TuftsMedicine
Tufts Medical Center

Department of Pharmacy
and Division of Geographic Medicine
and Infectious Diseases

Antimicrobial Treatment and Dosing Guide for ADULT Patients

2024-2025

Antimicrobial Treatment and Dosing Guide for ADULT Patients 2024-2025: Table of Contents

Body Weight Equations

1 inch = 2.54 cm **1 foot** = 12 inches
5 feet = 60 inches = 152.4 cm

Ideal Body Weight (IBW)

IBW male = 50 kg + (2.3 kg x every inch above 5 feet), or
= 50 kg + (0.9 x [height(cm) – 154])

IBW female = 45.5 kg + (2.3 kg x every inch above 5 feet), or
= 45.5 kg + (0.9 x [height(cm) – 154])

Dosing Weight (DW) for Obese (>20% over IBW) Patients Or BMI greater than 40

BMI = weight (kg) / (height (m))^2

DW = IBW + 0.4(total weight – IBW)

Creatinine Clearance (CrCl)

CrCl male (mL/min) = $\frac{(140 - \text{age}) \times \text{IBW}}{(\text{SCr}^* \times 72)}$

*In patients > 60 years old with an actual SCr < 0.7 mg/dL, use SCr = 1 mg/dL for estimating CrCl.

CrCl female (mL/min) = 0.85 x CrCl male

For patients with a body mass index (BMI) < 40 kg/m^2, IBW should be used to estimate creatinine clearance (CrCl).

For patients with a BMI ≥ 40 kg/m^2, dosing body weight (DBW) should be used to estimate CrCl instead of IBW.

Appropriate Culturing Techniques

Blood

- Blood cultures may be drawn only by RN and laboratory personnel who have demonstrated *competency and MDs who have been properly trained* in aseptic venipuncture technique and/or use of venous access devices to draw blood cultures.
- The patient's physician/NP/PA is responsible for ordering blood cultures and specifying the number of cultures, timing of cultures, and special collection orders. Absent special timing/collection orders, blood cultures should be collected within one hour of order.
- Make sure that blood cultures have not already been drawn in the ED or another inpatient unit within the last 24 hours before ordering additional sets of blood cultures.
- Peripheral blood is collected by aseptic venipuncture. A blood culture broth set of aerobic and anaerobic bottles are immediately and aseptically inoculated with the patient specimen.
- Follow nursing protocol regarding obtaining cultures from vascular access catheters when venipuncture is not feasible.
- This procedure must be performed using strict aseptic technique. Attention should be paid to maintaining sterility of the blood culture bottle tops as well as any needles and syringe openings.
- Blood Culture bottles are manufactured with vacuum and will draw 10ml of blood automatically.
- Blood should be evenly distributed into aerobic and anaerobic culture bottles. If unable to achieve appropriate volume from adult patient (i.e. if volume is less than 10 ml), inoculate only the aerobic specimen bottle with the entire amount.
- Care should be taken to avoid letting air into the anaerobic blood culture bottle. Expel any dead air space in syringe before injecting blood.
- Tufts MC uses molecular diagnostics for identification of common microbes detected in blood cultures. The identification and limited resistance patterns may be available within hours of the blood culture flagging positive.

Appropriate Culturing Techniques

Guidelines and Considerations

Clinical Condition	Protocol	Comments
Fever in which **bacteremia** is suspected (generally ≥38°C unless elderly or immunocompromised as these patients may be bacteremic without fever; use clinical judgment)	Collect **two sets from different sites** prior to antibiotic administration. Repeat if patient is persistently febrile AND prior blood cultures are negative no more frequently than every 48 hours. If cultures are negative on 2 occasions, repeat only if suspicion of bacteremia remains.	Yield of blood cultures in the absence of systemic symptoms suggestive of bacterial sepsis (hypotension, fevers, or leukocytosis) is low. Yield beyond **four** culture sets is very minimal. Volume of blood/bottle: **8-10 ml.** Volumes < 5ml/bottle are associated with low yield. However, do not overfill.
Suspected **bacterial endocarditis**, acute and subacute	Collect **three sets from different sites** prior to administration of antibiotic. These should ideally be drawn 1-2 hours apart, if possible. If first three sets are negative after 48 hours, re-evaluate likelihood of bacteremia prior to obtaining additional cultures.	Yield beyond **six** culture sets is very minimal. Volume of blood/bottle: **8-10 mL**. However, do not overfill.
Follow-up cultures	In general, follow-up cultures to document clearance of bacteremia/fungemia are <u>not</u> necessary. **Notable exceptions include**: *Staphylococcus aureus* bacteremia, Candidemia, endocarditis, intravascular infections (especially related to foreign devices left in place).	Consider waiting 48 hours to ensure prior blood cultures are negative before obtaining repeat follow-up blood cultures. All of the exceptional circumstances should be managed in conjunction with an Infectious Disease consultation.

Appropriate Culturing Techniques

Bronchial alveolar lavage (BAL) a

- Obtained by bronchoscopy Culture results are qualitative (1-4+)
- Requires prompt transport to laboratory for processing

Cerebral Spinal Fluid (CSF)

- For bacteria, send 1-2 mL; if mycobacteria or fungi suspected, send 5-10 mL. Cryptococcus grows on routine media and fungal cultures are not required in cases of suspected Cryptococcus unless patient has been on prolonged treatment
- In general, for initial evaluation, send CSF for cell count, glucose (also draw simultaneous blood glucose), and protein with gram stain and bacterial culture.
- Do not routinely order bacterial antigens, AFB, and fungi, or PCR for herpes until initial results from routine studies are available; drawing an extra tube to save for additional studies pending initial results is more appropriate and cost effective.

Sputum

- Instruct patient to cough deeply
- Collect and transport specimen in a sterile container. Gram stain is performed on all sputum specimens. Microbiology screens specimens for oral contamination (presence of >10 squamous epithelial cell/LPF). Re-collection is recommended if specimen is inadequate.
- The microbiology laboratory will reject specimens sent within 72 hours of a prior processed respiratory specimen. These specimens will be held for 48 hours and will be processed by special request. If a patient has a new pneumonia within 72 hours of a prior specimen, order a sputum culture and write “new pneumonia” on the requisition.
- Molecular testing for TB can be performed on respiratory specimens for the rapid rule-out of pulmonary tuberculosis.

Stool

- Collect specimen in a sterile container and transport promptly to microbiology lab
- Stool multiplex molecular pathogen panel is performed at TMC which detects the most common bacterial and viral causes of acute diarrhea. Low volume stool (<5ml) will be rejected
- In general, do not test using molecular panel if patient develops symptoms > 3 days after admission as these pathogens are not acquired in the hospital. Consider *C. difficile* for hospitalized patients with diarrhea.
- Only send test for *C. difficile* if the patient is newly symptomatic with diarrhea. Consider laxatives, oral solutions/suspensions of medications, and enteral nutrition as a potential cause of diarrhea. Do not send C. difficile if the patient has had a positive in the prior 30 days or has had a negative test in the prior 7 days for risk of a false negative. Multiple specimens per day are not indicated.
- Formed stools should not be submitted and will be rejected.

Tracheal aspirate

- Does not need to be screened for oral contamination like sputum; perform gram stain along with routine cultures. The laboratory will reject specimens sent within 72 hours of a prior processed respiratory specimen. These specimens will be held for 48 hours and will be processed by special request. If a patient has a new pneumonia within 72 hours of a prior specimen, order a tracheal aspirate culture and write “new pneumonia” on the requisition.

Appropriate Culturing Techniques

Urine

- Midstream
  - Instruct women to hold labia apart and men to retract foreskin (if uncircumcised), discard the first portion of voided urine and collect midstream urine in a sterile container.
- Catheterized
  - Short-term: collect specimen by aseptically aspirating from port of urinary catheter.
  - Long-term (≥14 days): change urinary catheter, then collect specimen by aseptically aspirating port of urinary catheter.
- Urine culture should be performed via the "Urinalysis Reflex to Culture" order with few exceptions listed in the order set.
- Transport: keep urine refrigerated and send to microbiology lab promptly.
- **Do NOT treat asymptomatic bacteriuria except in pregnancy or GU instrumentation.**

Wound/Abscess

- Clean surface of wound or abscess with 70% alcohol and allow to dry; aspirate pus or fluid if possible and either transport in syringe (preferred) or place in anaerobic transport vial; anaerobic transport tubes are appropriate for aerobic and anaerobic cultures; always request a gram stain for initial guidance and comparison.
- The yield of wound culture is directly related to volume of sample. Swabs should be discouraged since swabs usually have insufficient material for gram stain and culture (< 0.05ml). If swabs must be used, be sure quantity is adequate for both culture and gram stain.
- Swabs can only be cultured for aerobic pathogens, they cannot be cultured for anaerobic pathogens or acid fast bacilli.
- Do not culture chronic superficial wounds or sinus drainage since superficial cultures correlate poorly with deep cultures. Try to obtain a deep culture or biopsy for culture whenever possible.

Lab Notification for Potential Pathogens

The following pathogens pose a safety hazard to lab personnel when grown in culture. **Please notify the lab** i **these organisms are on your differential** so we can take the necessary safety precautions:

Bacteria

- *Bacillus anthracis*
- *Brucella* spp.
- *Burkholderia pseudomallei*
- *Bukholderia mallei*
- *Francisella tularensis*
- *Neisseria meningitides*
- *Yersinia pestis*

Fungi

- *Blastomyces dermatitidis*
- *Coccidioides immitis*
- *Histoplasma capsulatum*
- *Taloromyces (formerly Penecillum) marneffei*

Other

- Prion/CJD (CNS tissue specimens)

If you have any questions, please email: **Tufts MC Microbiology Director** (TuftsMCMicrobiologyDirector@tuftsmedicine.org)

Methicillin Resistant Staphylococcus aureus (MRSA) Nasal PCR

- For respiratory and bloodstream infections, MRSA nasal swab has a high negative predictive value >95% but poor positive predictive value <50%.
- This means that a negative MRSA nasal swab is highly accurate in predicting the absence of MRSA infection, however a positive test has a very low accuracy in confirming the presence of MRSA infection.
- Culture data is the gold standard for optimization of antimicrobial therapy regardless of MRSA nasal swab results.

Indications for testing for empiric coverage or de-escalation of MRSA directed therapy

- Community acquired or hospital associated pneumonia in patients
- Bloodstream infections.
- Sepsis (see contraindications below)

Contraindications for testing

Clinical scenarios (with or without sepsis) where MRSA nasal swab and empiric MRSA coverage are **not indicated**

1. Intra-abdominal infection
2. Urinary tract infections
3. Non-purulent cellulitis
4. Neutropenic fever if the suspected source is not pulmonary

Clinical scenarios where MRSA nasal swab is **not recommended** and should not be used to change antibiotic decision making

5. Purulent skin and soft tissue infections
6. Abscess
7. Necrotizing fasciitis
8. Septic shock suspected from GI/GU, SSTI

Antimicrobial Management Team (AMT)

TigerConnect: @ T Antimicrobial (AMT) Adult
0800-1700 (7 days/week)

Shira Doron, MD
Maureen Campion, PharmD
Gabriela Andujar, MD
Kap Sum Foong, MD
Rachel Erdil, MD
Majd Alsoubani, MD

Antimicrobials can be ordered via the "Gen: Infection Admission" orderset, via infectious order panels or as individual orders. All antimicrobial orders require an indication and duration prior to the order being signed.

Helpful Hints

- Contact the AMT **BEFORE** writing orders for restricted antimicrobials.
- Restricted antimicrobials can be identified by ordering instructions and the restricted ordering question within the EMR.
- Select **STAT** on all orders for which therapy should start immediately.
- Contact the AMT the next morning if you prescribe a restricted anti-infective after 1700.
    - The pharmacy will only dispense a sufficient number of doses of drug until 0900 if approval is not obtained.
- For "time-limited" drugs, you must contact the AMT within 72 hours of treatment to continue therapy.
- Reconsider the appropriateness of antimicrobial therapy daily.
- Positive cultures do not always mean infection.
- Long courses of anti-infective drugs are not always better than a short course of therapy and are sometimes worse.
- Check each patient's medication administration record daily to evaluate dose, interval, missed doses, etc.
- Consider early IV to PO switch.

Mandatory ID Consult Policy

1. *Staphylococcus aureus* (MSSA or MRSA) or *Enterococcus* bacteremia diagnosed in the last 6 weeks cultured at Tufts Medical Center or another facility.
2. Active invasive fungal infection (positive culture in the last six weeks or suspected infection requiring empiric therapy) diagnosed at Tufts Medical Center or another facility, including but not limited to:
    a. Any yeast or mold cultured from the blood or detected by PCR.
    b. Any yeast or mold cultured from a sterile site, detected by PCR or seen on histopathology.
    c. *Aspergillus* or other mold isolated from any site or suspected at any site (with the exception of presumed respiratory colonization) based on clinical presentation, imaging or histopathology findings.
3. Identification of Candida auris from any body site as reported at Tufts Medical Center or another facility.
4. Multidrug-resistant gram negative infection determined by culture or PCR of any site and defined as (for the purpose of this policy) an organism resistant to a carbapenem (ertapenem, meropenem, imipenem or doripenem) and either piperacillin-tazobactam or cefepime.
5. Tuberculosis or atypical Mycobacterial infection except for patients followed by a pulmonologist.
6. Necrotizing fasciitis.
7. Infection treated with an antimicrobial agent designated as "ID consult required" per the Antimicrobial Subcommittee of the Pharmacy and Therapeutics committee. See Antimicrobial Management Program section.
8. Endocarditis.
9. Encephalitis or meningitis thought to be due to infection or intracranial infection.
10. Intent to discharge patient with 7 days or more IV antibiotics. Some of these patients may warrant Outpatient Parenteral Antibiotic Therapy (OPAT) program and monitoring (please call for consult as early in the hospitalization as possible).
11. Patient's re-admitted who are currently on OPAT or within 2 weeks of discharge from OPAT.
12. The specific parameters of the requirement for ID consultation for patients with suspected or confirmed COVID-19 are expected to change with the context of the pandemic and will be communicated to clinicians in real time.

AMT FAQs

Q: *What is the purpose of AMT?*
A: The AMT has several goals we try to address simultaneously when we speak to you on the phone: a) teach something with every interaction; b) ensure the best possible care for the patient (right choice of antibiotic, right dose for renal function, review allergies, review culture results); c) address the emerging problem of antibiotic resistance by not using a drug that is overly broad or covers organisms unlikely to be present; d) contain healthcare costs by not using an expensive antibiotic when a less expensive one will do the same job.

Q: *How do I know if an antimicrobial requires approval?*
A: Within the antimicrobial order in the EMR the ordering instructions will identify a medication as being restricted. All restricted antimicrobials also require a response to the question "I acknowledge I have reviewed the restrictions on this antimicrobial and have obtained appropriate approval as described in the ordering instruction, if indicated. [Yes][No]" The list of restricted antimicrobials is also found on pages 10-12 of this guidebook. Call AMT *before* placing the order.

Q: *How do I know whom to call to get AMT approval?*
A: AMT can be reached on **TigerConnect @ T Antimicrobial (AMT) Adult from 0800-1700 seven days a week**. If the drug you are ordering is restricted to "ID consult only", then page the ID consult fellow day or night for a consult (the ID team may or may not come in to see your patient during the night, but they can call approval in to the pharmacy for the drug if they agree with the choice). After 1700, you may write for any drug that is AMT restricted, and the pharmacy will release just enough drug so that you can then call AMT the next morning if you wish to continue it.

Q: *What do I do if my attending really wants me to start a drug that AMT doesn't think is appropriate?*
A: Often when we explain to you why we think the drug is the wrong one, and you take that information back to your attending, they will see our point and agree with our recommendation. If they do not agree with our recommendation, have your attending call us directly. If you don't feel that you understand the case well enough to give us a good explanation for why you need a particular drug, please either ask someone senior to you to explain it to you, or have someone senior to you call us.

Q: *AMT has approved my antimicrobial for a certain number of days. What happens when those days are up?*
A: AMT will approve your antimicrobial for the number of days it should take to get a culture result, or for the number of days it takes to treat the infection in question. At the end of this period, you should be stopping or changing antibiotics. If you wish to continue a restricted antibiotic beyond this time period, you must call us. Call AMT before the drug expires if you wish to continue treatment.

Q: *I am not sure what antibiotic to choose. Can I call AMT with questions?*
A: Yes. AMT is a teaching service. As with any call to AMT, we may advise you to get an ID consult if the case is too complex to manage over the phone.

Q: *Do I need to get AMT approval if I am the intern or resident on the ID ward team?*
A: It depends. Your attending may provide approval, if they are an ID attending. If the ID ward is being managed by a hospitalist or internal medicine physician, AMT/ID approval is required.

Q: *I used the pneumonia order set and all of the antibiotics are only ordered for three days. What do I do at the end of the three days?*
A: At the end of the three days, if you do not re-order any antibiotics, your patient **will no longer receive any antibiotics**. You should have culture data by then that should guide you as to which antibiotic, if any, you should continue, and which you should discontinue. If you are unsure as to how to proceed, feel free to call AMT with questions.

Q: *Do I need to get AMT approval if the ID consult service recommended the antimicrobial?*
A: No.

Q: *Are there any circumstances in which I have to consult ID?*
A: Yes, see the mandatory ID consult list within this book and on Policy Tech.

Q: *Whom do I call for approval after 1700?*
A: **There is no need to call for approval after 1700 unless you are ordering a drug for which an ID consult is required** (as stated on the in the Antimicrobial order), in which case you should call the ID consult fellow on call. If you are ordering an AMT restricted antimicrobial, place the order as usual. The pharmacy will release enough drug so that you can call us between 0800 and 1700 for approval if you wish to continue the drug.

Q: *Who answers the AMT pager?*
A: An ID attending physician, senior fellow, or ID trained clinical pharmacist answers the phone in most cases. On some weekends, first year ID fellows may answer the AMT pager.

Q: *How do I know when to call AMT versus ID for questions/approvals?*
A: For all patients followed by the ID consult team, antibiotic changes must be approved by the ID consult team. If your patient is not followed by the ID consult team, and you do not think you need an ID consult, call the AMT pager for approval, as long as the rules on in the order do state that the drug you wish to use requires "AMT approval" and not "ID consult". If the case is very complex, or the patient very sick, we may advise you to obtain an ID consult.

Q: *Do I need to get AMT approval for rewrites/in-hospital transfers?*
A: It depends. If your patient is stepping down from the ICU to the med/surg floor on an antimicrobial that is restricted to 72 hour approval in the ICU, AMT must contacted to extend approval on the floor, if necessary. If an antimicrobial has already been approved by ID/AMT and approval has not expired, no additional approval is necessary.

Q: *Do I need to call AMT if I am using an established CPOE order set?*
A: Restricted antimicrobials still require AMT approval if ordered through an order set. If the order is for a limited time frame, your patient will no longer receive any antibiotics after that time has elapsed, and you will need to write for whatever antibiotics you want to continue. At that point you will need to use the CPOE antimicrobial orders, and will need approval to use restricted antibiotics. Do not use the CPOE order set to continue antibiotics.

Time-limited therapy: Drugs may be prescribed for up to 72 hours without prior appro
the Antimicrobial Management Team (AMT). Approval is required to continue therapy
more than 72 hours.
AMT approval required: Drugs require approval by the AMT prior to the start of therap
ID consult required: Drugs require consultation with the General ID Consult Team or
Transplant ID Consult Team.

Drug	Approval Category
Amikacin	AMT approval required
Amphotericin B – Liposomal (Ambisome) Febrile neutropenia (ANC ≤500) Invasive fungal infection	 No approval required ID consult required
Artesunate	ID consult required
Aztreonam (Azactam) Pneumonia All other indications	 Must use Pneumonia CPOE order set AMT approval required
Bezlotoxumab (Zinplava) Inpatient Outpatient	 Restricted to ID PharmD approval Restricted to GI and ID prescribers
Cefepime (Maxipime) Febrile neutropenia (ANC ≤500) Pneumonia ICU patients Grade III fractures All other indications	 No approval required Must use Pneumonia CPOE order set Time limited: up to 72 hours 48 hours post wound closure AMT approval required
Ceftaroline (Teflaro)	AMT approval required
Cefiderocol (Fetroja)	ID consult required
Ceftazidime (Fortaz) *(cefepime is the preferred cephalosporin at Tufts MC)*	AMT approval required, excluding IP administration ordered by renal fellows/attendings
Ceftazidime/avibactam (Avycaz)	ID consult required
Ceftolozane/tazobactam (Zerbaxa)	ID consult required
Ceftriaxone (Rocephin) 1 g q24 2 g q24 2 g q12	 No approval required BMI > 35 or >120 kg, critically ill in the ICU – no approval required All other indications- AMT approval required ID consult required
Cidofovir	ID consult required
Colistin (Polymixin E) Inhaled IV	 AMT approval required ID consult required
Dalbavancin (Dalvance) Inpatient Outpatient See Guideline on Policy Tech for more info	 Restricted to ID PharmD approval Restricted to ID prescribers

Drug	Approval Category
Daptomycin (Cubicin)	ID consult required
Ertapenem (Invanz) ICU patients All other patients	 Time limited: up to 72 hours AMT approval required
Fidaxomicin (Dificid)	AMT approval required (including when ordered through *C. difficile* order set)
Fosfomycin (Monurol)	AMT approval required
Fluconazole (Diflucan) IV/PO Esophagitis, oral thrusH, vaginitis, dermatitis, ppx in leukemia, severe neutropenia (ANC< 500) or HSCT All other indications	 No approval required ID consult required
Imipenem (Primaxin) *(meropenem is the preferred carbapenem at Tufts MC)*	AMT approval required
Isavuconazole (Cresemba) IV/PO	ID consult required
Letermovir (Prevymis) IV/PO Hematology CMV prophylaxis All other indications	 No approval required ID consult required
Linezolid (Zyvox) IV/PO Pneumonia All other indications	 Must use Pneumonia CPOE order set AMT approval required
Maribavir (Livtencity)	ID consult required
Meropenem (Merrem) Febrile neutropenia (ANC ≤500) All other indications	 No approval required (cefepime preferred) AMT approval required
Micafungin (Mycamine) Prophylaxis in leukemia, severe neutropenia (ANC ≤500) or BMT patients with Grade 11-IV GVHD or or receiving intense immunosuppression, unable to tolerate oral therapy Invasive fungal infection	 No approval required ID consult required
Remdesivir (Veklury)	AMT/ID consult required
Rezafungin (Rezzayo)	Outpatient Only - Restricted to ID approval
Minocycline IV (Minocin)	AMT approval required
Piperacillin/tazobactam (Zosyn) ICU patients All other patients	 Time limited: up to 72 hours AMT approval required
Polymyxin B	ID consult required
Posaconazole (Noxafil) PO Prophylaxis in leukemia, severe neutropenia, or BMT patients with Grade II-IV GVHD or those receiving intense immunosuppression All other patients	 No approval required ID consult required
Posaconazole (Noxafil) IV	ID consult required
Tigecycline (Tygacil)	ID consult required
Tobramycin INH	AMT approval required

Drug	Approval Category
Voriconazole (Vfend) IV/PO	
Febrile neutropenia (ANC ≤500)	No approval required
Invasive fungal infection	ID consult required

Central Nervous System (CNS) Infections

<table>
<tr><th colspan="2">Bacterial Meningitis (ID consult required)</th></tr>
<tr><td colspan="2">Community-Acquired and Age 18-50 years
Usual pathogens: N. meningitidis; S. pneumoniae</td></tr>
<tr><th>Primary</th><th>Confirmed Life Threatening PCN and Cephalosporin allergy</th></tr>
<tr><td>Vancomycin (see dosing guidelines)
plus
Ceftriaxone 2g IV q12h</td><td>Vancomycin (see dosing guidelines)
plus
Aztreonam 2 g IV q8h</td></tr>
<tr><td colspan="2">Community-Acquired and Age >50 years
Usual pathogens: N. meningitidis; S. pneumoniae; L monocytogenes</td></tr>
<tr><th>Primary</th><th>Confirmed Life Threatening PCN and Cephalosporin allergy</th></tr>
<tr><td>Vancomycin (see dosing guidelines)
plus
Ceftriaxone 2g IV q12h
plus
Ampicillin 2g IV q4h</td><td>Vancomycin (see dosing guidelines)
Plus
Aztreonam 2 g IV q8h
plus
Sulfamethoxazole/TMP 5mg/kg* IV q6h
*dose based on trimethoprim component</td></tr>
<tr><td colspan="2">Comments
Give dexamethasone 0.15 mg/kg (maximum 10mg) IV q6h prior to the first dose of antibiotics and continue for four days,if streptococcus pneumoniae is isolated.
All drug doses listed are for patients with normal renal function. Consult pages antimicrobial dosing section for adjustments in patients with renal dysfunction.</td></tr>
</table>

Central Nervous System (CNS) Infections

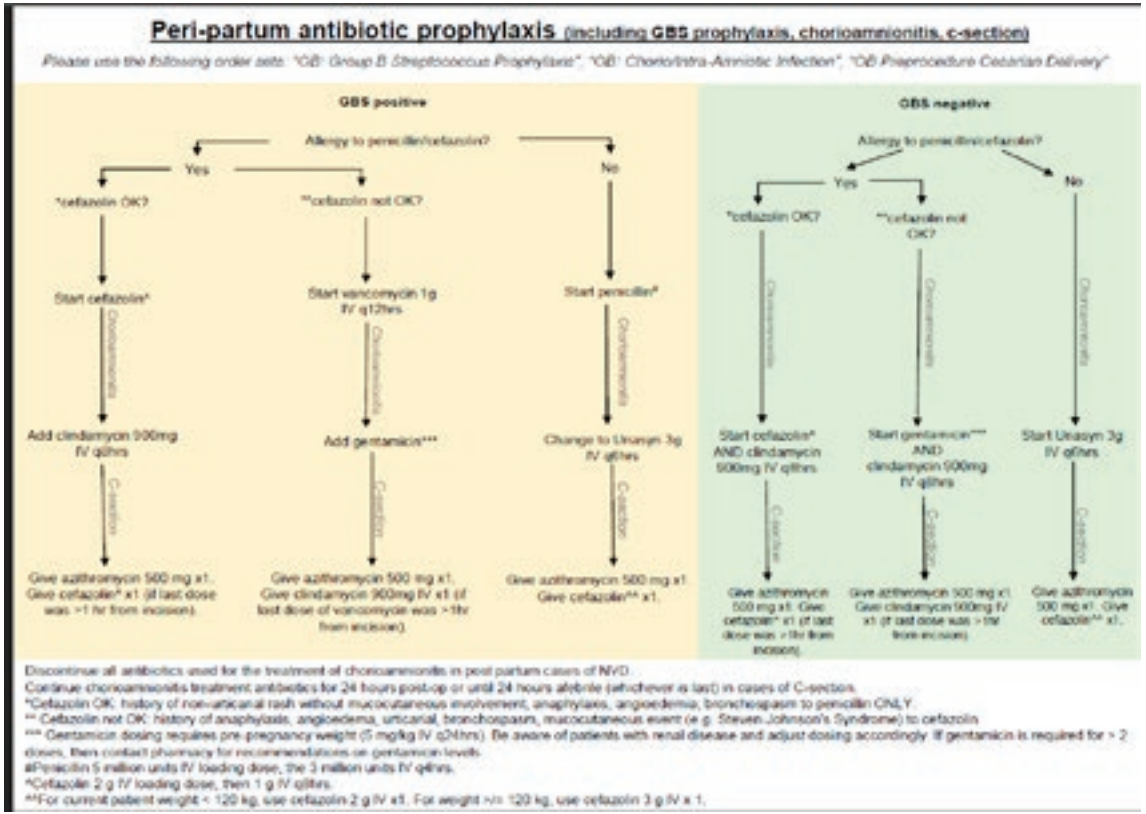
<table>
<tr><th colspan="2">Bacterial Meningitis (ID consult required)</th></tr>
<tr><td colspan="2">Post-Neurosurgery
Usual pathogens: P. aeruginosa; S. aureus; S. epidermidis</td></tr>
<tr><th>Primary</th><th>Confirmed Life Threatening PCN and Cephalosporin allergy</th></tr>
<tr><td>Vancomycin (see dosing guidelines)
plus
Cefepime 2g IV q8h (administered over a 3 hour infusion)</td><td>Vancomycin (see dosing guidelines)
plus
Aztreonam 2 g IV q8h</td></tr>
<tr><td colspan="2">Comments
Consult antimicrobial dosing section for dosage adjustments in patients with renal dysfunction.</td></tr>
</table>

Genitourinary Infections

<table>
<tr><th colspan="2">Urinary Tract Infection (UTI)</th></tr>
<tr><td colspan="2">Acute Bacterial Cystitis
(community acquired; no recent antibiotics)
Usual pathogens: Enterobacterales</td></tr>
<tr><th>Primary</th><th>Alternative</th></tr>
<tr><td>Nitrofurantoin 100 mg PO q12h
(avoid use in patients with CrCl <30 ml/min)</td><td>Cefpodoxime 200 mg PO q12h</td></tr>
<tr><td colspan="2">Comments
All drug doses listed are for patients with normal renal function. Consult antimicrobial dosing section for patients with renal dysfunction.
Treatment duration is 3-5 days.</td></tr>
<tr><td colspan="2">Acute Pyelonephritis or complicated UTI (see below)
(community acquired; no recent antibiotics)
Usual pathogens: Enterobacterales</td></tr>
<tr><th>Primary</th><th>Alternative
(for life threatening penicillin or cephalosporin allergy)</th></tr>
<tr><td>Ceftriaxone 1g IV q24h</td><td>Aztreonam 1g IV q8h</td></tr>
<tr><td colspan="2">Comments
Initial IV therapy is recommended for inpatient pyelonephritis/complicated UTI. Switch to oral therapy based on sensitivity report for step down therapy or outpatient initial therapy
Treat for a total duration of 5-7 days if a quinolone or sulfamethoxazole/TMP is the definitive treatment or 10-14 days if oral ß-lactam is the definitive treatment.
Complicated includes, but not limited: stents, indwelling urinary catheters, obstructive uropathy [ureteral stones], febrile UTI
Consult antimicrobial dosing section for dosage adjustments in patients with renal dysfunction.</td></tr>
</table>

Genitourinary Infections

<table>
<tr><th colspan="2">Urinary Tract Infection (UTI)</th></tr>
<tr><td colspan="2">Nosocomial Acute Cystitis or Pyelonephritis
(hospitalized for ≥ 72 hours, recent antibiotics)
Usual pathogens: Enterobacterales, P. aeruginosa, Enterococci</td></tr>
<tr><th>Primary</th><th>Alternative
(for life threatening penicillin or cephalosporin allergy)</th></tr>
<tr><td>Cefepime 1 g IV q8h</td><td>Aztreonam 1 g IV q8h</td></tr>
<tr><td colspan="2">Comments
Evaluate need for indwelling urinary catheters daily.
Cultures are often positive in catheterized patients without infection. Treat only if symptomatic.
Proper collection after 14 days of catheterization requires changing of the foley (evaluate need for indwelling catheter).
Initial IV therapy is recommended for inpatient pyelonephritis/complicated UTI. Switch to oral therapy based on sensitivity report for step down therapy or outpatient initial therapy
Treat for a total duration of 5-7 days if a quinolone or sulfamethoxazole/TMP is the definitive treatment or 10-14 days if oral ß-lactam is the definitive treatment.
Complicated includes, but not limited: stents, indwelling urinary catheters, obstructive uropathy [ureteral stones], febrile UTI, and pyelonephritis
All drug doses listed are for patients with normal renal function. Consult antimicrobial dosing section for dose adjustments in patients with renal dysfunction.</td></tr>
<tr><td colspan="2">Candida Cystitis
Usual pathogens: C. albicans; C. glabrata</td></tr>
<tr><th>Primary</th><th>Alternative
(if symptoms persist after catheter change with ongoing positive cultures)</th></tr>
<tr><td>No treatment; Change catheter in catheterized patients, recheck urine if symptoms persist</td><td>Fluconazole 400 mg PO x 1 dose then Fluconazole 200 mg PO q24h x 7d</td></tr>
<tr><td colspan="2">Comments
Most candiduria represents colonization.
Consult antimicrobial dosing section for dosage adjustments in patients with renal dysfunction.</td></tr>
</table>


Peri-partum antibiotic prophylaxis (including GBS prophylaxis, chorioamnionitis, c-section)
Please use the following order sets: "OB: Group B Streptococcus Prophylaxis", "OB: Chorio/Intra-Amniotic Infection", "OB Preprocedure Cesarian Delivery"
GBS positive
Allergy to penicillin/cefazolin?
Yes
No
*cefazolin OK?
**cefazolin not OK?
Start cefazolin*
Start vancomycin 1g IV q12hrs
Start penicillin*
Chorioamnionitis
Add clindamycin 900mg IV q8hrs
Add gentamicin***
Change to Unasyn 3g IV q6hrs
C-section
Give azithromycin 500 mg x1. Give cefazolin** x1 (if last dose was >1 hr from incision).
Give azithromycin 500 mg x1. Give clindamycin 900mg IV x1 (if last dose of vancomycin was >1hr from incision).
Give azithromycin 500 mg x1. Give cefazolin** x1.
GBS negative
Allergy to penicillin/cefazolin?
Yes
No
*cefazolin OK?
**cefazolin not OK?
Chorioamnionitis
Start cefazolin* AND clindamycin 900mg IV q8hrs
Start gentamicin*** AND clindamycin 900mg IV q8hrs
Start Unasyn 3g IV q6hrs
C-section
Give azithromycin 500 mg x1. Give cefazolin* x1 (if last dose was >1hr from incision).
Give azithromycin 500 mg x1. Give clindamycin 900mg IV x1 (if last dose was >1hr from incision).
Give azithromycin 500 mg x1. Give cefazolin** x1.
Discontinue all antibiotics used for the treatment of chorioamnionitis in post partum cases of NVD.
Continue chorioamnionitis treatment antibiotics for 24 hours post-op or until 24 hours afebrile (whichever is last) in cases of C-section.
*Cefazolin OK: history of non-urticarial rash without mucocutaneous involvement, anaphylaxis, angioedema, bronchospasm to penicillin ONLY.
** Cefazolin not OK: history of anaphylaxis, angioedema, urticarial, bronchospasm, mucocutaneous event (e.g. Steven Johnson's Syndrome) to cefazolin.
*** Gentamicin dosing requires pre-pregnancy weight (5 mg/kg IV q24hrs). Be aware of patients with renal disease and adjust dosing accordingly. If gentamicin is required for > 2 doses, then contact pharmacy for recommendations on gentamicin levels.
#Penicillin 5 million units IV loading dose, the 3 million units IV q4hrs.
^Cefazolin 2 g IV loading dose, then 1 g IV q8hrs.
^^For current patient weight < 120 kg, use cefazolin 2 g IV x1. For weight >/= 120 kg, use cefazolin 3 g IV x 1.

Intraabdominal Infections

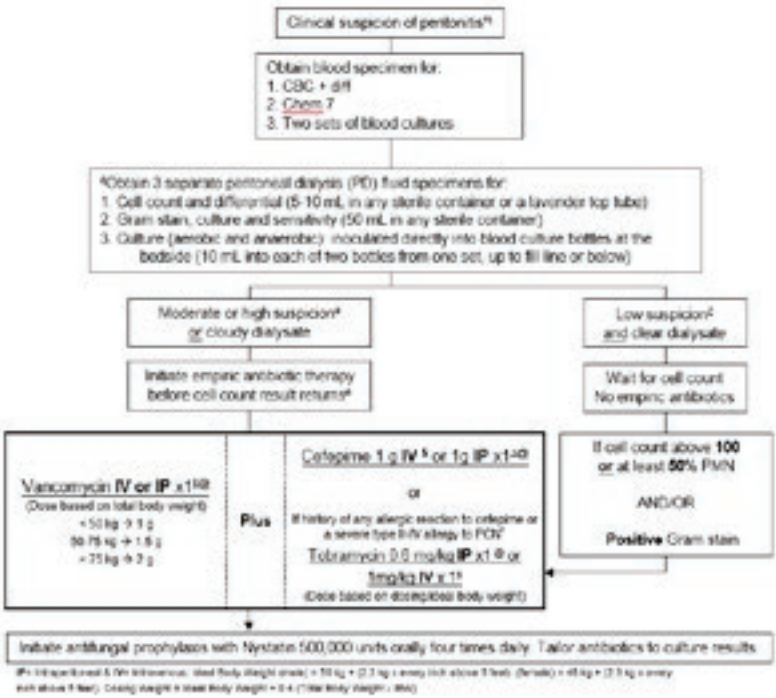
<table>
<tr><th colspan="2">Intra-abdominal Infection not including Spontaneous Bacterial Peritonitis
(e.g. cholecystitis, appendicitis, colitis, abscess)</th></tr>
<tr><td colspan="2">Community Acquired Mild to Moderate Infection
(onset prior to or within 5 days of hospitalization)
Usual pathogens: E. coli; Klebsiella sp., anaerobic coverage (not necessary for CA biliary infections)</td></tr>
<tr><th>Primary</th><th>Alternative
(for life threatening penicillin or cephalosporin allergy)</th></tr>
<tr><td>Ceftriaxone 1g q24h
plus
Metronidazole 500mg IV q12h</td><td>Aztreonam 1g IV q8h
plus
Vancomycin (see dosing guidelines)
plus
Metronidazole 500mg IV q12h</td></tr>
<tr><td colspan="2">Comments
Switch to appropriate oral therapy when clinically stable.
Therapy should be discontinued no later than 4 days after achieving adequate source control. If source control cannot be achieved, ID consult should be considered.</td></tr>
<tr><td colspan="2">Healthcare-Associated Infection
(Onset after 5 days of hospitalization or community-acquired with recent broad spectrum antibiotic therapy, moderate to severe immunosuppression)
Usual pathogens: E. coli; Klebsiella species; Serratia species; P. aeruginosa; anaerobes</td></tr>
<tr><th>Primary</th><th>Alternative
(for life threatening penicillin or cephalosporin allergy)</th></tr>
<tr><td>Cefepime 1g q8h
plus
Metronidazole 500mg IV q12h</td><td>Aztreonam 1g IV q8h
plus
Vancomycin (see dosing guidelines)
plus
Metronidazole 500mg IV q12h</td></tr>
<tr><td colspan="2">Comments
Empiric therapy for MRSA and Enterococcus is not indicated (e.g vancomycin). Therapy should be discontinued no later than 4 days after achieving adequate source control. If source control cannot be achieved, ID consult should be considered.
All drug doses listed are for patients with normal renal function. Consult antimicrobial dosing section for dose adjustments in patients with renal dysfunction.</td></tr>
</table>

Intraabdominal Infections

Spontaneous Bacterial Peritonitis	
Usual pathogens: *E. coli; K. pneumoniae; S. pneumoniae*	
Primary	**Alternative** (for life threatening penicillin or cephalosporin allergy)
Ceftriaxone 2g q24h	**Levofloxacin 500mg IV q24h**
Comments • Stop antibiotic therapy after five days. • Consult antimicrobial dosing section for dosage adjustments in patients with renal dysfunction.	

Upper GI bleed (for cirrhosis and active bleed)	
Usual pathogens: *E. coli; K. pneumoniae; S. pneumoniae*	
Primary	**Alternative**
Ceftriaxone 1 g IV q24 hours	Ciprofloxacin 500 mg PO BID
Comments • Stop antibiotic therapy after 3 days • Consult antimicrobial dosing section for dosage adjustments in patients with renal dysfunction	

Clinical Suspicion of Peritonitis in Patients on Peritoneal Dialysis



Peritonitis in a PD patient can present with minimal symptoms. Pain, if present, is often mild. Even if there is low clinical suspicion of peritonitis, peritoneal fluid should always be obtained.

£Low suspicion of peritonitis: clear alternative etiology of symptoms, no fever or abdominal pain, clear dialysate.

¥Moderate/high suspicion of peritonitis: unexplained fever or abdominal pain, history of cloudy dialysate.

#In the absence of cloudy dialysate, a positive cell count is preferred prior to antibiotic administration; however, depending on clinical suspicion and turnaround time for the lab test, empiric antibiotics may be indicated

€If the patient has a 'dry' abdomen, see the policy "Assessing Cell Counts and Obtaining Cultures in a 'Dry' Abdomen."

ł Consult Nephrology for all PD patient presentations to the emergency department.

$Dwell duration should be at least 6 hours to allow for antibiotic contact time. The dwell can be longer than 6 hours.

^Severe type II-IV allergic rxn: SJS/TEN, exfoliative dermatitis, DRESS, hemolytic anemia, drug-induced hepatitis, AIN.

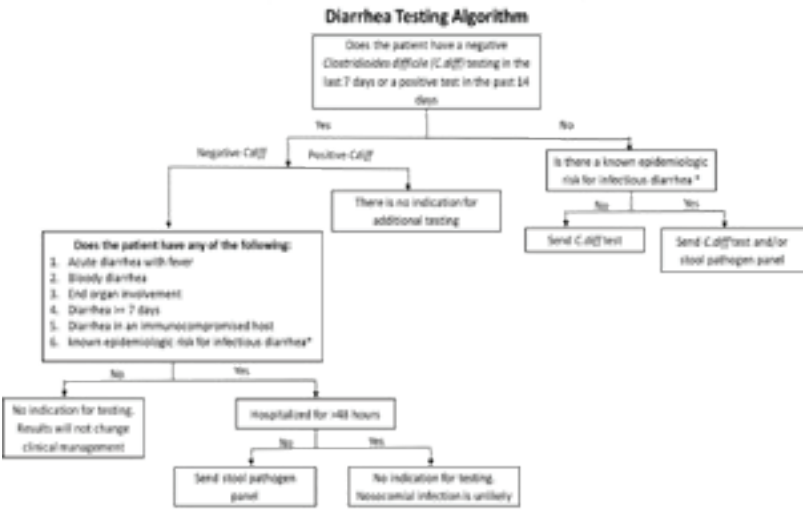
ΔIt is safe to mix vancomycin and cefepime in peritoneal dialysis solution.

@IP antibiotics must be ordered by the Nephrology fellow/attending. IV cefepime requires AMT approval.

Stool Testing Algorithm

Indications for sending stool testing

- > 3 loose stools in the past 24 hours, abnormal from baseline
- DO NOT SEND TEST IF:
    - Receipt of laxatives the prior 48 hours



* Epidemiologic risk factors for infectious diarrhea within 48 hours of admission:

- Travel outside of US
- Known outbreaks in the community
- High-risk occupation (i.e. food workers, school teachers)

If your patient presents with epidemiological risk factors for *Giardia, Cryptosporidium* or other parasitic infections, please order stool *Giardia/Cryptosporidium* antigen and/or O&P (x3).

If there is suspicion for infectious diarrhea and the above algorithm does not apply to your patient or you are unable to order the test, please tiger text AMT (@ T Adult Antimicrobial AMT) role for additional assistance.

Stool pathogen panels may be rejected from the laboratory if sent > 48 hours after hospital admission, as it is unlikely to be positive.

Only stools that take the shape of the container will be accepted for testing.

Clostridioides difficile Diagnosis and Treatment Algorithm

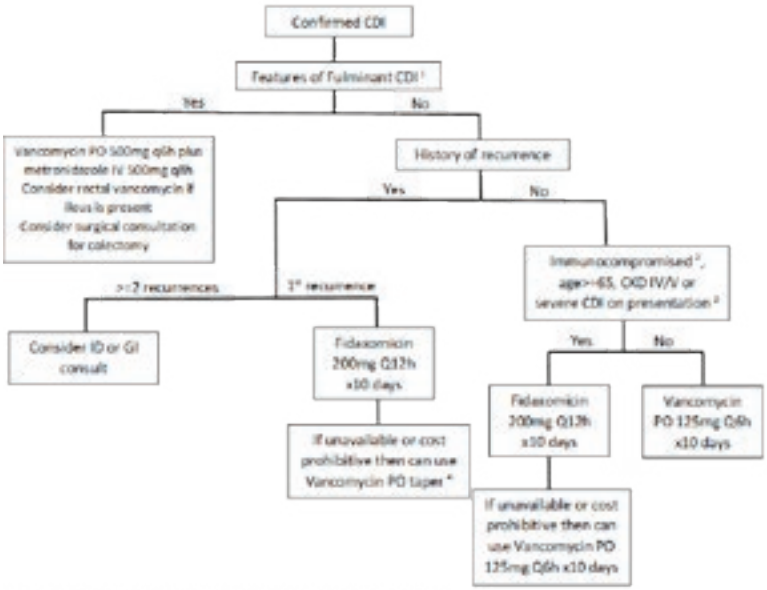
Step 1: Indications for Sending Stool

- > 3 loose stools in the past 24 hours, abnormal from baseline
- DO NOT SEND TEST IF:
  - Patient is <2 years old (high rate of asymptomatic carriage)
  - Positive test in the prior 30 days, unless acute symptoms in the prior 24 hours
  - Negative test in the prior 7 days, unless acute symptoms in the prior 24 hours
  - Receipt of laxatives or tube feeds in the prior 24-48 hours

Step 2: Interpretation of Test Results

- IF POSITIVE BY TOXIN EIA
  - Consider to be true positive, highly specific test. Initiate *C. difficile* treatment
- IF NEGATIVE BY TOXIN EIA or PCR
  - Consider to be true negative, highly sensitive test. Do not initiate therapy for *C. difficile* and continue workup for other causes of diarrhea
- IF TOXIN EIA INDETERMINATE OR POSITIVE by PCR
  - Often reflect colonization rather than infection
  - Correlate with likelihood of true *C. difficile* infection before initiating therapy as treatment of colonization increases risk for *C. difficile* infection
  - Contact @ T Antimicrobial Adult (AMT) role to request *C. difficile* PCR approval for indeterminate results

Step 3: Treatment



[1] Fulminant CDI: evidence of hypotension, shock, ileus or megacolon

[2] Immunocompromised: SOT, HSCT or CAR-T, immunomodulator therapy, >10mg of corticosteroids for 3 months

[3] Severe CDI: WBC >15, SCr >1.5

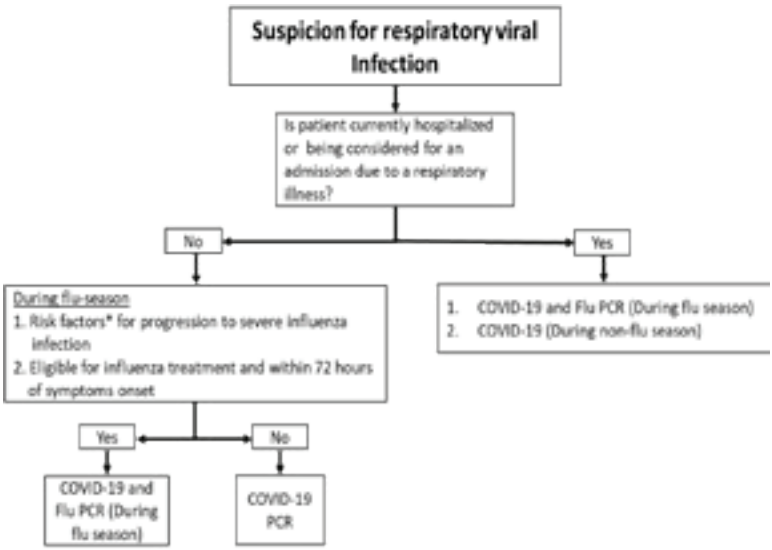
[4] Vancomycin treatment and taper: 125mg Q6h for 10 days followed by 2 times daily for 7 days, once daily for 7 days and then every 2-3 days for 2-8 weeks

Step 4: Prevention of recurrence

For patients with a first recurrence who are at increased risk of recurrences or patients with two or more recurrences, consider getting an ID or GI consult to facilitate outpatient preventative therapy including Bezlotuxumab, Vowst or Rebyota.

Pulmonary Infections

Respiratory Viral Testing



*Adults ≥ 65 years old, chart documentation of immunocompromised conditions, certain medical conditions (asthma, COPD, diabetes mellitus)
https://www.cdc.gov/flu/highrisk/index.htm

•Influenza testing is **not typically indicated** outside of flu season in the Northern Hemisphere, unless specific epidemiological risk factors are present e.g., recent travel to Southern Hemisphere or exposure to animals known to carry influenza viruses.
•RSV testing is **not recommended for adults**, except for those who are severely immunocompromised where a positive result will influence clinical management
RPP testing should be considered inpatient only for patients with critical illness due to respiratory infection without clinical improvement for >48 hours of admission or high suspicion for pertussis.
Respiratory Pathogens Panel [LAB1900] inpatient testing includes the following:

-Adenovirus	-Influenza A
-Bordetella pertussis	-Influenza A subtype H1
-Bordetella parapertussis	Influenza A subtype H3
-Chlamydophila pneumoniae	-Influenza A subtype H1-2009
-Coronavirus 229E	-Influenza B
-Coronavirus HKU1	-Mycoplasma pneumoniae
-Coronavirus NL63	-Parainfluenza virus 1
-Coronavirus OC43	-Parainfluenza virus 2
-Human metapneumovirus	-Parainfluenza virus 3
-Human rhinovirus/enterovirus	-Parainfluenza virus 4
	-Respiratory syncytial virus

COVID – 19 Treatment Recommendations

	Mild to Moderate Disease without Need for supplemental O2	**Hospitalized and requires conventional oxygen, (SpO2 < 94% on room air)**	**Hospitalized and requires HFNC Oxygen or Non-invasive ventilation**	**Hospitalized: Critical Disease (ECMO/MV)**
Cortico-steroids	--	Dexamethasone 6 mg PO/IV daily x 10 days	Dexamethasone 6 mg IV/PO daily IV/PO x 10 days	Dexamethasone 6 mg IV/PO daily x 10 days
IL-6 Inhibitors	--	*If rapidly increasing oxygen needs and systemic inflammation:* Tocilizumab€ 8 mg/kg IV x 1, Baricitinibα 4 mg PO daily	Tocilizumab € 8 mg/kg IV x 1, Baricitinibα 4 mg PO daily	Tocilizumab € 8 mg/kg IV x 1, Baricitinibα 4 mg PO daily
Antivirals	Paxlovid£ Remdesivir** x 3 days	Remdesivir** x 5 days	Immunocompromised[B]: Consider Remdesivir**, *data suggests no benefit in other populations*	--

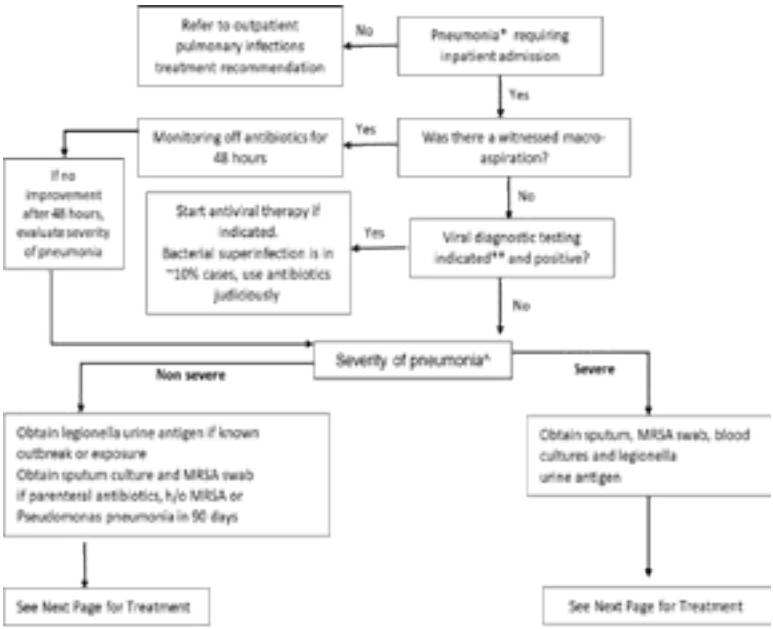
Asymptomatic infection should not need treatment
** Remdesivir requires AMT approval and renal adjustment. If patient is clinically stable and ready for discharge, ok to discontinue remdesivir early
£ Start within 5 days of symptom onset
€ Max dose 800 mg, may consider second dose within 24 hours if no clinical improvement
B Immunocompromised: solid organ or bone marrow transplant recipients, drug induced neutropenia, patients on chemotherapy, HIV with CD4<200, and immune deficiency syndromes

Outpatient Treatment of Pneumonia	
Community-acquired Usual pathogens: *S. pneumoniae; H. influenzae; Mycoplasma pneumoniae*	
Without co-morbidities	**With co-morbidities**
Amoxicillin 1g PO q8h x 5 days **~OR~** **Doxycycline 100mg PO q12h x 5 days**	**Amoxicillin/clavulanate 875 mg/125 mg PO q12h** OR **Cefpodoxime 400 mg PO q12h** plus **Azithromycin 500 mg daily x 3 days** OR **Doxycycline 100 mg PO twice daily** **~OR~** **Levofloxacin 500 mg PO daily**

Comments

- Several studies have demonstrated that a treatment duration of 5 days is as effective and safe as a longer treatment course (7-10 days).
- These regimens are commonly used outpatient.
- All drug doses listed are for patients with normal renal function. Consult antimicrobial dosing section for dose adjustments in patients with renal dysfunction.
- **Co-morbidities:** alcoholism, chronic heart, lung, liver or renal disease, diabetes, active malignancy, asplenia

Inpatient Treatment of Pneumonia



*Pneumonia definition:
New pulmonary infiltrate(s) on chest imaging
AND
≥ 2 respiratory symptoms (new or worsening cough, new or worsening sputum, dyspnea, or pleuritic chest pain)
OR
≥ 1 symptom (as above) and ≥ 1 sign (abnormal lung sounds, fever, hypoxia, or leukocytosis)

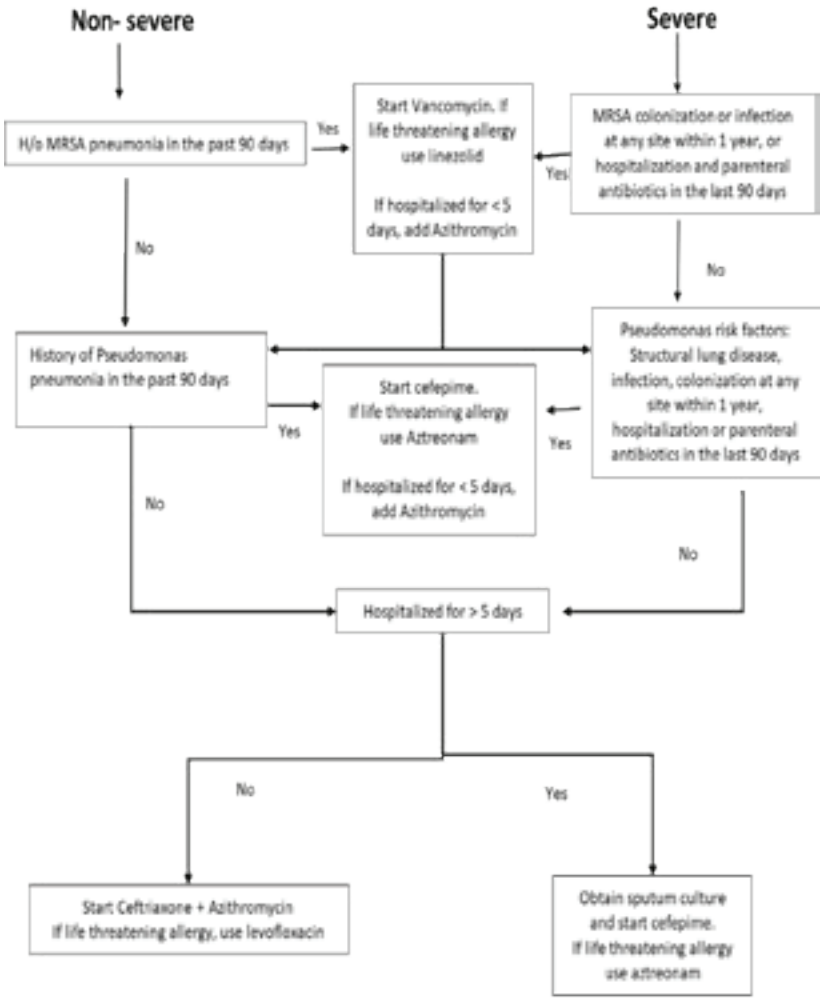
** flu/COVID test and/or RPP: Flu season, COVID outbreak, exposure, immunocompromised patients, severe pneumonia

^ Severe pneumonia is Defined by 1 Major or 3 Minor Criteria

Major:
Septic shock with need for vasopressors
Respiratory failure requiring mechanical ventilation
Empyema
Lung abscess

Minor:

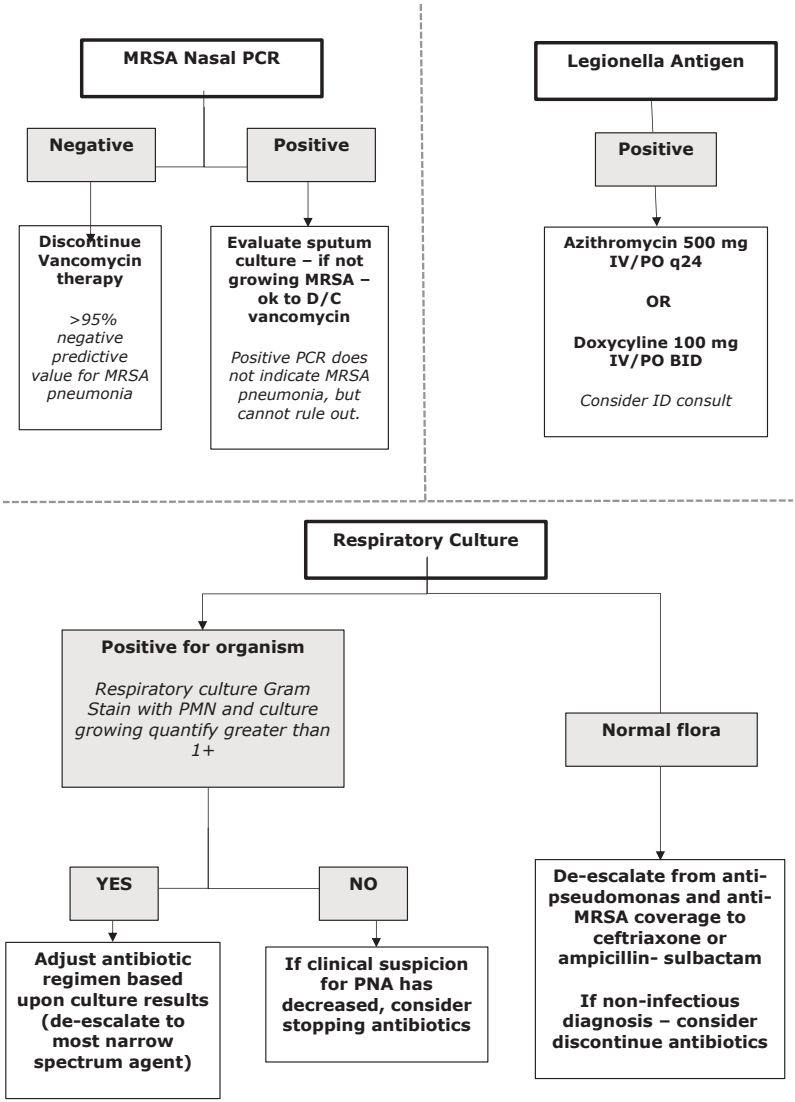
RR >/= 30	Leukopenia	Uremia	Hypothermia
PaO2/FIO2 ration </= 250	Thrombocytopenia	Multilobar infiltrates	
Confusion/disorientation	Hypotension		



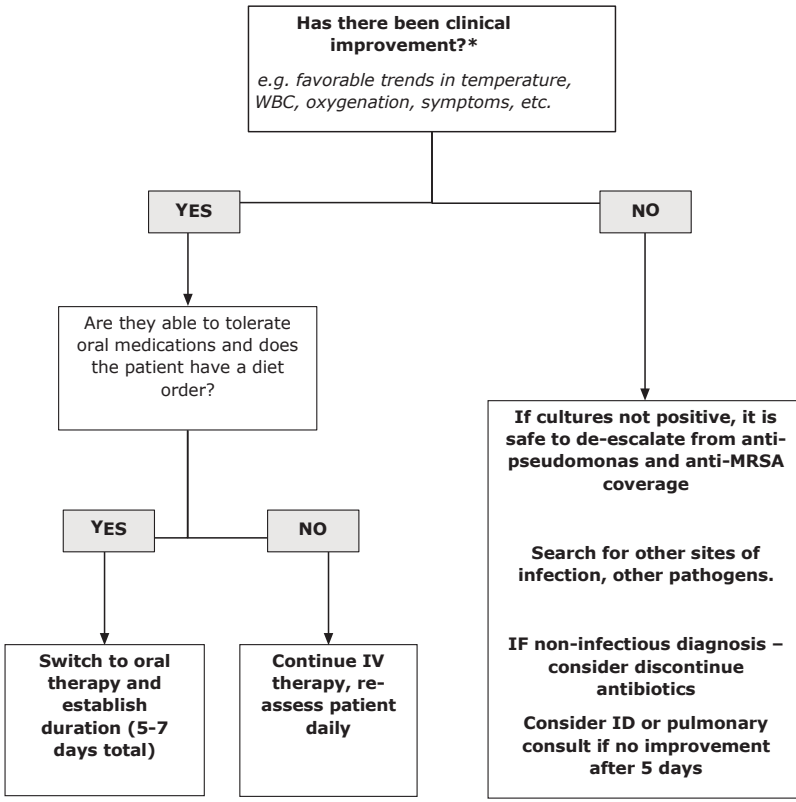
Anaerobic coverage is not needed, even in the setting of aspiration. Unless empyema or abscess is suspected, then start ampicillin/sulbactam or metronidazole + cefepime/ceftriaxone.

Interpretation of respiratory microbiology results

Day 2-3 of diagnostic workup and treatment



Community Acquired PNA: 5 days
Ventilator Associated/Hospital Associated: 7 days
Legionella PNA: 7-10 days or longer if immunocompromised
Consider oral therapy when possible



Skin and Soft Tissue Infections

<table>
<tr><th colspan="2">Cellulitis</th></tr>
<tr><td colspan="2">Cellulitis that has failed oral therapy and/or requires admission to the hospital
Usual pathogens: S aureus; Group A, B, C, or G Strep</td></tr>
<tr><th>Non-Purulent</th><th>Purulent</th></tr>
<tr><td>Primary:
Cefazolin 1-2g q8h

For confirmed life threatening penicillin and cephalosporin allergy
Vancomycin (see dosing guidelines)</td><td>Primary:
Vancomycin (see dosing guidelines)

If MRSA is suspected and the patient is allergic to vancomycin [not including vancomycin flushing syndrome] or has another contraindication
Linezolid PO 600mg q12h</td></tr>
<tr><td colspan="2">Comments
Higher doses of cefazolin should be used for BMI>35 and severe infection
Suspect MRSA if there is evidence of abscess, “spider bite”, or patient has risk factors (i.e. intravenous drug use or recent IV antibiotic use).
All drug doses listed are for patients with normal renal function. Consult pages antimicrobial dosing section for dose adjustments in patients with renal dysfunction.</td></tr>
</table>

Skin and Soft Tissue Infections

<table>
<tr><th colspan="2">Wound Infection</th></tr>
<tr><td colspan="2">head, neck, trunk, or extremity including post surgery
Usual pathogens: S aureus; Group A Strep</td></tr>
<tr><th>Primary</th><th>Alternative
(If MRSA is suspected and the patient is allergic to vancomycin [not including Vancomycin flushing syndrome] or has another contraindication)</th></tr>
<tr><td>Vancomycin
(see dosing guidelines)</td><td>Linezolid PO 600mg q12h</td></tr>
<tr><th colspan="2">Wound Infection</th></tr>
<tr><td colspan="2">Perineal or post- abdominal/pelvic surgery
Usual pathogens: GNRs, anaerobes; S aureus; Group A Strep;</td></tr>
<tr><th>Primary</th><th>Alternative
(for life threatening penicillin or cephalosporin allergy)</th></tr>
<tr><td>Piperacillin/tazobactam 3.375g q8h
plus
Vancomycin
(see dosing guidelines)</td><td>Aztreonam 2g IV q8h
plus
Vancomycin
(see dosing guidelines)
plus
Metronidazole 500 mg IV or PO q8h</td></tr>
<tr><td colspan="2">Comments
Switch to oral therapy when clinically stable.
Consult antimicrobial dosing section for dosage adjustments in patients with renal dysfunction.</td></tr>
</table>

Skin and Soft Tissue Infections

Acute Infected Diabetic Foot Ulcer (DFI)			
DFI may be complicated by arterial insufficiency and underlying osteomyelitis ID and Vascular Consultation recommended.			
	Mild	**Moderate**	**Severe**
No risk factors (see below)	Cephalexin PO	Cefazolin IV	
Life threatening PCN and CEPH Allergy:	Doxycycline PO or TMP/SMX PO	Vancomycin IV	
Risk Factor: Received antibiotics in the last 30 days	Amoxicillin/ Clavulanate PO	Piperacillin/Tazobactam IV	
Life threatening PCN and CEPH Allergy:	Aztreonam and Metronidazole and Vancomycin		
Risk Factors for Pseudomonas: • Macerated/soaked in water • History of P. aeruginosa in a skin or soft tissue in last 90 days	Levofloxacin PO	Piperacillin/Tazobactam IV	
Life threatening PCN and CEPH Allergy:	Aztreonam and Metronidazole and Vancomycin		
History of MRSA infection or colonization of skin and soft tissue source*	ADD Vancomycin to above regimens		
Severe/Rapidly Progressing	ADD Linezolid Linezolid replaces vancomycin in above regimens		

MRSA nasal PCR **is not indicated in the workup of soft tissue infections because of poor correlation between nasal MRSA colonization and wound cultures.*

Definitions per Infectious Diseases Society of America (IDSA) and International Working Group on Diabetic Foot Classifications of Diabetic Foot infections:

Presence of at least 2 symptoms	Local swelling or induration Erythema Local tenderness or pain Local warmth Purulent discharge
Mild	Local infection with no systemic manifestations and involving: Erythema extending < 2 cm from ulcer margin Tissue depth limited to skin and subcutaneous
Moderate	Infection with no systemic manifestations and involving: Erythema extending ≥ 2 cm from ulcer margin and/or Tissues deeper than skin - (tendon, muscle, joint, bone)
Severe	Any foot infection with ≥ 2 of the following systemic manifestations: Temperature > 38C or < 36C Heart rate > 90 beats/min Respiratory rate > 20 breaths/min or $PaCO_2$ < 32 mm Hg WBC > 12k or < 4k

Clinical Infectious Disease IWGDF/IDSA Guidelines on the Diagnosis and Treatment of Diabetes-related Foot Infections (IWGDF/IDSA 2023)s, October 2023, https://doi.org/10.1093/cid/ciad527

Skin and Soft Tissue Infections

Necrotizing Fasciitis (ID consult required)	
Usual pathogens: Group A *Strep; S. aureus; Clostridium* species	
Primary	**Alternative** (for life threatening penicillin or cephalosporin allergy)
Piperacillin/tazobactam 3.375g q8h plus **Linezolid 600mg IV/PO Q12h**	**Aztreonam 2g IV q8h** plus **Linezolid 600mg IV/PO Q12h**

Comments

- Clindamycin or Linezolid are used for their toxin inhibition properties against Gram positive organisms and can be discontinued after 2-3 days of use.
- Continue vancomycin/Linezolid until MRSA is ruled-out.
- Consult antimicrobial dosing section for dosage adjustments in patients with renal dysfunction.

Surgical Antimicrobial Prophylaxis FAQs

Q: *When should antibiotics be administered for pre-operative prophylaxis?*
A: Antibiotics should be administered within 60 minutes prior to incision. For vancomycin and quinolones, 120 minutes are acceptable.

.
Q: *How do I know what antibiotic is appropriate to give for a particular case?*
A: The Tufts MC protocol can be found in each operating room in the pocket on the wall and on the Policy Tech. If the antibiotics on the institutional protocol are not acceptable, confer with ID or AMT (@ T Antimicrobial AMT adult).

Q: *What do I do if my patient is already on an antibiotic at the time of surgery?*
A: To prevent wound infection, it is important to have high tissue blood levels at the time of incision. Depending on the antibiotic the patient is already on, you may be able to give an early dose right before the incision, or give an antibiotic of a completely different class in order not to have additive toxicity. When in doubt, page the Antimicrobial Management Team between 0800 and 1700 (@ T Antimicrobial AMT Adult) or call the ID consult (@ T ID New Consult) service after 1700.

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
Acyclovir IV Treatment of HSV/VZV	>50 25-50 10-24 <10 iHD CVVHD (1000 - 3000mL/hr)	5-10mg/kg q8h 5-10mg/kg q12h 5-10mg/kg q24h 2.5-5mg/kg q24h 2.5-5mg/kg q24h* 5-10mg/kg q12-24h	• Dose based on IBW • Use DW if TBW is >20% of IBW OR if BMI >30 • High dose for meningitis, encephalitis, or VZV • *Administer dose after hemodialysis
Acyclovir PO Treatment of HSV/VZV	>25 10-24 <10	200mg 5X daily 200mg q8h 200mg q12h	
Prophylaxis in SOT	≥ 25 < 25	400 mg BID 400 mg daily	
Prophylaxis in BMT	≥25 <25	400 mg TID 200 mg BID	
Amphotericin B – Liposomal IV	3-5 mg/kg q24h		• Restricted • Consider max dose of 600 mg for BMI > 30 • Consider 10 mg/kg for treatment of *Mucormycosis* • Give dose after hemodialysis • No renal adjustment is necessary, unlikely to be dialyzed
Amikacin IV	See aminoglycoside section for dosing information		
Amoxicillin PO	>30 10-30 <10 iHD* PD	500-1000mg q8-12h 500-1000mg q12h 250-500mg q12-24h 250-500mg q12-24h 250-500 mg q12h	• *Give dose after hemodialysis
Amoxicillin/ clavulanate PO	>30 10-30 <10 iHD*	875 or 500mg q8h-12h 250-500mg q12h 250-500mg q12-24h 250-500mg q12-24h	• Dose based on amoxicillin • 250mg, 500mg, and 875mg tablets contain 125mg clavulanate; 400mg suspension contains 57mg and 600mg suspension contains 43 mg clavulanate per 5 mL • *Give dose after hemodialysis

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
Ampicillin IV	>50 30-50 15-29 <15 iHD PD CVVHD (1500-3000mL/hr)	1-2g q4-6h 1-2g q6-8h 1-2g q8-12h 1-2g q12-24h 1-2g q12-24h* 1-2g q12-24h 1-2g q6-8h	• 1 g dose for mild infections • *Give dose after hemodialysis
Ampicillin/ sulbactam IV Mild-Severe Infections	>30 15-30 <15 iHD PD CVVHD (1500-3000mL/hr)	1.5-3g q6h 1.5-3g q12h 1.5-3g q24h 1.5-3g q12-24h* 1.5 q12h OR 3g q24h 3g q8-12h	• Dose based on total ampicillin plus sulbactam • 1.5g dose for mild infections • *Give dose after hemodialysis
Acinetobacter Baumannii pneumonia/ bacteremia	>30 15-30 <15 iHD* CRRT (1500- 3000 mL/hr)	3g q4h 3g q6-8h 3g q8-12h 3g q12-24h 3g q6h	• Dose based upon sulbactam component • *Give dose after hemodialysis
Aztreonam IV	>30 10-29 <10 or HD* or PD CVVHD (1000-2000mL/hr)	1-2g q6-8h 1 -2g q12h 1-2g q24h* 1-2g q24 2g x1 then 1g q8h	• Restricted • *Give dose after hemodialysis
CeFAZolin IV	>30 10-30 <10 iHD PD CVVHD (1500-3000mL/hr)	1-2g q8h 1g q12h 1g q24h 1g q24h or 2 g qHD* 1g q24h 2g x1 then 1-2g q8h	• 2g dose should be used for severe infection • *Give dose after hemodialysis for daily and qHD regimens • For patients > 120 kg of BMI > 35 with severe infection, consider increased frequency (2g q6h) or 3 g doses
Cefepime IV UTI, skin, or intra-abdominal infections	>60 30-60 11-29 <11 iHD or PD CVVHD (1500-3000mL/hr)	1g q8h 1g q12h 1g q24h 500mg q24h 1g q24h* 2g x1 then 1g q8h	• Restricted • 3 hour infusion preferred • *Give dose after hemodialysis
Febrile neutropenia, pneumonia, sepsis, meningitis or obesity	>60 30-60 11-29 <11 iHD or PD CVVHD (1500-3000mL/hr)	2g q8h^ 1g q8h 1g q12h 1g q24h 1g q24h* 2g x1 then 1-2g q8h**	• Restricted • 3 hour infusion preferred • **1g q8h for MIC ≤4 for concerns of neurotoxicity • *Give dose after hemodialysis

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
Cefiderocol IV CrCl, iHD	≥120 60-120 30-59 15-29 <15 or iHD	2g q6h 2g q8h 1.5g q8h 1g q8h 750mg q12h*	• Restricted • Infuse over 3 hours • *Give dose after hemodialysis
CVVHD	<2 L/hr 2.1-3 L/hr 3.1 - 4 L/hr ≥4.1L/hr	1.5g q12h 2g q12h 1.5g q8h 2g q8h	• Restricted • Infuse over 3 hours
Cefpodoxime PO	≥30 <30 HD	200-400mg q12h 200-400mg q24h 100-200mg Q24h	• *Give dose after hemodialysis
Ceftaroline IV	>50 30-50 15-29 IHD CVVH (1500 – 3000 mL)	600mg q8-12h 400mg q8-12jh 300mg q8-12h 200mg q8-12h 400 mg q8-12	• No dose adjustment needed for obesity
CefTAZidime IV	>50 31-50 16-30 <15 iHD PD CVVHD (1500 - 3000 mL/hr)	1-2g q8h 1-2g q12h 1-2g q24h 1g q24h 1- 2 g qHD*[t] 1g q24h 2g q8h-12h	• Restricted • [t]1 g qHD is sufficient for q48h intra-dialytic period and MIC< 4; Consider 2 g for 72 hour intra-dialytic period with MIC≥ 4 or MIC unknown • *Only administer on HD days; give dose after hemodialysis
CefTAZidime/ avibactam IV	>50 31-50 16-30 6-15 ≤5 iHD CVVHD 2000-3000mL/hr	2.5g q8h 1.25g q8h 0.94g q12h 0.94g q24h 0.94g q48h 0.94g q24* 1.25g q8h	• Restricted • Dose based on total ceftazidime plus avibactam • Preferred drug for CRE • *for not severe infections can consider q48; give dose after hemodialysis • Infuse over 2 hours
Ceftolozane/ tazobactam IV UTI	>50 31-50 16-30 ≤15 iHD CVVHD (1500-3000ml/hr)	1.5g q8h 0.75g q8h 0.375g q8h Not studied 0.75g x1 then 0.15g q8h 0.75g q8h	• Restricted • Dose based on total ceftolozane plus tazobactam • Preferred drug for MDR Pseudomonas
All other indications	>50 31-50 16-30 ≤15 iHD CVVHD (1500-3000ml/hr)	3g q8h 1.5g q8h 0.75g q8h Not studied 2.25g x1 then 0.45g q8h 1.5g q8h	• Restricted • Dose based on total ceftolozane plus tazobactam • Preferred drug for MDR Pseudomonas

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
CefTRIAXone Other indications Obesity, critical illness Meningitis	1g q24h		• No renal adjustment is necessary
	2 g q24h		• 2 g restricted if not critically ill or BMI < 35, weight < 120kg
	2g q12h		• Requires ID consult
Cephalexin PO	>30 15-30 <15 or iHD	250-1000mg q6-12h 250-500mg q8-12h 250-500mg q12-24h	• High doses for severe infections or obesity • *Give dose after hemodialysis
Ciprofloxacin IV	>30 <30 iHD or PD CVVHD (1500-3000mL/hr)	400mg q8[$]-12h 400mg q24h 400mg q24h* 400mg q12h	• High doses for severe infections or obesity • *Give dose after hemodialysis • [$] only use 400 mg q8 for severe infections or when MIc > 0.5 mcg/mL is suspected
Ciprofloxacin PO	>30 <30 iHD or PD	500-750mg q12h 500mg q24h 500mg q24h*	• High doses for severe infections or obesity • *Give dose after hemodialysis
Clarithromycin PO	≥30 <30 iHD	500mg q12h 250mg q12-24h 250mg q12-24h*	• *Give dose after hemodialysis
Clindamycin PO or IV	600-900mg IV q8h 150-450mg PO q6h-q8h		• No renal adjustment is necessary
Colistin IV	>90 70-90 40-69 20-39 5-19 IHD* CVVHD	300mg x1; then 160mg q12h 300mg x1; then 150mg q12h 300mg x1; then 125mg q12h 300mg x1; then 100mg q12h 300mg x1; then 75mg q12h 130mg x1; then 50mg q24h* 220 mg q12h	• Restricted • Dosing based on 2019 International Consensus Guidelines on Use of Polymixins • *Give dose after hemodialysis
Dalbavancin IV	≥30 OR iHD <30	1500mg x1 1125mg x1	• Restricted • Outpatient use only

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
DAPTOmycin IV SSTI (Staph and Strep sp.)	≥30 <30 iHD or PD CVVHD (1500-3000 mL/hr)	4-6 mg/kg q24h 4-6 mg/kg q48h 4-6 mg/kg q48h* 4-6 mg/kg q24h	• Restricted • Use Adjusted BW if TBW >/= 20% IBW or BMI > 30 • Round dose to nearest 50mg • *Give dose after hemodialysis
Bacteremia (MRSA and Enterococcus sp.)	≥30 <30 iHD or PD CVVHD (1500-3000 mL/hr)	8-10 mg/kg q24h 8-10 mg/kg q48h 8-10 mg/kg q48h* 8-10 mg/kgq24h	
Invasive Enterococcal infection	≥30 <30 iHD or PD CVVHD (1500-3000mL/hr)	8-10 mg/kg q24h 8-10 mg/kg q48h 8-10 mg/kg q48h* 8-10 mg/kg q24h	
Doxycycline IV or PO	100mg IV or PO q12h		• No renal adjustment is necessary
Entecavir (PO) *(Baraclude)*	≥ 50 30-49 10-29<10 or iHD or PD CVVHD (1500 – 3000mL/hr)	0.5 mg daily* 50% of dose daily or full dose q48h Full dose q72h Full dose q7days	• *Increase dose to 1mg daily in decompensated liver disease or if underlying resistance • *Give dose after hemodialysis
Ertapenem IV	≥30 <30 iHD or PD CVVHD (1500-3000mL/hr)	1g q24h 500mg q24h 500mg q24h* 1g q24h	• Restricted • *Give dose after hemodialysis on dialysis days • No dose adjustment needed for obesity
Famciclovir PO (prophylaxis)	>40 20-39 <20 iHD	500mg q12h 500mg q24h 250mg q24h 250mg QHD	• If QHD, administer only on hemodialysis days
Fidaxomicin PO	200mg q12h		• Restricted • No renal adjustment is necessary
Fluconazole PO or IV Prophylaxis, esophagitis, oropharyngeal or vulvovaginal	CrCl <50, PD, or iHD* give 50% of the usual maintenance dose based upon indication	200-400 mg q24h	• Restricted • PO preferred • *Give dose after hemodialysis • Total clearance during CRRT is 1.5 to 2.3 times higher than reported in healthy volunteers
Invasive disease (intra-abdominal infection, BSI)		LD: 12 mg/kg x1 followed by: 6 mg/kg q24h	

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
Fosfomycin PO	≥30 <30 iHD	3g q24-72h 3g q72h 3g q72h	• Restricted
Ganciclovir IV Induction therapy and treatment	≥70 50-69 25-49 10-24 <10 iHD PD CVVHD (1500-3000mL/hr)	5mg/kg q12h 2.5mg/kg q12h 2.5mg/kg q24h 1.25mg/kg q24h 1.25mg/kg 3x/week 1.25mg/kg QHD* 1.25mg/kg 3x/week 2.5mg/kg q24h	• Round dose to nearest 50mg • *If QHD, administer after HD only on hemodialysis days
Prophylaxis	≥70 50-69 25-49 10-24 <10 iHD PD CVVHD (1500-3000mL/hr)	5mg/kg q24h 2.5mg/kg q24h 1.25mg/kg q24h 0.625mg/kg q24h 0.625mg/kg 3x/week 0.625mg/kg QHD* 0.625mg/kg 3x/week 1.25 mg/kg q24h	• Round dose to nearest 50mg • *If QHD, administer after HD only on hemodialysis days
Gentamicin IV	See page aminoglycoside section for dosing information		
Imipenem/ cilastin IV	>60 30-59 15-29 <15 IHD or PD CVVHD (1000-2000mL/hr)	500mg-1g q6-8h 250-500mg q6-8h 250-500mg q8-12h Contraindicated[α] 500mg q12h* 1g x 1, 500mg q6-8h	• Restricted • *Give dose after hemodialysis • [α]Do not administer unless HD planned within 48 hours
Lamivudine PO (for chronic hepatitis B)	≥50 30-49 15-29 5-14 <5 or iHD or PD	100mg q24h 100mg x1; then 50mg q24h 100mg x1; then 25mg q24h 35mg x1; then 15mg q24h 35mg x1; then 10mg q24h	• Dosing not intended for HIV treatment (see antiretroviral section for HIV dosing)

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
Levofloxacin IV or PO Pneumonia, IAI, P*seudomonas*, obesity, complicated UTI	>50 20-50 <20 iHD or PD CVVHD (1500-3000mL/hr)	750mg q24h 750mg q48h 750mg x1;then 500mg q48h 750mg x1; then 500mg q48h* 750mg x1; then 500mg q24h	• *Give dose after hemodialysis
Febrile neutropenia, COPD exacerbation, prostatitis	>50 20-50 <20 iHD or PD CVVHD (1500 - 3000mL/hr)	500mg q24h 500mg x1; then 250mg q24h 500mg x1 then 250mg q48h 500mg x1 then 250mg q48h* 500mg x1 then 250mg q24h	
Uncomplicated UTI	>50 20-50 <20 iHD or PD	250mg q24h 250mg q24h 250mg q48h 250mg q48h*	
Linezolid IV or PO	600mg q12h		• Restricted • PO route preferred • No renal adjustment is necessary
Meropenem IV All other indications	>50 25-49 10-24 <10 iHD CVVHD (1500-3000mL/hr)	500mg q8h 500mg q8h 500mg q12h 500mg q24h 500mg q24h* 1g q8-12h	• Restricted • **3-hour infusion preferred** • No dose adjustment needed in obesity • *Give dose after hemodialysis
Febrile neutropenia	>50 25-49 10-24 <10 iHD CVVHD (1500-3000mL/hr)	1g q8h 1g q12h 500mg q12h 500mg q24h 500mg q24h* 1g q8-12h	
Meningitis	>50 25-50 10-24 <10 iHD CVVHD (1500-3000mL/hr)	2g q8h 2g q12h 1g q12h 1g q24h 1g q24h* 1g q8-12h	

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
Metronidazole PO or IV All other indications	500mg q12h		• No renal adjustment is necessary • PO preferred unless for severe *C. difficile* or CNS infections
C.*difficile* infection and CNS infections	500mg Q8h		
Micafungin IV	100mg q24h CVVHD (1500-3000mL/hr): 150mg q24h		• Restricted • No renal adjustment is necessary unless on CRRT
Minocycline IV	200mg x1; then 100mg q12h		• Non-formulary • No renal adjustment is necessary
Minocycline PO	100mg q12h		• No renal adjustment is necessary
Nitrofurantoin PO	≥30 <30 IHD or PD	100mg q12h Do not use Do not use	
Nirmatrelivir/ ritonavir PO	> 60 30-60 <30 IHD/PD and > 40 kg iHD/PD and < 40 kg	300/100 mg BID 150/100 BID 150/100 daily 300/100 x 1, then 150/100 daily 150/100 x 1, then 150/100 q48h	• Total treatment for 5 days • Start within 5 days of symptom onset
Oseltamivir PO Treatment of influenza	>60 30-60 10-29 <10 IHD PD CVVHD (1,500 – 3,000mL/hour))	75mg q12h 75 mg x 1, 30mg q12h 30mg q24h 30mg q48h 30 mg x 1, 30mg QHD 75mg x1 75mg q24h	• Usual course is 5 days • If QHD, administer only on hemodialysis days after dialysis
Prophylaxis of influenza	>60 30-60 10-29 <10 iHD PD	75mg q24h 30mg q24h 30mg q48h 30mg x 1 30mg x1, 30 mg QHD 30mg weekly	• If QHD, administer only on hemodialysis days
Oxacillin IV	≥10 <10 or iHD	2g q4h Consider alternatives	

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
Penicillin G IV	>50 10-50 <10 iHD CVVHD (1,000-2,000mL/hr)	3-4 million units q4h 2-3 million units q4h 1-2 million units q4 4 million units x1; then 2-4 million units q8h 4 million units x1; then 2-3 million units q4-6h	
Piperacillin/ tazobactam Preferred regimen	>20 CVVHD (1,500-3,000mL/hr)	3.375g q8h 3.375g q8h	• Restricted • Prolonged infusion over four hours • Consider 2.25g q6h on CVVHD for severe infection/elevated MIC
Nosocomial PNA and/or weight >120kg	>20 CVVHD (1,500-3,000mL/hr)	4.5g q8h 4.5g q8h	• Restricted • Prolonged infusion over four hours
Limited IV access or CrCl <20	>40 20-40 <20 iHD	3.375 q6h 2.25g q6h 2.25g q8h 2.25g q8h	• Restricted • Intermittent infusion over 30 minutes
Posaconazole IV or PO (tablets)	Loading dose 300mg q12h x2; then 300mg q24h		• Restricted • Tablets are the preferred formulation • No renal adjustment necessary • Consider increased treatment dose in patients > 140 kg
Posaconazole PO (suspension)	200mg q8h		• Restricted • Give with fatty meal and avoid acid suppression • No renal adjustment necessary
Remdesivir IV	No renal adjustment	200mg x1; then 100mg q24h	• Restricted

Antimicrobial	Renal Function (mL/min)	Usual Dose and Interval	Comments
SMX/TMP IV/PO *Pneumocystis jovenii/Steno. maltophilia* infections	>30 15-30 <15 iHD CVVHD (2,000-3,000mL/hr)	15-20mg/kg/day divided q8-12h[1,2] 7.5-10mg/kg/day divided q8-12h[3,4] 4-5mg/kg q24h[3,4] 15mg/kg/day x1-2 days, then 7.5mg/kg QHD[3,4] 15mg/kg/day divided q8-12h[3,4]	• Dose is based on trimethoprim • Round to nearest multiple of 40mg • If QHD, administer on hemodialysis days only, after HD • Max daily dose of 960 mg TMP • BMI <30 kg/m^2: use TBW • BMI >30kg/m^2: use AdjBW
Severe conditions other than listed above	>30 15-30 <15 or iHD or PD CVVHD (2,000-3,000mL/hr)	8-10mg/kg/day divided q8-12h[5] 4-5mg/kg/day divided q12h[5] 2-3mg/kg q24h[5] 15mg/kg/day divided q8-12h	
SMX/TMP PO Cellulitis and simple cystitis	>30 15-30 <15 iHD	1-2 DS tablets q12h[5] 1 DS tablet q12-24h[5] Use not recommended[5] Use not recommended[5]	• 1 DS tablet = 160 mg TMP; 20 mL suspension = 160mg TMP
SOT Prophylaxis	≥30 <30/iHD	1 DS tablet q24h 1 DS tablet three times weekly **OR** 1 SS tablet q24h[6]	
BMT Prophylaxis	≥30 <30/iHD	1 SS Daily or 1 DS MWF 1 SS MWF	
Tobramycin IV	See aminoglycoside section for dosing information		
ValACYclovir PO (dosing for Herpes Zoster treatment)	>50 30-50 10-29 <10 iHD	1g q8h 1g q12h 1g q24h 500mg q24h 500mg q24h*	• *Give dose after hemodialysis
ValGANciclovir PO Induction/ treatment of CMV	>60 40-60 25-39 10-24 iHD	900mg q12h 450mg q12h 450mg q24h 450mg q48h 200mg QHD	• Induction of CMV duration: 14-21 days • For iHD, use valGANciclovir PO suspension or ganciclovir IV • If QHD, administer only on hemodialysis days, after HD
Prophylaxis of CMV: Abdominal transplant	>60 40-60 25-39 10-24 iHD	900mg q24h 450mg q24h 450mg q48h 450mg twice weekly 450mg twice weekly	
Prophylaxis of CMV: Heart **OR** Kidney and Heart prophylaxis	>60 40-60 25-39 10-24 iHD	900mg q24h 450mg q24h 450mg q48h 450mg twice weekly 100mg QHD	
Vancomycin	See vancomycin section for dosing information		

Antimicrobial	Usual Dose and interval	Comments
Voriconazole IV or PO Invasive aspergillosis, candidemia, and other deep tissue *Candida* infections	6mg/kg IV or PO q12h x2 doses; then 4mg/kg IV or PO q12h Convert to maintenance dose of 200-300mg PO BID after 7 days	• Restricted • Recommend to use IBW. In patients > 120% IBW, use AdjBW • No renal adjustment necessary • For mild-moderate liver dysfunction (Child-Pugh A-B), follow standard loading dose and reduce maintenance dose by 50% • Trough levels should be obtained 5-7 days after starting therapy • Usual goal trough 1-5.5 mcg/mL
Empiric treatment of neutropenic fever	6mg/kg IV or PO q12h x2 doses; then 4mg/kg IV or PO q12h Convert to maintenance dose of 200-300mg PO BID after 7 days	

1. Nys, C.; Cherabuddi, K.; Venugopalan, V.; Klinker, K.P. Clinical and microbiologic outcomes in patients with monomicrobial Stenotrophomonas maltophilia infections. *Antimicrob Agents Chemother*. 2019, 63, e00788-19.
2. Junco, S.J.; Bowman,M.C.; Turner, R.B. Clinical outcomes of Stenotrophomonas maltophilia infection treated with trimethoprim/sulfamethoxazole, minocycline, or fluoroquinolone monotherapy. *Int J Antimicrob*. Agents 2021, 58, 106367.
3. Brown GR. Cotrimoxazole -optimal dosing in the critically ill. *Ann Intensive Care*. 2014;4:13. Published 2014 Apr 28. doi:10.1186/2110-5820-4-13.
4. Gibb J, Wong DW. Antimicrobial Treatment Strategies for Stenotrophomonas maltophilia: A Focus on Novel Therapies. *Antibiotics (Basel)*. 2021;10(10):1226. Published 2021 Oct 9. doi:10.3390/antibiotics101012265.
5. Bactrim (sulfamethoxazole and trimethoprim) injection package insert. Cranbury, NJ: Sun Pharmaceuticals Industries, Inc.; 2021 May.
6. Kaplan JE, Benson C, Holmes KK, et al. Guidelines for prevention and treatment of opportunistic infections in HIV-infected adults and adolescents: recommendations from CDC, the National Institutes of Health, and the HIV Medicine Association of the Infectious Diseases Society of America. *MMWR Recomm Rep*. 2009;58(RR-4):1-CE4.

ECMO Dosing Recommendations

Extracorporeal membrane oxygenation (ECMO) is a life-support modality used in patients with refractory cardiac and respiratory failure. Alterations in the pharmacokinetics of medications can occur due to drug sequestration in the circuit, membrane adsorption, increased volume of distribution, and critical illness. Two pharmacologic properties that have shown to have a significant impact on drug sequestration are high lipophilicity and high protein binding. Antibiotic dosing in ECMO should follow dosing recommendations below for normal renal function. Please consult pharmacy for dose adjustment in renal dysfunction, including CRRT (continuous renal replacement therapy). Medications not listed in the table should follow standard renal dosing unless alternative regimens have been discussed with infectious diseases or pharmacy. Dosing is based upon current literature and expert opinion.

CS = circuit sequestration, VD = colume of distribution, CL = drug clearance, C_{max} = maximum serum concertation,
PD = pharmacodynamics, PK = pharmacokinetics, TDM = therapeutic drug monitoring, MIC = minimum inhibitor concentration

Antimicrobial	PK/PD Alterations	ECMO Dosing Adjustment
Aminoglycosides[1]	Minimal CS, ↑VD, ↓CL	Insufficient data for a recommendation, TDM-guided dosing recommended
Amphotericin B, liposomal[2,3]	Significant CS, ↑VD, ↑CL, ↓C_{max}	Conflicting data, consider increased dosing of 10 mg/kg/day for known invasive fungal infection
Cefazolin[4]	Minimal	Standard renal dose adjustments
Cefepime[5]	↓CL	Standard renal dose adjustments Extended infusion preferred Use caution in <50 kg, CrCl <30 mL/min, or on CRRT due to risk for accumulation – dosing should be dependent upon MIC of organism and renal function
Cefiderocol[6]	Minimal	Standard renal dose adjustments
Ceftazidime[7,8]	Minimal	2g loading dose, followed by standard renal dose adjustments
Ceftazidime-avibactam[9]	Minimal	Standard renal dose adjustments
Ceftolozane-tazobactam[10]	↓ tazobactam CL, no change in ceftolozane PK	Standard renal dose adjustments
Ceftriaxone[11]	Minimal	Apply dosing recommendations based upon critical illness and renal function
Ciprofloxacin[12,13]	Minimal	Apply dosing recommendations based upon critical illness and renal function
Clindamycin[14]	Minimal	No dose adjustment
Doxycycline[15]	Minimal	No dose adjustment

Ertapenem[16]	N/A	Use is discouraged in patients with albumin < 2.5 mg/dL, meropenem is the preferred carbapenem in critically ill ECMO patients
Fluconazole[3,17]	Minimal CS, ↑VD	May require increased loading dose, standard renal dose adjustments
Isavuconazole[3,18,19]	↑ CL	Insufficient data, consider TDM
Ganciclovir[17]	Minimal	Standard renal dose adjustments
Levofloxacin[20]	Minimal	Standard renal dose adjustments
Linezolid[21,22]	↑VD, ↑CL	600mg q8-12h; if treating *S. aureus* with MIC ≥2, consider alternative
Meropenem[23,24]	Minimal	Standard renal dose adjustments Extended or continuous infusion preferred
Micafungin[3,25]	↑VD, ↑CL	Increase dose to 150 mg IV q24h
Piperacillin-tazobactam[26,27]	Minimal effect on VD or piperacillin exposure	Standard renal dose adjustments Extended or continuous infusion preferred
Sulfamethoxazole-trimethoprim[28]	No effect on PK observed	Standard renal dose adjustments
Vancomycin[29]	Minimal	TDM-guided dosing recommended
Voriconazole[3]	Moderate to significant circuit loss	Conflicting data, TDM-guided dosing recommended

References:

1. Cheng V, Abdul-Aziz MH, Roberts JA, Shekar K. Optimising drug dosing in patients receiving extracorporeal membrane oxygenation. *J Thorac Dis*. 2018;10(Suppl 5):S629-S641. doi:10.21037/jtd.2017.09.154
2. Zhao Y, Seelhammer TG, Barreto EF, Wilson JW. Altered Pharmacokinetics and Dosing of Liposomal Amphotericin B and Isavuconazole during Extracorporeal Membrane Oxygenation. Pharmacotherapy. 2020;40(1):89-95. doi:10.1002/phar.2348 43
3. Lyster H, Shekar K, Watt K, Reed A, Roberts JA, Abdul-Aziz MH. Antifungal Dosing in Critically Ill Patients on Extracorporeal Membrane Oxygenation. *Clin Pharmacokinet*. 2023;62(7):931-942. doi:10.1007/s40262-023-01264-0
4. Dhanani JA, Lipman J, Pincus J, et al. Pharmacokinetics of Total and Unbound Cefazolin during Veno-Arterial Extracorporeal Membrane Oxygenation: A Case Report. *Chemotherapy*. 2019;64(3):115-118. doi:10.1159/000502474
5. Cheng V, Abdul-Aziz MH, Burrows F, et al. Population pharmacokinetics of cefepime in critically ill patients receiving extracorporeal membrane oxygenation (an ASAP ECMO study). *Int J Antimicrob Agents*. 2021;58(6):106466. doi:10.1016/j.ijantimicag.2021.106466
6. Riera J, Domenech L, García S, et al. Pharmacokinetics of cefiderocol during extracorporeal membrane oxygenation: A case report. Perfusion. 2023;38(1_suppl):40-43. doi:10.1177/02676591231160462
7. Gomez F, Veita J, Laudanski K. Antibiotics and ECMO in the Adult Population-Persistent Challenges and Practical Guides. *Antibiotics (Basel)*. 2022;11(3):338. Published 2022 Mar 4. doi:10.3390/antibiotics11030338
8. Kühn D, Metz C, Seiler F, et al. Antibiotic therapeutic drug monitoring in intensive care patients treated with different modalities of extracorporeal membrane oxygenation (ECMO) and renal replacement therapy: a prospective, observational single-center study. *Crit Care*. 2020;24(1):664. Published 2020 Nov 25. doi:10.1186/s13054-020-03397-1
9. Curtiaud A, Petit M, Chommeloux J, et al. Ceftazidime/avibactam serum concentration in patients on ECMO. *J Antimicrob Chemother*. Published online March 28, 2024. doi:10.1093/jac/dkae091
10. Mané C, Delmas C, Porterie J, et al. Influence of extracorporeal membrane oxygenation on the pharmacokinetics of ceftolozane/tazobactam: an ex vivo and in vivo study. *J Transl Med*. 2020;18(1):213. Published 2020 May 27. doi:10.1186/s12967-020-02381-1

11.Cheng V, Abdul-Aziz MH, Burrows F, et al. Population Pharmacokinetics and Dosing Simulations of Ceftriaxone in Critically Ill Patients Receiving Extracorporeal Membrane Oxygenation (An ASAP ECMO Study). *Clin Pharmacokinet*. 2022;61(6):847- 856. doi:10.1007/s40262-021-01106-x
12. Cheng V, Abdul-Aziz MH, Burrows F, et al. Population pharmacokinetics of ciprofloxacin in critically ill patients receiving extracorporeal membrane oxygenation (an ASAP ECMO study). *Anaesth Crit Care Pain Med*. 2022;41(3):101080. doi:10.1016/j.accpm.2022.101080
13. Alihodzic D, Wicha SG, Frey OR, et al. Ciprofloxacin in Patients Undergoing Extracorporeal Membrane Oxygenation (ECMO): A Population Pharmacokinetic Study. *Pharmaceutics*. 2022;14(5):965. Published 2022 Apr 29. doi:10.3390/pharmaceutics14050965
14. Hunt JP, McKnite AM, Green DJ, Whelan AJ, Imburgia CE, Watt KM. Interaction of ceftazidime and clindamycin with extracorporeal life support. *J Infect Chemother*. 2023;29(12):1119-1125. doi:10.1016/j.jiac.2023.08.007
15. Tapan Mehta, Tine Vindenes, Kirthana Beaulac, Russel Roberts, Pharmacokinetics of Doxycycline in Extracorporeal Membrane Oxygenation, *Open Forum Infectious Diseases*, Volume 2, Issue suppl_1, December 2015, 804, https://doi.org/10.1093/ofid/ofv133.521
16. Tamma PD, Aitken SL, Bonomo RA, Mathers AJ, van Duin D, Clancy CJ. Infectious Diseases Society of America 2023 Guidance on the Treatment of Antimicrobial Resistant Gram-Negative Infections. *Clin Infect Dis*. Published online July 18, 2023. doi:10.1093/cid/ciad428
17. Dhanani JA, Lipman J, Pincus J, et al. Pharmacokinetics of fluconazole and ganciclovir as combination antimicrobial chemotherapy on ECMO: a case report. *Int J Antimicrob Agents*. 2021;58(5):106431. doi:10.1016/j.ijantimicag.2021.106431
18. Kriegl L, Hatzl S, Zurl C, et al. Isavuconazole plasma concentrations in critically ill patients during extracorporeal membrane oxygenation. *J Antimicrob Chemother*. 2022;77(9):2500-2505. doi:10.1093/jac/dkac196
19. Mertens B, Elkayal O, Dreesen E, et al. Isavuconazole Exposure in Critically Ill Patients Treated with Extracorporeal Membrane Oxygenation: Two Case Reports and a Narrative Literature Review. *Antibiotics (Basel)*. 2023;12(7):1085. Published 2023 Jun 21. doi:10.3390/antibiotics12071085
20. Sherwin J, Heath T, Watt K. Pharmacokinetics and Dosing of Anti-infective Drugs in Patients on Extracorporeal Membrane Oxygenation: A Review of the Current Literature. *Clin Ther*. 2016;38(9):1976-1994. doi:10.1016/j.clinthera.2016.07.169
21. De Rosa FG, Corcione S, Baietto L, et al. Pharmacokinetics of linezolid during extracorporeal membrane oxygenation. *Int J Antimicrob Agents*. 2013;41(6):590-591. doi:10.1016/j.ijantimicag.2013.01.016
22. Nikolos P, Osorio J, Mohrien K, Rose C. Pharmacokinetics of linezolid for methicillin-resistant Staphylococcus aureus pneumonia in an adult receiving extracorporeal membrane oxygenation. *Am J Health Syst Pharm*. 2020;77(11):877-881. doi:10.1093/ajhp/zxaa066
23. Gijsen M, Dreesen E, Annaert P, et al. Meropenem Pharmacokinetics and Target Attainment in Critically Ill Patients Are Not Affected by Extracorporeal Membrane Oxygenation: A Matched Cohort Analysis. *Microorganisms*. 2021;9(6):1310. Published 2021 Jun 16. doi:10.3390/microorganisms9061310
24. Lee JH, Lee DH, Kim JS, et al. Pharmacokinetics and Monte Carlo Simulation of Meropenem in Critically Ill Adult Patients Receiving Extracorporeal Membrane Oxygenation. Front Pharmacol. 2021;12:768912. Published 2021 Nov 1. doi:10.3389/fphar.2021.768912
25. López-Sánchez, M., Moreno-Puigdollers, I., Rubio-López, M. I., Zarragoikoetxea-Jauregui, I., Vicente-Guillén, R., & ArgenteNavarro, M. P. (2020). Pharmacokinetics of micafungin in patients treated with extracorporeal membrane oxygenation: an observational prospective study. Farmacocinética da micafungina em pacientes tratados com oxigenação por membrana extracorpórea: um estudo observacional prospectivo. *Revista Brasileira* de terapia intensiva, 32(2), 277–283.
26. Fillâtre P, Lemaitre F, Nesseler N, et al. Impact of extracorporeal membrane oxygenation (ECMO) support on piperacillin exposure in septic patients: a case-control study. *J Antimicrob Chemother*. 2021;76(5):1242-1249. doi:10.1093/jac/dkab031
27. Cheng V, Abdul-Aziz MH, Burrows F, et al. Population Pharmacokinetics of Piperacillin and Tazobactam in Critically Ill Patients Receiving Extracorporeal Membrane Oxygenation: an ASAP ECMO Study. *Antimicrob Agents Chemother*. 2021;65(11):e0143821. doi:10.1128/AAC.01438-21
28. Dhanani JA, Lipman J, Pincus J, et al. Pharmacokinetics of Sulfamethoxazole and Trimethoprim During Venovenous Extracorporeal Membrane Oxygenation: A Case Report. *Pharmacotherapy*. 2020;40(7):713-717. doi:10.1002/phar.2413
29. Cheng V, Abdul-Aziz MH, Burrows F, et al. Population Pharmacokinetics of Vancomycin in Critically Ill Adult Patients Receiving Extracorporeal Membrane Oxygenation (an ASAP ECMO Study). *Antimicrob Agents Chemother*. 2022;66(1):e0137721. doi:10.1128/AAC.01377-21

Antiretroviral Dosing

Speak with ID Consult or Pharmacy if:

- Patient is starting or already taking phenobarbital, rifampin, carbamazepine, or oral anticoagulation
- Patient is newly diagnosed with an opportunistic infection (consult with ID regarding optimal time to restart ART)
- Patient is unable to eat meals or requires feeding tube

Antiretroviral	Standard Dose	Dose Adjustment	Considerations
Complete Regimens			
Bictegravir/ emtricitabine/ tenofovir alafenamide PO *(Biktarvy)*	50mg/ 200mg/ 25mg 1 tablet once daily	Not recommended with CrCl <30 ml/min and not on iHD Chronic iHD: dose daily after iHD	• Do not crush; OK to dissolve tablet in water and administer immediately • Separate from polyvalent cations • Bictegravir may cause false elevations of Scr
Cabotegravir/ rilpivirine IM *(Cabenuva)*	Monthly: 600mg/ 900mg IM load dose followed by 400mg/ 600mg IM monthly Bi-monthly: 600mg/900mg IM x 2 doses 1 month apart for initiation, followed by 600/900mg IM q2 months		• If injection is missed by >7 days, daily oral bridge therapy should be started (DTG + RPV or otherwise fully suppressive regimen) • Only available on outpatient formulary
Nucleoside Reverse Transcriptase Inhibitors (NRTIs)			
Abacavir PO *(Ziagen)*	300mg twice daily or 600mg once daily	Mild hepatic impairment (Child-Pugh A): 200 mg BID Not recommended in moderate-severe hepatic impairment	• **Prior to initiation, check HLA-B*5701** • OK to crush
Emtricitabine PO *(Emtriva)*	200mg once daily	CrCl 15-29 mL/min: 200mg q72h CrCl <15 mL/min but not on iHD: 200mg q96h On chronic iHD: 200mg daily after HD	• Capsules may be opened and mixed with water • Oral solution and capsules are **not** bioequivalent

Antiretroviral Dosing

Antiretroviral	Standard Dose	Dose Adjustment	Considerations
Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs)			
Lamivudine PO (*Epivir) for HIV*	300mg once daily or 150mg twice daily	CrCl <30 ml/min including iHD and PD: 150mg daily	• OK to crush (solution also available)
Tenofovir disoproxil fumarate (TDF) PO *(Viread)*	300mg once daily	CrCl 30-49 mL/min: 300 mg q48h CrCl 10-29 mL/min: 300mg q72-96h iHD: 300mg weekly	• OK to crush
Tenofovir alafenamide (TAF) PO *(Vemlidy)*	25mg once daily	Use not recommended for CrCl <15 mL/min and not on iHD. Use not recommended in severe hepatic impairment	• OK to crush
Zidovudine PO *(Retrovir)* Treatment of HIV	300mg twice daily	CrCl <15 mL/min: 300mg once daily	• May open capsules and give in food or water (liquid also available)
Zidovudine IV *(Retrovir)* Perinatal transmission prophylaxis with HIV VL >1000 copies/mL or HIV RNA status unknown	2mg/kg IV over 1 hour; then 1 mg/kg/hr	No dosage adjustment necessary in renal impairment	• Continuous until cord clamping
NRTI Combination Tablets			
Emtricitabine/ TDF PO *(Truvada)*	200mg /300mg once daily	CrCl 30-40 mL/min: one tablet q48h Do not use with CrCl <30 ml/min	• OK to crush • Can be used alone for PrEP

Antiretroviral Dosing

Antiretroviral	Standard Dose	Dose Adjustment	Considerations
Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs)			
Doravirine PO *(Pifeltro)*	100mg once daily	Increase to 100mg q12h if co-administration with rifabutin	• OK to crush
Efavirenz PO *(Sustiva)*	600mg once daily		• **Administered at bedtime on empty stomach** • Do not crush tablets • CYP inducer; monitor for drug-drug interactions
Etravirine PO *(Intelence)*	200 mg twice daily		• Can be dispersed in water • CYP inducer; monitor for drug-drug interactions
Nevirapine PO *(Viramune)*	200mg twice daily or 400mg XR once daily	iHD: give an additional dose following each HD session Do not use in severe liver impairment	• ***Note 2 week run-in period with 200 mg q24 when initiating therapy*** • Can crush IR tabs in water (liquid also available); do not crush XR • CYP inducer; monitor for drug-drug interactions
Rilpivirine PO *(Edurant)*	25mg once daily		• Do not give with acid-suppressive therapy • **Dosed with a full meal** • Do not crush
Protease Inhibitors (PIs)			
Atazanavir PO *(Reyataz)*	400mg daily	300mg daily (if co-administration with ritonavir or cobicistat) Give atazanavir 400mg with ritonavir 100 mg if giving with efavirenz or to pregnant women in 2nd and 3rd trimester	• **Administer with food** • Do not give with acid-suppressive therapy • Capsules may be opened and mixed with applesauce • CYP inhibitor; monitor for drug-drug interactions
Darunavir PO *(Prezista)*	800mg once daily (with ritonavir or cobicistat)	600 mg twice daily (with ritonavir) for treatment experienced with PI resistance or pregnant women	• **Administer with food** • OK to crush • CYP inhibitor; monitor for drug-drug interactions

Antiretroviral Dosing

Antiretroviral	Standard Dose	Dose Adjustment	Considerations
Protease Inhibitors (PIs)			
Lopinavir/ ritonavir PO *(Kaletra)*	400mg/ 100mg twice daily or 800mg/ 200mg daily	500mg/ 125mg twice daily when co-administered with efavirenz, nelfinavir, or nevirapine (CYP inducers)	• **Dosed with food** • Do not crush; use liquid formulation • *Liquid formulation **not** compatible with polyurethene feeding tubes • Contains PK booster; monitor for drug-drug interactions
Ritonavir PO*(Norvir)* *Used only as boosting agent*	100mg once daily or twice daily		• Frequency based on dosing of other PI • Do not crush • PK booster; monitor for drug-drug interactions
Integrase Inhibitors (INSTIs)			
Cabotegravir IM *(Apretude)*	600mg IM x 2 doses 1 month apart for initiation, followed by 600mg IM q 2 months	• If injection is missed by >7 days, daily oral bridge therapy should be started • Used for **HIV prevention only (PrEP),** not to be used for HIV treatment • May delay HIV antibody formation, HIV screening should be done with HIV quant RNA • Only available on outpatient formulary	
Dolutegravir PO*(Tivicay)*	50mg daily	Give twice daily if INSTI resistance or if giving with carbamazepine, efavirenz, fosamprenavir, or rifampin	• Separate from polyvalent cations • OK to crush
Raltegravir PO *(Isentress)*	400mg twice daily or 1200mg once daily (HD tablets)	If giving with rifampin, 800mg twice daily	• Separate from polyvalent cations • OK to crush 400mg tablets • Do not crush HD 600 mg tablets

Antiretroviral Dosing

Antiretroviral	Standard Dose	Dose Adjustment	Considerations
Capsid Inhibitors			
Lenacapavir PO and SUBQ *(Sunlenca)*	2 day initiation: 600 mg PO on day 1 & 2, 927 mg SUBQ on day 1 15 day initiation: 600 mg PO on day 1 & 2, 300 mg PO on day 8, 927 mg SUBQ on day 15 Maintenance: 927 mg SUBQ every 26 weeks		• Only available on outpatient formulary • CYP3A4 inducer, monitor for drug interactions • Do not crush PO • If maintenance injections missed by >2 weeks, 300 mg weekly oral bridge therapy should be started
Entry/Attachment Inhibitors			
Fostemsavir PO *(Rukobia)*	600mg twice daily		• Do not crush
Ibalizumab IV *(Trogarzo)*	2000mg loading dose; then 800mg q2weeks		• Only available on outpatient formulary • If a dose is missed by ≥3 days, restart with loading dose
Maraviroc PO *(Selzentry)*	300mg q12h	Co-administration with CYP3A4 inhibitors: 150mg q12h Co-administration with CYP3A inducers: 600 mg q12h	• OK to crush • Only give to patients with R5 tropism

Antibiotic Dosing for Unique Routes of Administration

Inhaled (INH) Antibiotic Dosing	
Amikacin non –liposomal	500mg INH q12h
Colistin	150mg INH q12h
Tobramycin	300mg INH q12h

- Pre-treatment with albuterol can reduce the incidence of cough and bronchospasm.
- Administration by a Respiratory Therapist is preferred, but inhaled antibiotics may be administered by a nurse.

Intra-Peritoneal (IP) Antibiotic Dosing	
Cefazolin	1-2g IP once daily
Cefepime	1g IP once daily
Ceftazidime	1g IP once daily
Vancomycin	15mg/kg IP every 4-7 days*
Tobramycin	0.6mg/kg IP every 24-72h*~
Gentamicin	0.6mg/kg IP every 24-72h*~

*Monitor serum levels; see vancomycin and aminoglycoside dosing guidelines for goal concentrations
~Use loading dose for systemic infections, loading dose not needed for peritonitis

- These recommendations are intended for ESRD on peritoneal dialysis (PD).
- They can be used for treatment of peritonitis or other systemic infections in patients with peritoneal access. Dosing of IV medications for these patients can be found within the antimicrobial dosing section.
- **IP antibiotics can only be ordered by a Renal Fellow**. The amount of drug added to the dialysate bag may need to be adjusted to account for the actual volume of dialysate reaching the patient.
- The drug should be instilled with the longest dwell of the day.

Vancomycin Dosing at Tufts Medical Center

1. Identify patient's weight, CrCl, and indication for vancomycin. Use caution when calculating creatinine clearance for patients with low or altered body mass (elderly, para/quadriplegia, cerebral palsy, amputation), as it may overestimate renal function.
2. Vancomycin should be dosed based upon actual body weight, with a maximum single dose of 2000 mg.
3. If patient is septic or critically ill, consider a loading dose.
   - Loading dose = 25mg/kg actual body weight X 1 dose
   - (Maximum dose = 2g, rounded to the nearest 250 mg)
4. Calculate the empiric dose

Actual Body Weight	Renal Function (mL/min)	Dose	Interval
40 – 59kg	≥ 80	750 mg	q8h (age ≤40)
	45 - 79	750 mg	q12h
	20 - 44	750 mg	q24h
	< 20	750 mg x 1	Based on levels
60 – 74kg	≥ 80	1000 mg	q8h (age ≤40)
	45 - 79	1000 mg	q12h
	20 - 44	1000 mg	q24h
	< 20	1000 mg x 1	Based on levels
75 – 89kg	≥ 80	1250 mg	q8h (age ≤40)
	45 - 79	1250 mg	q12h
	20 - 44	1250 mg	q24h
	< 20	1250 mg x 1	Based on levels
90 – 109kg	≥ 80	1250 mg	q8h (age ≤40)
	45 - 79	1500 mg	q12h
	20 - 44	1500 mg	q24h
	< 20	1500 mg x 1	Based on levels
110 – 124kg	≥ 80	2000 mg	q12h
	45 - 79	1750 mg	q12h
	20 - 44	1750 mg	q24h
	< 20	1500 mg x 1	Based on levels
≥ 125kg	≥ 80	2000 mg	q12h
	45 - 79	2000 mg	q12h
	20 - 44	2000 mg	q24h
	< 20	1500 mg x 1	Based on levels

- If a patient requires more than 2g/dose or 4g/day, consult with AMT or ID for guidance

5. Considerations:
   - Frequency is based on creatinine clearance. Consider dosing more conservatively (less frequently) in patients who have a history of renal impairment, advanced age, or easy to treat infections (like cellulitis or UTI).
   - Do not initiate a frequency of q8h on anyone age 40 or older.
   - Frequency ≥q24h is recommended for patients >75 years old.
   - **Hemodialysis Dosing:**
     - Loading dose= 20mg/kg actual body weight X 1 dose
       - (Maximum dose = 2g, rounded to the nearest 250 mg)
     - Subsequent dose= 500-750mg after each dialysis
       - (500 mg if loading dose ≤1.5g; 750mg if loading dose >1.5g)
   - **CVVHD or Rapidly Changing Kidney Function Dosing:** 15mg/kg x1 dose, then re-dose when random serum vancomycin level is at goal
6. Monitoring
   - Renal function should be routinely monitored in all patients receiving vancomycin, including CrCl, urine output, and fluid status.
   - Trough levels should be obtained once the patient has reached steady state, typically after the third dose.
   - Trough vancomycin concentrations should be obtained in patients:
     - Undergoing hemodialysis or CVVHD.
     - Unresponsive to therapy after 5 days.
     - Who have a goal trough of 15-20 mg/dL or AUC:MIC 400-600,
     - With an AKI, rapidly changing Scr, or CrCl <30 mL/min.
     - Receiving concomitant therapy with a potential nephrotoxic agent (e.g., aminoglycosides, amphotericin B, contrast media, cyclosporine, lithium, loop diuretics, methotrexate, NSAIDs, tacrolimus, ACE inhibitors, etc.).
     - With a BMI ≥40kg/m^2.
     - Receiving doses exceeding nomogram or therapy for >7 days.
     - Patients in an ICU.

7. Pharmacy Monitoring

Pharmacists will monitor and document the review of vancomycin therapy in within the medical record for all patients EXCLUDING onetime orders for vancomycin in the emergency department, vancomycin prescribed for surgical prophylaxis and antepartum GBS prophylaxis for < 4 days.

Vancomycin Dosing at Tufts Medical Center

Goal Trough by Indication	
Goal Trough 10-20mg/L	Goal Trough 15-20mg/L For suspected MRSA infections*
Urinary Tract Infection Cellulitis Sepsis Surgical Wound Infection Coagulase-negative *Staphylococcus* or *Streptococcal* Infection	Bacteremia Meningitis Osteomyelitis Prosthetic Material Infection Joint Infection Pneumonia Endocarditis *Consider AUC:MIC monitoring

- Ensure that the vancomycin level was indeed a true trough.
- Trough concentrations represent the lowest concentration the drug achieves in the body. They should be measured as close as possible to one full dosing interval after the last dose (i.e. 7.5 hours after a dose given q8h). Ideally, trough concentrations are measured 30 minutes prior to the 4th dose.
- If the steady state trough is above the target range, consider reducing the dose or the frequency.
    - If you decrease the dose but keep the same frequency, the trough should reflect a proportional change (e.g., going from 1g q12h to 750q12h should reduce the trough approximately 25%).
    - If you decrease the frequency, the trough will decrease by more than a proportional change (e.g. going from 1g q8h to 1g q12h will decrease the trough more than 33%).
- If the trough is below the target range, consider increasing the dose or frequency. If the trough was just below target (within 1-2 mg/dL), consider leaving the dose as is to allow the patient to accumulate a little more. Recheck in 2-3 days to ensure the trough has come up.
- If you increase the dose but keep the same frequency, the new trough should reflect a proportional change (e.g. going from 1g q24h to 1.25g q24h should increase the trough by 25%).

- If you increase the frequency, the trough will increase more than proportionally (e.g. going from 1g q24h to 1g q12 will increase the trough more than 50%)

AUC:MIC Vancomycin Monitoring	
Patient Inclusion Criteria	Patient Exclusion Criteria
• Must have an ID consult • Have a severe MRSA infection (e.g. pneumonia, bacteremia) or is expected to be on vancomycin therapy for >2 weeks	• Unstable renal function • SCr changes of >0.3mg/dL within 48 hours or SCr >1.5x baseline within prior 7 days • Decrease in CrCl of 50% from baseline on two consecutive days in the absence of an alternative explanation • Requiring any sort of RRT • *Staphylococcus aureus* with Vancomycin MIC >1mcg/mL; consider alternative therapy

- Current IDSA guidelines recommend targeting a vancomycin AUC:MIC ≥400 for severe MRSA infections.
- Evidence shows increased rates of nephrotoxicity with troughs >15mg/mL and the target AUC:MIC ratio may be achieved with lower troughs.
- If goal troughs are not being attained, calculating AUC:MIC may assist in decisions to maintain or alter regimens.
- At TMC, Select patients are monitored with the AUC:MIC method.

Dose and Interval Documentation

- See **Vancomycin Dosing at Tufts Medical Center** for initial dosing/intervals.

Vancomycin Dosing at Tufts Medical Center

Monitoring

- Vancomycin levels will be ordered by the pharmacist.
- Pharmacists will order two steady state levels after the third dose.
    - A peak level should be drawn ~1 hour after the infusion ends.
        - Example: Third dose scheduled for 0900 and expected to be given over 90 minutes à Schedule peak to be drawn at 1130
    - A trough level should be drawn ~1 hour prior to administration of next dose.
        - Example: Fourth dose scheduled for 2100 à Schedule trough to be drawn at 2000
    - Levels should be at least 4 hours appropriate to assure accurate calculation of AUC.
- AUC:MIC calculations will be done with these levels to evaluate the attainment of AUC:MIC of 400-600.
    - See **AUC:MIC Calculations** for equations and step by step directions
- Once AUC:MIC is achieved with a scheduled dose, and SCr is stable, troughs will be drawn twice weekly.
- Monitor renal function q48h at a minimum while administering vancomycin.
- Additional monitoring may be required if:
    - SCr changes of > 0.3mg/dL within 48 hours or SCr >1.5x baseline within the prior 7 days.
    - Decrease in CrCl of 50% from baseline on two consecutive days in the absence of an alternative explanation.
    - If patient goes into AKI or renal function becomes unstable, he/she will be removed from AUC:MIC monitoring. However, pharmacy will continue to monitor and dose the patient's vancomycin.

AUC:MIC Calculations

- See **Appendix** for manual calculation formulas
- Calculator
    - A pharmacokinetics calculator is available in Epic for vancomycin AUC:MIC calculations à Kinetics Navigator
    - Patients should be evaluated using two levels for the most accurate evaluation of AUC:MIC
    - AUC above 600 is associated with increased toxicity

Appendix

- Manual AUC:MIC formulas

Elimination constant (K_e)	
$$k_e = \frac{\ln\left(\frac{C_1}{C_2}\right)}{T}$$	T = time difference between C_1 and C_2 C_1 = peak C_2 = trough

True trough (C_{min})	
$$C_{min} = \left(Ctr_{observed}\right)e^{-ke(t)}$$	$Ctr_{observed}$ = level drawn prior to next dose t = time difference between when level was drawn and when a true trough would be drawn

True peak (C_{peak})	
$$Cpeak = \frac{C_{min}}{e^{-ke(1)}}$$	C_{min} = trough level t = time difference between when C_{min} was drawn and when a true peak would be drawn

Volume of distribution (V_d)

$$V_d = \frac{dose\left(1 - e^{-ke}\right)}{ke\left[C_{true\,peak} - C_{true\,trough}\left(e^{-ke}\right)\right]}$$

AUC_{24} Equation

$$AUC_{24} = \left[\left(T_{infusion} \times \frac{(C_{max} + C_{min})}{2}\right) + \frac{(C_{max} - C_{min})}{k_e}\right] \times \frac{24}{dosing\ interval}$$

$T_{infusion}$ = infusion duration in hours

Appendix

- Manual AUC:MIC formulas

New Total Daily Dose (TDD)

$$TDD = Current\ TDD \times \frac{AUC_{24\ desired}}{AUC_{24\ calculated}}$$

Frequency of dosage ($t_{1/2}$)

$$t_{1/2} = \frac{0.693}{k_e}$$

Double check calculations

Verify C_{peak}, C_{trough}, and AUC_{24} with new dose

$$C_{peak} = \frac{dose\ (1 - e^{-k_e t})}{(k_e)(V_d)1 - e^{-k_e(i)}}$$

$$C_{trough} = C_{peak}\left(e^{-k_e(t\ -\ 1)}\right)$$

$$AUC_{24} = \left[\left(T_{infusion} \times \frac{(C_{max} + C_{min})}{2}\right) + \frac{(C_{max} - C_{min})}{k_e}\right] \times \frac{24}{dosing\ interval}$$

Aminoglycoside Dosing at Tufts Medical Center

1. Select optimal aminoglycoside
    a. Consider hospital antibiogram, organism MIC (if known) and lab monitoring (amikacin levels are send-out and are not available in real-time)
    b. Note: Gentamicin does not have activity against pseudomonas
2. Determine Ideal Body Weight (IBW)
3. If necessary, determine aminoglycoside dosing weight (DW) for obese patients (> 20% over IBW)
4. Estimate and assess renal function
5. Determine the dosing method
    a. **Extended Interval (Q24h) Dosing**: This is the *preferred* dosing regimen for adult patients without any of the following contraindications:
        i. Patient is on hemodialysis/peritoneal dialysis
        ii. Patient has infective endocarditis (except when caused by *Streptococcal* spp.)
    b. **Traditional Dosing:** for patients in whom ≥1 of the conditions listed above is met
    c. **Renal Replacement Dosing:** the patient is receiving hemodialysis, peritoneal dialysis, or CVVHD
6. Determine the dose, frequency, and subsequent monitoring

Extended Interval Dosing

- Administer a single dose and monitor two serum drug concentrations. Adjust dose and interval to targets.

Indication	Gentamicin/Tobramycin Dose (mg/kg q24h)	Amikacin Dose (mg/kg q24h)
Pneumonia, sepsis, empiric	7	15
UTI, intra-abdominal, SSTI	3	7.5
Endocarditis (gentamicin only)	3	-

Monitoring Extended Interval Dosing: Two Level Method

- Order TWO serum drug concentrations to be drawn after the first dose.
  - Schedule the first level to be drawn two hours after the end of the 30-minute infusion.
  - Schedule the second level to be drawn eight hours after the end of the 30-minute infusion.
  - Note the EXACT time of the blood draw.
- Contact the pharmacy for help ordering levels and to use above levels to estimate peak and trough

Indication	Drug	Desired Peak (mg/L)	Desired Trough (mg/L)
Pneumonia, Sepsis	Gentamicin/tobramycin	16 - 20	< 0.5
	Amikacin	40-60	<4
UTI; Endocarditis (*Streptococcal spp.*)	Gentamicin/tobramycin	N/A	<0.5
UTI	Amikacin	25-35	<4

Monitoring Extended Interval Dosing: One Level Method (Gentamicin/Tobramycin)

- Order level appropriate to predict interval necessary to achieve a minimum 4 hour "drug free" period prior after the first dose
  - Example: predicted interval based upon CrCL = 24hr, order random level 20 hours after dose is given
  - See desired troughs goals above
- Based upon expected interval order level:

CrCl (mL/min)	Interval	Level Timing After Dose
>60	q24h	20h
40-59	q36h	32h
20-39	q48h	44h
<20	q48-72h	44-56h

- Evaluation of level:

4h Pre-Trough Level	Action
< 0.5 mcg/mL	Schedule standard interval (q24h, q36h,q48h)
0.5 -1 mcg/mL	Consider extending interval (q24 à q36) **OR** Recheck a level at next appropriate interval
>1 mcg/mL	Extend interval to allow for "drug free" period **OR** Obtain 2nd level ≥6 hours apart and perform pharmacokinetic calculations

Aminoglycoside Dosing at Tufts Medical Center

Traditional Dosing

Indication	Gentamicin/Tobramycin Dose (mg/kg/dose)	Amikacin Dose (mg/kg/dose)
Pneumonia, Sepsis	3	7.5
Gram+ synergy (gentamicin only)	1	-

CrCl (mL/min)	Empiric Interval
> 90	Q8h
50 – 89	Q12h
10 – 49	Q24h
< 10 or iHD	Dose per serum levels

Monitoring Traditional Dosing

- Note the EXACT time the drug is administered.
- Obtain peak at the 3rd-4th dose (30 minutes after a 30-minute infusion)
- Obtain trough just prior to the 3rd-4th dose

Indication	Drug	Desired Peak (mg/L)	Desired Trough (mg/L)
Pneumonia, Sepsis	Gentamicin/tobramycin	8 – 10	< 1
	Amikacin	25-35	<8
Gram+ synergy, UTI	Gentamicin/tobramycin	3 – 5	< 1
UTI	Amikacin	20-25	<8

Aminoglycoside Dosing at Tufts Medical Center

Renal Replacement Dosing

RRT	Drug	Initial Dose
CVVH	Gentamicin/Tobramycin	5-7 mg/kg
	Amikacin	15 mg/kg
iHD	Gentamicin/tobramycin	2.5mg/kg
	Amikacin	7.5mg/kg
PD	Gentamicin/tobramycin	1.5mg/kg
	Amikacin	5mg/kg

RRT	Drug	Frequency
iHD	Gentamicin/tobramycin	Re-dose when post-HD level is <0.5mg/L
	Amikacin	Re-dose when post-HD level is <4mg/L
PD	Gentamicin/tobramycin	Re-dose when level is <0.5mg/L (often within 24 hours)
	Amikacin	Re-dose when level is <4mg/L (often within24 hours)
CVVHD	Gentamicin/tobramycin	Re-dose when level is <0.5mg/L (often within 48 hours)
	Amikacin	Re-dose when level is <4mg/L (often within 48 hours)

Subsequent doses can continue the initial dose or be based upon patient specific kinetics and/or the MIC of the organism.

Aminoglycoside Pharmacokinetic Formulae

- **Loading Dose (LD)**
  - LD = desired Cmax (mg/L) x Vd (L/kg) x IBW kg (or DW)
- **Volume of Distribution (Vd)**
  - Vd = 0.25 x IBW (or DW) for non-ICU patients
  - Vd = 0.3 x IBW (or DW) for ICU patients
- **Elimination Rate Constant (Ke)**
  - To estimate Ke you need 2 time points and 2 drug concentrations; or
  - Ke = 0.00293(Clcr) + 0.014
- **Half-Life (T1/2)**
  - T1/2 = 0.693/Ke
- **Dosing Interval (t)**
  - t = ln (desired Cmax / desired Cmin)/Ke

To calculate the dose (D)	
$D = \frac{t \times Ke \times Vd \times (\text{desired } Cmax) \times (1-e^{-kT})}{(1-e^{-kt})}$	T = dosing interval t = infusion time

Patient-specific formulae

Patient's elimination rate (Ke)

$$Ke = \frac{\ln (C_1 / C_2)}{(\text{time between samples}) (\text{hrs})}$$

OR

$\ln C_2 = \ln C_1 - kt$ (t= time between samples in hrs)

Patient's volume of distribution (Vd)

$$Vd = \frac{\text{dose } (1-e^{-Ke})}{Ke\,[C_{true\ max} - (C_{true\ min}\, e^{-Ke})]}$$

Dosing interval (*T*)

$$T = \frac{\ln (\text{desired } C_{max} / \text{desired } C_{min})}{Ke}$$

Treatment of Antimicrobial-Resistant Gram-Negative Infections

Organism	Treatment Options	Comments
Extended-Spectrum β-Lactamase Producing Enterobacterales (ESBL-E)	**Bacteremia**: Extended infusion (3 hrs) meropenem*[α] **Biliary/IAI/UTI/PNA**: Cefepime (MIC < 2)* **OR** meropenem Extended infusion (3 hrs) **Uncomplicated cystitis**: Nitrofurantoin or TMP-SMX if susceptible **Complicated UTI or pyelonephritis:** TMP-SMX or ciprofloxacin if susceptible	Most prevalent in: *Escherichia coli, Klebsiella pneumoniae, Klebsiella oxytoca, Proteus mirabilis* Non-susceptibility to ceftriaxone (MIC >2) used as proxy for ESBL production If cefepime or piperacillin-tazobactam are initiated as empiric therapy for uncomplicated infections and the organism later identified as ESBL, if there is clinical improvement, no need to change or extend therapy
Carbapenem-Resistant Enterobacterales (CRE)	**Urinary tract Infections**: TMP-SMX or ciprofloxacin are preferred if susceptible **Resistant to ertapenem (MIC >2) but susceptible to meropenem (MIC <1):** • Meropenem (2g IV q8h, over 3 hours)*[α] **Resistant to both ertapenem and meropenem**: • Ceftazidime/avibactam (2.5 g IV q8h, over 3 hours)*[α] • Cefiderocol (2g IV q8h, over 3 hours)*[α]	CRE: Enterobacterales resistant to ≥1 carbapenem ID Consult Required
***Pseudomonas aeruginosa* with Difficult-to-Treat (DTR) Resistance**	Isolate susceptible to traditional non-carbapenem agents, with MICs listed below, administer high-dose β-lactam agents with extended-infusion** **Susceptibility Breakpoints**: • Piperacillin/tazobactam MIC< 16/4 • Ceftazidime MIC < 8 • Cefepime MIC < 8 • Aztreonam MIC< 8 Nebulized antibiotics for treatment of DTR pseudomonas is not recommended **Poor source control with isolate resistance to carbapenem consider**: • Ceftolozane/tazobactam (preferred) 3g IV q8h*[α], over 3 hours • Cefiderocol (2g IV q8h, over 3 hours)*[α]	**DTR Pseudomonas**: Not susceptible ≥1 antibiotic in ≥3 antibiotic classes for which *P. aeruginosa* susceptibility is generally expected: PCNs, FQs, cephalosporins, aminoglycosides, and carbapenems ID consult required

Treatment of Antimicrobial-Resistant Gram-Negative Infections

Organism	Treatment Options	Comments
AmpC β-lactamase-Producing Enterobacterales (AmpC-E)	**Urinary tract Infections**: TMP-SMX, ciprofloxacin or nitrofurantoin (not pyelo) are preferred if susceptible **Cefepime MIC ≤4**: Cefepime extended infusion (3 hrs)* **Cefepime MIC 4-8**: • Localized site or source control obtained: Cefepime extended infusion (3hrs) • Uncontrolled source, critically ill: Meropenem*	High Risk for Amp-C: *Enterobacter cloacae, Klebsiella aerogenes,* and *Citrobacter freundii* Despite ceftriaxone susceptible, it should <u>not</u> be used to treat AMP-C organisms
Carbapenem-Resistant Acinetobacter baumannii (CRAB)	Ampicillin-sulbactam:* Total daily dose 18 grams (6 grams of sulbactam)* If there is clinical instability, poor source control or polymicrobial infection, consider addition of one of the following combinations: • Minocycline[α] 200mg IV/PO q12h + Ampicillin/sulbactam 18 gram daily • Cefiderocol[α] 2 g every 8 hours and Ampicillin/sulbactam 18 grams daily	2:1 formulation 3 g ampicillin-sulbactam = 2 g ampicillin + 1 g sulbactam* ID consult required Sulbactam is the active component against Acinetobacter.
Stenotrophomonas maltophilia	Mild infections • 15-20 mg/kg/day (TMP) in 3 or 4 divided doses (consider max 960 mg/day) • Minocycline 200 mg IV/PO q12h[α] Moderate/polymicrobial infections • TMP-SMX* with addition of second agent minocycline[α] • If there is clinical instability or resistance to other agents: ceftazidime-avibactam*[α] and aztreonam combination or cefiderocol*[α] and TMP-SMX* can be considered	

*Requires renal adjustment

[α]Restricted to ID

Outpatient Parenteral Antimicrobial Therapy (OPAT)

The Tufts OPAT team [OPAT@tuftsmedicine.org] systematically facilitates IV antimicrobials after hospital discharge. IV antibiotics are potentially risky and complex, so we have mechanisms to ensure appropriate care and monitoring after discharge.

To access the OPAT program, obtain an **inpatient ID consult**, which should be done ideally at least 24 hours prior to discharge.
Inform case management ASAP when you are considering OPAT to avoid discharge delays.
Talk to your patient early about OPAT. If the patient is going home on IV antimicrobials the patient and/or a caregiver will be taught how to infuse the antimicrobials while still in the hospital, and further training will be done at home after discharge.
Determination of line placement should be based upon the types of medications to be administered, the expected duration of IV therapy, and need for central access. Decisions on the need for long-term access should be discussed between consulting and primary team members PRIOR to line placement. This chart below is to serve as guidance for line placement and does not replace clinical judgement.
The following four steps must be completed to ensure patient safety:

- The ID fellow [or the resident rotating on ID ward service] will complete the OPAT note (.opatnote)
- The ID fellow or the resident on the ID ward service must place an "Ambulatory Referral to Outpatient Antibiotic Therapy (OPAT)" order on EPIC. This currently is the only way the OPAT team is made aware of the patient's enrollment onto the OPAT service.
- The IV antibiotics must be listed on the discharge medication list to avoid errors in transition of care
- The OPAT note must go into the discharge summary, again to avoid errors in transition of care.

The OPAT team will schedule a follow up ID/OPAT appointment and email the OPAT note to the inpatient team and the provider seeing the patient for discharge follow up to facilitate any necessary sign outs.
Please do not have the inpatient discharge planner call the ID clinic for OPAT patients – the OPAT team will set up the initial ID clinic appointment and/or combined ID/Wound clinic appointment.

Recommended Lab Monitoring for Common Antibiotics

Drug/Class	CBC-Diff	BUN/ SCr	Electrolytes	ALT/ Alk Phos	Other
Aminoglycosides	1xw	2xw	2xw		Consider audiology
Acyclovir	1xw	1xw			
Beta-lactams	1xw	1xw	1xw	1xw	
Daptomycin	1xw	1xw		1xw	CPK 1xw
Ganciclovir	2xw	2xw			
Linezolid	1xw				
Micafungin				1xw	
Vancomycin	1xw	1xw		1xw	Trough 1xw

1xw= once per week; 2xw= twice a week; Order ESR, CRP if duration antibiotics >2 weeks

General OPAT Eligibility Criteria

- A patient that needs IV or high risk oral antimicrobial therapy. The latter include but are not limited to valganciclovir, oral antifungal agents, linezolid
- Medically stable; Infection is not life threatening and responding to treatment
- Able to return for emergencies
- Stable home situation [has a working phone, reliable transportation, support network]
- Insurance and insurance approval
- If they live in another state, they must to be able to return for in-person visits or have their OPAT care transferred to a local team

Email: OPAT@tuftsmedicine.org; **EPIC Pool:** T INF DISEASE OPAT PROGRAM; **Tiger Text:** T OPAT Team; **Lead OPAT Program Specialist:** Yuran Tsuchida, 6-6368; **OPAT Director:** Dr. Tine Vindenes; **OPAT NP:** Katharine Pimentel; **OPAT PharmD:** Devin Donnelly. OPAT can be contacted within business hours 8:30AM-5PM, Monday–Friday, closed on hospital holidays. The ID fellow on call can be reached for OPAT questions if needed outside of these hours.

Outpatient Parenteral Antimicrobial Therapy for People Who Inject Drugs

The Division of Geographic Medicine and Infectious Diseases and the Division of Addiction Psychiatry implemented a protocol for persons who inject drugs (PWID) with serious infections requiring long term IV antibiotics to be individually assessed for treatment with outpatient parenteral antimicrobial therapy (OPAT) at home.

If patients meet the criteria noted below, they will be discharged with OPAT, initiated or continued on medications for opioid use disorder (MOUD), and be managed through weekly visits at an infectious disease and addiction psychiatry interdisciplinary outpatient clinic. **If you or your team is caring for a patient with a history of substance use disorder and has a serious infection requiring IV antimicrobial therapy, please consult the infectious disease and addiction psychiatry teams to discuss the possibility of at-home OPAT.** For less than 7 days of outpatient IV antimicrobial therapy, OPAT is needed only on a case-by-case basis. Please consult with the inpatient ID team regarding whether OPAT will be needed. If discharged to Lemuel Shattuck Hospital or Tewksbury State Hospital, do NOT send OPAT form or order. Patients will be followed by ID in these institutions and OPAT will not track them.

Contact

Inpatient Referral: to Infectious Disease and Addiction Psychiatry consultation teams
Outpatient Referral: via Tiger Text to T OPAT Team or email to OPAT
Email: opat@tuftsmedicine.org with any questions you may have
Shattuck: send sign-out to the ID fellow rotating there
Tewksbury: send sign-out to their ID consultant Dr. David Sidebottom David.Sidebottom@tuftsmedicine.org

Tufts Medical Center Home OPAT eligibility for PWID – All criteria must be met	Assessment completed by:
Needs IV antimicrobials after discharge from the hospital	ID
Has PT/OT clearance for discharge to home	PT/OT
Seen by ID and Addiction Psychiatry consultation teams	ID + Addiction
Stable on buprenorphine-naloxone or methadone* prior to d/c and agrees to remained engaged in therapy	Addiction
No unprescribed substance use, violent or threatening behavior during the latter part of the hospitalization, once stabilization from withdrawal is achieved	Addiction
Patient must be able to administer own IV antimicrobials and/or have sober help to administer the IV medications for at least the times/days the VNA cannot come	ID + social work+ Case management
Patient willing to let VNA into their home to change line dressing and draw labs weekly	ID
Patient has safe housing without cohabitants with active substance use	Social Work
Patient has a working telephone and voicemail	Social Work
Patient agrees to weekly follow-up with ID/Addiction Psychiatry at TMC	ID + Addiction
Return to f/u assessment done [transport arrangement, PT-1 needs, etc]	Social Work
Patient receives safety information “Safe while on OPAT”	ID
Patient will be offered a PCP at Tufts before discharge if needed	Apt scheduler
Patient will be educated on naloxone use and sent home with a kit	Addiction

Line Chart

Determination of line placement should be based upon the types of medications to be administered, the expected duration of IV therapy, and need for central access. Decisions on need for long term access should be discussed between consulting and primary team members PRIOR to line placement. This chart below is to serve as guidance for line placement and does not replace clinical judgment.

	Peripheral	Extend Dwell Catheter (EDC)/Midline	PICC
Type	Short Peripheral	Long Peripheral	Central Line
Definition	A .75"- 2.5" catheter that is inserted in the superficial veins.	A 2.7-3.6 "catheter utilized to access deeper (often larger) veins in the forearm or upper arm. Midline catheters are 8 inches (20cm) long and can be trimmed to fit the patients needs, used only in the upper arm and an option when veins are too deep for an EDC or is required by the outside infusion agency.	A catheter that is inserted in the upper arm and passed through the veins until it is positioned optimally in the lower 1/3 of the SVC near the junction of the right atrium (CAJ).
Contraindications	Vesicant drugs with expected infusion duration no longer than 24 hours. Long term therapy	ESRD preservation of vessels for potential of future dialysis Vesicant therapy >24 hours, vasopressor medications Injury/infection to area/limb Post mastectomy/lymph node dissection Documented DVT/thrombus	ESRD-preservation of vessels for future treatment Lack of vessel of adequate size Injury/Infection to area/ limb Post mastectomy/ Lymph node dissection Implanted device Pacemaker/AICD < 4 weeks prior
Insertion	RN or VAT @ bedside	VAT RN @ bedside	VAT RN @ bedside w/VPS or CXR confirmation or MD in IR for mal-positioned PICC repositioning or placement of a tunneled chest line for lack of adequate upper arm vessels for PICC placement.
Location/ Placement	Forearm, upper arm, hand or antecubital fossa with catheter tip located in a superficial vein.	Forearm or upper arm with catheter tip in the cephalic, basilic, or brachial vein inferior to the shoulder (below the axilla).	Peripherally inserted into basilic, brachial or cephalic vein with catheter tip optimally located in the lower 1/3 of the superior vena cava at or near the junction of the right atrium (CAJ).

	Peripheral	Extend Dwell Catheter (EDC)/Midline	PICC
Line Length	.75-2.5 inches (1.65-4.1cm)	2.7-3.6 inches (6-8 cm) Typically 30-50 centimeters 2.7-3.6 inches (6-8 cm) Midlines 10-20cm are an option when the vessel is deeper and requires a longer catheter than an Extended dwell catheter. *Midline and PICC length can be trimmed and is individualized to the patient. The length is documented on the dressing and catheter insertion note entered in EMR/Soarian.	
Lumens	1	1	1-3
Duration	Short-term therapy 7 days or less.	Short-term therapy 7 days to 4 weeks.	Intermediate to long-term therapy. Typically therapy lasting > than 4 weeks- 1 year.
Flushes	3-10mls NS before, along with aspiration of blood to evaluate catheter function and 10mls NS after each use. Minimum Q 8hours	**Unused lumens:** Flush with 10mls NS Q 8 hrs. and PRN **Intermittent use:** 10mL NS before and after each use. Minimum Q 8 hrs. and PRN * TPA for Midline/EDC occlusion is considered an off label use. Not current policy at TMC	**Unused lumens:** Flush with 10mls NS Q 8 hr. **Intermittent use:** 10mL NS before after each use. Minimum Q 8 hrs. TPA is utilized to correct occlusions and should be administered for partial occlusion when blood return is lost even if able to flush the catheter. Standard dose is 2mg/2mls mixed per Pharmacy instruction. Instilled for 30mins to 120 minutes, attempting to aspirate every 30 minutes until blood return is restored. The dose may be repeated times one.
Medication Compatibility	Isotonic solution, non-irritating/non-vesicant solution. Vesicants can be peripheral short term while Central access is being established.	Isotonic solution not over 600mOsm & with pH of 5-9. No TPN	******** **(Lumens should be thoroughly flushed between medications and medication compatibility checked to prevent line occlusions.)** ********** **Should be considered for all lines.**

	Peripheral	Extend Dwell Catheter (EDC)/Midline	PICC
Antibiotic Max Concentrations, If not explicitly noted, standard concentrations are safe	Ampicillin/Sulbactam 30/15 mg/mL Azithromycin 2 mg/mL¥ Aztreonam Cefazolin Ceftriaxone Ceftazidime Cefepime Ceftazidime/ Avibactam Ceftolozane/Tazobactam Ceftaroline Clindamycin¥	Daptomycin Ertapenem Imipenem Linezolid¥ Meropenem Micafungin Penicillin G Piperacillin/Tazobactam Tigecycline Vancomycin 4 mg/mL	****Should consider the smallest catheter to deliver therapy for best vessel preservation/reduction of complications.** Recommendations for TPN infusion is to place a Double Lumen to ensure adequate access for all needed infusion therapies and phlebotomy access capability.**

PICC= Peripherally Inserted Central Catheter, IR = Interventional Radiology, IJ = Internal Jugular, VAT = Vascular Access Team, CXR = Chest X-Ray, EDC = Extended Dwell Catheter, PIV- Peripheral IV

¥ 100% Bioavailability – consider oral therapy

References:

1. Caparas J, Hung HS, Vancomycin Administration Through a Novel Midline Catheter: Summary of a 5-year, 1086 Patient Experience in an Urban Community Hospital. JAVA: 2017; 22(1).
2. Phlebogenic Medications available at http://www.pedagogy-inc.com/Home/Resources/IV/Phlebogenic-Medications.aspx [Accessed January 19,2021]
3. Adapted from: "Chapter 7: Home Care." Handbook of Institutional Pharmacy Practice. Ed. Thomas R. Brown. 4th ed. Bethesda, Maryland: American Society of Health-Systems Pharmacists, 2006. 99-114. Print.
4. Antibiotic Concentrations from Trissel's IV Compounding Guidelines c 2020.
5. Gorski LA. The 2016 Infusion Therapy Standards of Practice. Home Healthc Now. 2017 Jan;35(1):10-18. doi: 10.1097/NHH.0000000000000481. PMID: 27922994.
6. *IDSA Clinical Practice Guideline for Management of Outpatient Parenteral Antimicrobial Therapy. Clinical Infectious Diseases*, Volume 68, Issue 1, 1 January 2019, Pages e1–e35, https://doi.org/10.1093/cid/ciy745

Conversion from Intravenous to Oral/Enteral Therapy

In accordance with Pharmacy and Therapeutics Committee guidelines, pharmacists may dispense, and nurses may administer to inpatients equivalent oral doses of certain intravenous (IV) medications (see following page). The goal is to provide the patient with effective, safe and cost-effective treatment.

- Patients with the following characteristics may be considered for conversion from the intravenous to the oral/enteral route
    - A functioning GI tract as indicated by the ability to take oral fluids and medications or tolerance of enteral feedings.
    - No evidence of:
        - Severe nausea and vomiting, gastrointestinal obstruction, malabsorption syndrome, ileus or severe diarrhea.
        - Active gastrointestinal bleeding.
        - Severe (Grade III or IV) mucositis.
        - High nasogastric (NG) tube output or continuous NG tube suctioning >500 mL/day.
    - **The following additional criteria apply to antimicrobial agents only:**
    - Normal, stable vital signs throughout the previous 24 hours:
        - Temperature ≤37.8˚C.
        - Heart rate ≤90 beats per minute.
        - Respiratory rate ≤20 breaths per minute.
        - Systolic blood pressure ≥90 mmHg (without the need for vasopressors).
        - A White Blood Cell count between 4,000 to 11,000 cells/microliter.
    - No evidence of life-threatening infection (e.g., sepsis) and no evidence of an infection with a high risk of treatment failure (e.g., meningitis, endocarditis, necrotizing soft tissue infection).

Conversion from Intravenous to Oral/Enteral Therapy: Dosing Equivalents for Select Antimicrobial Therapies

Intravenous Medication	Oral Equivalent
Azithromycin 500mg IV q24h	Azithromycin 500mg PO q24h
Ciprofloxacin 200mg IV q12h	Ciprofloxacin 250mg PO q12h
Ciprofloxacin 400mg IV q12h	Ciprofloxacin 500mg PO q12h
Ciprofloxacin 400mg IV q8h	Ciprofloxacin 750mg PO q12h
Clindamycin 600mg IV q8h	Clindamycin 300mg PO q6h
Doxycycline 100mg IV q12h	Doxycycline 100mg PO q12h
Fluconazole 200mg IV q24h	Fluconazole 200mg PO q24h
Fluconazole 400mg IV q24h	Fluconazole 400mg PO q24h
Fluconazole 800mg IV q24h	Fluconazole 800mg PO q24h
Linezolid 600mg IV q12h	Linezolid 600mg PO q12h
Metronidazole 500mg IV q8h	Metronidazole 500mg PO q8h
Levofloxacin 750mg IV q24h	Levofloxacin 750mg PO q24h
Rifampin 600mg IV q24h	Rifampin 600mg PO q24h
Rifampin 300mg IV q8h	Rifampin 300mg PO q8h
TMP/SMX 160mg IV q8h	Bactrim 1 DS tablet q8h
Voriconazole 300mg IV q12h	Voriconazole 300mg PO q12h

Intravenous Medication	Oral Step-Down
Ampicillin 2g IV q4-6h	Amoxicillin 2g PO q12h **OR** 875mg PO q12h **OR** 500mg PO q8h
Ampicillin/sulbactam 3g IV q6h	Amoxicillin/clavulanate 2g PO q12h **OR** 875mg PO q12h **OR** 500mg PO q8h
Cefazolin 2g IV q8h	Cephalexin 500mg PO q6h
Ceftriaxone 1g IV q24h	Cefpodoxime 200mg PO q12h

Sodium/Potassium Content of Select INJECTABLE Antimicrobial Agents

	Sodium Content	
Drug and Dose	**mg**	**mEq**
Acyclovir, 1 g	98	4.2
Ampicillin, 1 g	69	3
Ampicillin/ sulbactam, 1.5 g	115	5
Cefazolin, 1 g	48	2
Ceftazidime, 1 g	54	2.3
Ceftriaxone, 1 g	83	3.6
Ertapenem	137	6
Ganciclovir, 500 mg	46	2
Imipenem, 500 mg	37.5	1.6
Metronidazole, 500 mg	322	14
Meropenem, 1 g	90.2	4.2
Oxacillin, 1 g	63.5	2.8
Penicillin G potassium, 1 MU	7	0.3
Penicillin G sodium, 1 MU	46	1.68
Piperacillin/tazobactam, 3.375	192	8.37
Piperacillin/tazobactam, 2.25	128	5.58

	Potassium Content	
Drug and Dose	**mg**	**mEq**
Penicillin G potassium, 1 MU	66.94	1.7

****Please note this does not incorporate electrolytes contained in diluents****

Common Oral Antibiotics during Lactation

Antibiotic (systemic)	Relative Infant Dose (RID)*	Possible Infant Adverse Effects	General Recommendation**
Amoxicillin	0.15-0.54%	Self-limiting diarrhea, rash, thrush	Compatible with breastfeeding
Amoxicillin/ clavulanate	0.02-0.07%	Constipation, diarrhea, restlessness, rash	Compatible with breastfeeding
Azithromycin	5.9%	Possible effects on the GI flora, vomiting, diarrhea, thrush	Compatible with breastfeeding
Cefpodoxime	No published data; generally low levels	Cephalosporins associated with diarrhea, thrush	Compatible with breastfeeding
Cephalexin	0.2%-1.5%	Diarrhea	Compatible with breastfeeding
Ciprofloxacin	2.8%	Limited case reports of adverse events: diarrhea, thrush	Potential toxicity – use other agents if possible; recommend withholding breastfeeding during therapy and for 2 days after discontinuation; if use required, avoid breastfeeding for 3-4h after dose to decrease infant exposure
Levofloxacin	6%	No information available	Probably compatible – use other agents if possible; if use required, avoid breastfeeding for 3-4h after dose to decrease infant exposure
Doxycycline	6.14%	Potential for dental staining and inhibition of long bone growth, photosensitivity	Compatible – avoid prolonged (>21 days) or repeated courses
Metronidazole	13.7-22.9%	Loose stools, oral and perianal *Candida growth*; in vitro mutagen	Potential toxicity – use other agents if possible; hold breastfeeding for 12-24h if single dose given
SMX/TMP	3%	Monitor for jaundice, hemolysis in infants with G6PD deficiency	Potential toxicity – generally compatible but avoid in infants with G6PD deficiency or hyperbilirubinemia
Nitrofurantoin	5%	Diarrhea, potential decreased milk volume in mother	Limited data, probably compatible – contraindicated for mothers breastfeeding infants <1 month old and infants with G6PD deficiency
Fluconazole	5-21%	Flushed cheeks, GI upset, loose stools, mucous feces, somnolence	Compatible with breastfeeding
Acyclovir/ Valacyclovir	1.8-3.6%	Limited information available; no noted adverse events	Compatible with breastfeeding

*in general, breastfeeding is considered acceptable when RID is < 10%. RID estimates infant drug exposure via breast milk by using a known drug concentration in breast milk and comparing it to an infant therapeutic dose or weight-adjusted maternal dose

** Recommendation per Briggs Drugs in Pregnancy and Lactation

Possible general adverse effects with antibiotics: modification of bowel flora, allergic sensitization of the infant, interference with interpretation of culture results if a fever workup is required

References:

- American Academy of Pediatrics Committee on Drugs. Transfer of drugs and other chemicals into human milk. Pediatrics 2001 Sep; 108 (3): 776-89.
- Drugs and Lactation Database (LactMed) [Internet]. Bethesda (MD): National Library of Medicine (US); 2006. Available from: https://www.ncbi.nlm.nih.gov/books/NBK501922/#IX.A
- Briggs Drugs in Pregnancy and Lactation [Internet]. Waltham (MA): Wolters Kluwer Health. http://online.lexi.com/. Accessed Apr 26, 2022.
- Clinical Pharmacology [Internet]. Tampa (FL): Elsevier. [cited 2021 Mar 4]. Available from: http://www.clinicalpharmacology.com
- Lexi-Drugs. Hudson, OH: Lexicomp, 2021. http://online.lexi.com/. Accessed Apr 26, 2022.

Beta-Lactam Allergy Assessment

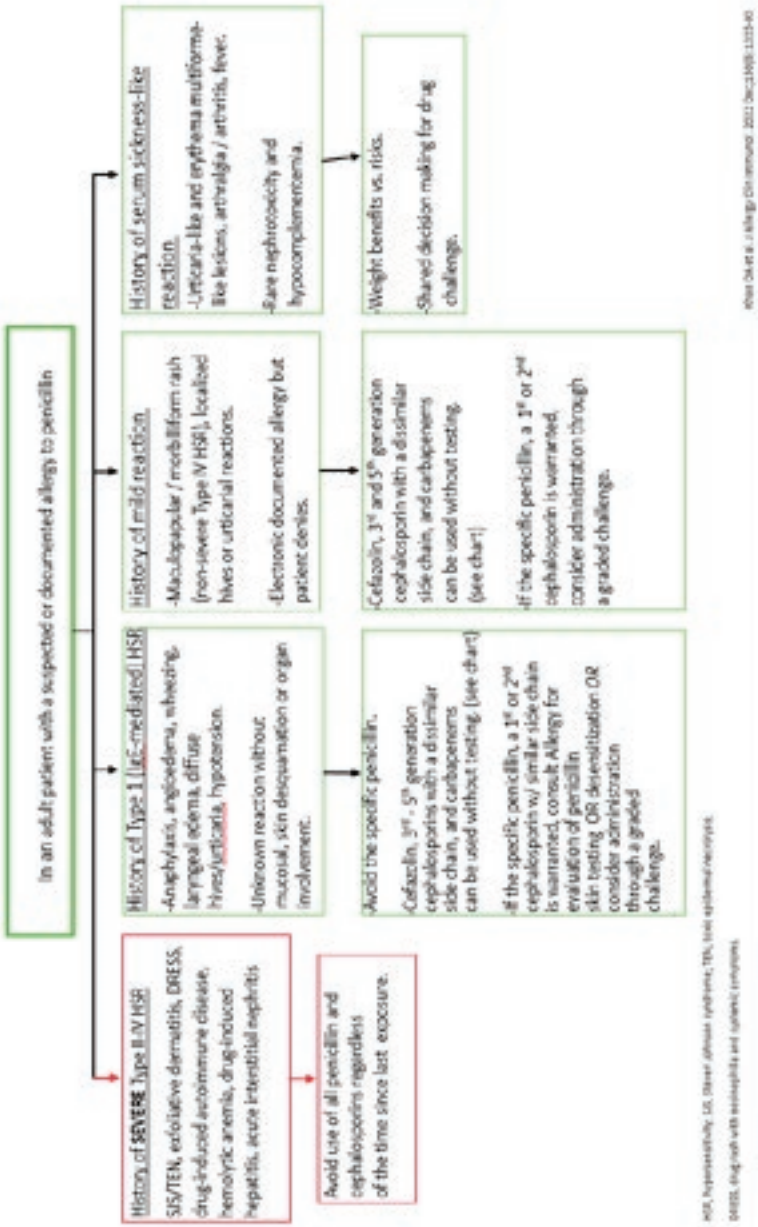
1. Obtain a complete allergy history (see algorithm on the following page).

2. If the history supports drug allergy, determine the severity and categorize the reaction based on the algorithm. Rule out drug intolerance or known pharmacologic reactions such as GI upset.

3. Determine if the patient has tolerated other beta-lactams in the past. (e.g., was the reaction to amoxicillin? Ampicillin? Has the patient tolerated other penicillins? Cephalosporins?)

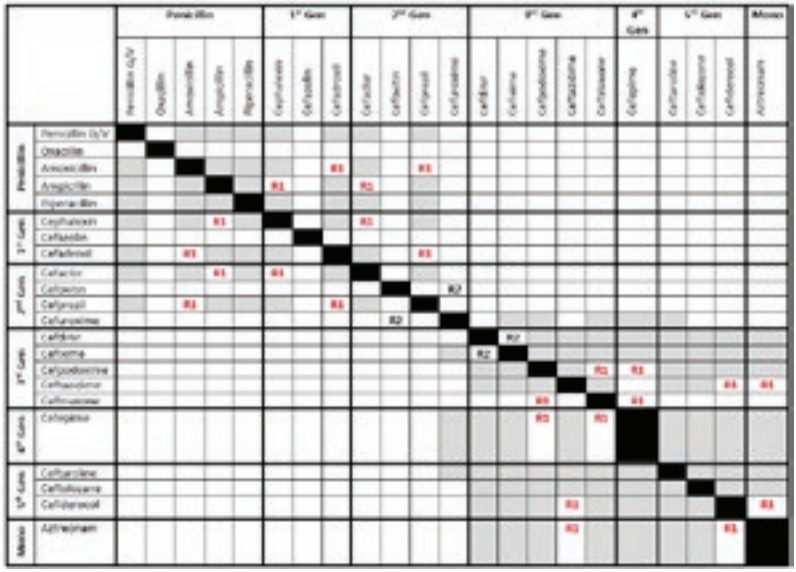
4. Choose the appropriate action based on the history. Actions may include:
    a. Avoidance of all beta-lactams.
    b. Avoidance of a specific beta-lactam (e.g., allergy history supports a reaction to amoxicillin and previous tolerance to other beta-lactam drugs).
    c. Initiate therapy with full doses of a beta lactam.
    d. Perform a Graded Challenge.
        i. A graded challenge is performed when there is low suspicion of true allergy when caution is warranted. It involves a single-step of escalation. Graded challenges can be completed to oxacillin, ampicillin, piperacillin/tazobactam, cefazolin and ceftriaxone at TMC.
    e. Perform desensitization. This procedure is used in patients with a history of IgE-mediated reactions (anaphylaxis, angioedema, and/or hypotension). Desensitization consists of administering incrementally increased doses of the intended agent every 15 to 20 minutes until the first full dose is reached. This procedure offers temporary desensitization to the drug. Consult Allergy or contact a pharmacist for details of the desensitization procedure.

Penicillin Allergy Assessment Algorithm



Cephalosporin Allergy Assessment Algorithm

Penicillin and Cephalosporin Cross Reactivity Chart



R1	**AVOID USE** due to identical R1 side chain structures.
R2	**AVOID USE** due to identical R2 side chain structures.
	Cross reactivity less likely due to dissimilar R1 and R2 side chain structures.
	CAUTION USE. Similar R1 or R2 side chain structures.

Zagursky RJ et al. J Allergy Clin Immunol Pract. 2022;10(2):651

Antibiotic Estimated Daily Cost (updated 05/2024)

Drug	Common Adult Inpatient Dose	Cost ($)/Day
Acyclovir IV	500mg IV q8h (5-10 mg/kg IV q8h)	6.70
Acyclovir PO	200-800mg PO 5X/day	0.5-2.00
Amikacin	1000mg IV q24h (15mg/kg/day)	10.4
Amoxicillin PO	500mg PO q8h	0.22
Amoxicillin clavulanate PO	500-125mg PO q8h/875-125mg q12h	0.63/ 2.36
Amphotericin liposomal	350mg IV daily	665
Ampicillin IV	1g IV q8h/ 2g IV q4h	6.18 / 19.20
Ampicillin/sulbactam	1.5g q6h/ 3gm q6h	5.80/ 32.52
Azithromycin IV/PO	500mg IV daily/ 500mg PO daily	3.03/ 1.80
Aztreonam	2g IV q8h	162.00
Cefazolin	1-2g IV q8h	7.18-12.63
Cefiderocol	2g IV q6h	1616
Cefepime	1-2g IV q8h	8.04-16.5
Cefpodoxime	200-400mg PO BID	6.52 -13.04
Ceftaroline	600mg IV q8-12h	362-543
Ceftazidime	1-2g IV q8h-12h	8.34-15.6
Ceftazidime-avibactam	2.5g IV q8h	1095
Ceftolozane-tazobactam	1.5-3g IV q8h	438-876
Ceftriaxone	1-2g IV daily	0.71-1.97
Cephelaxin	500mg PO q6h	0.92
Cidofovir	375 mg	431
Ciprofloxacin IV	400mg IV q12h	3.90
Ciprofloxacin PO	500-750mg PO q12h	0.44-1.08
Clindamycin IV	600mg IV q8h	9.36
Clindamycin PO	300mg PO q6h	1.04
Colistin	150mg IV q12h	18.76
Daptomycin	500- 750mg IV daily	14.78-22.17
Dalbavancin	1500 mg x 1 (restricted to outpatient)	2772
Doxycycline IV	100mg IV BID	20.50
Doxycycline PO	100mg PO BID	2.24
Ertapenem	1g IV daily	23.11
Fidaxomicin	200mg PO BID	212
Fluconazole IV	200-400mg IV daily	4.53-5.03
Fluconazole PO	200-400mg PO daily	1.50-3.00
Foscarnet	4200mg q8h/6300 mg q12	581.70/ 577.5
Fosfomycin PO	3g x 1	45.92
ganciclovir IV	350mg IV q12h	50.4
gentamicin IV	400mg IV daily (5-7 mg/kg)	5.36
Isavuconazole IV/PO	372mg IV/PO q24	318/186
Letermovir IV/PO	240/480mg IV/PO daily	248/ 361
Levofloxacin IV	500-750mg IV daily	3.23-3.7
Levofloxacin PO	500-750mg PO daily	0.20-0.42
Linezolid	600 mg IV/PO BID	13.90/3.34
Meropenem IV	500mg-1 g IV q8h	4.32-16.35
Metronidazole IV	500mg IV/PO q12h	0.68-1.90
Metronidazole PO	500mg PO q8h	0.33

Drug	Common Adult Inpatient Dose	Cost ($)/Day
Micafungin	100mg IV daily	24.95
Nitrofurantoin (Macrobid)	100mg PO BID	4.72
Oxacillin	2g IV q4h	50.44
Oseltamivir	75mg PO BID	4.78
Penicillin G IV	12 million units q24/24 million units q24h	13.08/ 26.16
Piperacillin-tazobactam	2.25/3.375/4.5 g IV q8h	6.72 / 7.50/8.50
Posaconazole PO	300mg PO daily	59.58
Posaconazole IV	300mg IV daily	490
Rifampin PO	300mg PO q8h	1.68
Tobramycin IV	400mg IV daily (5-7 mg/kg)	3.72
TMP-SMX IV	350mg TMP IV PO q8h	14.90
TMP-SMX PO	160mg PO q8-12h	0.22-0.33
Valacyclovir Po	500mg PO q24h - 1 g PO TID	1.07-6.42
Valganciclovir PO	900mg PO BID	109.04
Vancomycin IV	1g IV q12h/1.25g q12h/1.5g q12h	4.78/ 6.47/ 10.80
Voriconazole IV	300mg IV q12h	83.25
Voriconazole PO	200mg PO BID	15.06

Inpatient Tufts Medical Center Antibiogram 1/1/2023-12/31/2023

Confidential Information for TMC staff only

All sources, Adult inpatient and emergency department, 1st isolate per site

		Penicillins & Beta-lactamase inhibitors					Cephalosporins					Aminoglycosides			Quinolone		UTI Agent
Pathogen Tested,n % susceptible	Isolates	Ampicillin	Ampicillin /sulbactam	Piperacillin /tazobactam	Meropenem	Ertapenem	Cefazolin	Cefoxitin	Ceftriaxone	Cceftazidime	Cefepime	Gentamicin	Tobramycin	Amikacin	Ciprofloxacin	Trimethoprim /Sulfamethoxazole	Nitrofurantoin
Citrobacter spp.[A]	43	-	-	76	97	100	-	50	65	79	93	97	96	100	88	83	87
Enterobacter spp.[A]	90	-	-	65	100	92	-	0	65	70	93	97	96	98	93	85	37
Escherichia coli[B]	703	51	61	93	99	99	83	92	87	91	96	89	89	100	74	73	97
Klebsiella pneumoniae[B]	252	-	69	80	97	97	83	93	82	85	95	92	90	99	86	82	19
Klebsiella oxytoca[B]	45	-	47	80	100	100	-	95	73	91	93	91	91	100	89	91	85
Proteus mirablis	103	76	87	100	100	94	-	97	95	98	98	89	91	100	84	82	0
Serratia marcescens	52	0	0	83	98	98	-	-	80	98	100	96	82	100	98	98	0
Pseudomonas aeruginosa	215	-	-	80	88	-	-	-	-	84	86	-	96	95	86	-	-
Stenotrophomonas maltophilia[C]	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-
Acinetobacter spp.[C]	27	-	100	66	88	-	-	-	23	88	88	100	100	100	88	88	-
Outpatient urine isolates Enterobacterales	368	46	66	95	100	100	88	90	92	95	98	90	90	99	77	78	79
ED Urine Isolates Enterobacterales	540	43	66	94	99	99	84	89	90	94	97	89	90	97	82	78	73

(-) drug not tested or not indicated

A *Enterobacter, Citrobacter and Klebsiella aerogenes*, may produce inducible beta lactamases when exposed to 3rd geneteration cephalosporins and become resistant to therapy.

B Approximately 13% of E.coli, 18% of Klebsiella pneumoniae and 9% of Klebsiella oxytoca display ceftriaxone resistance which indicates reduced activity of penicillins, some cephalosporins and aztreonam.

C For organisms with less than 30 isolates reported, empiric therapy should not be based upon reported susceptibilities due to the inability to identify statistical significance.

ESBL positive,n: 97 E.coli, 44 Klebsiella species **Carbapenem resistant,n:** 2 E.coli, 55 Klebsiella spp.

Combined E.coli/Klebsiella (%): Ceftazidime/avibactam: 100%; Pseudomonas (%): Ceftazidime/avibactam: 87%; Ceftolozane/tazobactam 95%;

S. maltophilia %,n: :Levofloxacin 88%; Minocycline 100%,

Pathogen Tested, n % susceptibile	Isolates	Ampicillin	Oxacillin	Gentamicin	Clindamycin	Tetracycline	Doxycycline	Vancomycin	Daptomycin	Linezolid	Rifampin	Trimethoprim -sulfamethoaz
Staphylococcus aureus, ALL[A]	666	-	66	97	74	87	97	100	100	100	99	87
Methicililn Resistant *Staphylococcus aureus*	235	- -	-	96	73	76	95	100	100	100	99	86
Coagulase negative Staphylcocccus (w/o *S. lug*)	151	- --	29	83	49	75	-	100	-	100	93	54
S. lugdunensis [B,C]	25	-	50	96	64	84	-	100	-	-	100	100
Enterococcus faecalis	149	100	-	-	-	23	-	89	100	100	-	-
Enterococcus faecium	63	11	-	-	-	25	-	34	96	100	-	-
Corynebacterium spp.[B,C]	21	-	-	85	0	-	-	100	100	100	-	29

(-) Drug not tested or not indicated

A. 34% of all Staphylococcal inpatient isolates are MRSA, 66% are MSSA. If patient is at risk for MRSA, empiric therapy with vancomycin is recommended.

B. For organisms with less than 30 isolates reported, empiric therapy should not be based upon reported susceptibilities due to the inability to identify statistical significance.

C. For organisms with less than 30 isolates reported, empiric therapy should not be based upon reported susceptibilities due to the inability to identify statistical significance

2023 Candida species all sources	Isolates	Fluconazole	Micafungin	Voriconazole
Candida species	61	85	92	80
Candida alibicans	31	100	100	92

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