Guidelines for Blood Culture Identification (BCID) 2 Data

What is BCID2?

The BioFire® FilmArray® Blood Culture Identification Panel (BCID) 2 is a test used to rapidly identify pathogens by amplifying DNA through PCR. This laboratory method helps identify organisms and resistance genes from positive blood cultures. **Table 1** lists the bacterial and fungal pathogens, and resistance genes detected by the BCID2 panel.

Table 1: BCID2 Pathogen and Resistance Gene Panel

Gram-Positive Bacteria	Gram-Negative Bacteria	Yeast	Resistance Genes
Enterococcus faecalis *Enterococcus faecium* *Listeria monocytogenes* *Staphylococcus* genus - *Staphylococcus aureus* - *Staphylococcus epidermidis* - *Staphylococcus lugdunensis* *Streptococcus* genus - *Streptococcus agalactiae* - *Streptococcus pneumoniae* - *Streptococcus pyogenes*	*Acinetobacter baumannii complex* *Bacteroides fragilis* *Enterobacterales* Order - *Enterobacter cloacae complex* - *Escherichia coli* - *Klebsiella aerogenes* - *Klebsiella oxytoca* - *Klebsiella pneumoniae* group - *Proteus spp.* - *Salmonella spp.* - *Serratia marcescens* *Haemophilus influenzae* *Neisseria meningitidis* *Pseudomonas aeruginosa* *Stenotrophomonas maltophilia*	*Candida albicans* *Candida auris* *Candida glabrata* *Candida krusei* *Candida parapsilosis* *Candida tropicalis* *Cryptococcus neoformans/gatti*	Carbapenemases - IMP - KPC - OXA-48-like - NDM - VIM Colistin Resistance - mcr-1 ESBL - CTX-M Methicillin-resistance - mecA/C - mecA/C and MREJ (MRSA) Vancomycin Resistance - vanA/B

How is BCID2 incorporated into clinical practice?

The microbiology lab notifies clinicians of positive blood culture gram-stain results immediately after they are performed. Afterwards, the BCID2 assay is performed for rapid identification. BCID2 results are typically available in CPRS within 2 hours. When blood culture gram stain and BCID2 results are known, current antimicrobial therapy should be evaluated considering the clinical picture and adjusted to the most appropriate single agent if possible. Recommended empiric antibiotic therapies for BCID2 results are outlined in **Tables 2-4** for gram-positive bacteria, gram-negative bacteria, and fungi. The Antimicrobial Stewardship Team developed these recommendations based on an analysis of the institutional antibiogram and IDSA Clinical Guidelines. Contact the ASP Pharmacist for alternative recommendations if patient is not a candidate for first line therapy. All dosing recommendations assume normal renal or hepatic function, pleas adjust dosing accordingly.

How reliable are BCID2 results?

The BCID2 test is highly accurate in monomicrobial bacteremia (99% sensitivity and 99.8% specificity), but in the rare incidence of polymicrobial bacteremia it may be less accurate. Therefore, polymicrobial gram stain results and BCID2 results with multiple organisms detected should be interpreted with caution. On the other hand, certain infections may be polymicrobial in nature and the isolation of a single pathogen from blood cultures, while allowing narrowing of therapy, should not result in over-narrowing. An example would be complicated intra-abdominal infections where anaerobes are frequently present and therapy active against these pathogens should generally be included until definitive cultures of the site of infection have returned.

BCID2 identification is limited to the pathogens and resistance genes listed on the panel (**Table 1**). If a positive blood culture results in a negative BCID2 report, please contact ASP Pharmacist or ID team for guidance. Occasionally, the detection of a resistance gene does not equate to confirmation of resistance when susceptibility testing is performed. Standard susceptibility testing is required to determine final antimicrobial susceptibility and should be used to guide final therapy decisions. When full susceptibility results become available, therapy should be adjusted to the narrowest spectrum appropriate agent.

References:

1. Rhoads DD, Pournaras S, Leber A, et al. Multicenter Evaluation of the BIOFIRE Blood Culture Identification 2 Panel for Detection of Bacteria, Yeasts, and Antimicrobial Resistance Genes in Positive Blood Culture Samples. *J Clin Microbiol* 2023; 61(6): e0189122.
2. IDSA 2023 Guidance on the Treatment of Antimicrobial Resistant Gram-Negative Infections (idsociety.org)

Table 2: Gram-Positive Bacteria

Bacterial Marker	Result	Interpretation	Preferred Therapy/ Comments
Enterococcus faecalis *VanA/B*	Detected Not Detected	*Enterococcus faecalis* Not-VRE	Ampicillin 2 gm IV q4h Infectious diseases (ID) service auto-consulted per hospital policy
Enterococcus faecalis *VanA/B*	Detected Detected	*Enterococcus faecalis* VRE (uncommon)	Ampicillin 2 gm IV q4h ID service auto-consulted per hospital policy
Enterococcus faecium *VanA/B*	Detected Not Detected	*Enterococcus faecium* Not-VRE (uncommon)	Vancomycin* IV one-time loading dose + maintenance dose (see pages 43-44 for dosing and monitoring) ID service auto-consulted per hospital policy
Enterococcus faecium *VanA/B*	Detected Detected	*Enterococcus faecium* VRE	Daptomycin^ 10-12 mg/kg IV q24h ID service auto-consulted per hospital policy
Listeria monocytogenes	Detected	*Listeria monocytogenes*	Ampicillin 2 gm IV q4h
Staphylococcus *S. aureus* *S. epidermidis, S. lugdunensis* MREJ and *mecA/C*	Detected Detected Not Detected N/A	<u>Possible</u> Methicillin-susceptible *S. aureus* (MSSA)	Vancomycin* IV one-time loading dose + maintenance dose (see pages 43-44 for dosing and monitoring) Presume MRSA until final susceptibilities available due to high incidence of underdetection with this species ID service auto-consulted per hospital policy
Staphylococcus *S. aureus* *S. epidermidis, S. lugdunensis* MREJ and *mecA/C*	Detected Detected Not Detected Detected	Methicillin-resistant *S. aureus* (MRSA)	Vancomycin* IV one-time loading dose + maintenance dose (see pages 43-44 for dosing and monitoring) ID service auto-consulted per hospital policy
Staphylococcus *S. epidermidis* *S. aureus, S. lugdunensis* *mecA/C*	Detected Detected Not Detected Not Detected	Methicillin-susceptible *Staphylococcus epidermidis (*MSSE)	1 of 2 blood culture sets positive: likely contaminant • Do not start antibiotics • If severely ill and on antibiotics, continue current therapy until definitive results become available 2 of 2 blood culture sets positive: possible infection Cefazolin 2 gm IV q8h
Staphylococcus *S. epidermidis* *S. aureus, S. lugdunensis* *mecA/C*	Detected Detected Not Detected Detected	Methicillin-resistant *Staphylococcus epidermidis* (MRSE)	<u>Blood culture results:</u> 1 of 2 sets positive: likely contaminant • Do not start antibiotics • If severely ill and on antibiotics, continue current therapy until definitive results become available 2 of 2 sets positive: possible infection Vancomycin* IV one-time loading dose + maintenance dose (see pages 43-44 for dosing and monitoring)
Staphylococcus *S. lugdunensis* *S. aureus, S. epidermidis* *mecA/C*	Detected Detected Not Detected Not Detected	Methicillin-susceptible *Staphylococcus lugdunensis*	Cefazolin 2 gm IV q8h Consider ID consult • Although a coagulase-negative species, infections are more like *S. aureus*. If 1 of 2 blood culture sets positive, may be a contaminant, but favor treatment and repeating blood cultures
Staphylococcus *S. lugdunensis* *S. aureus, S. epidermidis* *mecA/C*	Detected Detected Not Detected Detected	Methicillin-resistant *Staphylococcus lugdunensis*	Vancomycin* IV one-time loading dose + maintenance dose (see pages 43-44 for dosing and monitoring) Consider ID consult Although a coagulase-negative species, infections are more like *S. aureus*. If 1 of 2 blood culture sets positive, may be a contaminant, but favor treatment and repeating blood cultures
Staphylococcus *S. aureus, S. epidermidis,* *S. lugdunensis*	Detected Not detected Not detected	Presumed methicillin-resistant Coagulase-negative *Staph spp*. not listed on BCID2 panel	1 of 2 blood culture sets positive: likely contaminant • Do not start antibiotics • If severely ill and on antibiotics, continue current therapy until definitive results become available

		mecA not reported for species not on BCID 2 panel (ex: *S. hominis*)	2 of 2 blood culture sets positive: possible infection Vancomycin* IV one-time loading dose + maintenance dose (see pages 43-44 for dosing and monitoring)
Streptococcus spp. *S. agalactiae* (Group B) *S. pneumoniae* *S. pyogenes* (Group A)	Detected Detected Not Detected Not Detected	*S. agalactiae* (Group B)	Penicillin G 3 million units IV q4h or Ceftriaxone 2 gm IV q24h
Streptococcus spp. *S. agalactiae (Group B)* *S. pneumoniae* *S. pyogenes (Group A)*	Detected Not Detected Detected Not Detected	*S. pneumoniae*	Non-CNS infection: Ceftriaxone 2 gm IV q24h CNS infection: Ceftriaxone 2 gm IV q12h + Vancomycin* one-time loading dose + maintenance dose (see pages 43-44 for dosing and monitoring)
Streptococcus spp. *S. agalactiae (Group B)* *S. pneumoniae* *S. pyogenes (Group A)*	Detected Not Detected Not Detected Detected	*S. pyogenes (Group A)*	Penicillin G 3 million units IV q4h or Ceftriaxone 2 gm IV q24h
Streptococcus spp. *S. agalactiae (Group B)* *S. pneumoniae* *S. pyogenes (Group A)*	Detected Not Detected Not Detected Not Detected	*Streptococcus spp*. not listed on BCID2 panel	1 of 2 blood culture sets positive: likely contaminant • Consider withholding antibiotics • If severely ill and on antibiotics, continue current therapy until definitive results become available 2 of 2 blood culture sets positive: possible infection Ceftriaxone 2 gm IV q24h

* Contact team pharmacist/ inpatient pharmacy for assistance with vancomycin target achievement (AUC and/or trough)

^ Contact ASP Pharmacist or ID fellow is unavailable for antibiotic approval

Table 3: Gram-Negative Bacteria

Bacterial Marker	Result	Interpretation	Preferred Therapy/ Comments
Acinetobacter calcoaceticus-baumannii complex IMP, KPC, NDM, VIM CTM-X	Detected Not Detected Not Detected	*Acinetobacter calcoaceticus-baumannii* complex	Ampicillin-sulbactam 3 gm IV q6h
Acinetobacter calcoaceticus-baumannii complex IMP, KPC, NDM, VIM CTM-X	Detected Detected Not Detected	Presumed carbapenem-resistant *Acinetobacter calcoaceticus-baumannii* complex	KPC: Ampicillin-sulbactam 3 gm IV q4h + Minocycline^ 200 mg IV/PO q12h IMP, NDM, or VIM: Ampicillin-sulbactam 3 gm IV q4h + Minocycline^ 200 mg IV/PO q12h + Cefiderocol^ 2 gm IV q6h ID service auto-consulted per policy
Acinetobacter calcoaceticus-baumannii complex IMP, KPC, NDM, VIM CTM-X	Detected Not Detected Detected	Presumed beta-lactamase producing *Acinetobacter calcoaceticus-baumannii* complex	Meropenem^ 2 gm IV q8h
Bacteroides fragilis	Detected	*Bacteroides fragilis* (anaerobe)	Metronidazole 500 mg IV/PO q8h
Haemophilus influenzae	Detected	*Haemophilus influenzae*	Ampicillin-sulbactam 3 gm IV q6h
Neisseria meningitidis (encapsulated)	Detected	*Neisseria meningitidis*	Ceftriaxone 2 gm IV q12h
Pseudomonas aeruginosa IMP, KPC, NDM, VIM CTM-X	Detected Not Detected Not Detected	*Pseudomonas aeruginosa*	Piperacillin-tazobactam^ 4.5 gm IV q6h or Cefepime^ 2 gm IV q8h
Pseudomonas aeruginosa IMP, KPC, NDM, VIM CTM-X	Detected Detected Not Detected	Presumed carbapenem-resistant *Pseudomonas aeruginosa*	KPC: Ceftazidime-avibactam^ 2.5 gm IV q8h IMP, NDM, VIM: Cefiderocol^ 2 gm IV q6h ID service auto-consulted per policy
Pseudomonas aeruginosa IMP, KPC, NDM, VIM CTM-X	Detected Not Detected Detected	Presumed beta-lactamase producing *Pseudomonas aeruginosa*	Non-CNS: Meropenem^ 1 gm IV q8h CNS: Meropenem^ 2 gm IV q8h
Stenotrophomonas maltophilia	Detected	*Stenotrophomonas maltophilia*	TMP/SMX 5 mg/kg (of TMP component) IV/PO q12h + Levofloxacin^ 750 mg IV/PO q24h

The following guidelines are in reference to BCID2 results positive for the *Enterobacterales* order **Results and interpretation for resistance genes are grouped separately (see last 3 rows of this table)**			
Bacterial Marker	**Result**	**Interpretation**	**Preferred Therapy/ Comments**
Enterobacterales *Enterobacter cloacae* complex *Escherichia coli, Klebsiella aerogenes, Klebsiella oxytoca, Klebsiella pneumoniae* group, *Proteus spp., Salmonella spp., Serratia marcescens*	Detected Detected Not Detected	*Enterobacter cloacae* complex	Ertapenem 1 gm IV q24h Inducible AmpC beta-lactamase producer – carbapenems are drug of choice
Enterobacterales *Escherichia coli* *Enterobacter cloacae complex, Klebsiella aerogenes, Klebsiella oxytoca, Klebsiella pneumoniae* group, *Proteus spp., Salmonella spp., Serratia marcescens*	Detected Detected Not Detected	*Escherichia coli*	Ceftriaxone 2 gm IV q24h
Enterobacterales *Klebsiella aerogenes* *Enterobacter cloacae complex, Escherichia coli, Klebsiella oxytoca, Klebsiella pneumoniae* group, *Proteus spp., Salmonella spp., Serratia marcescens*	Detected Detected Not Detected	*Klebsiella aerogenes*	Ertapenem 1 gm IV q24h Inducible AmpC beta-lactamase producer – carbapenems are drug of choice
Enterobacterales *Klebsiella oxytoca* *Enterobacter cloacae complex, Escherichia coli, Klebsiella aerogenes, Klebsiella pneumoniae* group, *Proteus spp., Salmonella spp., Serratia marcescens*	Detected Detected Not Detected	*Klebsiella oxytoca*	Ceftriaxone 2 gm IV q24h
Enterobacterales *Klebsiella pneumoniae* group *Enterobacter cloacae complex, Escherichia coli, Klebsiella aerogenes, Klebsiella oxytoca*, *Proteus spp., Salmonella spp., Serratia marcescens*	Detected Detected Not Detected	*Klebsiella pneumoniae group*	Ertapenem 1 gm IV q24h Antibiogram 2024: 19% of isolates were ESBL positive and may not be mediated through CTM-X gene
Enterobacterales *Proteus spp.* *Enterobacter cloacae complex, Escherichia coli, Klebsiella aerogenes, Klebsiella oxytoca, Klebsiella pneumoniae* group, *Salmonella spp., Serratia marcescens*	Detected Detected Not Detected	*Proteus spp.*	Ceftriaxone 2 gm IV q24h
Enterobacterales *Salmonella spp.* *Enterobacter cloacae complex, Escherichia coli, Klebsiella aerogenes, Klebsiella oxytoca, Klebsiella pneumoniae* group, *Proteus spp., Salmonella spp.*	Detected Detected Not Detected	*Salmonella spp.*	Ceftriaxone 2 gm IV q24h
Enterobacterales *Serratia marcescens* *Enterobacter cloacae complex, Escherichia coli, Klebsiella aerogenes, Klebsiella oxytoca, Klebsiella pneumoniae group, Proteus spp., Serratia marcescens*	Detected Detected Not Detected	*Serratia marcescens*	Ertapenem 1 gm IV q24h

Enterobacterales *Enterobacter cloacae* complex *Escherichia coli, Klebsiella aerogenes, Klebsiella oxytoca, Klebsiella pneumoniae* group, *Proteus spp., Salmonella spp., Serratia marcescens*	Detected Not Detected	*Enterobacterales* organism not listed on BCID2 panel	Ertapenem 1 gm IV q24h Consider ID consult
Enterobacterales Any species **Resistance genes:** CTM-X IMP, KPC, NDM, VIM, OXA-48 -like mcr-1	Detected Detected Detected Not Detected Not Detected	Presumed Beta-lactamase producing (ESBL) *Enterobacterales*	Ertapenem 1 gm IV q24h
Enterobacterales Any species **Resistance genes:** CTM-X IMP, KPC, NDM, VIM, OXA-48 -like mcr-1	Detected Detected Not Detected Detected Not Detected	Presumed Carbapenem resistant *Enterobacterales*	ID service auto-consulted per policy
Enterobacterales Any species **Resistance genes:** CTM-X IMP, KPC, NDM, VIM, OXA-48 -like mcr-1	Detected Detected Not Detected Not Detected Detected	Presumed Colistin resistant *Enterobacterales*	If mcr-1 is the only resistance gene identified, continue empiric therapy for isolated organisms If more than 1 resistance gene present, consider ID consult for guidance

^Contact ASP Pharmacist for antibiotic approval

Table 4: Fungal Pathogens

Bacterial Marker	Result	Interpretation	Preferred Therapy/ Comments
Candida albicans	Detected	*Candida albicans*	Fluconazole 12 mg/kg IV/PO once, then 6 mg/kg q24h IV/PO
Candida auris	Detected	*Candida auris*	Micafungin 100 mg IV q24h
Candida glabrata	Detected	*Candida glabrata*	Micafungin 100 mg IV q24h
Candida krusei	Detected	*Candida krusei*	Micafungin 100 mg IV q24h
Candida parapsilosis	Detected	*Candida parapsilosis*	Micafungin 100 mg IV q24h
Candida tropicalis	Detected	*Candida tropicalis*	Micafungin 100 mg IV q24h
Cryptococcus neoformans/gatti	Detected	*Cryptococcus neoformans/gatti*	Amphotericin B (liposomal) 3-4 mg/kg IV q24h +/- flucytosine 25 mg/kg PO q6h

All fungal pathogens isolated in the blood will trigger an automatic ID consult per hospital policy