

TREATMENT GUIDELINE FOR PEDIATRIC PATIENTS WITH BLOODSTREAM INFECTIONS

Purpose:

This guideline is intended to help guide antimicrobial therapy for patients admitted to pediatric service lines following the results of Gram Stain, Organism Identification (with or without Verigene™ molecular resistance results) and Antimicrobial Susceptibilities. Deviation from the recommendations in this guideline may be required for patients with concomitant infections, history of resistant pathogens, or with antimicrobial allergies or intolerance.

The recommendations in this guideline reflect susceptibility patterns found at Michigan Medicine and C. S. Mott Children's Hospital.

How to use this guideline:

For patients with ONLY Gram stain results, refer to the left column (labeled GRAM STAIN) for treatment recommendations

For patients with organism identification results, refer to the middle column (labeled ORGANISM IDENTIFICATION) for treatment recommendations

For patients with antimicrobial susceptibility results, refer to the right column (labeled SUSCEPTIBILITIES) for treatment recommendations

GRAM STAIN

*Gram-positive cocci in clusters:
Vancomycin

*Single positive cultures from

ORGANISM IDENTIFICATION

S. aureus and mecA negative:
Endocarditis or CNS infection: **Nafcillin**
Other infections: **Cefazolin**

S. aureus and mecA positive or mecA not performed:
Vancomycin

S. lugdunensis:
Vancomycin

SUSCEPTIBILITIES

S. aureus or S. lugdunensis sensitive to methicillin:
Non-CNS/endocarditis: **Cefazolin**
CNS infection or endocarditis: **Nafcillin**
Life-threatening PCN allergy: **Vancomycin**

S. aureus or S. lugdunensis intermediate or resistant to methicillin:
Vancomycin

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Revision History:

The recommendations in this guide are meant to serve as treatment guidelines for use at Michigan Medicine facilities. If you are an individual experiencing a medical emergency, call 911 immediately. These guidelines should not replace a provider's professional medical advice based on clinical judgment, or be used in lieu of an Infectious Diseases consultation when necessary. As a result of ongoing research, practice guidelines may from time to time change. The authors of these guidelines have made all attempts to ensure the accuracy based on current information, however, due to ongoing research, users of these guidelines are strongly encouraged to confirm the information contained within them through an independent source.

If obtained from a source other than med.umich.edu/asp, please visit the webpage for the most up-to-date document.

GRAM STAIN

Yeast:
 Neonatal (<44 weeks PMA): **Consult ID**

Infant (>44 weeks PMA) – Adult:
Micafungin

Consult ID

If suspicion for *Cryptococcus* or *Histoplasma* (fungemia in setting of pneumonia or meningitis in immunocompromised patient), call Infectious Diseases consult service for immediate antifungal recommendations

ORGANISM IDENTIFICATION

All Candida species:
 Neonatal: **Consult ID**
 Infant – Adult: **Micafungin**

See [Candidemia Guideline](#). Therapy should not be de-escalated until guideline criteria are met.

ID consult is strongly recommended.

If concern for urinary, ocular, endocarditis, or CNS infection, alternative therapy may be needed.
 Consult with ID

Cryptococcus spp.:
Liposomal amphotericin B (Ambisome™)
+ Flucytosine

Consult ID

Histoplasma:
Liposomal amphotericin B (Ambisome™)

Consult ID

SUSCEPTIBILITIES

C. albicans, C. parapsilosis, C. tropicalis, C. dublinensis, and C. lusitanae:
 Consider de-escalation to **Fluconazole** for clinically stable patients with clearance of blood cultures and fluconazole susceptibility

Otherwise:
Micafungin

See [Candidemia Guideline](#). Therapy should not be de-escalated until guideline criteria are met, in conjunction with ID consult recommendations

C. glabrata with fluconazole MIC ≤8 (SDD):
 Consider de-escalation to **Fluconazole** for clinically stable patients with clearance of blood cultures

Otherwise:
Micafungin

Cryptococcus spp.:
Fluconazole may be appropriate for step down therapy when criteria is met in conjunction with ID consult recommendations

Histoplasma:
 Step down therapy may be appropriate when clinically stable in conjunction with ID consult recommendations

GRAM STAIN

*Gram-positive cocci in clusters:
Vancomycin

*Single positive cultures from peripheral sources in patients without:

- Neutropenia
- Prosthetic material infection
- Premature neonates

May represent contamination; assess for possible source of infection and hold antibiotics if clinically stable

ORGANISM IDENTIFICATION

S. aureus and mecA negative:
Endocarditis or CNS infection: **Nafcillin**
Other infections: **Cefazolin**

S. aureus and mecA positive or mecA not performed:
Vancomycin

S. lugdunensis:
Vancomycin

Consult ID

Consider discontinuing adjunctive gram-negative therapy between 48-72 hours if cultures are negative for gram-negative pathogens, except for patients with intra-abdominal infections

Single positive culture for Coagulase-negative Staphylococcus or *S. epidermidis* in suspected infection of prosthetic material, neutropenia, premature neonates, or in hemodynamically unstable patients:

S. epidermidis and mecA negative:
Cefazolin

S. epidermidis and mecA positive or coagulase negative Staphylococcus:
Vancomycin

For patients who do not meet the above criteria, a single positive culture for coagulase-negative Staphylococcus or *S. epidermidis* may represent contamination, assess for possible source of infection and hold antibiotics if clinically stable

SUSCEPTIBILITIES

S. aureus or S. lugdunensis sensitive to methicillin:
Non-CNS/endocarditis: **Cefazolin**
CNS infection or endocarditis: **Nafcillin**
Life-threatening PCN allergy: **Vancomycin**

S. aureus or S. lugdunensis intermediate or resistant to methicillin:
Vancomycin

Coagulase-negative Staphylococcus or S. epidermidis sensitive to methicillin:
Non-CNS/endocarditis: **Cefazolin**
CNS infection or endocarditis: **Nafcillin**
Life-threatening PCN allergy: **Vancomycin**

Coagulase-negative Staphylococcus or S. epidermidis intermediate or resistant to methicillin:
Vancomycin

GRAM STAIN

Gram-positive cocci in chains or pairs:
Vancomycin

ORGANISM IDENTIFICATION

E. faecalis and *vanA/vanB* Negative:
Ampicillin
(consider **piperacillin-tazobactam** as alternative for intra-abdominal infections)
Life-threatening PCN allergy: **Vancomycin**

E. faecalis and *vanA/vanB* positive:
Ampicillin
(consider **piperacillin-tazobactam** as alternative for intra-abdominal infections)
Life-threatening PCN allergy: **Linezolid** or **Daptomycin** for BMT patients with ANC <1,000

E. faecium and *vanA/vanB* negative:
Vancomycin

E. faecium and *vanA/vanB* positive:
Linezolid or **Daptomycin** for BMT patients with ANC <1,000

E. casseliflavus, *E. gallinarium*:
Linezolid or **Daptomycin** for BMT patients with ANC <1,000

Other *Enterococcus* species:
Vancomycin

S. pneumoniae, *S. anginosus* or *Streptococcus* species:
Non-CNS/endocarditis: **Ceftriaxone***
CNS infection or endocarditis: **Ceftriaxone* + Vancomycin**
Febrile neutropenia: **Vancomycin + anti-Pseudomonal beta-lactam**

S. agalactiae or *S. pyogenes*:
Penicillin or **Ampicillin**
Mild PCN allergy: **Cefazolin** (if no CNS infection)
Life-threatening PCN allergy: **Vancomycin**

SUSCEPTIBILITIES

Penicillin-based antibiotics should be first line therapy for all *Enterococcus* species if sensitive:
Ampicillin
(consider **ampicillin-sulbactam** or **piperacillin-tazobactam** for intra-abdominal infections)

Life-threatening PCN allergy or ampicillin-resistant *Enterococcus*:
Vancomycin

Patients with vancomycin allergy or ampicillin and vancomycin-resistant *Enterococcus*:
Linezolid or **Daptomycin** for BMT patients with ANC <1,000

Patients with suspected endocarditis will likely require combination therapy and ID consult is strongly recommended

Penicillin-based antibiotics should be first line therapy for all *Streptococcus* species infections, if sensitive:
Penicillin or **Ampicillin**
Mild PCN allergy: **Cefazolin** (if no CNS infection)
Mild PCN allergy CNS infection: **Ceftriaxone***
Life-threatening PCN allergy: **Vancomycin**

Febrile neutropenic patients should be continued on **anti-Pseudomonal beta-lactam**

*neonates should receive **cefotaxime** in the place of ceftriaxone

GRAM STAIN

*Gram-negative bacilli:
Cefepime
(add **metronidazole** for intra-abdominal infections)

*Evaluate if patient has history of resistance to cefepime with prior year and modify therapy accordingly

ORGANISM IDENTIFICATION

E. coli, Klebsiella, or Proteus:
No CTX-M, KPC, IMP, VIM, NDM, OXA detected:
Ceftriaxone (cefotaxime for neonates)

CTX-M positive:
Meropenem

KPC positive:
Meropenem-vaborbactam

IMP, VIM, or NDM positive:
Ceftazidime-avibactam + Aztreonam + Polymyxin B*

OXA positive:
Ceftazidime-avibactam

*substitute Tobramycin for Polymyxin B when treating Proteus

Enterobacter, Serratia, Morganella, or Citrobacter:
No CTX-M, KPC, IMP, VIM, NDM, OXA detected:
Cefepime

CTX-M positive:
Meropenem

KPC positive:
Meropenem-vaborbactam + Polymyxin B*

IMP, VIM, or NDM positive:
Ceftazidime-avibactam + Aztreonam + Polymyxin B*

OXA positive:
Ceftazidime-avibactam

*substitute Tobramycin for Polymyxin B when treating Morganella or Serratia

SUSCEPTIBILITIES

Narrow antibiotic selection based on susceptibility results, clinical status, concomitant infections:

- Narrow-spectrum antibiotics are preferred if no resistance or allergies. These include **ampicillin, penicillin, ampicillin-sulbactam, ceftazidime, and cefuroxime.**
- ID consult is strongly encouraged for patients with infections from organisms with CTX-M, KPC, IMP, VIM, NDM, or OXA resistance genes

Narrow antibiotic selection based on susceptibility results, clinical status, concomitant infections:

- ID consult is strongly encouraged for patients with infections from organisms with CTX-M, KPC, IMP, VIM, NDM, or OXA resistance genes
- *Enterobacter, Serratia* and *Citrobacter freundii* frequently have an inducible beta-lactamase resistance gene (*AmpC*), which can confer resistance to penicillin, ampicillin, ampicillin/sulbactam, and 1st-3rd generation cephalosporins. **Cefepime** should be first-line therapy if susceptible.
- *Citrobacter koseri* is not associated with having *AmpC* gene, and narrow spectrum antibiotics should be prescribed if susceptible.

GRAM STAIN

*Gram-negative bacilli:
Cefepime
(add **metronidazole** for intra-abdominal infections)

*Evaluate if patient has history of resistance to cefepime with prior year and modify therapy accordingly

ORGANISM IDENTIFICATION

Pseudomonas aeruginosa
No CTX-M, KPC, IMP, VIM, NDM, OXA detected:
Cefepime

CTX-M positive:
Meropenem

KPC positive:
Meropenem-vaborbactam + Polymyxin B

IMP, VIM, or NDM positive:
Aztreonam + Polymyxin B

OXA positive:
Cefepime + Polymyxin B

Acinetobacter baumannii
No CTX-M, KPC, IMP, VIM, NDM, OXA detected:
Cefepime

CTX-M positive:
Meropenem

KPC positive:
Meropenem-vaborbactam + Polymyxin B

IMP, VIM, or NDM positive:
Minocycline + Polymyxin B

OXA positive:
Meropenem + Polymyxin B

SUSCEPTIBILITIES

Narrow antibiotic selection based on susceptibility results, clinical status, concomitant infections.

- If Pseudomonas isolate is resistant to cefepime, piperacillin-tazobactam, meropenem, imipenem, aztreonam, levofloxacin and ciprofloxacin, request **ceftolozane-tazobactam, ceftazidime-avibactam, and meropenem-vaborbactam** susceptibilities from microbiology lab (phone number 6-6831)
- Double coverage of Pseudomonas is not indicated after susceptibilities are available, unless isolate is resistant to all beta-lactam antibiotics, cystic fibrosis patient, or decompensating on susceptible antibiotics
- ID consult is encouraged for patients with Pseudomonas bacteremia

Narrow antibiotic selection based on susceptibility results, clinical status, concomitant infections.

- There is no evidence double coverage of Acinetobacter improves outcomes. The decision to double cover should be made based on source of bacteremia, severity of infection, and patient's medical history.

GRAM STAIN

*Gram-negative bacilli:
Cefepime
(add **metronidazole** for intra-abdominal infections)

*Evaluate if patient has history of resistance to cefepime with prior year and modify therapy accordingly

Gram-positive rod:
Most likely the result of skin flora contamination of blood culture

Consider treatment in HD unstable, prosthetic material with suspected infection, BMT, SOT, Neutropenia:
Vancomycin

If concern for Listeria:
Ampicillin

ORGANISM IDENTIFICATION

Achromobacter:
Piperacillin-tazobactam
Life-threatening PCN allergy: **Meropenem**
(Avoid cefepime unless susceptibility is verified)

Stenotrophomonas:
Trimethoprim-sulfamethoxazole
Sulfa-allergy: **Levofloxacin + minocycline**
(Piperacillin-tazobactam and cefepime do not have activity against Stenotrophomonas)

Bacillus, *Lactobacillus*, and *Corynebacterium* spp. are possible contaminants, consider treatment in HD unstable, prosthetic material with suspected infection, BMT, solid organ transplant, neutropenia

Bacillus or Corynebacterium spp.: **Vancomycin**

Lactobacillus: **Piperacillin-tazobactam**

Listeria: **Ampicillin**

Patients with multiple positive sets of blood cultures are more likely true infection. Consider ID consult.

SUSCEPTIBILITIES

Narrow antibiotic selection based on susceptibility results, clinical status, concomitant infections.

- Achromobacter is frequently multi-drug resistant, and ID consult is encouraged to guide appropriate management of these infections

Narrow antibiotic selection based on susceptibility results, clinical status, concomitant infections.

- Susceptibilities will not be routinely performed by the microbiology lab. Please call to request susceptibilities if strong suspicion for infection