30 ml/min) OR Cefuroxime 500 mg PO q12h x 7d	Nitrofurantoin , macrocrystals 100mg PO q12h x 5d (CrCl≥30 ml/min) OR Fosfomycin 3g x 1 dose	TMP/SMX and ciprofloxacin no longer recommended empirically due to high rates of *E. coli* resistance. An abnormal urinalysis alone is not an indication for antimicrobial therapy. Absence of pyuria is a strong indication that UTI is not present; do not treat. The following are not specific signs or symptoms for UTI: Foul smelling or cloudy urine, falls or gait instability, functional decline. These findings should not prompt treatment in the absence of other clinical features of infection. Acute mental status change alone is not a criterion for UTI unless the patient has an indwelling urinary catheter and no other explanation.
Acute Uncomplicated Bacterial Pyelonephritis (severe symptoms, hospitalized)	*E. coli* (~85%), *enterococci* and other *Enterobacteriaceae*	Ceftriaxone 2g q24h[3]	Ciprofloxacin 400mg IV q8h + Gentamicin (see aminoglycoside dosing section) or Aztreonam 2g IV q8h	Note on duration: 5-7 days is adequate in patients with appropriate clinical response.[7-8] Some patients may require longer therapy, 10-14 days. Consider oral therapy with signs of clinical improvement (usually within 48-72 hours) with TMP/SMX OR ciprofloxacin OR an oral β-lactam if susceptibility confirmed.[8] For suspected Gram-positive infections, use ampicillin sulbactam ± aminoglycoside.

ANTIBIOTIC RECOMMENDATIONS IN URINARY TRACT INFECTIONS (CONTINUED)

Diagnosis	Likely Pathogens	First Line Empiric Therapy	Alternative	Comments
Complicated Bacterial UTI (urinary tract abnormalities, immunosuppression, pregnancy) Differentiate colonization versus infection based on the following criteria: 1.) Lack of urinary OR infectious symptoms 2.) Lack of pyuria (< 10 WBCs in the urinalysis) 3.) Presence of epithelial cells 4.) Multiple organisms	*Enterobacteriaceae, P. aeruginosa, enterococci*, Group B streptococci	Cefuroxime sodium 1.5g IV q8h Oral Option: Cefuroxime axetil 500 mg PO q12h	Ciprofloxacin 400 mg IV q8h + Gentamicin (see aminoglycoside dosing) OR Aztreonam 2g IV q8h Oral Options: TMP/SMX DS (160-800mg) PO q12h OR Ciprofloxacin 500mg PO q12h if susceptibility confirmed.	Agents listed may not have activity against *Pseudomonas* spp. Streamline therapy based on culture and susceptibility. Change to PO therapy upon signs of clinical improvement (usually 48 to 72 hours). For suspected Gram-positive infections, use ampicillin OR ampicillin/sulbactam ± aminoglycoside. For males, suspect prostatitis if recurrence. Treatment duration depends on patient characteristics and clinical response, 7-14 days recommended. Catheter-associated - 3 days duration appropriate for females <65 y/o without upper tract symptoms after catheter removal -Otherwise, 7 days if prompt response, 10-14 if response delayed.

[1] *Clin Infect Dis 2019; 68 (10) e83–e110*
[2] *Drugs Exp Clin Res 1987; 13:95-99.*
[3] *Clin Infect Dis 2011; 52: e102-e120.*
[4] *Ann Pharmacother 2013; 47 (1): 106-11.*
[5] *J Am Geriatr Soc. 2015; 63 (11): 2227-2246.*
[6] *J Am Ger Soc. 2016; 64:798-805.*
[7] *Am J Med 2017; 130-842.*
[8] *J Antimicrob Chemother 2013; 68: 2183–2191*

TMP/SMX = trimethoprim/sulfamethoxazole (DS = double strength)
TMP = trimethoprim
Nitrofurantoin macrocrystals = Macrobid

EMPIRIC TREATMENT GUIDELINES FOR CANDIDIASIS‡

Infection / Modifying Factors		Primary	Alternative(s)	Duration	Comments
Candidemia	Non-neutropenic adults patients	Caspofungin IV 70mg IV x1, then 50mg IV q24h. Transition to fluconazole after 5-7 days for patients who are clinically stable, have isolates that are susceptible to fluconazole and have negative repeat blood cultures following initiation of antifungal therapy	Fluconazole, IV or oral, (loading dose 800 mg, then 400 mg daily) is an acceptable alternative as initial therapy in select patients, including those who are not critically ill and who are considered unlikely to have a fluconazole resistant Candida species	14 days after last positive blood culture and resolution of signs/ symptoms	Remove IV catheter if possible. All patients should undergo ophthalmological exam to exclude possible endophthalmitis. Persistence of candidemia despite antifungal treatment suggests infected intravascular device, lack of OR inadequate source control significant immunosuppression OR microbiological resistance. Patients on Ampho B should receive hydration. Anidulafungin and micafungin are currently nonformulary, and are considered therapeutically interchangeable with caspofungin.
	Neutropenic Adults	Caspofungin IV 70mg IV x1 , then 50mg IV q24h. Transition to fluconazole after 5-7 days for patients who are clinically stable, have isolates that are susceptible to fluconazole and have negative repeat blood cultures following initiation of antifungal therapy	Fluconazole, intravenous or oral, loading dose 800 mg, then 400 mg daily) is an acceptable alternative in those who are not critically ill and who are considered unlikely to have a fluconazole resistant Candida species	14 days after last positive blood culture and resolution of signs/ symptoms and neutropenia	
Intra-abdominal Candidiasis		Caspofungin 70mg IV x1, then 50 mg q24h OR Fluconazole 6 mg/kg IV q24h (400 mg IV/ PO q24h for 70 kg patient)	Vorizonazole 200-300mg (3-4mg/kg) q12h OR posaconazole delayed-release tab 300mg q24h. Can be used for isolates susceptible to these agents but not susceptible to fluconazole	Duration depends on adequacy of source control and clinical response	For patients treated with voriconazole, check voriconazole trough level after ~1 week, and keep trough level ~ 1-2 mcg/mL. Targeted therapeutic dose window is between 1-5 mcg/mL Consult ID
Endocarditis		(Consult Infectious Diseases) Ambisome 3-5 mg/kg IV q24h +/- Flucytosine 25 mg/kg PO q6h* See note in comment section	Consult Infectious Diseases	At least 6 weeks	Fluconazole 200-400 mg PO q24h is recommended to prevent recurrence, especially when valve surgery is not an option

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EMPIRIC TREATMENT GUIDELINES FOR CANDIDIASIS‡(CONTINUED)

Infection / Modifying Factors	Primary	Alternative(s)	Duration	Comments
Endophthalmitis	For fluconazole/voriconazole[R] susceptible isolates, fluconazole, loading dose 800 mg, then 400-800 mg daily OR voriconazole, loading dose 6 mg/ kg IV bid for 2 doses, then 4 mg/kg IV OR 200mg PO twice daily. For fluconazole/ voriconazole resistant Isolates, liposomal AmB, 3-5 mg/kg IV daily, with OR without oral flucytosine, 25 mg/kg 4 times daily	Ambisome 5 mg/kg IV q24h (consider increase to 10mg/kg if no response)	≥ 4-6 weeks until complete resolution of visible disease whichever is longer	Ophthalmology and Infectious Diseases consult. Consider intravitreal therapy for macular involvement. For patients treated with voriconazole, trough level after ~1 week should be performed. Targeted therapeutic dose window is between 1-5 mcg/mL
Meningitis	(Consult Infectious Diseases) OR Ambisome 5 mg/kg IV q24h PLUS Flucytosine 25mg/kg PO q6h (request I.D. consultation)	Consult Infectious Diseases	Minimum of 4 weeks after resolution of all signs and symptoms associated with infection	Check flucytosine level if > 2 weeks of therapy or with renal insufficiency. Keep peak serum concentration between 40-60mcg/ml. Candida meningitis associated with neurosurgical procedures should include removal of ventricular devices if possible (See NOTE below)
Mucocutaneous candidiasis Oropharyngeal ("Thrush")	Mild disease - Nystatin 200,000 - 400,000 Units PO 5 times/day. Moderate to severe disease: Fluconazole 200mg loading dose x 1, then 100mg PO q24h. (For fluconazole-refractory disease: Itraconazole oral solution 200mg PO q24h	For fluconazole Refractory Disease: Voriconazole 200 mg q12h, OR AmB deoxycholate oral suspension, 100 mg/ml four times daily	7-14 days after clinical improvement	Most patients respond initially to topical therapy, but relapses occur sooner with topical therapy. Recurrent infections are common in patients with immunosuppression, especially AIDS. Resistance may develop with either topical or systemic therapy.

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EMPIRIC TREATMENT GUIDELINES FOR CANDIDIASIS‡(CONTINUED)

Infection / Modifying Factors	Primary	Alternative(s)	Duration	Comments
Esophageal	Fluconazole 200-400mg IV/PO q24h	Refractory Disease Capofungin 50 mg IV q24h	14-21 days after clinical improvement	Recurrent infections are observed more commonly in patients treated with an echinocandin agent.
Urinary Candidiasis	Treatment indicated only in symptomatic patients, renal transplant patients within 6 months of transplant, neutropenic patients, and in those who will soon undergo surgical manipulation of the urinary tract, independent of the U/A results. For patients w/ urinary catheter in place, remove or replace the catheter. In patients meeting the above criteria fluconazole 200mg PO or IV q24h For patients undergoing urological procedures, Fluconazole 400mg	Amphotericin B deoxycholate IV 0.3mg/kg/day	7-14 days	Neither capofungin nor voriconazole have good urinary tract penetration and should not be used for UTI. Do not treat asymptomatic candiduria in non-neutropenic, catheterized patients. Removal of urinary devices is often helpful. If removal of a device is not possible, replacement is beneficial.
Vaginal Candidiasis Uncomplicated (mild to moderate severity, sporadic frequency, normal host, presumed pathogen *C. albicans*)	Fluconazole 150 mg PO x 1 dose	Topical over-the counter azoles: butoconazole, clotrimazole, miconazole, tioconazole, terconazole	1-7 days depending upon chosen regimen	~ 90% of cases are uncomplicated.

NOTE: Fluconazole can be considered 400-800mg daily as step down therapy after Ampho for patients who show full response to initial meningitis therapy.
‡ Adapted from IDSA Guideline for treatment of candidiasis. Clin Infect Dis 2016.
AmphoB = amphotericin B deoxycholate;

ANTIFUNGAL RECOMMENDATIONS IN SYSTEMIC FUNGAL INFECTIONS

Infection / Modifying Factors	Primary	Alternative(s)	Duration	Comments
Allergic bronchopulmonary aspergillosis	[1,2] Corticosteroids	[2]Itraconazole oral solution 200 PO q12h (steroid-sparing regimen)		
Aspergilloma	No therapy OR surgical resection			Do not use voriconazole in severe cirrhosis unless the benefit outweighs the risk. Caspofungin is not FDA-approved for initial treatment of invasive aspergillosis, but only in refractory patients OR those intolerant to other therapies. Check voriconazole level after ~1 weeks, and keep trough level 1-2mcg/mL. Consult ID. Targeted therapeutic voriconazole dose window is between 1-5 mcg/mL
Invasive aspergillosis (pulmonary, extra-pulmonary)	(Please see note at end of table on pg. 66) Voriconazole 6 mg/kg IV q12h x 2 doses, then 4 mg/kg IV q12 h x at least 7 days; convert to PO as soon as possible[1]; 200 mg PO q12h (> 80kg) and 100 mg PO q12h (< 80 kg); The dose must be adjusted for mild to moderate hepatic cirrhosis (see comments).	Ambisome 5 mg/kg IV q24h		
Blastomycosis pulmonary infection and extra-CNS disease	(Please see note at end of table on page 66.)	Severe; Ambisome 5 mg/kg IV q24h	Severe; > 6 months	

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Antimicrobial Agent

Infection / Modifying Factors	Primary	Alternative(s)	Duration	Comments
Blastomycosis Pulmonary infection and extra-CNS disease	**Severe:** **Ambisome 5mg/kg IV q24h, until stable/improved then itraconazole1 200 mg PO q8h x3 days, then 200-400 mg PO q24h** **Mild-Moderate:** **Itraconzale[1] 200 mg PO q8h x 3 days, then 200-400 mg PO q24h**	Mild-Moderate: Fluconazole 400-800 mg PO q24h OR ketoconazole 400-800 mg PO q24h	Mild-Moderate: > 6 months	**(Please see note at end of table on page 66.)** The primary treatment course of Ampho B should be followed with suppressive therapy in immunosuppressed patients.
Blastomycosis CNS disease	Ambisome 5mg/kg IV q24h	Ambisome 5 mg/kg IV q24h	> 4 weeks	
Candidiasis	See Empiric Treatment Guidelines for Candidiasis section			
Coccidioidomycosis Pulmonary and extra-CNS disease	**(Please see note at end of table on page 66.)** **Severe:** **Ambisome 5mg/kg IV q24h until stable/improved, then fluconazole 800mg or Itraconazole 200mg POq8hx3days then 200mg POq12h PO q24h**	Severe; Ambisome 5 mg/kg IV q24h	Severe: > 1 year	For acute pulmonary infection, treatment is indicated only for patients with immunosuppression, 3rd trimester pregnancy, OR severe disease (weight loss 10%, intense night sweats > 3 weeks), infiltrates > 1/2 lung, CF titer > 1:16, prominent OR persistent hilar adenopathy.
Coccidioidomycosis Pulmonary and extra-CNS disease	**Moderate to Severe:** **Itraconazole[1] 200 mg PO q8h x 3 days, then 200 mg PO q12h or fluconazole 400 mg PO q24h**	Moderate to Severe: Ambisome 5mg/kg IV q24h	Moderate to Severe: 3-6 months	ARDS presentation: give concomitant prednisone 60-80 mg/d PO until improved then taper. In pregnancy use amphotericin B deoxycholate 0.5-0.7 mg/kg IV q24h

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Antimicrobial Agent

Infection / Modifying Factors	Primary	Alternative(s)	Duration	Comments
Coccidioidomycosis CNS disease	**(Please see note at end of table on page 66.)** **Fluconazole 400-1,200 mg IV/ PO q24h until improved then fluconazole 400 mg q24h PO lifelong**	Intrathecal amphotericin B deoxycholate 0.1-1.5 mg Itraconazole[1] 200 mg PO q8h x 3 days, then 400-600 mg q24h		**(Please see note at end of table on page 66.)**
Cryptococcosis Pulmonary disease	**(Please see note at end of table on page 66.)** **Severe:** **Ambisome 5mg/kg IV q24h until improved, then fluconazole 400 mg PO q24h** **Mild to Moderate[2]:** **Fluconazole 400 mg PO q24h**	Severe: Ambisome 5 mg/kg IV q24h then fluconazole 400 mg PO q24h OR itraconazole[1] 200 mg PO q24h Mild to Moderate: Itraconazole[1] 200-400 mg q24h	Severe: 6-12 months Mild to Moderate: 6-12 months	Lumbar puncture should be performed to rule out CNS Involvement (exception: normal host with asymptomatic nodule(s), no CNS symptoms, and low OR absent serum cryptococcal antigen). All immunosuppressed patients with pulmonary cryptococcosis should be treated.

continued on next page

Antimicrobial Agent

Infection / Modifying Factors	Primary	Alternative(s)	Duration	Comments
Cryptococcosis* (meningoencephalitis)	**• HIV-infected patients:** **Induction and Consolidation:** **Ambisome 3-4mg/kg IV q24h + flucytosine 25mg/kg PO qid for at least 2 weeks, then fluconazole 400 mg PO q24h for a minimum of 8 weeks** **Maintenance:** **Fluconazole 200 mg PO q24h** **• Transplant patients:** **Induction:** **Ambisome 6mg/kg IV q24h + flucytosine 25 mg/kg PO qid x at least 2 weeks, then fluconazole 400-800 mg/d x 8 weeks, then fluconazole 200-400mg PO q24h for 6-12 months as maintenance** **• Non-HIV and non-transplant patients:** **Induction:** **Ambisome 3-4mg/kg IV q24h, + flucytosine 25 mg/kg PO q6h x 4-6 weeks, then fluconazole 400 mg PO q24 h x 8 weeks.**	• HIV-infected patients: Induction: Ambisome 3-4 mg/kg IV q24h then fluconazole 400 mg PO q24h Maintenance: Itraconazole[1] 200-400mg PO q24h OR ampho B 1 mg/kg IV 3x/week • Transplant patients: Consult Transplant Infectious Diseases • Non-HIV and non-transplant patients: Consult Transplant Infectious Diseases	• HIV-infected patients: Maintenance: 1 year minimum. Antifungal therapy can be discontinued after introduction of ART and achievement of CD4 count of >100 cells/mcL and an undetectable OR low HIV RNA level sustained for ≥ 3 months and at least a year of antifungal therapy • Transplant patients: Maintenance: 6 months to 1 year • Non-HIV and non-transplant patients: Maintenance: 6 months to 1 year	Serum flucytosine levels should be measured after 3 to 5 days of therapy, with a target 2-hour post dose level of 30-80mcg/ml; flucytosine levels >100mcg/ml should be avoided. In HIV-infected patients, begin HAART 2-10 weeks after start of initial antifungal treatment. *See note end of page 66.

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Antimicrobial Agent

Infection / Modifying Factors	Primary	Alternative(s)	Duration	Comments
Histoplasmosis (Pulmonary and disseminated)	**(Please see note at end of table on page 66.)** **Severe:** **Ambisome 5mg/kg IV q24h then itraconazole[1] 200 mg PO q8h x 3 days, then 200 PO mg q12h** **Mild to Moderate Disease:** **Itraconazole[1] 200 mg PO q8h x 3 days, then 200 mg PO q12h**	Severe: Ambisome 5 mg/kg IV q24h	12 weeks for acute pulmonary disease 12-24 months for chronic pulmonary OR disseminated disease.	Treatment not necessary for mild-to-moderate acute pulmonary histoplasmosis of symptoms of < 1 month duration. *See note end of page 66.
Mucormycosis	**(Please see note at end of table on page 66.)** **Ambisome 5 mg/kg IV q24h**	Ambisome IV q24h up to 10mg/kg for severe OR worsening infection OR Posaconazole DR tabs, 300mg PO q12h on day 1, then 300mg q24h thereafter	> 6 months	Surgical debridements, normalization of glucose and blood pH, and minimization of immunosuppressed agents are strongly recommended. *See note end of page 66. Check posaconazole trough level ~1 week after initiation. Treatment efficacy is associated with level >1 mcg/mL.
Sporotrichosis • Cutaneous	**Itraconazole[1] 200 mg PO q24h (or q12h for severe cases)**	Terbinafine 500 mg PO bid OR SSKI 40-50 drops q8h	3-6 months	*See note end of page page 66.

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Antimicrobial Agent

Infection / Modifying Factors	Primary	Alternative(s)	Duration	Comments
Sporotrichosis • Deep-seated infection (mild to moderate)	**Itraconazole[1] 200 mg PO q8h, then 200 mg PO q12h**	OR Ambisome 5 mg/kg IV q24h until stable then itraconazole[1] 200 mg PO q8h, then 200 mg PO q12h	12 months	See note end of this page.
Sporotrichosis • Disseminated/ meningeal/severe deep-seated infection		When clinically stable and improved, de-escalate to itraconazole[1] 200 mg PO q8h then 200 mg PO q12hh	12 months	See note end of this page.

[1]Therapy can be switched to PO before 7 days are completed at 4mg/kg. Complete the 7-day duration at 4mg/kg PO then switch dose to 200mg PO BID.
**Clin Infect Dis 2010;50: 291-322*
[1]Check itraconazole trough level after 2 weeks and keep levels ≥1 mg/L. Toxicity is associated with trough levels >5 mg/L.
[2]Absence of diffuse infiltrates, no severe immunosuppression, and negative work-up for dissemination.
[3] N Engl J Med 2002;347:408-15.

Note: Due to the rarity and/or complexity of certain fungal infections listed in the above tables coupled with the often unique patient-specific scenario, please consult Infectious Diseases for expertise in antifungal agent selection, management, and treatment duration.

GUIDE TO ANTIMICROBIAL CHEMOTHERAPY — ELECTRONIC FORMAT

ACCESSING THE GUIDE IN ELECTRONIC VERSION:

Starting at the Infonet homepage — (Infonet.UPMC.com)

1.) In the Search the Infonet search bar, type "Antimicrobial Guide"

2.) A link to the PDF version of the 2020-2021 antimicrobial guide will appear in the search results

3.) Click on the link to launch the guide in your browser

ANTIMICROBIAL PROPHYLAXIS IN HEMATOPOIETIC CELL TRANSPLANT (HCT)

	Duration	Prophylaxis	Alternative Prophylaxis
Antibacterial Prophylaxis	Pre-engraftment (neutropenic): Start Day -2 and continue until ANC ≥500 x 1-3 days or until initiation of empirical antibacterial therapy for febrile neutropenia	Levofloxacin 500 mg po daily*	Ciprofloxacin 500 mg po BID* OR Cefuroxime 500 mg po BID*
	Chronic GVHD or hypogammaglobulinemia: Consider prophylaxis to prevent infection with *Streptococcus pneumoniae*	Penicillin VK 500 mg po BID	Cefuroxime 500 mg po BID* OR Azithromycin 250 mg po daily
Antifungal Prophylaxis	Pre-engraftment (neutropenic): Start at Day -2 and continue until ANC ≥500 x 1-3 days (auto-HCT) or until 3 months after discontinuation of immunosuppression (allo-HCT).	Fluconazole 200 mg po daily*	Caspofungin 70 mg IV x1, then 50 mg IV daily OR Voriconazole 4 mg/kg IV BID*† (or PO as clinically appropriate) OR Posaconazole 300 mg IV Q24hrs (no load required when indication is prophylaxis) OR Fluconazole 400mg po daily*
	GVHD: Consider mold-active antifungal prophylaxis in high risk patients: • Grade 2-4 acute GVHD or chronic GVHD treated with ≥ 2 immunosuppressive therapies	Posaconazole tablets 300 mg po daily (no load required when indication is prophylaxis)*	
Antiviral Prophylaxis-HSV/VZV	Start at Day -2. Auto-HCT (no bortezomib): continue until day +30 Auto-HCT (received bortezomib): continue for at least 6 months Allo-HCT: continue for 1 year, or longer if GVHD or on immunosuppression (may stop 6 mo. after discontinuation of immunosuppression)	Acyclovir 800 mg po BID* OR Acyclovir 200mg IV Q8 hrs*	Valacyclovir 500 mg po BID* Note: patients receiving valganciclovir, ganciclovir, cidofovir or foscarnet do not need acyclovir/valacyclovir therapy
			Dose adjustment may be required for patients with renal and/or hepatic dysfunction. ***†Consider monitoring voriconazole serum levels as clinically appropriate.***

ANTIMICROBIAL PROPHYLAXIS IN HEMATOPOIETIC CELL TRANSPLANT (HCT)

	Duration	Prophylaxis	Alternative Prophylaxis
CMV prophylaxis	Consider CMV prophylaxis with letermovir in high-risk patients starting between day 0 and day +28 and continuing through day +100: • CMV-seropositive recipient AND • Related donor with mismatch at either HLA-A, B, or DR; unrelated donor with mismatch at either HLA-A, B, C, or DRB1; haploidentical donor; cord blood; ex vivo T-cell-depleted drafts; grade 2-4 GVHD requiring prednisone (equivalent) of at least 1mg/kg/day	Letermovir 480mg po daily (Letermovir 240mg po daily if on concurrent cyclosporine) Note: these patients still require acyclovir prophylaxis and preemptive CMV management	
CMV viremia or disease	Consult Infectious Diseases		
PCP Prophylaxis	Allo-HCT patients only: The first pentamidine administration is to be given on day of admission prior to the start of the conditioning regimen and continued for 6 months. Patients who are still receiving immunosuppression or who have cGVHD beyond 6 months should continue to receive PJP prophylaxis until all immunosuppressive agents are discontinued.	Pentamidine 4 mg/kg IV every 4 weeks starting prior to conditioning therapy Switch to TMP/SMX 1 DS tablet PO 3 times/week if in complete remission with stable blood counts and 100% donor chimerism. In particular, patients who have a positive toxoplasmosis IgG pre-transplant should be switched to TMP/SMX.	TMP/SMX 1 DS tablet po 3 times/week (begin at day +28 if ANC ≥500) OR TMP/SMX 1 SS tablet po daily (begin at day +28 if ANC ≥500) OR Dapsone 100 mg PO daily (screen for G6PD deficiency) OR Atovaquone 1500 mg PO daily with food
Toxoplasmosis Prophylaxis	Seropositive allogeneic HCT recipients: start at engraftment and continue for duration of immunosuppressive therapy.	TMP/SMX 1 DS tablet po 3 times/week OR TMP/SMX 1 SS tablet po daily	Clindamycin 300-450 mg orally every 6-8 hrs PLUS Pyrimethamine 25-75 mg orally daily PLUS Leucovorin 10-25 mg orally daily
			Dose adjustment may be required for patients with renal and/or hepatic dysfunction. ***†Consider monitoring voriconazole serum levels as clinically appropriate.***

ANTIMICROBIAL PROPHYLAXIS IN HEMATOLOGY/ONCOLOGY PATIENTS (NON-HCT)

• Consider prophylaxis during period of neutropenia for high-risk patients with expected prolonged and profound neutropenia (ANC ≤100 cells/mm^3 for >7 days).
• Note: The majority of patients with solid tumors undergoing conventional chemotherapy with or without biologics do not routinely require antimicrobial prophylaxis.

	Antimicrobial Prophylaxis	Alternative Prophylaxis
Antibacterial	Levofloxacin 500 mg po daily*	Ciprofloxacin 500 mg po BID* OR Cefuroxime 500 mg po BID*
Antifungal	Fluconazole 200-400 mg po daily*	Patients with acute myeloid leukemia or myelodysplastic syndrome should receive posaconazole during induction therapy (unless posaconazole therapy is precluded by an unavoidable drug-drug interaction [eg, midostaurin], in which case use fluconazole or caspofungin) • Posaconazole delayed-release tablet: 300 mg PO daily (no load required when indication is prophylaxis)* • Posaconazole intravenous: 300mg IV Q24hrs (no load required when indication is prophylaxis)*
Antiviral (HSV, VZV)	Acyclovir 800 mg po BID*	Valacyclovir 500mg po BID*
HBV[a]	Consider GI/Hepatology consult for patients at high risk for HBV reactivation	
PJP[b]	Pentamidine 4 mg/kg IV monthly* OR TMP/SMX 1 DS tablet PO 3 times/week* OR TMP/SMX 1 SS tablet PO daily*	Dapsone 100 mg PO daily (screen for G6PD deficiency) OR Atovaquone 1500 mg PO daily with food

a. Patients receiving anti-CD20 (e.g. rituximab) OR anti-CD52 (e.g. alemtuzumab) directed therapies should be screened for:
  • Hepatitis B surface antigen (HBsAg)
  • Hepatitis B core antibody (HBcAb)
  • Patients at high risk for reactivation of HBV (HBcAb positive OR HBsAg positive) should be considered for prophylactic therapy with entecavir

b. Hematology/Oncology Indications for PJP Prophylaxis:
  • Prednisone ≥ 20 mg daily (or equivalent) for > 1 month
  • Treatment with T-cell depleting agents (e.g. alemtuzumab, purine analogues)
  • Treatment with concomitant temozolomide/radiation therapy
  • Patients with acute lymphoblastic leukemia

*Dose adjustments may be necessary for renal and/or hepatic dysfunction

RISK STRATIFICATION FOR TREATMENT OF FEBRILE NEUTROPENIA

Consider use of the Multinational Association for Supportive Care in Cancer (MASCC) criteria to stratify febrile neutropenia patients into low- or high-risk categories

MASCC Risk-Index Score (max score = 26)

Characteristic	Weight
Burden of febrile neutropenia (CHOOSE ONE)	
Mild symptoms	5
Moderate symptoms	3
Severe symptoms	0
NO hypotension (systolic blood pressure >90 mmHg)	5
NO active chronic obstructive pulmonary disease - Requiring treatment at presentation	4
Solid tumor OR hematological malignancy with no previous fungal infection—culture proven or presumed and empirically treated	4
NO dehydration requiring parenteral fluids	3
Outpatient status at time of fever	3
Age <60 years	2
TOTAL SCORE =	

Low risk (MASCC ≥21) – Admit for 24-hour observation and initial IV antimicrobial treatment. If patient defervesces and no clinically documented infection is identified, consider discharge to complete treatment with an oral course of amoxicillin/clavulanate plus ciprofloxacin regimen if:

- No active co-morbid conditions
- Hemodynamically stable
- Patient was NOT receiving fluoroquinolone prophylaxis prior to febrile neutropenia episode
- Adequate hepatic and renal function
- Compliant with oral medications
- Close follow up with outpatient oncologist
- Access to immediate acute care facility

High risk (MASCC <21) – Admit for IV antimicrobial treatment as described on next page

Treatment of Febrile Neutropenia
Temperature of ≥38.3˚C (101˚F) or ≥38.0˚C (100.4˚F) sustained over 1 hour
PLUS
ANC of <500 cells/mm3 or an ANC that is expected to decrease to <500 cells/mm3 over the next 48 hours
*Dose adjustments may be necessary for renal and/or hepatic dysfunction

Initiate Empiric Therapy
- IV Anti-pseudomonal β-lactam
  - *Cefepime 2 gm IV Q8hrs OR
- If concerned for anaerobic infection
  - Piperacillin/tazobactam 4.5 gm IV Q6hrs OR
  - Add metronidazole 500mg IV Q8hrs to cefepime
- History of anaphylactic or urticarial reaction to β-lactam
- Refer to CP-72 and contact Infectious Diseases if unable to give piperacillin/tazobactam or cefepime

*Dose adjustments may be necessary for renal and/or hepatic dysfunction
†Please refer to vancomycin dosing section of this manual

Vancomycin is not considered a standard part of the initial antibiotic regimen for febrile neutropenia. Consider adding initial IV vancomycin if:
- Hemodynamic instability
- Catheter-related infection
- Skin or soft tissue infection
- Hospital- or Healthcare-associated Pneumonia
- Identification of gram positive cocci in blood cultures (before susceptibilities are available)
- Aztreonam used for gram-negative coverage

Modifications to initial empirical therapy may be considered for patients with hemodynamic instability and those at risk for infection with antibiotic-resistant organisms.
- Hemodynamic instability: Consider early use of meropenem 1g IV Q8hrs and/or aminoglycoside
- MRSA- Consider early use of vancomycin
- VRE- Consider early use of daptomycin or linezolid
- ESBL-producing bacteria: Consider early use of meropenem 1g IV Q8hrs
- Other multidrug-resistant-GNR – Consult Infectious Diseases

Additional Therapy for Persistently Febrile Patients
Infectious Disease consult recommended
- Note: persistent fever in clinically stable patients during the initial 1-3 days of empirical antimicrobial coverage rarely requires a change to the initial regimen. The median time to defervescence is ~2 days in solid tumor patients and ~5 days in patients with hematologic malignancy.

Days 4-7: Invasive fungal infection (IFI) should be considered in patients with persistent fevers despite appropriate antibiotic therapy. Examples of IFI include azole-resistant Candida, Aspergillus, mucormycosis, Fusarium, Scedosporium, and other molds. The risk for specific pathogens will differ based on host factors, antifungal prophylaxis, imaging findings, and other criteria. Consult Infectious Diseases for antifungal recommendations.

Antimicrobial Therapy Duration for Febrile Neutropenia
- If vancomycin is included in the initial empiric antimicrobial regimen, it may be discontinued after 2 days if there is no evidence of a gram-positive infection
- For patients without a clinically documented infection, antibiotics can be discontinued when fevers resolve and there is evidence of bone marrow recovery (ANC increasing and ≥ 500 cells/μL for more than 48 hours)
- For patients with a clinically documented infection, antibiotics should be continued for at least the standard duration indicated for the specific organism, site of infection, and at least until the ANC is ≥ 500 cells/μL or longer if clinically indications

GUIDELINES FOR TREATMENT OF COMMON VIRAL INFECTIONS

Infection	First-line	Alternative	Duration	Comments
Herpes zoster (VZV)	Valacyclovir* 1 Gram PO q8h (If immunocompromised, use acyclovir 10mg/kg q8h IV)	Acyclovir* 800mg PO 5x/day	7-10 days if immunocompetent; 10-14 days if immunocompromised	MUST BE IN CONTACT/DROPLET PRECAUTIONS: Health care workers who have not had chickenpox OR vaccine should not enter the patient's room. Airborne precaution is needed for subsets of patients with herpes zoster.
Cytomegalovirus (CMV)	Ganciclovir* 5 mg/kg q12h IV	Foscarnet* — suggest ID consult for dosing	2-3 weeks; may need maintenance therapy	Usually treatment is only given to immunocompromised patients.
Hepatitis A virus	None	None	-	Ensure hands are washed when leaving the patient's room.
Hepatitis B virus	Options include lamivudine, interferon, entecavir, tenofovir, and telbivudine — should be initiated only with Hepatology consult	-	Variable	All health care workers should be vaccinated against hepatitis B virus.
Hepatitis C virus	Due to the nature of rapidly changing recommendations for this infection, please visit www.hcvguidelines.org for the most current information	-	Variable	Treatment guidelines for Hepatitis C is a complex and rapidly evolving field. Please consult Hepatology for detailed recommendations.
Herpes simplex virus (genital — initial episode)	Valacyclovir 1g PO q12h	Acyclovir* 400mg PO q8h	7-10 days	No vaccine is available.
Herpes simplex virus (genital — recurrent episode)	Acyclovir* 800mg PO q8h x 2 days OR Valacyclovir 1g PO q24h x 5 days	-	See first-line recommendation for duration	Initiate at earliest sign of symptom OR recurrence.

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GUIDELINES FOR TREATMENT OF COMMON VIRAL INFECTIONS (CONTINUED)

Infection	First-line	Alternative	Duration	Comments
Herpes simplex virus (oral — recurrent)	Valacyclovir* 2g PO q12h x 1 day	Acyclovir cream — apply to affected area 5 times per day x 4 day	See first-line and alternative recommendation for duration.	
Herpes simplex virus (encephalitis)	Acyclovir* 10 mg/kg q 8h IV	-	14-21 days	
Influenza	Oseltamivir* 75 mg q12h PO	Peramivir IV 600mg x 1 dose	5 days	Zanamavir 10mg inhalation BID

** Dose adjustment is necessary for patients with renal dysfunction.*

INFECTIONS IN SOLID-ORGAN TRANSPLANT RECIPIENTS

Solid organ transplant recipients are at increased risk of infection compared to non-transplant patients due to several factors, including surgical complications, immunosuppression, allograft rejection, and underlying illnesses. Although most infections occur in the first 6 months after transplant, patients remain at elevated risk for infections for the remainder of their lives. Accordingly, prophylaxis and preemptive strategies are commonly employed for transplant patients. Below are some of the more common targeted infections and practices. Of note, protocols vary substantially depending on the specific transplant type. As such, clinicians are directed to the appropriate transplant service (or Transplant Infectious Diseases) for patient-specific recommendations.

Infection	Prophylaxis	Treatment	Comments
Cytomegalovirus (CMV)	Valganciclovir: Select patients may receive preemptive therapy rather than prophylaxis	Ganciclovir* 5 mg/kg IV q12h OR Valganciclovir* 900 mg PO q12h	Risk of infection is greatest for recipients who are CMV IgG negative pre-transplant who receive an organ from a CMV IgG+ donor
Herpes simplex virus (HSV) and Varicella zoster virus (VZV)	Acyclovir* in patients not receiving (val)ganciclovir	Acyclovir* - dose depends on the site of infection and whether it's HSV OR VZV	Ganciclovir and valganciclovir also give protection against HSV
PCP pneumonia (*Pneumocystis jiroveci* formerly known as *Pneumocystis carinii*)	TMP/SMX (Bactrim). Alternatives include dapsone, atovaquone, and aerosolized pentamidine	See PCP pneumonia in Pulmonary Disease section of this book for treatment recommendations	TMP/SMX also gives protection against listeriosis, salmonellosis, and toxoplasmosis. Alternative PCP prophylaxis should only be used if there is a true allergy to TMP-SMX
Toxoplasmosis	TMP/SMX. If unable to receive TMP/SMX, alternative options may include dapsone + pyrimethamine + folinic acid OR pyrimethamine + sulfadiazine	Sulfadiazine PLUS pyrimethamine – seek ID advice for dosage	Risk is greatest in toxoplasma IgG- heart transplant recipients receiving a heart from a toxoplasma IgG+ donor
Aspergillosis	Voriconazole in new lung transplant recipients and in select high-risk liver transplant recipients	Voriconazole +/- caspofungin. Recommend transplant ID involvement to optimize treatment regimen	Other mold-active azoles may be considered in case of breakthrough infections, voriconazole intolerance OR in those with a history of squamous cell skin cancer.
Tuberculosis	Isoniazid 300 mg PO daily x 9 months OR rifampin 600 mg PO daily x 4 months in candidates who are PPD+ OR IGRA+ pre-transplant OR who have a known exposure	Isoniazid, rifabutin**, pyrazinamide, and ethambutol – seek ID advice for dosage	Start pyridoxine 25-50 mg PO daily when TB regimen contains isoniazid to prevent peripheral neuropathy. Rifabutin will interact significantly with tacrolimus and cyclosporine

**Dose adjustment is necessary for patients with renal dysfunction*
***Rifabutin is recommended in lieu of rifampin for TB treatment post-transplant, as rifampin has unacceptable drug interactions with immunosuppressive agents*

TREATMENT RECOMMENDATIONS FOR INFECTIONS DUE TO *KLEBSIELLA PNEUMONIAE* CARBAPENEMASE (KPC) PRODUCING ORGANISMS

What is KPC?
KPC is a β-lactamase enzyme produced by Gram-negative bacteria capable of hydrolyzing penicillins, cephalosporins, aztreonam, and carbapenems. Often, KPC-producing organisms harbor other resistance mechanisms that confer resistance to the aminoglycoside and fluoroquinolone classes. Treatment options are limited. At UPMC Presbyterian, approximately 5% of K. pneumoniae produce KPC.

How do I identify a KPC-producing organism?
K. pneumoniae isolates that are resistant to ertapenem and/or meropenem are highly suggestive of KPC production. A positive carbapenem inactivation test (CIT) confirms that an organism produces a carbapenemase, most commonly KPC.

How should I treat a patient infected with a KPC-producing organism?
Two newly developed antibiotics with excellent in vitro activity against KPC-producing organisms are now available, ceftazidime-avibactam (Avycaz) and meropenem-vaborbactam (Vabomere). The clinical efficacy of these agents is limited, but encouraging. It is unknown if the addition of a second antibiotic improves response rates. In the setting of severe sepsis or septic shock, the addition of gentamicin may be reasonable if the infecting strain is susceptible to this agent.

In all cases, please contact AMP or consult the Infectious Diseases service for the latest recommendations and guidance.

Diagnosis	Primary	Alternative
Cystitis	Doxycycline 100mg PO q12h OR Fosfomycin 3g (Call AMP for dosing)	Gentamicin IV (see pages 150-153)
Pyelonephritis	Meropenem-vaborbactam 4g IV q8h	Ceftazidime-avibactam 2.5g IV q8h
Bacteremia	Meropenem-vaborbactam 4g IV q8h	Ceftazidime-avibactam 2.5g IV q8h
Intra-abdominal infection	Meropenem-vaborbactam 4g IV q8h	Ceftazidime-avibactam 2.5g IV q8h (PLUS metronidazole)
Pneumonia[1]	Meropenem-vaborbactam 4g IV q8h	Please contact AMP for the latest treatment recommendations

[1]. Consider combination therapy for patients with pneumonia.

What else should I keep in mind?
1. Treatment options for KPC-producing organisms are severely limited; newly FDA-approved antibiotic agents must be used judiciously.
2. Like other Gram-negative bacteria, KPC-producing organisms isolated from non-sterile site cultures may represent colonization.
3. When KPC-producing organisms are identified, patients must be placed in contact precautions to reduce the risk of horizontal transmission to other hospitalized patients.
4. Rarely, *E. coli* and *Enterobacter spp.* may produce KPC enzymes; thus far, isolation of such organisms from UPMC Presbyterian patients is rare.
5. Most carbapenem-resistant *Enterobacter spp.* do not produce KPC enzymes and can be treated with dose-optimized meropenem; please contact AMP and the XDR Pathogens Laboratory for guidance

TREATMENT RECOMMENDATIONS FOR MULTIDRUG-RESISTANT *ACINETOBACTER* INFECTIONS[1,2,3]

- *Acinetobacter* is a nosocomial pathogen capable of causing significant morbidity and mortality.
- *Acinetobacter* isolates at UPMC have become resistant to all conventional antibiotics. The following definitions have been created:
  - Multidrug-Resistant (MDR): Resistance to ≥ 3 antimicrobial classes
  - Extensively Drug-Resistant (XDR): Resistance to all antimicrobial agents except tigecycline AND/OR colistin
  - Pandrug-Resistant (PDR): Resistance to all antimicrobial agents including tigecycline AND colistin
- Treatment of these organisms has proven to be a challenge, and combination therapy now is necessary for many nosocomial infections.
- The following guidelines should be followed when assessing a patient with MDR or XDR *Acinetobacter*:[1]
  - Adherence to strict infection control policies is mandatory.
  - Only treat proven or strongly suspected infection caused by *Acinetobacter* (*Acinetobacter* is a common colonizer).
  - Tigecycline or colistin should NOT be used as monotherapy.[1]
  - Rifampin based combinations should not be used.[1]
  - An ID consult should be sought before a treatment regimen is selected.
  - Antibiotic Management Program (AMP) should be consulted for the optimal dosing of antibiotics selected.

Pathogen	Regimen*
MDR *Acinetobacter* Susceptible to ampicillin/sulbactam AND carbapenems	Ampicillin/sulbactam 3g IV q4h PLUS inhaled agent[&] (if pneumonia)
MDR *Acinetobacter* Susceptible to ampicillin/sulbactam ONLY	Ampicillin/sulbactam 3g IV q4h PLUS inhaled agent[&] (if pneumonia)
MDR *Acinetobacter* Susceptible to carbapenems ONLY	Meropenem 2g IV q8h PLUS inhaled agent[&] (if pneumonia)
PDR OR XDR *Acinetobacter*[†]	Meropenem 2g IV q8h PLUS Polymyxin B IV (see Polymyxin B dosing, page 100) PLUS inhaled agent[&] (if pneumonia)

* All agents must be adjusted for renal dysfunction

[&]Inhaled options: tobramycin 300mg twice daily (if susceptible) or colistin 75mg twice daily (if tobramycin resistant)
[†] Addition of ampicillin/sulbactam can be considered for patients with severe infections, or those previously exposed to colistin and a carbapenem.

[1] Internal UPMC Presbyterian susceptibility studies assessing synergy, additivism, or antagonism.
[2] Shields RK et al. Diagn Microbiol Infect Dis 2011;70:246-52.
[3] Shields RK et al. PLoS One 2012;7:e52349.

TREATMENT RECOMMENDATIONS FOR VANCOMYCIN-RESISTANT *ENTEROCOCCUS* INFECTIONS

- Vancomycin-Resistant *Enterococcus* (VRE) most frequently causes infections in immunocompromised patients, post-operative patients with intra-abdominal infection and those with prior antibiotic exposure and indwelling devices such as central venous catheters
  - VRE is frequently a colonizer of the urinary tract, the skin and clinically-uninfected wounds; VRE is not a cause of respiratory infections
  - Treatment is NOT needed for colonization
- Data are conflicting for the best treatments for some VRE infections
  - For the rare VRE susceptible to ampicillin, ampicillin 2g IV q4-6 hours is first line
- Linezolid is the first-line therapy for VRE in many cases, caution must be taken to monitor patients on linezolid and serotonergic agents such as SSRIs and tricyclic antidepressants
  - Linezolid is contraindicated with MAO inhibitors
  - If linezolid is used with other serotonergic agents, please consider the following guidelines
    - Discontinue all non-essential serotonergic agents (e.g. low dose trazadone, mirtazapine, amitriptyline)
    - It is reasonable to continue a maintenance SSRI while inpatient if patient is monitored closely for serotonin sydrome[1]
    - Consider ID consult, especially if duration of therapy >14 days

Pathogen/Infection	Regimen	Alternative
VRE bacteremia Source: Central venous catheter, wound, intra-abdominal infection, central nervous system infection OR undetermined	Linezolid 600mg IV/po q12h[2,3]	Daptomycin 9-10mg/kg IV q24h (rounded to nearest 50mg)[2,3]
VRE bacteremia Source: Endocarditis OR genitourinary	Daptomycin 9-10mg/kg IV q24h (round to nearest 50mg)[2,3,4]	Linezolid 600mg IV/po q12h[2,3]
VRE wound infection OR intra-abdominal infection without bacteremia	Linezolid 600mg IV/po q12h	Tigecycline 100mg IV x1 then 50mg IV q12h OR Daptomycin 9-10mg/kg IV q24h (rounded to nearest 50mg)
VRE CNS infection	Linezolid 600mg IV/po q12h	
VRE Urinary infection	Suspect colonization	If treatment required: Doxycycline 100mg po BID for cystitis Daptomycin 9-10mg/kg IV q24h for complicated UTI
VRE Osteomyelitis OR septic arthritis	Daptomycin 9-10mg/kg IV q24h (rounded to nearest 50mg)	Tigecycline 100mg IV x1 then 50mg IV q12h

[1]*Taylor JJ, Wilson JW, Estes LL. , Clin Infect Dis , 2006. 43:180-7*
[2]*Britt NS, Potter EM, Patel et al Clin Infect Dis. 2017 Mar 1;64(5):605-61*
[3]*Chuang YC, Lin HY, Chen PY et al Clin Infect Dis. 2017 Apr 15;64(8):1026-1034*
[4]*Baddour LM et al Circulation. 2015;132:00-00.*

UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES

Doses of all antimicrobials administered on dialysis days should be given after HD sessions EXCEPT for cidofovir which should be given before HD sessions
Contact a member of the ID team for any questions regarding renal replacement therapy dosing based on patient characteristics or varying haemofiltration rates
Obese = BMI > 30 kg/m^2

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Acyclovir [dosed on TBW, use AdjBW if obese]	HSV treatment - encephalitis - IV	10mg/kg IV q8h	10mg/kg IV q12h	10mg/kg IV q24h	5mg/kg IV q24h	5mg/kg IV q12h
	VZV treatment - encephalitis - IV	10-15mg/kg IV q8h	10-15mg/kg IV q12h	10mg/kg IV q24h	5mg/kg IV q24h	5mg/kg IV q12h
	HSV treatment - non CNS - IV	5-10mg/kg IV q8h	5-10mg/kg IV q12h	5mg/kg IV q24h	2.5-5mg/kg IV q24h	5mg/kg IV q24h
	HSV treatment - non CNS - PO	400mg PO q8h	400mg PO q8h	400mg PO q8h	200mg PO q12h	400mg PO q8h
	VZV treatment - PO	800mg PO 5x/day	800mg PO 5x/day	800mg PO q8h	800mg PO q12h	800mg PO q8h
	HSV Prophylaxis - BMT	800mg PO q12h 200mg IV q8h	400mg PO q12h 200mg IV q12h	400mg PO q24h 200mg IV q24h	400mg PO q24h 200mg IV q24h	400mg PO q12h 200mg IV q12h
	HSV Prophylaxis - SOT	400mg PO q12h 200mg IV q8h	400mg PO q12h 200mg IV q12h	400mg PO q24h 200mg IV q24h	400mg PO q24h 200mg IV Q24h	400mg PO q12h 200mg IV q12h
Amikacin [dosed on IBW, use AdjBW if obese and TBW if TBW < IBW]	See aminoglycoside dosing in institutional pharmacokinetics guide					

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Amoxicillin	Pneumonia	1g PO q8h	1g PO q8-12h	500mg PO q12h	500mg PO q24h	1g PO q8h
	H. pylori	1g PO q12h	1g PO q12h	500mg PO q12h	500mg PO q24h	1g PO q12h
	Other indications	500mg PO q8h OR 875mg PO q12h	500mg PO q8h OR 875mg PO q12h	500mg PO q12h	500mg PO q24h	500mg PO q8h
Amoxicillin/ clavulanate (Augmentin)	Standard dose	875mg/125mg Augmentin IR PO q12h	875mg/125mg Augmentin IR PO q12h	500mg/125mg Augmentin IR PO q12h	500mg/125mg Augmentin IR PO q24h	Insufficient data
	High dose	2000mg/125mg Augmentin XR PO q12h	2000mg/125mg Augmentin XR PO q12h	500mg/125mg Augmentin IR PO q12h	500mg/125mg Augmentin IR PO q24h	Insufficient data
	Note: If using suspension, the clavulanate component varies. Be cognizant of product selection. If Augmentin XR is unavailable OR cost prohibitive, can give Augmentin 875mg/125mg PO q12h PLUS Amoxicillin 875mg PO q12h					
Ampicillin	Endocarditis, Meningitis, Osteomyelitis (Consider administration via continuous infusion)	2g IV q4h	2g IV q6h	2g IV q8h	2g IV q12h	2g IV q6-8h
	Other indications	2g IV q6h	2g IV q8h	2g IV q12h	<10 mL/min: 1g IV q12h HD: 2g IV q24h	2g IV q8h
	Cystitis	1g IV q6h OR 500mg PO q6h	1g IV q6h OR 500mg PO q8h	1g IV q8h OR 500mg PO q12h	1g IV q12h OR 500mg PO q12h	1g IV q6h OR 500mg PO q6h

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Ampicillin/ sulbactam	*Acinetobacter* spp. Dosing is based on sulbactam component	3g IV q4h	3g IV q6h	3g IV q8h	3g IV q12h	3g IV q4-6h
	Note: Do NOT substitute amoxicillin-clavulanate for treatment of Acinetobacter spp. The sulbactam component is the active drug.					
	All other indications	3g IV q6h	3g IV q8h	3g IV q12h	3g IV q24h	3g IV q6-8h
	Cystitis	1.5g IV q6h	1.5g IV q8h	1.5g IV q12h	1.5g IV q24h	1.5g IV q6h
Liposomal amphotericin [dosed on TBW, use AdjBW if obese]	All indications	3-5mg/kg IV q24h *Contact your local (if available) OR system infectious diseases expert(s) for dosing guidance.*				
Atovaquone	PJP prophylaxis	1500mg PO q24h				
	PJP treatment	750mg PO q12h				
	Toxoplasmosis encephalitis	1500mg PO q12h				
Atovaquone/ proguanil	Malaria treatment	1,000mg/400mg PO q24h	1,000mg/400mg PO q24h	Consider alternative therapy		
	Malaria prophylaxis	250mg/100mg PO q24h	250mg/100mg PO q24h	Consider alternative therapy		

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Azithromycin	CAP	500mg IV OR PO q24h x 1 day, then 250mg PO q24h x 4 days OR 500mg IV OR PO q24h x 3 days				
	Legionella, Mycobacterium	500mg IV OR PO q24h				
Aztreonam	*Pseudomonas* spp. OR Meningitis *(consider 3h infusion)*	2g IV q6h	2g IV q6h	1g IV q6h	1g IV q12h OR 500mg IV q6-8h	2g IV q8h
	All other indications *(consider 3h infusion)*	2g IV q8h	2g IV q8h	1g IV q8h	1g IV q12h OR 500mg IV q8h	2g IV q12h OR 1g IV q8h
	Cystitis	1g IV q8h	1g IV q8h	500mg IV q8h	500mg IV q12h	1g IV q8h
Caspofungin	Non-endocarditis indications and BMT prophylaxis	70mg IV q24h x 1 day, then 50mg IV q24h If co-administered with phenytoin, phenobarbitol, rifampin, carbamazapine, dexamethasone, efavirenz, nevirapine: 70mg IV q24h				
	Endocarditis	150mg IV q24h				
Cefazolin	Cystitis, Streptococcal SSTI	1g IV q8h	1g IV q8h	1g IV q12h	1g IV q24h	1g IV q8h
	All other indications *Consider 3h infusion for gram-negative OR complicated MSSA infections*	2g IV q8h	2g IV q8h	1g IV q12h	1g IV q24h OR 2g after HD, 2g after HD, 3g after HD if 3x weekly HD	2g IV q8-12h
Cefdinir	Cystitis	300mg PO q12h	300mg PO q12h	300mg PO q24h	300mg PO q24h	300mg PO q12h

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Cefepime	Meningitis, Endocarditis, Cystic Fibrosis, F&N, Septic Shock, HAP/VAP, OR infections caused by *Enterobacter* cloacae, *Klebsiella* (*Enterobacter*) aerogenes, Citrobacter freundii, *Pseudomonas*, OR cefepime SDD isolates (MIC 4-8 µg/mL)	2g IV q8h Infuse over 3h	2g IV q12h OR 1g IV q8h Infuse over 3h	1g IV q12h Infuse over 3h	1g IV q24h OR 2g IV 3x weekly after HD Infuse over 3h	2g IV q8-12h Infuse over 3h
	Other indications ***Consider 2g LD for sepsis***	1g IV q6h Infuse over 3h	1g IV q8h Infuse over 3h	1g IV q12h Infuse over 3h	1g IV q24h OR 2g IV 3x weekly after HD Infuse over 3h	1g IV q6-8h Infuse over 3h
	Contact your local (if available) OR system infectious diseases expert(s) for dosing guidance. *Acceptable to infuse first dose for patients with sepsis in the ED, Rehab unit, OR one-time preprocedural use over 30 minutes.*					

Cefiderocol	**Renal function**	≥120 mL/min	60-119 mL/min	30-59 mL/min	15-29 mL/min	< 15 mL/min or HD	CVVHD @ 2000 mL/hr
	All indications	2g IV q6h *Infuse over 3h*	2g IV q8h *Infuse over 3h*	1.5g IV q8h *Infuse over 3h*	1g IV q8h *Infuse over 3h*	750mg IV q12h *Infuse over 3h*	No data

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Cefoxitin	Mycobacterium	2g IV q4h or 3g IV q6h	2g IV q6h	2g IV q8-12h	2g IV q24h	2g IV q8h
	Other indications	2g IV q6h	2g IV q8h	2g IV q12h	1g IV q24h	2g IV q8-12h
Cefpodoxime	All indications	200-400mg PO q12h	200-400mg PO q12h	200-400mg PO q24h	200-400mg PO q24h	200-400mg PO q12h
Ceftaroline (Teflaro)	SSTI, CAP	600mg IV q12h	400mg IV q12h	300mg IV q12h	200mg IV q12h	400mg IV q12h
	MRSA monotherapy	600mg IV q8-12h	400mg IV q8-12h	300mg IV q8-12h	200mg IV q8-12h	400mg IV q8-12h
	SDD isolates (MIC 2-4 µg/mL)	600mg IV q8h	400mg IV q8h	300mg IV q8h	200mg IV q8h	400mg IV q8h
	Combination therapy for gram-positive synergy	600mg IV q12h	400mg IV q12h	300mg IV q12h	200mg IV q12h	400mg IV q12h
Ceftazidime	All indications	2g IV q8h *Infuse over 3h*	2g IV q12h *Infuse over 3h*	2g IV q24h *Infuse over 3h*	1g IV q24h OR 2g IV 3x weekly after HD *Infuse over 3h*	2g IV q8-12h *Infuse over 3h*
Ceftazidime/ avibactam (Avycaz)	All indications	2.5g IV q8h *Infuse over 2h*	1.25g IV q8h *Infuse over 2h*	0.94g IV q12h *Infuse over 2h*	0.94g IV q24h *Infuse over 2h*	1.25-2.5g IV q8h *Infuse over 2h*

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Ceftolozane/ tazobactam (Zerbaxa)	Pneumonia	3g IV q8h *Infuse over 3h*	1.5g IV q8h *Infuse over 3h*	750mg IV q8h *Infuse over 3h*	Loading dose 2.25g IV x 1, 450mg IV q8h *Infuse over 3h*	1.5-3g IV q8h *Infuse over 3h*
	Intraabdominal infection, UTI	1.5g IV q8h *Infuse over 3h*	750mg IV q8h *Infuse over 3h*	375mg IV q8h *Infuse over 3h*	Loading dose 750mg IV x 1, 150mg IV q8h *Infuse over 3h*	1.5g IV q8h *Infuse over 3h*
Ceftriaxone	Cystitis, SBP prophylaxis, CAP (non-ICU)	1g IV q24h				
	CAP (ICU), Pyelonephritis, other indications	2g IV q24h				
	Meningitis, Enterococcal endocarditis	2g IV q12h				
Cefuroxime	All indications (IV)	1.5g IV q8h	1.5g IV q8h	1.5g IV q8-12h	1.5g IV q24h	1.5g IV q8h
	Standard dose (PO)	500mg PO q12h	500mg PO q12h	500mg PO q24h	500mg PO q24h	500mg PO q12h
	High dose (PO)	500mg PO q8h	500mg PO q8h	500mg PO q12h	500mg PO q24h	500mg PO q8h
Cephalexin	Standard dose	500mg PO q6h	500mg PO q6h	500mg PO q8-12h	500mg PO q12h	500mg PO q6h
	High dose	1g PO q8h	1g PO q8h	1g PO q12h	500mg PO q12h	1g PO q8h

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Ciprofloxacin	HAP/VAP, Bacteremia, other serious infections, and empiric therapy in critically-ill patients	400mg IV q8h OR 750mg PO q12h	400mg IV q8-12h OR 500-750mg PO q12h	400mg IV q24h OR 500-750mg PO q24h	400mg IV q24h OR 500mg PO q24h	400mg IV q12-24h OR 500mg PO q12-24h
		Pseudomonas spp. infections should be treated with higher end of dosing range. 2019 CLSI susceptibility breakpoints are ***≤0.25 µg/mL for Enterobacterales and ≤0.5 µg/mL for P. aeruginosa****. Recommend using higher end of dosing range if the exact MIC is unknown.*				
	Mild community-acquired IAI, Cystitis*, BMT prophylaxis, and other mild infections OR prophylaxis indications	400mg IV q12h OR 500mg PO q12h	400mg IV q12h OR 500mg PO q12h	400mg IV q24h OR 500mg PO q24h	400mg IV q24h OR 500mg PO q24h	400mg IV q24h OR 500mg PO q24h
	*Serious adverse effects associated with fluoroquinolones generally outweigh the benefits for patients with uncomplicated urinary tract infections OR upper respiratory tract infections who have alternative treatment options					
Clarithromycin	All indications	500mg PO q12h	500mg PO q12h	250mg PO q12h	250mg PO q12h	250mg PO q12h

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Clindamycin	Standard dose IV	600mg IV q8h				
	High dose IV	900mg IV q8h ***Use this dosing strategy for necrotizing infections***				
	PO	300mg PO q6h **OR** 450mg PO q8h				
Colistin	All infections	Give loading dose of 300mg x 1 dose, then start maintenance dose 12h later				
	All infections Give loading dose (see above), [Dose based upon calculated creatinine clearance]	*CrCl > 90:* 180mg IV q12h *CrCl 80-89:* 170mg IV q12h *CrCl 70-79:* 150mg IV q12h *CrCl 60-69:* 137.5mg IV q12h *CrCl 50-59:* 122.5mg IV q12h	*CrCl 40-49:* 110mg IV q12h *CrCl 30-39:* 97.5mg IV q12h	*CrCl 20-29:* 87.5mg IV q12h *CrCl 10-19:* 80mg IV q12h	*CrCl 5-9:* 72.5mg IV q12h *CrCl 0-4:* 65mg IV q12h HD: supplement 40-50mg after each HD	220mg IV q12h
Dalbavancin (non-preferred; oritavancin is preferred)	SSTI	1,500mg IV once	1,500mg IV once	1,125mg IV once	1,125mg IV once	Insufficient data

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Daptomycin [dosed on TBW, consider AdjBW if obese] Round to nearest 50mg	UTI, SSTI	4mg/kg IV q24h	4mg/kg IV q24h	4mg/kg IV q48h	<10 mL/min: 4mg/kg q48h HD: 4mg/kg* 3x weekly after HD	6mg/kg IV q24-48h
	MRSA	6-8mg/kg IV q24h	6-8mg/kg IV q24h	6-8mg/kg IV q48h	<10 mL/min: 6-8mg/kg q48h HD: 6-8mg/kg* 3x weekly after HD	8mg/kg IV q24-48h
	VRE	9-10mg/kg IV q24h	9-10mg/kg IV q24h	9-10mg/kg IV q48h	<10 mL/min: 9-10mg/kg q48h HD: 9-10mg/kg* 3x weekly after HD	9-10mg/kg IV q24-48h
	Complicated, persistent infection	10-12mg/kg IV q24h	10-12mg/kg IV q24h	10-12mg/kg IV q48h	<10 mL/min: 10-12mg/kg q48h HD: 10-12mg/kg 3x weekly after HD	10-12mg/kg IV q24-48h
	**Consider increasing dose by 2mg/kg after dialysis on the 72h intradialytic day if patient has any residual renal function (i.e., if dose is 6mg/kg 3x weekly, give 6mg/kg on Mon and Wed, but 8mg/kg on Fri). Administer doses after HD. If patient is dialyzed more frequently than 3x weekly, give dose after each dialysis session.*					
Dapsone	PJP prophylaxis	100mg PO q24h (monotherapy) OR 50mg PO q24h (with pyrimethamine)				
Dicloxacillin	All indications	500mg PO q6h				
Doxycycline	All indications	100mg IV OR PO q12h Consider 200mg LD for serious infections. 200mg PO x 1 dose is sufficient for Lyme prophylaxis.				
Eravacycline [dosed on TBW]	All indications	1 mg/kg IV q12h (increase to 1.5mg/kg IV q12h when administered with CYP3A inducers)				

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Ertapenem	All indications	1g IV q24h	1g IV q24h	500mg IV q24h	500mg IV q24h	1g IV q24h
Fidaxomicin	Clostridium difficile	200mg PO q12h				
Fluconazole [dosed on TBW, consider AdjBW if obese, max dose 1200mg/day]	Oropharyngeal candidiasis, UTI	200mg IV or PO q24h	200mg IV or PO q24h	200mg IV or PO q24h	200mg IV or PO q24h	200-400mg IV or PO q24h
	Non-glabrata/krusei Candida spp. (~6mg/kg)	400mg IV or PO q24h	400mg IV or PO q24h	200mg IV or PO q24h	200mg IV or PO q24h	400-600mg IV or PO q24h
	Consider 12mg/kg (max 800mg) LD x 1 dose prior to starting ~6mg/kg maintenance dosing					
	Endocarditis (any spp.) OR C. glabrata/krusei (~12mg/kg)	800mg IV or PO q24h	400-600mg IV or PO q24h	400mg IV or PO q24h	400mg IV or PO q24h	800-1200mg IV or PO q24h
	BMT prophylaxis	200mg IV or PO q24h	200mg IV or PO q24h	200mg IV or PO q24h	200mg IV or PO q24h	200-400mg IV or PO q24h
	SOT prophylaxis	400mg IV or PO q24h	200mg IV or PO q24h	200mg IV or PO q24h	200mg IV or PO q24h	400-600mg IV or PO q24h
Flucytosine [dosed on IBW, use TBW if TBW < IBW] Round to nearest 500mg	All indications	25mg/kg PO q6h	25mg/kg PO q8-12h	25mg/kg PO q12-24h	25mg/kg PO q48h OR 3x weekly post-HD	25mg/kg PO q12h

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/ min	CrCl 10-29 mL/ min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Foscarnet [dosed on TBW, consider AdjBW if obese]	See Foscarnet Section					
Fosfomycin		3g PO once	3g PO once	Use not recommended	Use not recommended	Use not recommended
	Cystitis					
	Complicated cystitis	3g PO q48h x 3 doses	3g PO q48h x 3 doses			
Ganciclovir [dosed on TBW, consider AdjBW if obese]	**Renal Function**	**CrCl ≥ 70**	**CrCl 50-69**	**CrCl 25-49**	**CrCl 10-24 or HD**	**CVVHD @ 2000 mL/hr**
	Treatment (Induction)	5mg/kg IV q12h	2.5mg/kg IV q12h	2.5mg/kg IV q24h	10-24: 1.25mg/kg IV q24h HD: 1.25mg/kg IV 3x weekly after HD	2.5-5mg/kg IV q24h
	Treatment (Maintenance) and Prophylaxis	5mg/kg IV q24h	2.5mg/kg IV q24h	1.25mg/kg IV q24h	10-24: 0.625mg/kg IV q24h HD: 0.625mg/kg IV 3x weekly after HD	1.25-2.5mg/kg IV q24h
Gentamicin [dosed on IBW, used AdjBW if obese and TBW if TBW < IBW]	See aminoglycoside dosing in institutional pharmacokinetics guide					

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/ min	CrCl 10-29 mL/ min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Imipenem/ cilastatin (non-preferred)	All indications	500mg IV q6h *Infuse over 1h*	500mg IV q8h *Infuse over 1h*	500mg IV q12h *Infuse over 1h*	250mg IV q12h *Infuse over 1h*	500mg IV q6-8h *Infuse over 1h*
	Note: Dose with normal renal function is 500mg imipenem + 500mg cilastatin, but is indicated as 500mg per packaging					

Imipenem/ cilastatin/ relebactam	**Renal function**	≥90 mL/min	60-89 mL/min	30-59 mL/min	15-29 mL/min	< 15 mL/min	HD	CVVHD @ 2000mL/hr
	All indications	1.25g IV q6h *Infuse over 1h*	1g IV q6h *Infuse over 1h*	750mg IV q6h *Infuse over 1h*	500mg IV q6h *Infuse over 1h*	Avoid unless dialysis initiated	500mg IV q6h *Infuse over 1h*	750mg IV q6h *Infuse over 1h*
	Note: Dose with normal renal function is 500mg imipenem + 500mg cilastatin + 250mg relebactam and is indicated as 1.25g per packaging							

Isavuconazole (Cresemba)	All indications	372mg IV OR PO q8h x 6 doses LD, then 372mg IV OR PO q24h maintenance dose
Itraconazole	Treatment	200mg PO q8h x 9 doses LD, then 200mg PO q12h maintenance dose [PO = suspension **only**, do not use capsules]
	Prophylaxis	200mg PO q12-24h [PO = suspension **only**, do not use capsules]
Letermovir (Prevymis)	BMT prophylaxis	480mg IV OR PO q24h (decrease dose to 240mg IV OR PO q24h if co-administered with cyclosporine)

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Levofloxacin	Indications other than cystitis	750mg IV OR PO q24h	750mg IV OR PO q48h	750mg IV OR PO x 1 dose, then 500mg q48h	750mg IV OR PO x 1 dose, then 500mg 3x weekly after HD OR 750mg IV OR PO x 1 dose, 500mg q48h	750mg IV OR PO q24h
	Cystitis* and BMT prophylaxis	500mg IV OR PO q24h	500mg IV OR PO x 1 dose, then 250mg q24h	500mg IV OR PO x 1 dose, then 250mg q48h	500mg IV OR PO x 1 dose, then 250mg q48h	500mg IV OR PO q24h
	**Serious side effects associated with fluoroquinolones generally outweigh the benefits for patients with uncomplicated urinary tract infections OR upper respiratory tract infections who have other treatment options*					
Linezolid	All indications	600mg IV OR PO q12h				

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Meropenem	Meningitis, Endocarditis, Septic Shock, Cystic Fibrosis, OR infections caused by *Acinetobacter spp.*, *Enterobacter*cloacae, *Klebsiella*(*Enterobacter*) aerogenes, *Pseudomonas*, OR isolates with MIC > 1	2g IV q8h Infuse over 3h	2g IV q12h **OR** 1g IV q8h Infuse over 3h	1g IV q12h Infuse over 3h	1g IV q24h **OR** 500mg IV q12h Infuse over 3h	2g IV q12H **OR** 1g IV q8h Infuse over 3h
	HAP/VAP	1-2g IV q8h Infuse over 3h (Consider 2g for *Pseudomonas*)	1g IV q8h Infuse over 3h	1g IV q12h Infuse over 3h	1g IV q24h **OR** 500mg IV q12h Infuse over 3h	1g IV q8h Infuse over 3h
	ESBL infections, UTI, and other indications	1g IV q6-8h Infuse over 3h	1g IV q8-12h Infuse over 3h	500mg-1g IV q12h Infuse over 3h	500mg IV q12-24h Infuse over 3h	1g IV q8h Infuse over 3h
	Contact your local (if available) OR system infectious diseases expert(s) for dosing guidance. Acceptable to infuse first dose for patients with sepsis in the ED, Rehab unit, OR one-time preprocedural use over 30 minutes.					

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/ min	CrCl 10-29 mL/ min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Meropenem/ vaborbactam (Vabomere) *Dose and interval in package insert determined using MDRD formula (eGFR); dosing in clinical trials based on Cockcroft-Gault (mL/min)*	All indications	4g IV q8h *Infuse over 3h*	2g IV q8h *Infuse over 3h*	2g IV q12h *Infuse over 3h*	1g IV q12h *Infuse over 3h*	2g IV q8h *Infuse over 3h*
Metronidazole	Non-meningitis	500mg IV OR PO q8-12h				
	Meningitis	500mg IV OR PO q6h OR 750mg IV OR PO q8h				
Minocycline	Acinetobacter, Burkholderia, Stenotrophomonas	200mg IV OR PO q12h				
	Other indications	200mg IV OR PO x 1 dose, then 100mg IV OR PO q12h				
Moxifloxacin [NF] (non-preferred)	All indications	400mg IV OR PO q24h				
Nitrofurantoin	Cystitis- Macrobid capsules	100mg PO q12h	100mg PO q12h	Use not recommended	Use not recommended	Use not recommended
	Cystitis- Macrodantin suspension	50mg PO q6h	50mg PO q6h	Use not recommended	Use not recommended	Use not recommended

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/ min	CrCl 10-29 mL/ min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Oritavancin [outpatient infusion only]	SSTI	1200mg IV once				
Oseltamivir	Influenza treatment	75mg PO q12h	30mg PO q12h	30mg PO q24h	30mg PO q48h OR 30mg PO 3x weekly after HD	75mg PO q12h
	Influenza prophylaxis	75mg PO q24h	30mg PO q24h	30mg PO q48h	30mg PO twice weekly	75mg PO q24h
Oxacillin and Nafcillin *(Oxacillin preferred)*	All indications	12g IV q24h OR 2g IV q4h				
		Continuous infusion preferred, but may divide daily doses				
Penicillin K+ *(Penicillin Na+ is NOT preferred)*	All indications	12-24 million units IV q24h	9-18 million units IV q24h	6-12 million units IV q24h	6-12 million units IV q24h	9-18 million units IV q24h
		Continuous infusion preferred, but may divide daily doses				
Penicillin VK	All indications	500mg PO q6h	500mg PO q6h	500mg PO q8h	500mg PO q8h	500mg PO q6h
Pentamidine [dosed on TBW, use AdjBW if obese]	PJP prophylaxis	4mg/kg IV q28 days (q4 weeks)				Insufficient data
	PJP treatment	4mg/kg IV q24h (may lower to 3mg/kg IV q24h if toxicity occurs)				Insufficient data
Peramavir	Influenza treatment in a hospitalized patient	600mg IV q24h	200mg IV q24h	100mg IV q24h	100mg IV q24h	600mg IV q24h

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Piperacillin/tazobactam (Zosyn)	All indications *Infuse over 3h*	CrCl > 40		CrCl 20-40	CrCl < 20 and HD	CVVHD @ 2000 mL/hr
		4.5g IV q6h		4.5g IV q8h	4.5g IV q12h	4.5g IV q6-8h
	Acceptable to infuse first dose for patients with sepsis in the ED, Rehab units, OR one-time preprocedural use over 30 minutes.					
Plazomicin [NF] [dosed on TBW, use AdjBW if obese]	See aminoglycoside dosing in institutional pharmacokinetics guide					
Polymyxin B [dosed on TBW, use AdjBW if obese]	All indications *If a polymyxin is used for UTI treatment, use colistin instead of polymyxin B*	20,000 – 25,000 units/kg LD x 1 dose, then 12,500 – 15,000 units/kg q12h maintenance dose 10,000 units = 1mg Max daily dose = 3,000,000 units (300mg) per day				
Posaconazole	All other indications	300mg IV OR PO q12h x 2 doses LD; then 300mg IV OR PO q24h maintenance dose [PO = delayed release tablet **only**, do not use suspension]				
	BMT prophylaxis	300mg IV OR PO q24h [PO = delayed release tablet **only**, do not use suspension]				
Primaquine	All indications	30mg PO q24h [NOTE: 15 mg base = 26.3 mg primaquine phosphate]				
Quinupristin-dalfopristin (Synercid) [dosed on TBW, use AdjBW if obese]	All indications	7.5mg/kg IV q8h				

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Ribavirin	RSV, hMPV	600mg PO q8h	400mg PO q8h	200mg PO q8h	200mg PO q24h	Insufficient data
Rifabutin	All indications	300mg PO q24h OR 150mg PO q12h **caution: dose adjustments may be necessary for certain drug interactions**				
Rifampin	Endocarditis	300mg IV OR PO q8h **OR** 600-900mg IV OR PO q24h				
	Other indications	300-450mg IV OR PO q12h **OR** 600mg IV OR PO q24h				
Tedizolid	All indications	200mg IV OR PO q24h				
Telavancin [dosed on TBW]	All indications	10mg/kg IV q24h	7.5mg/kg IV q24h	10mg/kg IV q48h	10mg/kg IV 3x weekly post-HD **OR** q48h	Insufficient data
	Alternative dosing strategy for non-CF patients	7.5mg/kg IV q24h	5.6mg/kg IV q24h	3.8mg/kg IV q24h	3.8mg/kg IV q24h	Insufficient data
Tigecycline	CRE, Acinetobacter	100mg IV q12h				
	Other indications	100mg IV x 1 dose, then 50mg IV q12h				

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/ min	CrCl 10-29 mL/ min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Trimethoprim/ Sulfamethoxazole (TMP/SMX, Bactrim) [dosed on TBW, use AdjBW if obese] All doses based on TMP component DS = 160mg TMP	PJP Pneumonia	5mg/kg IV OR PO q8h	5mg/kg IV OR PO q8h	5mg/kg IV OR PO q12h	5mg/kg IV OR PO q24h	5mg/kg IV q8-12h
	PJP Prophylaxis and Toxoplasmosis IgG+	1 DS tab PO q24h				
	PJP Prophylaxis and Toxoplasmosis IgG-	1 SS tab PO q24h **OR** 1 DS tab 3x weekly (e.g., qMWF)				
	Enterobacteriaceae, *Stenotrophomonas*, *MRSA* PNA, Meningitis, Nocardia	5mg/kg IV OR PO q8-12h	5mg/kg IV OR PO q12h	5mg/kg IV OR PO q12-24h	5mg/kg IV OR PO q24h	5mg/kg IV q12h
	SSTI (w/ abscess), Osteo, Pyelonephritis	2 DS tabs PO q12h	2 DS tabs PO q12h	1 DS tab PO q24h	1 DS tab PO q24h	2 DS tabs PO q12h
	Cystitis	1 DS tab PO q12h	1 DS tab PO q12h	1 DS tab PO q24h	1 SS tab PO q24h	1 DS tab PO q12h
Tobramycin [dosed on IBW, used AdjBW if obese and TBW if TBW < IBW]	See aminoglycoside dosing in institutional pharmacokinetics guide					
Valacyclovir	HZV Treatment	1g PO q12h	1g PO q12h	1g PO q24h	500mg PO q24h	500mg PO q12h
	VZV Treatment	1g PO q8h	1g PO q12h	1g PO q24h	500mg PO q24h	500mg PO q12h

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/ min	CrCl 10-29 mL/ min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Valganciclovir	**Renal Function**	**CrCl ≥ 60**	**CrCl 40-59**	**CrCl 25-39**	**CrCl 10-24 or HD**	**CVVHD @ 2000 mL/hr**
	Induction (treatment)	900mg PO q12h	450mg PO q12h	450mg PO q24h	10-24: 450mg PO q48h HD: Use ganciclovir	450mg PO q24h *Consider ganciclovir if CMV disease*
	Maintenance (treatment) and Prophylaxis	900mg PO q24h	450mg PO q24h	450mg PO q48h	450mg PO twice weekly	450mg PO q48h *Consider ganciclovir if CMV disease*
Vancomycin IV [dosed on TBW]	See vancomycin dosing in institutional pharmacokinetics guide					
Vancomycin PO	Non-fulminant C. difficile	125mg PO q6h				
	Fulminant C. difficile	500mg PO q6h				
Voriconazole [dosed on TBW, use AdjBW if obese]	All indications	6mg/kg IV q12h x 2 doses LD, then 4mg/kg IV q12h maintenance dosing **OR** 300mg PO q12h x 2 doses LD, then 200mg PO q12h (if < 80kg) **OR** 300mg PO q12h (if > 80kg) maintenance dosing				

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UPMC PRESBYTERIAN-SHADYSIDE RENAL DOSING GUIDELINES (CONTINUED)

Antimicrobial	Indication	CrCl ≥ 50 mL/min	CrCl 30-49 mL/min	CrCl 10-29 mL/min	CrCl < 10 mL/min or HD	CVVHD @ 2000 mL/hr
Cidofovir [dosed on TBW; consider AdjBW if obese]	Adenovirus and CMV Induction	5mg/kg IV weekly x 2 weeks	3-4mg/kg IV weekly x 2 weeks	3mg/kg IV weekly x 2 weeks	1mg/kg IV TIW **BEFORE** HD	3mg/kg IV weekly x 2 weeks
	Adenovirus and CMV Maintenance	5mg/kg IV every other week	3-4mg/kg IV every other week	3mg/kg IV every other week	1mg/kg IV TIW **BEFORE** HD	3mg/kg IV every other week
	For traditional dosing, administer probenecid 2g PO 3h prior to cidofovir and then 1g PO 2h and 8h after completion of infusion. Prehydrate patient with 1L NS 1-2h prior to infusion. If SCr ↑ 0.3-0.4 while on therapy, decrease dose to 3mg/kg.					
	Adenovirus and CMV alternative treatment dosing	1mg/kg IV TIW	1mg/kg IV TIW	1mg/kg IV TIW	1mg/kg IV TIW **BEFORE** HD	1mg/kg IV TIW
	BK Virus	1mg/kg IV every 1-3 weeks				

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AdjBW = adjusted body weight; BMT = bone marrow transplant; CAP = community acquired pneumonia; CF = cystic fibrosis; CRE = carbapenem-resistant *Enterobacteriaceae*; CVVHD = continuous venovenous hemodialysis; DS = double strength; ERCP = endoscopic retrograde cholangiopancreatography; ESBL = extended-spectrum beta-lactamase; F&N = fever and neutropenia; hMPV = human metapneumovirus; HSV = herpes simplex virus; IBW = ideal body weight; IFI = invasive fungal infection; LD = loading dose; MIC = minimum inhibitory concentration; NF = nonformulary; Obese = BMI > 30kg/m2; PJP = *Pneumocystis jiroveci*i pneumonia; PNA = pneumonia; R = restricted; RSV = respiratory syncytial virus; SBP = spontaneous bacterial peritonitis; SDD = susceptible-dose dependent; SOT = solid organ transplantation SSTI = skin and soft tissue infection; TBW = total body weight; UTI = urinary tract infection; VZV = varicella zoster virus

Guidelines are intended to be flexible. They serve as a reference points OR recommendations, not rigid criteria. Guidelines should be followed in most cases, but there is an understanding that, depending upon the patient, the setting, the circumstances, OR other factors, guidelines can and should be tailored to fit individual needs.

Foscarnet	Induction Dosing [dosed on TBW, consider AdjBW if obese]			Maintenance Dosing [dosed on TBW, consider AdjBW if obese]	
CrCl mL/min/kg	**CMV** 90mg/kg q12h	**CMV** 60mg/kg q8h	**HSV** 40mg/kg q8h	**CMV** 120mg/kg q24h	**CMV** 90mg/kg q24h
> 1.4	90mg/kg q12h	60mg/kg q8h	40mg/kg q8h	120mg/kg q24h	90mg/kg q24h
>1-1.4	70mg/kg q12h	45mg/kg q8h	30mg/kg q8h	90mg/kg q24h	70mg/kg q24h
>0.8-1	50mg/kg q12h	50mg/kg q12h	35mg/kg q12h	65mg/kg q24h	50mg/kg q24h
>0.6-0.8	80mg/kg q24h	40mg/kg q12h	25mg/kg q12h	105mg/kg q48h	80mg/kg q48h
>0.5-0.6	60mg/kg q24h	60mg/kg q24h	40mg/kg q24h	80mg/kg q48h	60mg/kg q48h
≤0.5 and HD*	50mg/kg q24h	50mg/kg q24h	35mg/kg q24h	65mg/kg q48h	50mg/kg q48h
Alternative HD strategy	45-60mg/kg TIW postHD	45-60mg/kg TIW postHD	45-60mg/kg TIW postHD	45-60mg/kg TIW postHD	45-60mg/kg TIW postHD
VVHD @ 2000mL/hr	30mg/kg q12h	30mg/kg q12h	15mg/kg q12h	30mg/kg q24h	30mg/kg q24h

*Aggressive dosing in initial weeks of therapy has been associated with favorable viral clearance kinetics and improved infectious outcomes.
Monitor SCr, Ca, Mg, K, Phos frequently and replete electrolytes consistently in patients receiving foscarnet therapy.
Infuse at rate of 1 mg/kg/min. Maximum concentration for peripheral administration = 12 mg/mL.
Administer with 500-1000mL of D5 OR NS **concurrently** with foscarnet.

RENAL DOSING RECOMMENDATIONS FOR CONTINOUS AMBULATORY PERITONEAL DIALYSIS (CAPD)[1]

Drug	Systemic Dosing	Intraperitoneal Dosing[2,3]		
	CAPD	Intermittent[4]	Continuous	
			Loading[4]	Maintenance[5]
Acyclovir	5mg/kg IV q24h			
Amikacin	Limited to no data	2mg/kg IP q24h	25mg/L	12mg/L
Amoxicillin	250mg PO q12h	N/A		
Amoxicillin/Clavulanate	250mg/125mg PO q12h	N/A		
Ampicillin	1-2g IV Q24H	Limited to no data	N/A	125m/L
Ampicillin/Sulbactam	1.5-3g IV q24h	3g IP q12h	1500mg/L	150mg/L
Aztreonam [R]	0.5-1g IV q12h	Limited to no data	1000mg/L	250mgL
Cefazolin	500mg IV q12h	15mg/kg IP q24h	500mg/L	125mg/L
Cefepime [R]	1-2g IV q48h	1g IP q24h	500mg/L	125mg/L
Cefotaxime [R]	1g IV q24h			
Cefotetan	1g IV q24h			
Cefoxitin	0.5-1g IV q24h			
Ceftaroline	Limited to no data	Limited to no data		
Ceftazidime [R]	1g x 1, then 500mg IV q 24h	1-1.5g IP q24h	500mg/L	125mg/L

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RENAL DOSING RECOMMENDATIONS FOR CONTINOUS AMBULATORY PERITONEAL DIALYSIS (CAPD)[1] (CONTINUED)

Drug	Systemic Dosing	Intraperitoneal Dosing[2,3]		
	CAPD	Intermittent[4]	Continuous	
			Loading[4]	Maintenance[5]
Ceftriaxone [R]	1g IV q24h			
Cefuroxime	IV: 0.75-1.5g IV q24h; PO: 500mg q24h			
Cephalexin	500mg PO q12h	N/A		
Ciprofloxacin [R]	IV: 400mg q24h; PO: 250-500mg q24h	Limited to no data	50mg/L	25mg/L
Colistin	Limited to no data	Limited to no data		
Daptomycin [R]	4-6mg/kg IV q48h	Limited to no data	100mg/L	20mgL
Doripenem [R]	Limited to no data			
Ertapenem [R]	0.5g IV q24H			
Fluconazole	100-200mg IV q24h[6]	200mg IP q24-48h	Limited to no data	
Flucytosine [R]	Limited to no data	Limited to no data		
Ganciclovir[7]	1.25mg/kg IV thrice weekly (induction) 0.625mg/kg IV thrice weekly (maintenance)	Limited to no data		
Gentamicin	Limited to no data	0.6mg/kg IP q24h	8mg/L	4mg/L
Imipenem [R]	250mg IV q12h[8]	Limited to no data	250mg/L	50mg/L

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RENAL DOSING RECOMMENDATIONS FOR CONTINOUS AMBULATORY PERITONEAL DIALYSIS (CAPD)[1] (CONTINUED)

Drug	Systemic Dosing	Intraperitoneal Dosing[2,3]		
	CAPD	Intermittent[4]	Continuous	
			Loading[4]	Maintenance[5]
Levofloxacin[R]	250-500mg			
Meropenem [R]	500mg IV q24h			
Moxifloxacin [R]	Limited to no data, usual dose recommended			
Nitrofurantoin	Contraindicated	Contraindicated		
Oseltamivir	Treatment: 30mg x1 immediately after a dialysis exchange.	Limited to no data		
Penicillin G	0.5-2MU IV q6h	Limited to no data	Limited to no data	Limited to no data
Piperacillin/Tazobactam [R]	4.5g IV q12h			
TMP/SMX	Not removed by CAPD, consider 5mg/kg q24h			
Tobramycin	Limited to no data	0.6mg/kg IP q24h	8mg/L	4mg/L
Valacyclovir	500mg PO q24h	N/A		
Valganciclovir	Limited to no data	Limited to no data		
Vancomycin	15-20mg/kg IV q4-7days[9]	15-30mg/kg IP q5-7days[9]	1000mg/L	25mg/L

[1] Drug Prescribing in Renal Failure. American College of Physicians, Philadelphia, Pa., 5th Edition, 2007
[2] Intraperitoneal administration of antimicrobials preferred for the treatment of peritonitis
[3] Perit Dial Int 2010;30:393-423
[4] Must dwell for at least 6 hours
[5] Administer with every exchange
[6] 400mg IV q24h may be used to treat C.glabrata and other susceptible dose dependent isolates
[7] Please call AMP for assistance in dosing weight-based drugs in obese/morbidly obese patients
[8] Peritoneal excretion is limited, consider meropenem
[9] Give initial dose and base subsequent doses on serum levels

ANTIMICROBIAL DOSING RECOMMENDATIONS FOR HEPATIC IMPAIRMENT

Drug	Usual Dose	Mild	Moderate	Severe
Oxacillin/Nafcillin	2g q4h OR 12g continuous infusion	No adjustment	No adjustment	Decrease dose by 50% if concurrent renal failure
Rifampin	300-900mg IV/PO daily (in divided doses)"	Decreased clearance**	Decreased clearance**	Do not exceed 8mg/kg biweekly*
Rimantadine	100mg PO BID	No adjustment	No adjustment	100mg PO daily
Tigecycline	LD: 100mg IV x 1 MD: 50mg IV q 12h	No adjustment	No adjustment	LD: 100mg IV x 1 MD: 25mg IV q 12h

LD = Loading Dose; MD = Maintenance Dose
**Use only if the benefit clearly outweighs the risk.*
***Drug clearance is impaired. Use only with close monitoring as no specific dosing recommendations are available.*

Mild = Child-Pugh Class A (score 5-6); Moderate = Child-Pugh Class B (score 7-9); Severe = Child-Pugh Class C (score 9-12)
eravacycline: Severe impairment (Child-Pugh class C): 1 mg/kg every 12 hours on day 1, then 1 mg/kg every 24 hours

Based on the attached literature and after discussing with our local Infectious Diseases providers, we are recommending the following approach to dose reduction of caspofungin based on Child-Pugh classification and cirrhosis.

Drug	Child-Pugh Class (with or without cirrhosis)					
Caspofungin	A (5-6)		B (7-9)		C (10-15)	
	NO Cirrhosis	CIRRHOSIS	NO Cirrhosis	CIRRHOSIS	NO Cirrhosis	CIRRHOSIS
Infective Endocarditis	Consult Infectious Diseases/ID-AMP pharmacist					
All other indications**	LD: 70mg IV ONCE MD: 50mg IV q24hours*		LD: 70mg IV ONCE MD: 50mg IV q24hours*		LD: 70mg IV ONCE MD: 50mg IV q24hours*	Consult Infectious Diseases/ID-AMP pharmacist

LD: loading dose, MD: maintenance dose
**If co-administered with phenytoin, rifampin, carbamazapine, dexamethasone, efavirenz, nevirapine: caspofungin 70mg IV q24h*

References:
Cornely OA, Vehreschild JJ, Vehreschild MJ, et al. Phase II dose escalation study of caspofungin for invasive Aspergillosis. Antimicrob Agents Chemother 2011;55(12):5798-803
Gustot T, Ter Heine R, Brauns E, et al. Caspofungin dosage adjustments are not required for patients with Child-Pugh B or C cirrhosis. J Antimicrob Chemother 2018;73(9):2493-2496
Martial LC, Bruggemann RJ, Schouten JA, et al. Dose reduction of caspofungin in intensive care unit patients with Child Pugh B will result in suboptimal exposure. Clin Pharmacokinet 2016;55(6):723-33
Betts RF, Nucci M, Talwar D, et al. A multicenter, double-blind trial of a high-dose caspofungin treatment regimen versus a standard caspofungin treatment regimen for adult patients with invasive candidiasis. Clin Infect Dis 2009;48(12):1676-84

ANTIRETROVIRAL DOSING RECOMMENDATIONS

Drug	Usual Dosing	Adult Dosing in Renal Insufficiency			Adult Dosing in Hepatic Impairment
NUCLEOSIDE/TIDE REVERSE TRANSCRIPTASE INHIBITORS (NRTIs)					
Abacavir	300mg PO BID OR 600mg PO daily	No adjustments necessary			Child-Pugh 5-6: 200mg PO BID (oral solution) Child-Pugh >6: contraindicated
Emtricitabine	200mg PO daily (cap) OR 240mg PO daily (oral solution)	CrCl (mL/min)	Capsule	Solution	No adjustment recommendations
		30-49	200mg PO q48h	120mg PO q24h	
		15-29	200mg PO q72h	80mg PO q24h	
		<15 OR HD	200mg PO q96h	60mg PO q24h	
Lamivudine	300mg PO daily OR 150mg PO BID	CrCl (mL/min)	Dose		No adjustments necessary
		30-49	150mg PO q24h		
		15-29	150mg x1, then 100mg PO q24h		
		5-14	150mg x1, then 50mg PO q24h		
		<5 OR HD	150mg x1, then 25mg PO q24h		
Tenofovir disoproxil fumarate (TDF)	300mg PO daily	CrCl (mL/min)	Dose		No adjustments necessary
		30-49	300mg PO q48h		
		10-29	300mg PO q72-96h		
		HD	300mg PO q7days		

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ANTIRETROVIRAL DOSING RECOMMENDATIONS[1] (CONTINUED)

Drug	Usual Dosing	Adult Dosing in Renal Insufficiency		Adult Dosing in Hepatic Impairment
Zidovudine	300mg PO BID	CrCl <15 OR HD: 100mg PO TID OR 300mg PO daily		No adjustment recommendation
Abacavir/lamivudine (EPZICOM)	600mg/300mg 1 tablet PO daily	CrCl <50mL/min: not recommended		Contraindicated in hepatic impairment
Tenofovir disoproxil fumarate /emtricitabine (TRUVADA)	300mg/200mg 1 tablet PO daily	CrCl (mL/min)	Dose	No adjustment recommendation
		30-49	1 tablet PO q48h	
		<30	Not recommended	
Tenofovir disoproxil fumarate / lamivudine (CIMDUO)	300mg/300mg 1 tablet PO daily	CrCl <50mL/min: not recommended		No adjustment recommendation
Tenofovir alafenamide/ emtricitabine (DESCOVY)	200mg/25mg 1 tablet PO daily	CrCl <30mL/min: not recommended		No dose adjustment in Child-Pugh A OR B No dosing data for Child-Pugh C
Zidovudine/lamivudine (COMBIVIR)	300mg/150mg 1 tablet PO BID	CrCl <50mL/min: not recommended		No adjustment recommendation
NON-NUCLEOSIDE REVERSE TRANSCRIPTASE INHIBITORS (NNTRIs)				
Doravirine	100mg PO daily	No adjustment necessary No data for ESRD OR HD		No dose adjustment in Child-Pugh A OR B No dosing data for Child-Pugh C

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ANTIRETROVIRAL DOSING RECOMMENDATIONS[1] (CONTINUED)

Drug	Usual Dosing	Adult Dosing in Renal Insufficiency		Adult Dosing in Hepatic Impairment	
Efavirenz	600mg PO daily	No adjustments necessary		No adjustments necessary Use with caution in hepatic impairment	
Etravirine	200mg PO BID	200mg PO BID		Child-Pugh	Dose
				A OR B	No adjustment
				C	No data
Nevirapine	200mg daily x 2 weeks THEN 200mg PO BID	CrCl (mL/min)	Dose	Contraindicated Child-Pugh Class B OR C	
		≥20	No adjustment		
		<20	No data		
Rilpivirine	25mg PO daily	No adjustments necessary		No adjustments necessary	
INTEGRASE INHIBITORS					
Raltegravir	400mg PO BID 1200mg (2x600mg HD tabs) PO daily	No adjustments necessary		No adjustments necessary No data in severe hepatic impairment	
Dolutegravir	50 mg PO daily OR 50mg PO BID	No adjustments necessary		No adjustments necessary Not recommended in severe hepatic impairment	

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ANTIRETROVIRAL DOSING RECOMMENDATIONS[1] (CONTINUED)

Drug	Usual Dosing	Adult Dosing in Renal Insufficiency	Adult Dosing in Hepatic Impairment
ENTRY INHIBITORS			
Enfuvirtide	90mg SC BID	No adjustments necessary	No adjustments necessary
Maraviroc	Consult ID for dosing recommendations		
PROTEASE INHIBITORS (PIs)			
Atazanavir	300mg + RTV 100mg PO daily	No adjustments necessary for patients NOT requiring HD. *Not recommended in treatment-experienced patients on HD.	Child-Pugh Class B: 300mg PO daily Child-Pugh Class C: NOT recommended *RTV boosting is NOT recommended in hepatic impairment (Class B OR C)
Atazanavir + Cobicictat	300mg/150mg 1 tablet PO daily	With TDF: not recommended CrCl <70mL/min Without TDF: no dose adjustment for patients NOT requiring HD.	No dose recommendations NOT recommended in patients with hepatic impairment
Darunavir	800mg + RTV 100mg PO daily (Naive OR experienced) OR 600mg + RTV 100mg PO BID (experienced with resistance)	No adjustments necessary	Child-Pugh Class A or B No dose adjustment necessary NOT recommended in patients with severe hepatic impairment
Darunavir + Cobicistat	800mg/150mg 1 tablet PO daily	With TDF: not recommended CrCl <70mL/min Without TDF: no dose adjustment.	No dose recommendations NOT recommended in patients with severe hepatic impairment
Lopinavir + Ritonavir	400mg/100mg PO BID	Avoid daily dosing regimen in HD patients	No dosage recommendations Use with caution in hepatic impairment.

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ANTIRETROVIRAL DOSING RECOMMENDATIONS[1] (CONTINUED)

Drug	Usual Dosing	Adult Dosing in Renal Insufficiency		Adult Dosing in Hepatic Impairment
1-PILL COMBINATION REGIMENS				
ATRIPLA Efavirenz/ emtricitabine/ tenofovir disoproxil fumarate	600mg/200mg/300mg 1 tablet daily	CrCl <50mL/min: not recommended		Child-Pugh Class B OR C: not recommended
SYMFI Efavirenz/ lamivudine/ tenofovir DF	600mg/200mg/300mg OR 400mg/200mg/300mg 1 tablet daily	CrCl <50mL/min: not recommended		Child-Pugh B OR C: not recommended
COMPLERA Rilpivirine/emtricitabine/ tenofovir disoproxil fumarate	25mg/200mg/300mg 1 tablet daily	CrCl <50mL/min: not recommended		Mild/moderate impairment: no adjustment Severe impairment: no data
ODEFSEY Emtricitabine/rilpivirine/ tenofovir alafenamide	200mg/25mg/25mg 1 tablet daily	CrCl <30mL/min: not recommended		Mild/moderate impairment: no adjustment Severe impairment: no data
DELSTRIGO Doravirine/lamivudine/ tenofovir DF	100mg/300mg/300mg 1 tablet daily	CrCl <50mL/min: not recommended		Child-Pugh A OR B:no adjustment Child-Pugh C: not recommended
STRIBILD Elvitegravir/cobicistat/ tenofovir disoproxil fumarate /emtricitabine	150mg/150mg/300mg/200mg 1 tablet daily	CrCl (mL/min)	Dose	Child-Pugh Class A OR B: no adjustment Child-Pugh Class C: not recommended
		≥70	No adjustment	
		<70	Initial use not recommended	
		<50	Continued use not recommended	
		HD	Not recommended	

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ANTIRETROVIRAL DOSING RECOMMENDATIONS[1] (CONTINUED)

Drug	Usual Dosing	Adult Dosing in Renal Insufficiency	Adult Dosing in Hepatic Impairment
GENVOYA Elvitegravir/cobicistat/ tenofovir alafenamide/ emtricitabine	150mg/150mg/10mg/200mg 1 tablet daily	CrCl <30mL/min: not recommended	Child-Pugh Class A OR B: no adjustment Child-Pugh Class C: not recommended
TRIUMEQ Dolutegravir/abacavir/ lamivudine	50mg/600mg/300mg 1 tablet daily	CrCl <50mL/min: not recommended	Not recommended in hepatic impairment
JULUCA Dolutegravir/ rilpivirine	50mg/25mg 1 tablet daily	No adjustment necessary	Mild/moderate impairment: no adjustment Severe impairment: no data
DOVATO Dolutegravir/ lamivudine	50mg/300mg 1 tablet daily	CrCl <50mL/min: not recommended	Child-Pugh Class A OR B: no adjustment Child-Pugh Class C: not recommended
BIKTARVY Bictegravir/ tenofovir alafenamide/ emtricitabine	50mg/25mg/200mg 1 tablet daily	CrCl <30mL/min: not recommended	Child-Pugh A OR B: no adjustment Child-Pugh C: not recommended
SYMTUZA Darunavir/ cobicistat/ tenofovir alafenamide/ emtricitabine	800mg/150mg/25mg/200mg 1 tablet daily	CrCl <30mL/min: not recommended	Not recommended in patients with severe hepatic impairment

** Dose after dialysis on dialysis days.*
† Child-Pugh Class A = Score 5-6; Class B = Score 7-9; Class C = Score 9-12.
[1] Panel on Antiretroviral Guidelines for Adults and Adolescents. Guidelines for the Use of Antiretroviral Agents in Adults and Adolescents with HIV. Department of Health and Human Services. Available at http://aidsinfo.nih.gov/contentfiles/lvguidelines/AdultandAdolescentGL.pdf. Section accessed [12/13/2019]

ANTIRETROVIRAL AGENTS BY CLASS

Nucleoside/tide Reverse Transcriptase Inhibitors (NRTIs)	NRTI Combinations
Abacavir (ZIAGEN) ABC Didanosine (VIDEX EC) ddI Emtricitabine (EMTRIVA) FTC Lamivudine (EPIVIR) 3TC Stavudine (ZERIT) d4T Tenofovir disoproxil fumarate (VIREAD) TDF Tenofovir alafenamide (VEMLIDY) TAF Zidovudine (RETROVIR) AZT, ZDV	Zidovudine/lamivudine (COMBIVIR) Abacavir/lamivudine (EPZICOM) Abacavir/lamivudine/zidovudine (TRIZIVIR) Tenofovir disoproxil fumarate /emtricitabine (TRUVADA) Tenofovir alafenamide/emtricitabine (DESCOVY) Tenofovir disoproxil fumarate /lamivudine (CIMDUO)
Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs)	NNRTI Combinations
Doravirine (PIFELTRO) DOR Delavirdine (RESCRIPTOR) DLV Efavirenz (SUSTIVA) EFV Etravirine (INTELENCE) ETR Nevirapine (VIRAMUNE) NVP Rilpivirine (EDURANT) RVP	Doravirine/lamivudine/tenofovir disoproxil fumarate (DELSTRIGO) Efavirenz/emtricitabine/tenofovir disoproxil fumarate (ATRIPLA) Efavirenz/lamivudine/tenofovir disoproxil fumarate (SYMFI) Rilpivirine/emtricitabine/tenofovir disoproxil fumarate (COMPLERA) Rilpivirine/emtricitabine/tenofovir alafenamide (ODEFSEY)
Integrase Inhibitors	Integrase Inhibitors Combinations
Raltegravir (ISENTRESS) RAL Dolutegravir (TIVICAY) DTG	Elvitegravir/cobicistat/tenofovir disoproxil fumarate /emtricitabine (STRIBILD) Elvitegravir/cobicistat/tenofovir alafenamide/emtricitabine (GENVOYA) Dolutegravir/abacavir/lamivudine (TRIUMEQ) Dolutegravir/ Rilpivirine (JULUCA) Dolutegravir/ Lamivudine (DOVATO) Bictecravir/ emtricitabine/ Tenofovir alafenamide (BIKTARVY)
Protease Inhibitors (PIs)	Entry Inhibitors
Atazanavir (REYATAZ/EVOTAZ) ATV/ATVc* Darunavir (PREZISTA/PREZCOBIX) DRV/DRVc* Fosamprenavir (LEXIVA) FPV Indinavir (CRIXIVAN) IDV Lopinavir/ritonavir (KALETRA) LPV/r Nelfinavir (VIRACEPT) NFV Ritonavir (NORVIR) RTV Saquinavir (INVIRASE) SQV Tipranavir (APTIVUS) TPV *c= cobicistat	Enfuvirtide (FUZEON) ENF, T-20 Maraviroc (SELZENTRY) MVC
	Protease Inhibitor Combinations
	Darunavir/cobicistat/emtricitabine/tenofovir alafenamide (SYMTUZA)

COMMON DRUG-DRUG INTERACTIONS WITH HIV MEDICATIONS [1,2]

Drug Class	Interacting HIV Medication(s)	Recommendation
Lipid Lowering Agents -Simvastatin* -Lovastatin*	Protease inhibitors Cobicistat containing products (Stribild, Genvoya, Prezcobix, Evotaz, Symtuza)	Pravastatin is the preferred agent at the lowest effective dose. Atovastatin: do not exceed 20 mg daily with boosted darunavir and fosamprenavir, use with caution and use lowest dose necessary with lopinavir/ritonavir, avoid with boosted tipranavir, and do not exceed 40mg/day with nelfinavir. Rosuvastatin: limit dose to 10 mg/daily when given with boosted atazanavir and lopinavir/ritonavir.
Anticonvulsants -Phenytoin -Carbamazepine -Phenobarbital	Protease inhibitors NNRTIs Integrase Inhibitors	Avoid phenytoin, carbamazepine, and phenobarbital if possible. Clinicians must monitor levels very closely if any of these agents are used. Valproic acid, levetiracetam, gabapentin, topiramate, OR pregabalin may be considered.
Azole Antifugnal Agents -Ketoconazole -Itraconazole -Voriconazole	Protease inhibitors Cobicistat containing products (Stribild, Genvoya, Prezcobix, Evotaz, Symtuza)	Fluconazole is the preferred azole antifungal agent. Voriconazole and itraconazole should be used only if the benefit clearly outweighs the potential risk of toxicity, and appropriate dose adjustments are made. Caspofungin is also a safe alternative.
Psychotropics -Midazolam* -Triazolam* -Alprazolam	Protease inhibitors Cobicistat containing products (Stribild, Genvoya, Prezcobix, Evotaz, Symtuza)	Temazepam OR lorazepam are the preferred agents in this class.
Acid Reducers -Proton pump inhibitors (PPI) -H2 Antagonists	Atazanavir (ATV) Nelfinavir (NFV) Rilpivirine	PPIs are contraindicated for patients receiving unboosted ATV OR for treatment-experienced patients receiving ATV. If treatment naïve, PPI doses should not exceed a dose equivalent to omeprazole 20mg daily administered ≥12 hours prior to ATV. ATV should be administered ≥2 hours before and/or ≥10 hours after a H2 antagonist. Do not co-administer PPIs and NFV. Rilpivirine containing regimens are contraindicated with PPIs. Administer H2 blocker at least 12 hours before OR 4 hours after rilpivirine
Antimycobacterials -Clarithromycin -Rifampin* -Rifabutin	Protease inhibitors Cobicistat containing products (Stribild, Genvoya, Prezcobix, Evotaz, Symtuza)	Rifabutin is preferred over rifampin at a dose of 150mg QOD OR 3x/week. Clarithromycin should be monitored closely for QTc prolongation and dose must be reduced by 50% in patients with CrCl 30-60 mL/min and 75% in patients with a CrCl <30mL/min. Avoid use of TAF with Rifamycins, May result in lower TAF concentrations

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COMMON DRUG-DRUG INTERACTIONS WITH HIV MEDICATIONS [1,2] (CONTINUED)

Drug Class	Interacting HIV Medication(s)	Recommendation
Immunosuppressants -Tacrolimus -Sirolimus -Cyclosporine	Protease inhibitors Cobicistat containing products (Stribild, Genvoya, Prezcobix, Evotaz, Symtuza)	Doses of tacrolimus require as much as a 70-fold reduction during concurrent PI therapy; expert consultation is recommended. Similarly, sirolimus and cyclosporine require significant reductions. Careful therapeutic drug monitoring and consultation is recommended for all patients receiving concurrent immunosuppressant therapy.
Corticosteroids - Fluticasone (inhaled, intranasal) -Triamcinolone (intra articular) -Budesonide (inhaled, intranasal)	Protease inhibitors Cobicistat containing products (Stribild, Genvoya, Prezcobix, Evotaz, Symtuza)	Inhaled OR intranasal beclomethasone, ciclesonide OR mometasone may be safer alternatives, but use caution (all are 3a4 substrates) If steroids are clearly indicated, ritonavir boosted PIs should be avoided if other options are feasible (NNRTIs, integrase inhibitors).

NNRTI = Non-Nucleoside Reverse Transcriptase Inhibitors
**Contraindicated*
[1] Panel on Antiretroviral Guidelines for Adults and Adolescents. Guidelines for the Use of Antiretroviral Agents in Adults and Adolescents with HIV. Department of Health and Human Services. Available at http://aidsinfo.nih.gov/contentfiles/lvguidelines/AdultandAdolescentGL.pdf. Section accessed [12/13/2019]
[2] Expert Opin Pharmacother 2007;8:2947.

ADMINISTRATION CONSIDERATIONS WITH HIV MEDICATIONS

Take WITH food	Take on an EMPTY STOMACH
Atazanavir, ATV/c (REYATAZ, EVOTAZ) Darunavir, DRV/c (PREZISTA, PREZCOBIX) Ritonavir (NORVIR) Etravirine (INTELENCE) Rilpivirine (EDURANT) COMPLERA (rilpivirine/ tenofovir DF/ emtricitabine) ODEFSEY (rilpivirine/ tenofovir AF/ emtricitabine) JULUCA (dolutegravir/ rilpivirine) STRIBILD (elvitegravir/ cobicistat/tenofovir DF/ emtricitabine) GENVOYA (elvitegravir/ cobicistat/ tenofovir AF/ emtricitabine) SYMTUZA (darunavir/ cobicistat/ tenofovir AF/ emtricitabine)	Efavirenz (SUSTIVA) ATRIPLA (efavirenz/ tenofovir DF/ emtricitabine) SYMFI (efavirenz/ tenofovir DF/ lamivudine)
No food restrictions	
Abacavir (ZIAGEN) Emtricitabine (EMTRIVA) Lamivudine (EPIVIR) Tenofovir DF (VIREAD) Zidovudine (RETROVIR) Raltegravir (ISENTRESS) Dolutegravir (TIVICAY) Maraviroc (SELZENTRY) Doravirine (PIFELTRO)	COMBIVIR (zidovudine/ lamivudine) EPZICOM (abacavir/lamivudine) TRUVADA (tenofovir DF/ emtricitabine) DESCOVY (tenofovir AF/ emtricitabine) CIMDUO (tenofovir DF/ lamivudine) TRIUMEQ (dolutegravir/ abacavir/ lamivudine) BIKTARVY (bictegravir/ tenofovir AF/ emtricitabine) DOVATO (dolutegravir/ lamivudine) DELSTRIGO (doravirine/ tenofovir DF/ lamivudine)
DO NOT CRUSH (or open capsule)	
Atazanavir/cobicistat (EVOTAZ) Ritonavir (NORVIR)	SYMTUZA (darunavir/ cobicistat/ tenofovir AF/ emtricitabine)

Liquid Formulations Available
Abacavir (ZIAGEN), Emtricitabine (EMTRIVA), Lamivudine (EPIVIR), Darunavir (PREZISTA)

PREVENTION OF INFECTIVE (BACTERIAL) ENDOCARDITIS

The American Heart Association's Endocarditis Committee, along with a national/international expert panel of infective endocarditis (IE) experts recently have performed an extensive review of the data surrounding whether dental, gastrointestinal (GI), or genitourinary (GU) tract procedures are possible causes of IE. Their findings are available in published form and on PubMed (www.pubmed.gov).[1,2] The following is a summary of their updated recommendations.

When is prophylaxis reasonable?

1.) Only for patients with cardiac conditions associated with a the highest risk of adverse outcomes from endocarditis, including:

- Prosthetic cardiac valve or prosthetic material used in valve repair
- Previous endocarditis
- Congenital heart disease only in the following categories
- Unrepaired cyanotic congenital heart disease, including those with palliative shunts and conduits.
- Completely repaired congenital heart disease with prosthetic material or device, whether placed by surgery or catheter intervention, during the first six months after the procedure.
- Repaired congenital heart disease with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device (which inhibit endotheliazation).

2.) Dental procedures for which prophylaxis is reasonable in patients with the cardiac conditions listed above include:

- Manipulation of gingival tissue or periapical region of the teeth
- Perforation of the oral mucosa

What about gastrointestinal (GI) or genitourinary (GU) procedures?

- Antibiotic prophylaxis solely to prevent IE is no longer recommended for patients who undergo a GI or GU tract procedure, including patients with the highest risk of adverse outcomes due to IE.

What about other procedures?

- Procedures involving the respiratory tract or infected skin, superficial layers below the skin, or musculoskeletal tissue for which prophylaxis is reasonable are discussed in the published document found in references [1, 2]. The interested reader should consult the referenced material.

When prophylaxis is reasonable, what regimen should I use?

Situation	Agent	Regimen — Single Dose 30-60 minutes before procedure	
		Adults	Children
Oral	Amoxicillin	2g PO	50mg/kg PO
Unable to take oral medication	Ampicillin OR Cefazolin	2g IV OR IM 1g IV OR IM	50mg/kg IV OR IM 50mg/kg IV OR IM
Allergic to penicillins OR ampicllin — oral regimen	Cephalexin OR Clindamycin OR Azithromycin	2g PO 600mg PO 500mg PO	50mg/kg PO 20mg/kg PO 15mg/kg PO
Allergic to penicillins OR ampicillin and unable to take oral medication	Cefazolin OR Clindamycin	1g IV OR IM 600mg IV OR IM	50mg/kg IV OR IM 20mg/kg IV OR IM

[1] *Circulation 2007;116:1736-54.*
[2] *http://circ.ahajournals.org/cgi/reprint/CIRCULATIONAHA.106.183095*

HEPATITIS C

*See HCV guidelines for most up to date recommendations. www.hcvguidelines.org

RECOMMENDATIONS FOR ANTIMICROBIAL RE-DOSING FOR SURGICAL PROPHYLAXIS[1,2,3] (CONTINUED)

Antimicrobial Agent	Adult Dose	Half-life (h) in adults with normal renal function	Redosing interval (h) from initiation of preoperative dose in patients with normal renal function	Redosing interval (h) from preoperative dose in patients with CrCl < 30 mL/min or HD	Therapeutic Levels in CSF † Only with inflammation; inflamed meninges
Ampicillin	2 gm	1 – 1.9	2	6	Yes †
Ampicillin/Sulbactam (Unasyn)	3 gm	0.8 – 1.3	2-4	6	No for sulbactam
Aztreonam (Azactam)	2 gm	1.3 – 2.4	4	8	Yes †
Cefazolin (Ancef)	2 gm ≥ 120 kg: 3 gm	1.2 – 2.2	4 (redose = 2g for all weights)	6 (redose = 2g for all weights)	No
Cefepime (Maxipime)	2 gm	2	6	If CrCl < 50 mL/min, redose cefepime every 8 hours	Yes
Cefoxitin (Mefoxin)	2 gm	0.7 – 1.1	2	4	No
Ceftriaxone (Rocephin)	2 g	5.4 – 10.9	Not Recommended	Not Recommended	Yes
Cefuroxime (Zinacef)	1.5 gm	1 – 2	4	6	Yes
Ciprofloxacin (Cipro)	400 mg	3 – 7	Not Recommended	Not Recommended	Yes
Clindamycin (Cleocin)	900 mg	2 – 4	6	6	No
Daptomycin (Cubicin)	6 mg/kg	8 – 9	Not Recommended	Not Recommended	@ High Doses

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RECOMMENDATIONS FOR ANTIMICROBIAL RE-DOSING FOR SURGICAL PROPHYLAXIS[1,2,3] (CONTINUED)

Antimicrobial Agent	Adult Dose	Half-life (h) in adults with normal renal function	Redosing interval (h) from initiation of preoperative dose in patients with normal renal function	Redosing interval (h) from preoperative dose in patients with CrCl < 30 mL/min or HD	Therapeutic Levels in CSF † Only with inflammation; inflamed meninges
Doxycycline (Doxy)	100 mg	18 – 22	Not Recommended	Not Recommended	Minimally
Ertapenem (INVanz)	1 gm	3 – 5	Not Recommended	Not Recommended	No
Gentamicin	5 mg/kg/day	2 – 3	Not Recommended	Not Recommended	No
Levofloxacin (Levaquin)	500 -750 mg	6 – 8	Not Recommended	Not Recommended	Minimally
Linezolid (Zyvox)	600 mg	4.9 – 5	Not Recommended	Not Recommended	Yes
Meropenem (Merrem)	1 gm	1	4	8	Yes
Metronidazole (Flagyl)	500 mg	6 – 8	6	6	Yes
Moxifloxacin (Avelox)	400 mg	8 – 15	Not Recommended	Not Recommended	Yes
Oxacillin, Nafcillin	2 gm	0.5 – 1	2	2	@ High Doses
Penicillin G (Pfizerpen-G)	3 – 6 mil units	0.5 – 1	2	4	Yes†
Piperacillin/Tazobactam (Zosyn)	4.5 gm	0.7 – 1.2	4	6	No for tazobactam
Rifampin (Rifadin)	300 – 600 mg	1.5 – 5	Not Recommended	Not Recommended	Yes
SMX/TMP (Bactrim)	5 mg/kg	9 – 12/6 – 11	Not Recommended	Not Recommended	Yes
Tigecycline (Tygacil)	50 mg	27 – 42 (Hepatic Cl.)	Not Recommended	Not Recommended	No
Vancomycin	15 mg/kg	4 – 8	12	Not Recommended	@ High Doses

UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS

Updated 12/20/2018

Supporting References:
Berrios-Torres SI et al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA Surg. 2017;152(8):784-791
Bratzler DW et al. Clinical Practice Guidelines for antimicrobial prophylaxis in surgery. Am J Health-Syst Pharm 2013; 70: 195-283.
Antimicrobial Prophylaxis for Surgery, Treatment Guidelines of the Medical Letter, 2006; 4(52):83-85

UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS

Surgical Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
CLEAN				
CARDIAC				
Valve surgery, coronary artery bypass, open heart surgery, and heart transplant	*S. aureus, S. epidermidis, Corynebacterium,* enteric Gram-negative bacilli	Preferred†	Cefazolin 2g IV x1 (3g if > 120kg)	Cefazolin 1-2g IV Q8H x 48 hours
		Allergy	Vancomycin 15mg/kg IV x1 OR Clindamycin 900mg IV x1	Vancomycin 15mg/kg IV Q12H x 48 hours OR Clindamycin 900mg IV Q8H x 48 hours
VAD Placement		Preferred and Allergy	Vancomycin 15mg/kg IV + Cefepime 2g IV x1 Fluconazole 400mg IV x1	Vancomycin 15mg/kg IV Q12H x3 doses + Cefepime 2g IV Q8H x3 doses + Fluconazole 200mg IV x1 dose
THORACIC (NON-CARDIAC)				
Pulmonary, lobectomy, other mediastinal surgery	*S. aureus, S. epidermidis,* streptococci, enteric Gram-negatives, *Pseudomonas* for transplant patients	Preferred†	Cefazolin 2g IV x1 (3g if > 120kg)	No antibiotics needed
		Allergy	Vancomycin 15mg/kg IV x1	No antibiotics needed
Lung Transplant *May be individualized based on pre-transplant cultures		Preferred	Vancomycin 15mg/kg IV + Cefepime 2g IV Q12H x1	Vancomycin 15mg/kg IV Q12H + Cefepime 2g IV Q12H x 48 hours
		Allergy	Vancomycin 15mg/kg IV + Meropenem 2g IV x1	Vancomycin 15mg/kg IV Q12H + Meropenem 2g IV q8h x 48 hours

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UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS (CONTINUED)

Surgical Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
NEUROSURGERY				
General	*S. aureus, S. epidermidis*	Preferred†	Cefazolin 2g IV x1 (3g if > 120kg)	If no hardware placed: no antibiotics needed If hardware is placed: Cefazolin 1-2g IV Q8H x 48 hours
		Allergy	Vancomycin 15mg/kg IV x1	If no hardware placed: no antibiotics needed If hardware is placed: Vancomycin 15 mg/kg IV Q12H x 48 hours
ORTHOPEDIC (ORTHO TRAUMA BELOW)				
Internal fixation of fractures, hip fracture repair, total joint replacement	*S. aureus, S. epidermidis*	Preferred†	Cefazolin 2g IV x1 (3g if > 120kg)	No antibiotics needed If spinal hardware is placed and/or exposed pins remain open: Cefazolin 1-2g IV Q8H x48 hours
		Allergy	Vancomycin 15mg/kg IV x1	If no hardware placed: no antibiotics If spinal hardware is placed and/or exposed pins remain open: Vancomycin 15 mg/kg IV Q12H x 48 hours
PERIPHERAL VASCULAR				
Arterial surgery involving the abdominal aorta, prosthesis, OR groin incision; lower extremity amputation for ischemia	*S. aureus*, *S. epidermidis*, enteric Gram-negative bacilli	Preferred†	Cefazolin 2g IV x1 (3g if > 120kg)	If no graft placed: no antibiotics needed If graft is placed: Cefazolin 1-2g IV Q8H x 48 hours
		Allergy	Vancomycin 15mg/kg IV x1	If no graft placed: no antibiotics If graft is placed: Vancomycin 15 mg/kg IV Q12H x 48 hours

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UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS (CONTINUED)

Surgical Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
CLEAN-CONTAMINATED				
HEAD AND NECK				
General	*S. aureus*, anaerobes, enteric Gram-negative bacilli	Uncomplicated cases	cefazolin + metronidazole x 24h	No antibiotics unless hardware placed
		History of radiation or fistula	cefazolin + metronidazole x 72h	No antibiotics unless hardware placed
		Penicillin allergy mild/moderate (rash, hives > 10 years ago, pruritis, patient doesn't remember details):	cefazolin + metronidazole x 24h	No antibiotics unless hardware placed
		Penicillin allergy severe (anaphylaxis, hive within 10 years, angioedema, hypotension)	levofloxacin + metronidazole x24h	No antibiotics unless hardware placed

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UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS (CONTINUED)

Surgical Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
Abdominal				
Low risk gastroduodenal and biliary tract: PEG insertion, resection of ulcers, bariatric procedures, planned cholecystectomy, non-obstructed small intestinal procedures, hernia repair	Strep. spp., enteric Gram-negative bacilli, *Staphylococcus*	Preferred	Cefazolin 2g IV x1 (3g if > 120kg)	No antibiotics needed
		Allergy	Vancomycin 15mg/kg IV + Aztreonam 2g IV x1	No antibiotics needed
High risk gastroduodenal and biliary tract: obstruction, esophageal obstruction, decreased GI motility, gastric bleeding, ASA classification >3, cancer, morbidity obesity; age >70 years, obstructive jaundice, non-functioning gall bladder, acute cholecystitis, open cholecystectomy, risk of intraoperative gallbladder rupture	Strep. spp., *enterococci*, enteric Gram-negative bacilli, *Staphylococcus*	Preferred	Cefazolin 2g IV x1 (3g if > 120kg)	Cefazolin 1-2g IV Q8H x 24 hours
		Allergy	Vancomycin 15mg/kg IV + Aztreonam 2g IV Q8H	Vancomycin 15 mg/kg IV Q12H + Aztreonam 2g IV Q8H

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UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS (CONTINUED)

Surgical Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
Appendectomy	Enterococci, enteric Gram-negative bacilli, *Staphylococcus*	Preferred	Cefoxitin 2g IV x1 OR Cefuroxime 1.5g IV + Metronidazole 500mg IV x1 OR Ceftriaxone 1-2g IV + Metronidazole 500mg IV x1 OR Amp/sulbactam 3g IV x1	If uncomplicated, no antibiotics needed If complicated: Cefoxitin 2g IV Q6H x 72 hours OR Cefuroxime 1.5g IV Q8H + Metronidazole 500mg IV Q8H x 72 hours OR Ceftriaxone 2g IV Q24H + Metronidazole 500mg IV Q8H x72 hours
		Allergy	Vancomycin 15mg/kg IV + Aztreonam 2g IV + Metronidazole 500mg IV x1	If uncomplicated, no antibiotics needed If complicated: Vancomycin 15 mg/kg IV Q12H + Aztreonam 2g IV Q8H + Metronidazole 500mg IV Q8H x 72 hours
Colorectal	Enterococci, enteric Gram-negative bacilli, anaerobes	Preferred	Ceftriaxone 2g IV + Metronidazole 500mg IV x1 OR Cefoxitin 2g IV x1	Ceftriaxone 2g IV x1 dose + Metronidazole 500mg IV Q8H x3 doses OR Cefoxitin 2g IV Q6H x24 hours
		Allergy	Vancomycin 15mg/kg IV + Aztreonam 2g IV + Metronidazole 500mg IV x1	Vancomycin 15 mg/kg IV Q12H + Aztreonam 2g IV Q8H + Metronidazole 500mg IV Q8H x 24 hours

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UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS (CONTINUED)

Surgical Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
GENITOURINARY/UROLOGIC				
High risk: prolonged preop catheterization, positive OR unavailable urine culture, transrectal prostatic biopsy	Enterococci, enteric Gram-negative bacilli	Preferred	Ciprofloxacin 500mg PO x1 OR TMP/SMX 160/800mg PO x1 OR Cefuroxime 1.5 g IV x1 OR Ceftriaxone 2g IV x1 OR Ciprofloxacin 400mg IV x1	No antibiotics needed
Clean surgery without entry into urinary tract with/without prosthetic material placed	Enterococci, enteric Gram-negative bacilli	Preferred	Cefazolin 2g IV x1 (3g if > 120kg) [+ Gentamicin 5mg/kg IV x1 if placement of prosthetic material]	No antibiotics needed
		Allergy	Vancomycin 15mg/kg IV x1 [+ Gentamicin 5mg/kg IV x1 if placement of prosthetic material]	
Clean-contaminated	Enterococci, enteric Gram-negative bacilli and anaerobes	Preferred	Cefoxitin 2g IV x1 OR Cefuroxime 1.5 g IV + Metronidazole 500mg IV x1 OR Ceftriaxone 2g IV + Metronidazole 500mg IV x1	Post-op doses not required
		Allergy	Vancomycin 15mg/kg IV + Gentamicin 2.5 mg/kg IV + Metronidazole 500mg IV x1	

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UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS (CONTINUED)

Surgical Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
ABDOMINAL TRANSPLANT				
Liver (recipient) *Individualized based on pre-transplant cultures	Enterococci, enteric Gram-negative bacilli, *Staphylococcus*, anaerobes	Preferred	Amp/sulbactam 3g IV x1 OR Tigecycline 100mg IV x1 (if VRE colonized)	Amp/sulbactam 3g IV Q6H x 3 days if deceased donor, 5 days if living donor OR Tigecycline 50mg Q12H x 3 days if deceased donor, 5 days if living donor
		Allergy	Tigecycline 100mg x1	Tigecycline 50mg IV q12h x 48 hours
Multi-visceral *Individualized based on pre-transplant cultures	Enterococci, enteric Gram-negative bacilli, *Staphylococcus*, anaerobes	Preferred	Non-VRE colonized: Vancomycin 1g IV q12 hrs (trough goal 12-18), cefepime 2g IV q8h, and metronidazole 500mg IV q8h x14 days Cefepime allergy OR VRE colonized: tigecycline 50mg q12h x14 days (Remove aztreonam from both) History of MDR organisms: consult TID Caspofungin 50mg IV ONCE	Non-VRE colonized: Vancomycin 1g IV q12 hrs (trough goal 12-18), cefepime 2g IV q8h, and metronidazole 500mg IV q8h x14 days Cefepime allergy OR VRE colonized: tigecycline 50mg q12h x14 days (Remove aztreonam from both) History of MDR organisms: consult TID Caspofungin 50mg IV ONCE
Kidney *Individualized based on pre-transplant cultures	Enterococci, enteric Gram-negative bacilli, *Staphylococcus*, anaerobes	Preferred	Cefazolin 2g IV x1 (3g if > 120kg)	Cefazolin 1-2g IV Q8H x 24 hours
		Allergy	Vancomycin 15mg/kg IV x1	Vancomycin 15mg/kg IV Q12H x 24 hours
Kidney-Pancreas *Individualized based on pre-transplant cultures	Enterococci, enteric Gram-negative bacilli, *Staphylococcus*, anaerobes	Preferred	Cefoxitin 2g IV x1	Cefoxitin 2g IV Q6H x 48 hours
		Allergy	tigecycline 100mg IV x1	tigecycline 50mg q12h x48h

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UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS (CONTINUED)

Surgical Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
GYNECOLOGIC AND OBSTETRIC				
Cesarean delivery Non-invasive hysterectomy	Enteric gram negatives, anaerobes, *enterococci*, streptococci, *staphylococci*, Group B streptococcus	Preferred	Cefazolin 2g IV x1 (3g if > 120kg) OR Cefuroxime 1.5g IV x1 OR Ceftriaxone 2g IV x1	Post-op doses not required
		Allergy	Clindamycin 900mg IV + Gentamicin 5mg/kg IV	Post-op doses not required
Abdominal/vaginal hysterectomy		Preferred	Cefoxitin 2g IV x1 OR Cefazolin 2g IV x1 (3g if > 120kg) + Metronidazole 500mg IV x1	Post-op doses not required
		Allergy	Clindamycin 900mg IV + [either: gentamicin 5mg/kg IV, OR ciprofloxacin 400mg IV, OR aztreonam 2g[V] x1 OR Metronidazole 500mg IV + [either: gentamicin 5mg/kg IV OR ciprofloxacin 400mg IV]	Post-op doses not required
PLASTIC SURGERY				
Clean with risk factors, OR clean-contaminated. Skin grafts, fat grafts, implants, complex reconstructions, mesh	*S. aureus*, *Streptococcus* *Staphylococcus*	Preferred†	Cefazolin 2g IV x1 (3g if > 120kg) OR Cefuroxime 1.5gIV x1 OR Amp/sulbactam 3g IV x1	Post-op doses not required in most cases without implants OR mesh
		Allergy	Vancomycin 15mg/kg IV x1 OR Clindamycin 900mg IV x1	Post-op doses not required in most cases without implants OR mesh

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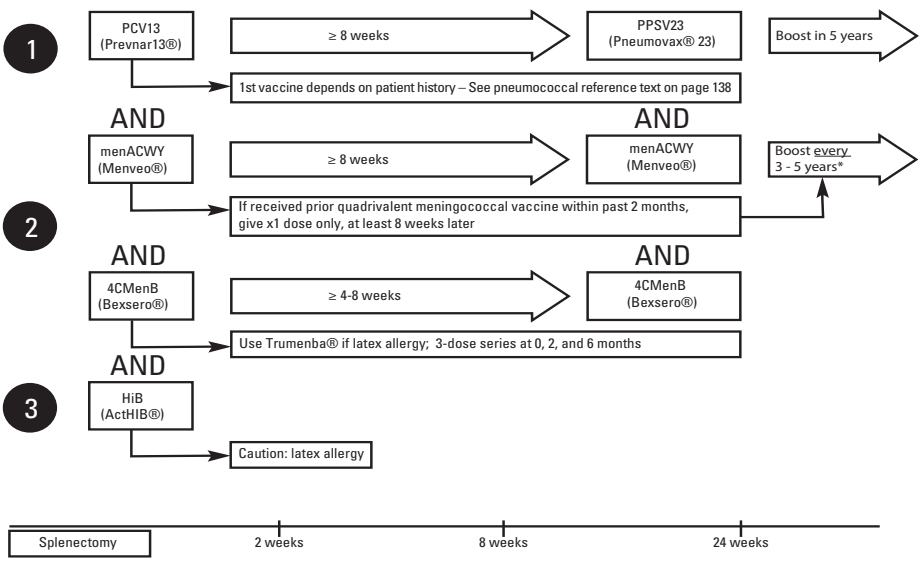
UPMC RECOMMENDATIONS FOR SURGICAL ANTIMICROBIAL PROPHYLAXIS (CONTINUED)

Surgical Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
CONTAMINATED				
PENETRATING ABDOMINAL TRAUMA				
General	Enterococci, enteric gram-negative bacilli, *Staphylococcus*, anaerobes	Preferred†	Cefoxitin 2g IV x1	Cefoxitin 2g IV Q6H x 24 hours
		Allergy	Vancomycin 15mg/kg IV + Aztreonam 2g IV + Metronidazole IV 500mg x1	Vancomycin 15mg/kg IV Q12H + Aztreonam 2g IV Q8H + Metronidazole 500mg IV Q8H x 24 hours
OPEN FRACTURES				
Grade 1 Open Fractures	Enterococci, enteric gram-negative bacilli, *Staphylococcus*, anaerobes	Preferred†	Cefazolin 2g IV x1 (3g if > 120kg)	Cefazolin 1-2g IV Q8H x 48 hours
		Allergy	Vancomycin 15mg/kg IV x1	Vancomycin 15mg/kg IV Q12H x 48 hours
Grade 2 Open Fractures	Enterococci, enteric gram-negative bacilli, *Staphylococcus*, anaerobes	Preferred†	Cefazolin 2g IV x1 (3g if > 120kg)	Cefazolin 1-2g Q8H IV x 48 hours
		Allergy	Vancomycin 15mg/kg IV x1	Vancomycin 15mg/kg IV Q12H x 48 hours
Grade 3 Open Fractures	Enterococci, enteric gram-negative bacilli, *Staphylococcus*, anaerobes	Preferred†	Pip/tazobactam 4.5g x1	Pip-tazobactam 4.5g IV Q6H x 7 days
		Allergy	Vancomycin 15mg/kg + Ciprofloxacin 400mg IV x1	Vancomycin 15mg/kg IV Q12H + Ciprofloxacin 400mg IV Q8H x7 days

PROCEDURAL PROPHYLAXIS

Procedure	Likely Pathogens	Regimen Classification	Pre-Op	Post-Op
ERCP	Enterococci, enteric Gram-negative bacilli, clostridia	Preferred	Pip-tazobactam 4.5g IV x1 OR Ciprofloxacin 500mg PO x1 OR Ciprofloxacin 400mg IV x1	No antibiotics needed
Hernioplasty and herniorrhaphy	Gram-positive aerobes, *MRSA*	Preferred†	Cefazolin 2g IV x1 (3g if > 120kg)	No antibiotics needed
		Allergy	Vancomycin 15mg/kg IV x1	
Patients undergoing EUS of cystic lesions along the GI tract	Gram-positive cocci, enteric Gram-negative bacilli	Preferred	Ciprofloxacin 500mg PO x1 OR Ceftriaxone 2g IV x 1	Continue pre-operative regimen for 3 days
EGD in the setting of: cirrhosis WITH acute GI bleeding	Enteric Gram-negative bacilli	Preferred	Ceftriaxone 2g IV x1	Complete course as per treatment recommendations (~5 days total)
Patients undergoing PEG placement	*Staphylococcus* and strep. spp	Preferred	Cefazolin 2g IV x1 (3g if > 120kg)	No antibiotics needed
Colonoscopy in the setting of peritoneal dialysis	Enteric Gram-negative bacilli	Preferred	Ciprofloxacin 500mg PO + Metronidazole 500mg PO x1	No antibiotics needed

VACCINATION POST-SPLENECTOMY[1]



1 PowerPlan available in Cerner electronic health record

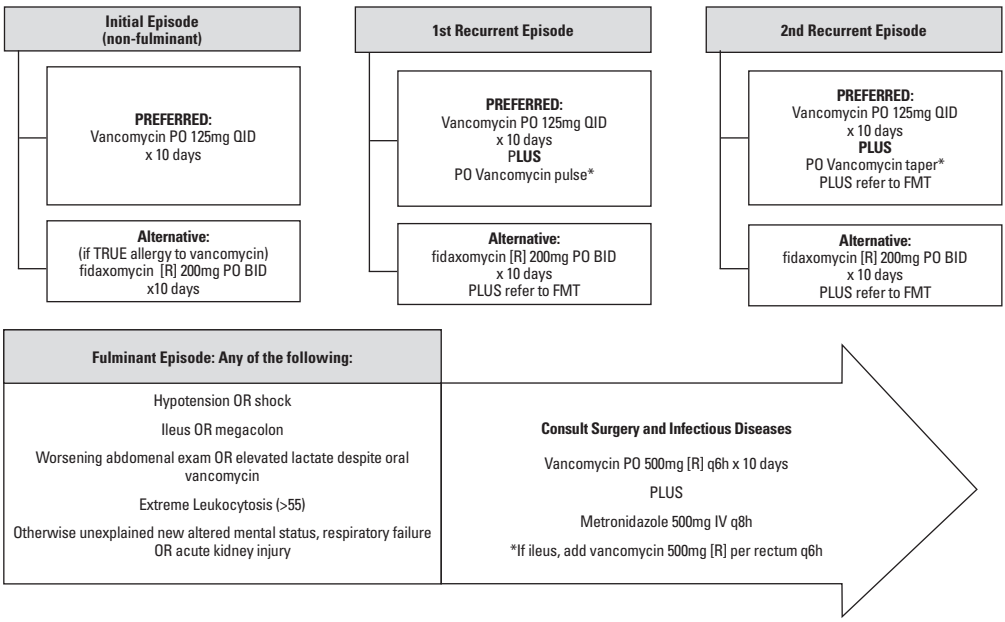
*Although 5 years is the interval for the booster dose that is recommended by ACIP, because of evidence of waning antibodies and the high case fatality of meningococcal disease in this population, a 3 year interval for the booster dose could be considered.

PNEUMOCOCCAL REFERENCE TEXT FOR POST-SPLENECTOMY VACCINES

Pneumococcal Vaccine History	Inpatient Pneumococcal Vaccine to be Ordered	Follow-Up Pneumococcal Vaccine(s)	Booster
No (or unknown) prior vaccination	Prevnar13®	Pneumovax®23 at least 8 weeks after Prevnar13®	Pneumovax®23 booster 5 years later
Prior Prevnar13®, no prior Pneumovax®23	Pneumovax®23 if at least 8 weeks have lapsed since Prevnar13® administration (defer to outpatient if not eligible as inpatient)	Pneumovax®23 if patient not eligible as inpatient and at least 8 weeks have lapsed since Prevnar13® administration	Pneumovax®23 booster 5 years later
Prior Prevnar13® , and prior Pneumovax®23	Pneumovax®23 if at least 8 weeks have lapsed since Prevnar13® administration and at least 5 years have lapsed since last Pneumovax®23 administration (defer to outpatient if not eligible as inpatient)	Pneumovax®23 if patient not eligible as inpatient and at least 8 weeks have lapsed since Prevnar13® and at least 5 years have lapsed since last Pneumovax®23 administration	None
Prior Pneumovax®23 within last year	None	Prevnar13® at least 1 year after Pneumovax®23 administration	Pneumovax®23 booster 5 years later
Prior Pneumovax®23 between 1-5 years ago	Prevnar13®	Pneumovax®23 at least 8 weeks after Prevnar13® and at least 5 years after last Pneumovax®23 vaccine	None
Prior Pneumovax®23 greater than 5 years ago	Prevnar13®	Pneumovax®23 if at least 8 weeks have lapsed since Prevnar13® administration	None
Two prior doses of Pneumovax®23 with latest dose received within last year	None	Prevnar13® at least 1 year after Pneumovax®23 administration	None
Two prior doses of Pneumovax®23 with latest dose received over 1 year ago	Prevnar13®	None	None

CLOSTRIDIOIDES DIFFICILE-ASSOCIATED DISEASE CLINICAL PATHWAY

at UPMC Presbyterian Shadyside



NOTE 1: TESTING

C. difficile testing should only be ordered when diarrhea (≥3 liquid stools/24 hours) is present in the absence of an alternative etiology (e.g., tube feeds, laxatives)

Effective November 26, 2018, the microbiology laboratory updated its testing method for the detection of *C. difficile* to a two-step algorithm:

STEP 1: Detection of *C. difficile* antigen (GDH) and toxin A/B (Toxin) proteins by enzyme immunoassay (EIA).

- If both GDH and toxin are positive (or negative), the result is reported as final.
- If the GDH is positive but the toxin is negative, the sample will automatically be reflexed to STEP 2.

STEP 2: Detection of *C. difficile* toxin gene by PCR. PCR results will be reported in addition to the EIA results.

- If PCR test is negative, the result will be reported a negative
- If PCR test is positive, the results will be reported as positive, but this suggests the presence of a toxin gene without detectable toxin production, and may represent either colonization (or infection)

Testing restrictions

- Specimens- *C. difficile* testing should only be ordered when diarrhea (≥3 liquid stools/24 hours) is present in the absence of an alternative etiology (e.g., tube feeds, laxatives)
  - › Only liquid or loose stools are useful for testing. Formed stools and rectal swabs are not appropriate
- Diagnostic- The CERNER Powerchart order set (*C. difficile* DNA) will restrict testing to a single sample every 4 days (96 hours)
  - › Orders for additional samples within this time period will be considered as duplicates and will not be accepted
  - › Any request for duplicate testing must be cleared by Infectious Diseases or the medical director of Infection Prevention
- Test of cure- For patients who test positive for *C. difficile*, there is no value in repeat testing to verify cure
  - › Positive results in such patients neither indicate failure nor predict relapse
  - › Samples for repeat testing will not be accepted for two weeks after a positive test result

NOTE 2: RECURRENCE

Recurrent Episode

Defined as recurrent *C. difficile* infection (CDI) within 12 weeks of completion of therapy ***Definition of Pulse/Taper:**

Note: if a patient received a pulse or taper for the 1st recurrent episode, the opposite strategy should be implemented for the 2nd occurrence (the preferred order is designated in the treatment algorithm)

Pulse

After 10 days of vancomycin 125mg PO QID à vancomycin 125mg PO every third day x 7 doses

Taper

After 10 days of vancomycin 125mg PO QID à begin taper

Vancomycin 125mg PO q12h x 7 days, then

Vancomycin 125mg PO q24h x7 days, then

Vancomycin 125mg PO q72h x 3 doses, then STOP [or continue as pulse pending FMT eval]

NOTE 3: COST

Fidaxomicin is very expensive and some patients may not have coverage for discharge. For patients without insurance to cover these capsules, Presbyterian, Falk, Hillman and Children's Hospital outpatient pharmacies can create oral syringes using the IV form a consider cost savings. Please contact these pharmacies for details upon discharge of your patients.

NOTE 4: BEZLOTOXUMAB

Bezlotoxumab is a monoclonal antibody to *C. difficile* toxin B. In clinical trials, it did not improve outcomes for treatment of CDI, but reduced risk of recurrent. Consider bezlotoxumab for inpatient administration. Call AMP phone (412-225-7866) during weekday business hours for approval query. Criteria for approval include current CDI:

- 65 years of age or greater
- At least 1 documented CDI within prior 6 months
- PLUS one of the following:
  - › Not eligible/unwilling to undergo fecal microbiota transplant

    OR
  - › Additional infection requiring at least 4 additional weeks of systemic antibiotics

NOTE 5: CHOLESTRYRAMINE
Cholestyramine, a bile acid sequestrant, may absorb concomitantly administered drugs leading to the possibility of subtherapeutic levels. These include (but are not limited to) warfarin, glipizide, digoxin, metronidazole, vancomycin, valproic acid, amiodarone, acetaminophen, and cephalexin. Although this interaction may be avoided by administering concomitant agents hours before and after cholestyramine, other interaction mechanisms may not be avoided by this approach (for example decreased enterohepatic recycling of warfarin). For these reasons, cholestyramine is not routinely recommended.

NOTE 6: Fecal Microbiota Transplantation
Fecal microbiota transplantation (FMT) has been proven to be the most effective treatment for recurrent CDI. At UPMC this therapy is available due to a stool donor bank. The most common method of administration is via stool capsules, swallowed orally. Feces infusion via duodenal tube or colonoscopy is also available. The current inclusion criteria for FMT at UPMC are:

- At least 3 episodes of documented CDI and failure of standard therapy with extended vancomycin (ie 6-8-week taper with vancomycin or 30-90-day pulsed dosing of vancomycin following standard therapy) with or without an alternative antibiotic
- CDI with at least 1 episode (first or subsequent) of CDI (with WBC > 15K and albumin <3) resulting in hospitalization

[1]*McDonald LC, Gerding DN, Johnson S et al. Clin Infect Dis 2018. 66(7):e1–e48.*
[2]*Wilcox MH, Gerding DN, Poxton I, et al. N Engl J Med. 2017 ;376(4):305-317.*

INFECTION CONTROL AND PREVENTION

CONTACTING INFECTION PREVENTION
The UPMC Presbyterian Infection Prevention team is available to help!

Please contact the team if you are concerned about a transmissible pathogen, have questions about which precautions to use for a suspected or confirmed pathogen, if you have questions about any aspect of infection prevention, or would like to partner on an educational or quality improvement intervention:

Office phone: 412-692-2566

Team pager: 11591 (Infection Control, PUH/SHY)

Team leadership:
- Ashley Ayres, BS CIC – Infection Prevention Manager
- Graham Snyder, MD SM – Medical Director of Infection Prevention and Hospital Epidemiology
- Elise Martin, MD MS – Associate Medical Director of Infection Prevention and Hospital Epidemiology

ANTIMICROBIAL STEWARDSHIP + INFECTION PREVENTION + DIAGNOSTIC STEWARDSHIP
Multidrug-resistant organisms and Clostridioides (Clostridium) difficile are major infectious causes of morbidity and mortality among all patients. Additionally, device-associated infections are an important cause of infections in hospitalized patients. Every provider has a part to play in reducing patient harm from these threats.

- Prudent use of antimicrobials reduces the risk of developing multidrug-resistant bacteria and *C. difficile*.
- Diagnostic stewardship means testing appropriately – identifying bacterial colonization (rather than infection) often leads to inappropriate treatment with antimicrobials, which then perpetuates the risk of developing multidrug-resistant bacteria and *C. difficile*.
- Antimicrobial stewardship and diagnostic stewardship are important Infection Prevention interventions!

FOUR WAYS YOU CAN AVOID PRESCRIBING ANTIMICROBIALS INAPPROPRIATELY
1. Only test for urinary tract infection when appropriate

2. Reducing indwelling urinary catheter use will reduce the risk of catheter-associated urinary tract infections (CAUTI)

3. Limiting central line use reduces the risk of central line-associated bloodstream infections (CLABSI)

4. Understand 2-step *C. difficile* testing and only test when appropriate

URINE INFECTION TESTING
Asymptomatic bacteriuria is common, particularly in hospitalized patients. Inappropriate treatment of bacteriuria is a common cause of antimicrobial overuse that leads to development of resistance and *C. difficile*.

UPMC multidisciplinary teams have identified these indications for urine infection testing:

- Indications when it is appropriate to test and treat for asymptomatic bacteriuria:
  - pregnancy
  - peri-operative for urologic surgery
- Indications to test for urinary tract infection:
  - Unexplained suprapubic or flank pain
  - Frequency, urgency, or dysuria
  - Fever and known urinary tract obstruction
  - Sepsis of uncertain etiology
  - Chronically catheterized with new fever or unexplained mental status changes
  - Neurogenic bladder and new signs/symptoms of infection
  - Spinal cord injury with new or worsening spasticity, autonomic hyperreflexia, malaise, lethargy, or sense of unease
  - Kidney transplant with symptoms above or as part of a screening protocol
- Common situations where published evidence supports NOT testing:
  - Pre-operative screening prior to non-urologic surgeries
  - Elderly patient with delirium and/or falls (without the symptoms/signs above)
  - Fever ("pan-culturing") in a hospitalized adult (without the symptoms/signs above)

AVOID CAUTI BY MINIMIZING USE OF INDWELLING URINARY CATHETERS
Each day an indwelling urinary catheter is in place increases the risk of bacteriuria by 3-10%.

These appropriate indications for indwelling urethral catheter use can be found online in policy HS-NA0414:
https://infonet.upmc.com/UPMCPolicies/SYSPolicyDocuments/HSNA0414.pdf

- Patients with active Urology or Nephrology consult.

- Acute urinary retention, bladder outlet obstruction, or traumatic catheterization.
- Perioperative use for selected surgical procedures:
  - Patients undergoing urologic surgery or surgeries of the urinary tract (kidney, ureters, bladder, or urethra), reproductive organs, rectum with low anastomosis site or musculoskeletal oncology surgeries of pelvis or lower abdomen.
  - Anticipated prolonged duration of surgery (catheters inserted for this reason should be removed in PACU).
  - Patients anticipated to receive large-volume infusions or diuretics during surgery.
  - Operative patients for whom urinary incontinence would compromise the wound.
  - Need for intra-operative monitoring of urinary output.
- To assist in healing of open sacral or perineal Stage III, IV, or unstageable wounds in incontinent patients where wound cannot be protected from moisture.
- Need for accurate measurements of urinary output in critically ill patients (ex. IV Diuretics given ≤ every six hours).
- Requires prolonged immobilization (e.g. potentially unstable thoracic or lumbar spine, multiple traumatic injuries such as pelvic fractures).
- To improve comfort for end of life care if needed.
- Continuous bladder irrigation.
- Requires IV Sedation, Mechanical Ventilation, and IV Inotropic Agents.
- Non-urologic surgery less than 24 hours ago. Indwelling catheters should not be used:
- As a substitute for nursing care of the patient with incontinence.
- As a means of obtaining urine for culture or other diagnostic tests when the patient can voluntarily void (please refer to straight catheterization procedure).
- For prolonged postoperative duration without appropriate indications (e.g., structural repairs of urethra or contiguous structures, prolonged effect of epidural anesthesia, etc.)

Remember that even in these cases alternative urine drainage solutions including intermittent straight catheterization, external urinary catheter, and incontinence care are preferred to reduce infection risk if appropriate for the patient.

AVOID CLABSI BY MINIMIZING USE OF CENTRAL VENOUS CATHETERS
These appropriate indications for central venous catheter use can be found online in the CLABSI Best Practice Guide:
https://infonet.upmc.com/ClinicalTools/PatientSafety/Documents/CLABSI_Best_Strategy_Guide.pdf

- Line is needed upon discharge for long term access.
- Total parenteral nutrition (TPN).
- Chemotherapy.
- Vesicant.
- High-risk medications.
- Poor venous access.
- Multiple simultaneous IV infusions.
- Vasopressors.
- Femoral line is needed due to no other site available.
- Hemodialysis.

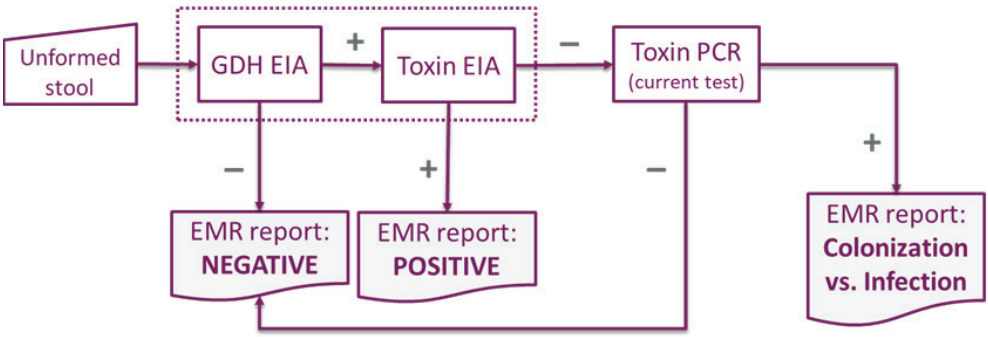
CHOOSE THE RIGHT TIME FOR C. DIFFICILE TESTING
Information related to *C. difficile* can be found on the Infonet including information on testing and prevention:
https://infonet.upmc.com/ClinicalTools/PatientSafety/Pages/Clostridium-Difficile-C-Diff.aspx

Testing for *C. difficile* should only be performed when:

- Patient has ≥3 unexplained/unformed stools within 24 hours NOT due to laxatives, enemas, bowel prep, or tube feedings, AND
- At least one of the following:
  - WBC >10K within 24 hours of unformed stools
  - Abdominal tenderness, cramping, or distention
  - Fever >38C°
  - Received antibiotics within 60 days
  - Recent chemotherapy/immunosuppression
  - History of *C. difficile* infection

Be sure to test promptly when the diagnosis is considered, and do not perform a test of cure.

The 2-step diagnostic test algorithm implemented January 2019 provides additional information for providers about *C. difficile* infection and colonization:



In the case of GDH EIA + / Toxin EIA - / Toxin PCR + test result, several factors may help you decide if a patient is colonized or infected:

- Is there an alternative explanation for diarrhea to suggest colonization?
- Are there multiple symptoms and findings to suggest infection?
- Does clinical instability suggest infection?

Treating colonization is not recommended, as it may increase the risk for recurrent disease.

The Antimicrobial Stewardship and Infectious Diseases teams are available to help determine the need for treatment.

SODIUM CONTENT OF SELECT ANTIMICROBIALS*

Antibiotic and vial size/dose	Sodium (mg)	Sodium (mEq)
Acyclovir 1g vial	102	4.4
Amikacin 500mg	29.9	1.3
Ampicillin 1g	66.7	3
Ampicillin/Sulbactam 1.5g (Add-vantage vial)	115	5
Cefazolin 1g	48	2
Cefotaxime 1g	51.7	2.2
Cefotetan 1g	80	3.5
Cefoxitin 1g	54	2.3
Ceftazidime 1g	54	2.3
Ceftriaxone 1g (Add-vantage vial)	83	3.6
Cefuroxime 750mg	111	4.8
Colistin 150mg	15	0.6
Ganciclovir 500mg	46	2
Imipenem 500mg	37.5	1.6
Meropenem 1g	90.2	3.9
Nafcillin 1g	68.2	2.9
Oxacillin 1g	63.8	2.8
Penicillin G potassium, 5MU	35	1.68
Penicillin G sodium, 5MU	186.6	8.4
Piperacillin/Tazobactam 4.5g (Add-vantage vial)	216	9.39

**All data taken from package insert information unless otherwise noted.*

SITE COMPATIBILITY TABLE FOR PROLONGED INFUSIONS

Vancomycin (D5W or NS)	Piperacillin/ Tazobatam		Cefepime		Ceftolozane/ Tazobactam		Ceftazidime/ Avibactam	
	3.375g (30-3.86mg/mL)	4.5g (40-5mg/mL)	1g (20mg/mL)	2g (40mg/mL)	1.5g (10-5mg/mL)	3g (20-10mg/mL)	0.94g (15-3.8mg/mL)	1.25g (20-5mg/mL)
500mg/100mL	C	C	C	C	C	VC	VC	C
750mg/150mL	C	C	C	C	C	VC	VC	C
1000mg/200mL	C	C	C	C	C	VC	VC	C
1250mg/250mL	C	C	C	C	C	VC	VC	C
1500mg/250mL	C	C	C	C	C	VC	VC	C
1750mg/500mL	C	C	C	C	C	VC	VC	C
2000mg/500mL	C	C	C	C	C	VC	VC	C
2250mg/500mL	C	C	C	C	C	VC	VC	C
2500mg/500mL	C	C	C	C	C	VC	VC	C

Vancomycin (D5W or NS)	Ceftazidime		Meropenem			Meropenem/ Vaborbactam		
	1g (20mg/mL)	2g (40mg/mL)	500mg (10mg/mL)	1g (20mg/mL)	2g (20mg/mL)	1g (2-2mg/mL	2g (4-4mg/mL)	4g (8-8mg/mL)
500mg/100mL	C	C	C	C	C	C	C	C
750mg/150mL	C	C	C	C	C	C	C	C
1000mg/200mL	C	C	C	C	C	C	C	C
1250mg/250mL	C	C	C	C	C	C	C	C
1500mg/250mL	C	C	C	C	C	C	C	C

C= compatible
VC= variable compatibility

References:
Berti AD, et al. Am J Health-Syst Pharm. 2015; 72:390-5
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AMINOGLYCOSIDE DOSING (AMIKACIN, GENTAMICIN, TOBRAMYCIN) [1]

I. DETERMINE THE DOSING WEIGHT (NOTE: DO NOT PROCEED TO SECTIONS II OR III UNTIL A DOSING WEIGHT IS DETERMINED)

Aminoglycoside distribution decreases relative to total body weight in patients who are obese. For this reason, determining the appropriate dosing weight requires a comparison of the patient's Total Body Weight (TBW) versus his or her Ideal Body Weight (IBW).

1.) Determine the patients' Ideal Body Weight (IBW):

a. IBW for men (kg) = 50 + [2.3 x (every inch > 5 feet tall)

b. IBW for women (kg) = 45.5 + [2.3 x (every inch > 5 feet tall)

Scenario[1]	Dosing Weight to Use
ABW < IBW	Use ABW
ABW < 120% of the IBW	Use IBW
ABW > 120% IBW	Use Adjusted Body Weight (see below)

[1]*Murphy JE, editor. Clinical Pharmacokinetics, Bethesda, MD: American Society of Health System Pharmacists; 1993.*

2.) If calculating the Adjusted Body Weight is necessary (see above) use the following step:

AdjBW (kg) = IBW + (0.4 x [TBW – IBW])

II. DETERMINE THE CREATININE CLEARANCE

$$\text{CrCl mL/min} = \frac{(140 - \text{age}) \times \text{IBW}}{72 \times \text{SCr}} \quad (\times 0.85 \text{ in female patients})$$

AMINOGLYCOSIDE DOSING (AMIKACIN, GENTAMICIN, TOBRAMYCIN) [1] (CONTINUED)

III. EXTENDED INTERVAL DOSING (FOR GRAM-NEGATIVE INFECTIONS)

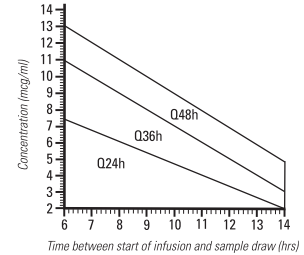
1) Extended interval dosing is developed to maximize bacterial killing by known pharmacodynamic principles of aminoglycosides

Contraindications to extended interval dosing include: Pregnancy, breastfeeding, postpartum, cirrhosis with ascites, altered volume status, burns (>20%), synergy for Gram-positive infections, chronic renal insufficiency

Renal Function	Dose and Frequency per Aminoglycoside		
	Gentamicin	Tobramycin	Amikacin
Creatinine clearance > 60mL/min	7mg/kg of dosing weight q24h	7mg/kg of dosing weight q24h	15mg/kg of dosing weight q24h
Creatinine clearance < 60mL/min	7mg/kg of dosing weight as a single dose	7mg/kg of dosing weight as a single dose	15mg/kg of dosing weight as a single dose

[2] *Antimicrob Agents Chemother. 1995;39:650-5*

2) To assess adequacy of the frequency, a random level may be obtained 6 to 14 hours after administering the dose, and this level can be plotted on the Hartford nomogram below.



Nomogram for gentamicin and tobramycin at 7mg/kg

NOTES

Gentamicin/Tobramycin

- The nomogram was based on a dose of 7 mg/kg of gentamicin/tobramycin.
- If a lower dose if used, the level should be multiplied by a factor equal to 7 mg divided by the dose (mg/kg). Example: if 5 mg/kg dose is used, multiply the level by 1.4 (7/5) and then plot on the nomogram

Amikacin

- Divide the amikacin serum level by 2 before applying to the nomogram

If a level falls off the nomogram, traditional dosing should be used

AMINOGLYCOSIDE DOSING (AMIKACIN, GENTAMICIN, TOBRAMYCIN) [1] (CONTINUED)

3. Peaks/troughs for Gram-negative infections

- Critically ill patients may often have their regimens individualized according to the MIC of the infecting organism (this should not be done without the aminoglycoside MIC)
- Peak: Ideally 10-12 times the MIC of the infecting organism
- Trough: When using the previous nomogram, trough should be undetectable (i.e. less than 1 mcg/mL for most situations)

IV. TRADITIONAL AMINOGLYCOSIDE DOSING

1) Should be utilized in scenarios where extended-interval dosing is contraindicated (see prior page) and in patient with a CrCl < 30 mL/min

Indication	Dose[1]	Goal Peak	Goal Trough
Uncomplicated lower UTI, gram-positive synergy[2]	1 mg/kg[3]	3-5 mg/mL	<1 mcg/L
Serious Gram-negative infection	1.7-2.5 mg/kg[4]	6-10 mcg/mL	< 1-2 mcg/mL
Amikacin (only for gram-negative infection)	7.5 mg/kg	20-30 mcg/mL	< 8 mcg/mL

[1] Use dosing weight from Section I
[2] Aminoglycosides are sometimes added to beta-lactam/vancomycin in patients being treated for gram-positive bacteremia or endocarditis. The dosing strategy is different from that of Gram-negative infections
[3] Total daily dose (i.e. 3 mg/kg) may be administered as single, once daily dose for patients with a CrCl >80mL/min
[4] Do not exceed 7 mg/kg/day

2) Select interval based on Creatinine Clearance (CrCl):

CrCl (mg/ml)	Dosing Interval (hrs)	
	Gentamicin, Tobramycin	Amikacin
>80	Q8h	Q12h
50-80	Q12h	Q12h
20-49	Q24h	Q24h
<20 OR renal replacement therapy	Give initial dose and base subsequent doses on serum concentrations	

AMINOGLYCOSIDE DOSING (AMIKACIN, GENTAMICIN, TOBRAMYCIN) [1] (CONTINUED)

3) Monitoring

- Peak concentrations are monitored to ensure efficacy while trough concentrations are monitored to minimize nephrotoxicity
- Obtain levels around 4th dose (see exceptions below). Trough concentrations should be obtained 30 minutes prior to start of infusion and peak concentrations should be obtained 30 minutes after the end of the infusion
  - Exceptions: In critically ill patients or those with CrCl < 30mL/min, peak and trough concentrations may need to be drawn before the 4th dose to monitor toxicity
    - CRRT: check peak/trough after 1st dose given variability based on dialysis flow rates, volume status, residual renal function.
    - HD: if level is obtained prior to hemodialysis, assume 30-50% removal during typical 4-hour session. If post-HD level predicted to be < 1-2mcg/mL, redose. If level is obtained after the hemodialysis session, re-dose if level < 1-2mcg/mL. Note: levels should not be drawn until 4-6 hours after hemodialysis to allow for redistribution of drug.
  - In prophylactic use of aminoglycosides when duration of therapy is less than 48-72 hours, serum concentrations generally are not necessary.
  - Once target aminoglycoside serum concentrations are reached, monitoring can be extended to once weekly (at a minimum) in patients with stable renal function

AMINOGLYCOSIDE DOSING (PLAZOMICIN)

I. DETERMINE THE DOSING WEIGHT (NOTE: DO NOT PROCEED TO SECTIONS II OR III UNTIL A DOSING WEIGHT IS DETERMINED)

Aminoglycoside distribution decreases relative to total body weight in patients who are obese. For this reason, determining the appropriate dosing weight requires a comparison of the patient's Total Body Weight (TBW) versus his or her Ideal Body Weight (IBW).

3.) Determine the patients' Ideal Body Weight (IBW):

a. IBW for men (kg) = 50 + [2.3 x (every inch > 5 feet tall)

b. IBW for women (kg) = 45.5 + [2.3 x (every inch > 5 feet tall)

Scenario[1]	Dosing Weight to Use
TBW < IBW	Use TBW
TBW < 125% of the IBW	Use TBW
TBW > 125% IBW	Use Adjusted Body Weight (see below)

[1]*Zemdri (plazomicin) [package insert]. South San Francisco, CA: Achaogen, Inc*

4. If calculating the Adjusted Body Weight (AdjBW) is necessary (see above) use the following step:
AdjBW (kg) = IBW + (0.4 x [TBW – IBW])

II. DETERMINE THE CREATININE CLEARANCE

Note: calculated using TBW except when TBW > 125% of IBW, in which case use IBW

$$\text{CrCl mL/min} = \frac{(140 - \text{age}) \times \text{IBW}}{72 \times \text{SCr}} \quad (\times 0.85 \text{ in female patients})$$

AMINOGLYCOSIDE DOSING (PLAZOMICIN) (CONTINUED)

III. SELECT THE APPROPRIATE DOSING REGIMEN

Creatinine Clearance (mL/min)	Plazomicin Regimen
> 90	15 mg/kg IV Q24hours
60-89	15 mg/kg IV Q24hours*
30-59	10 mg/kg IV Q24hours*
15-29	10 mg/kg IV Q48hours*
<15 OR renal replacement therapy	Contact AMP/ID

*adjustments based on therapeutic drug monitoring to ensure plasma trough concentration less than 3 mcg/mL

IV. MONITORING

a. Serum creatinine should be check prior to plazomicin initiation and daily while on therapy

b. Therapeutic drug monitoring should be performed for patients with a CrCl less than 90mL/min

i. Collect plazomicin plasma trough concentration approximately 30 minutes prior to administering the 2nd dose and repeat as needed based on changes in renal function

Plasma trough concentration	Dosing adjustment
< 3 mcg/mL	No change
< 3 mcg/mL	Increase dosing interval 1.5 fold (i.e. from Q24hours to Q36hours OR from Q48hours to Q72hours)

VANCOMYCIN

Please refer to CP-80 "Therapeutic Drug Monitoring: Vancomycin Protocol" on the InfoNet for more information on vancomycin dosing

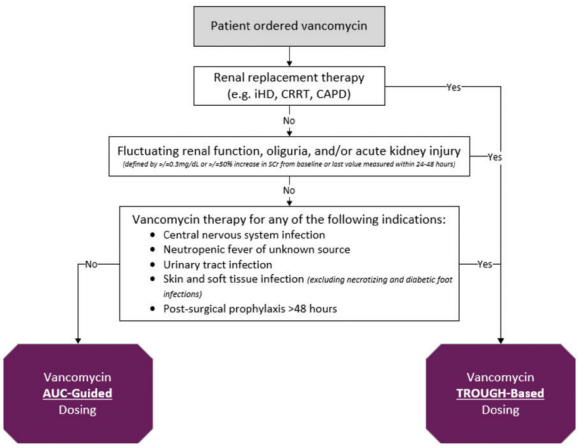
Pharmacy Pharmacokinetics Consult for Vancomycin Dosing and Management is available for all patients receiving vancomycin at Presbyterian and Shadyside.

VANCOMYCIN AUC BASED DOSING

I. WHAT IS AUC BASED DOSING?

AUC (area under the curve) based vancomycin dosing has been shown to be the most predictive pharmacokinetic/pharmacodynamic parameter of vancomycin efficacy and safety for treatment of S. aureus infections. ***The goal for most infections is AUC24 400-600****.*

II. WHO SHOULD RECEIVE AUC BASED DOSING STRATEGIES?



III. HOW ARE DOSES CALCULATED

There are various calculators available to completed calculation of the area under the curve (AUC). A Bayesian approach is the most preferred methodology.
CONSULT PHARMACY FOR ASSISTANCE

VANCOMYCIN TROUGH BASED DOSING

I. DETERMINE WHETHER TO ADMINISTER A LOADING DOSE

a. Patient populations that may benefit from a loading dose: critically ill patients, those with central nervous system infections (ie. meningitis), obese (BMI>30), bacteremia, endocarditis, necrotizing soft tissue infections

b. A dose of 20-25mg/kg (based on total body weight) can be used as a one-time loading dose to rapidly attain target trough serum concentrations.

i. This dose should be rounded to 250mg

ii. Maximum loading dose = 2500mg

Total Body Weight (kg)	Loading dose (mg)
≤ 40	1000
41-49	1000-1250
50-59	1000-1500
60-69	1250-1750
70-79	1500-2000
80-89	1750-2250
90-99	2000-2500
≥100	2500

II. DETERMINE THE MAINTENANCE DOSE

a. Maintenance dose → 15-20mg/kg (based on total body weight)

i. Doses should be rounded to the nearest 250mg

ii. Maximum initial maintenance dose = 2000mg per dose

III. DETERMINE THE INTERVAL

a. Determine the patient's creatinine clearance and select interval from table

$$CrCl = \frac{[(140 - age) * weight]}{72 * SCr} \times [0.85 \text{ if female}]$$

Note: Use adjusted body weight if actual body weight (ABW) ≥120% of the ideal body weight (IBW).
*Adjusted body weight = IBW + [0.4 * (ABW-IBW)]*

Note: Serum creatinine should NOT be rounded to 1mg/mL for patients greater than 65 years of age.

CrCl (mL/min)§	Interval
>75	Q8-12H‡¥
50-75	Q12-24H‡*
30-49	Q24H
< 30	See section on vancomycin dosing by random levels
CRRT	15 mg/kg IV Q24H or 7.5-10 mg/kg IV Q12H (if flow rate > 3 L/hr)
CAPD	10-15 mg/kg IV Q4-7 days
iHD	See section on vancomycin dosing & monitoring in iHD

§ With or without fluctuating renal function, oliguria, or AKI (defined as ≥0.3mg/dL or ≥50% increase in SCr from baseline or last value measured within 24 – 48 hours)
‡Interval based on clinical judgment. Use less frequent dosing interval for patients with oliguria or AKI as defined above
¥For empiric dosing, reserve Q8H interval for treating complicated infections in patients < 40 years old
*For empiric dosing, consider Q24H for patients > 75 years old

IV. WHEN SHOULD TROUGH CONCENTRATIONS BE DRAWN?

a. It takes ~4 doses for vancomycin to reach steady state. Remember, the loading dose is considered the first dose. Troughs may be drawn earlier, especially in critically ill patients, patients with unstable renal function, and patients on intervals >24 hours. However, if drawn earlier, clinicians should realize that concentrations continue to accumulate until steady-state is achieved.

b. Ideally, serum vancomycin concentrations should be drawn immediately before the next scheduled vancomycin dose. Realistically, however, serum trough vancomycin levels may be drawn within 1 hour of the next scheduled vancomycin dose, assuming the prior dose was administered on time.

c. Specific recommendations for patient scenarios:

i. In patients with stable renal function and urine output, or with fluctuating renal function, decreased urine output, AKI with calculated CrCl > 30mL/min:

Dosing Interval	Trough Level Obtained
Q8H	Prior to 4th, 5th, or 6th dose
Q12H	Prior to 4th or 5th dose
Q24h	Prior to 3rd dose
Dosing interval >Q24h	Consider prior to 2nd dose

ii. In patients with fluctuating renal function, decreasing urine output, AKI AND calculated CrCl < 30mL/min (or doubling in SCr from baseline), change to vancomycin dosing by random levels

iii. In patients requiring CRRT:

1. Consider checking random vancomycin serum level 24 hours post initial dose. Vancomycin dosing may vary depending on dialysis flow rates, residual renal function, and if CRRT is interrupted for a significant period of time.

iv. In patients requiring CAPD:

1. Consider checking random vancomycin dose every 24-48 hours with AM labs and re-dose by levels

d. Vancomycin should be administered as scheduled unless otherwise specified on vancomycin trough order (e.g. HOLD DOSE IF LEVEL GREATER THAN 20 mcg/mL)

e. Once target vancomycin serum trough concentration is reached, vancomycin trough concentrations may be monitored less often in patients with stable renal function. Vancomycin trough concentrations are typically re-checked in 3-5 days then weekly at a minimum if 2 consecutive therapeutic serum trough concentrations are obtained in patients with stable renal function. More frequent vancomycin serum levels may be necessary in patients with unstable renal function or decreasing urine output.

V. WHAT TROUGH CONCENTRATIONS SHOULD I TARGET?

a. In patients with complicated infections such as bacteremia, endocarditis, osteomyelitis, necrotizing fasciitis, diabetic foot infections, and hospital-acquired pneumonia caused by *Staphylococcus aureus*, vancomycin trough serum concentrations may be kept between 12-18mcg/mL.

b. For central nervous system infections, vancomycin trough serum concentrations may be kept between 15-20mcg/mL.

c. In patients with skin and soft tissue infection, urinary tract infections and prolonged post-surgical prophylaxis >48hours, vancomycin trough serum concentrations may be kept between 10-15mcg/mL.

d. Adjusted vancomycin doses based on trough levels as follows:

Vancomycin Trough Level (mcg/mL)			Recommended Adjustment
Goal Trough: 10-15	Goal Trough: 12-18	Goal Trough: 15-20	
Less than 5	Less than 7	Less than 10	Dose more frequently (e.g. Q24H → Q12H)
5.1 – 9.9	7.1 – 11.9	10 – 14.9	Increase dose by 250-500mg
10 – 15	12 – 18	15 – 20	No change*
15.1 – 20	18.1 – 23	20.1 – 25	Decrease dose by 250-500mg
20.1 – 25	23.1 – 25	26 – 30	Dose less frequently or dose by levels (e.g. Q24H → Q48H)
>25	>25	>30	Dose by levels

*Consider possible dose reduction by 250mg if nearing upper limit of target range for goal trough 10-20mcg/mL

VI. SHOULD I ORDER A VANCOMYCIN PEAK SERUM CONCENTRATION?

a. No. Peak serum concentrations do not correlate well with the incidence of nephrotoxicity or ototoxicity. When completing trough based vancomycin dosing, peak serum concentrations should not be collected.

VII. HOW OFTEN SHOULD I MONITOR RENAL FUNCTION WHILE ON VANCOMYCIN THERAPY?

a. Serum creatinine should be monitored at least twice weekly throughout the length of therapy. Serum creatinine should be monitored daily in patients with fluctuating renal function, decreasing urine output, or other safety concerns.

VANCOMYCIN DOSING AND MONITORING RECOMMENDATIONS- HEMODIALYSIS

I. HOW SHOULD VANCOMYCIN BE DOSED IN PATIENTS ON INTERMITTENT HEMODIALSIS (IHD)?

a. Calculate the initial vancomycin "iHD loading" dose.
- 20 mg/kg * TBW in kg
- 30 mg/kg * TBW in kg if intradialytic vancomycin administration
- Round initial dose ("HD-loading dose") to nearest 250mg increment, not to exceed 2000mg

b. Determine the target pre-hemodialysis vancomycin level (most indications 15-20mcg/mL)

c. Calculate the initial vancomycin "iHD maintenance" dose.
i. Maintenance dosing to be administered after iHD on iHD days only
1. If patient has significant renal function remaining, supplemental dosing on non-iHD days may be warranted.

ii. Assuming "iHD loading" dose was sufficient – 10-15mg/kg based on total body weight
1. Doses should be rounded to nearest 250mg increment, do not exceed 2000mg
2. If maintenance dose administered during the end of iHD session, consider 15mg/kg dose
3. Subsequent doses should be adjusted based on pre-iHD levels

II. HOW TO MONITOR VANCOMYCIN SERUM LEVELS IN HEMODIALYSIS

a. Vancomycin dose adjustments should be made based on results of pre-hemodialysis levels.

Recommended adjustment for intermittent hemodialysis (round to nearest 250mg increment, do not exceed 2000mg)		Recommended Adjustment*
Goal Pre iHD Level: 10-15mcg/mL	Goal Pre iHD Level: 15-20mcg/mL	
–	Less than 5	Give 15 – 20mg/kg dose
Less than 5	5 – 9.9	Increase previous dose by 500-750mg
5 – 9.9	10 – 14.9	Increase previous dose by 250-500mg
10 – 14.9	15 – 20.9	No change
15 – 20.9	21 – 25	Decrease previous dose by 250-500mg
>21	>25	Hold dose and recheck prior to next iHD session

** Initial maintenance dose adjustments should be based on calculated maintenance dose (10-15 mg/kg). Subsequent adjustments can be based on the dose that was received during/after the last iHD session*