UCLA Health System

Antimicrobial Susceptibility Summary 2023

Clinical Microbiology
Department of Pathology & Laboratory Medicine

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The information contained in this booklet can also be found at:

https://asp.mednet.ucla.edu/pages/

Select “Clinical Microbiology”
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Preface

This booklet contains up-to-date information to assist the clinician in making decisions concerning antimicrobial therapy and testing.

These tables summarize susceptibility data obtained for organisms isolated in the UCLA Clinical Microbiology Laboratory in 2022.

In order to provide the most meaningful information, the laboratory is selective in reporting antimicrobial susceptibility results.
Reporting guidelines are based on:

1. Identity of the organism
2. Body site of culture
3. Overall antibiogram of the organism
4. Therapeutically relevant antimicrobials
5. Formulary status of the antimicrobial

Non-formulary drugs are not routinely reported and controlled formulary agents are reported only in the appropriate setting: e.g. amikacin and tobramycin if resistant to gentamicin. Results of all relevant drugs tested, including those not reported, are available upon request.

We thank:
Daniel Uslan, MD, Chief Infection Prevention
Tara Vijayan, MD, Medical Director, Adult ASP
Ishminder Kaur, MD, Medical Director, Pediatric ASP
Kavitha Prabaker, MD, Hospital Epidemiologist SMH
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Allison Tsan, CLS, Sr. Specialist, Brentwood Annex
Stephanie Horiuchi, CLS, Sr. Specialist, Brentwood Annex

Guidelines for Interpretation of Minimal Inhibitory Concentrations (MICs)

MICs are interpreted as susceptible, susceptible dose dependent, intermediate, resistant, or non-susceptible according to Clinical and Laboratory Standards Institute (CLSI) M100, 33rd edition guidelines. When deciding whether the interpretation is meaningful, one should consider the antimicrobial pharmacokinetics, taking into account dosage and route of administration, the infecting organism and site of infection, and previous clinical experience.

For antimicrobials without interpretive criteria consultation with Infectious Diseases strongly advised.

For additional information, please call the antimicrobial testing laboratory, or Antimicrobial Stewardship hotline.

Clinical Microbiology
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171315

Frequently called numbers*:

Antimicrobial Stewardship: antimicrobialstewardship@mednet.ucla.edu
Antimicrobial Testing Laboratory: 310-794-2760
Drug Information Center: 310-267-8522
Infection Control SMH-UCLA: 424-259-4454
Infection Control RRUMC: 310-794-0187
Infectious Diseases Adult: 310-825-7225
Infectious Diseases Pediatric: 310-825-5235
RRMC and RNPH ID Pharmacist - Adult: 310-267-1423, page 99917
RRMC ID Pharmacist - Adult and Pediatric: 310-267-8510, page 92528
SMH ID Pharmacist - Adult: 310-267- 7567, page 91059
Microbiology Fellow on-call: page 90103

* If calling within UCLA system, dial the last 5 digits of the phone number.

Resources at UCLA through the Antimicrobial Stewardship Program (ASP)

The Antimicrobial Stewardship Program (ASP) has made resources available for the sole purpose of improving clinical outcomes of patients with infections. Questions and guidance on interpretation of culture reports (contaminant/pathogen), drug dosing, etc. are welcome. The ASP can be contacted numerous ways, depending on the urgency and clinical needs:

ASP Helpdesk/Consultation Email:
antimicrobialstewardship@mednet.ucla.edu
Website: https://asp.mednet.ucla.edu/pages/
Note that the website has a **guidebook**, with detailed information about specific clinical syndromes, interpretation of microbiology reports, and guidelines for treatment.

We encourage you to reach out to the program with questions. The program is staffed by:

- Christine Pham, PharmD, ID Pharmacist
- Ethan Smith, PharmD, ID Pharmacist
- Lynn Chan, PharmD, BCID, ID Pharmacist
- Meganne Kanatani, PharmD, ID Pharmacist
- Daniel Uslan, MD, Chief Infection Prevention
- Tara Vijayan, MD, Medical Director, Adult ASP
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- Omai Garner, PhD, Section Chief Clinical Microbiology
- Sukantha Chandrasekaran, PhD, D(ABMM), Associate Director, Clinical Microbiology

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Glossary and Acronyms

—	Not routinely tested and/or not applicable
%R	Percent resistant
%S	Percent susceptible
Cipro R	Ciprofloxacin resistant
CP CRE	Carbapenemase producing carbapenem resistant Enterobacterales
CRE	Carbapenem Resistant Enterobacterales
I	Intermediate
ICU	Intensive care unit
IP	Inpatient (**excludes** intensive care unit and Emergency Department)
MDR	Multi-drug resistant
Mero R	Meropenem resistant
MIC	Minimal inhibitory concentration µg/mL
MRSA	Methicillin resistant Staphylococcus aureus
MSSA	Methicillin susceptible Staphylococcus aureus
Non-CP CRE	Non-Carbapenemase producing carbapenem resistant Enterobacterales
OP	Outpatient (**includes** Emergency Department collections)
Pip-Tazo R	Piperacillin tazobactam resistant
R	Resistant, can be resistant due to intrinsic resistance
S	Susceptible
SDD	Susceptible dose dependent
spp.	Species
UTIs	Urinary tract infections
V	Variable
VRE	Vancomycin-resistant Enterococcus

Table 1. Adults (> 21 y.o.) Most Common Gram-negative Bacteria – Non-Urine Isolates, % Susceptible

Organism	Location	No. Isolates	Penicillin				Cephalosporins				Carbapenems			Aminoglycosides			Fluoro-quinolone		Other
			Ampicillin	Amoxicillin-Clavulanic acid	Ampicillin - sulbactam	Piperacillin – tazobactam [1]	Cefazolin	Cefepime [1]	Ceftazidime	Ceftriaxone [2]	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin	Levofloxacin	Trimethoprim - sulfamethoxazole
Enterobacter cloacae complex[3]	OP	114	R	R	R	91	R	99	—[4]	—[4]	97	99	99	99	97	96	96	96	89
	IP	107	R	R	R	76	R	97	—[4]	—[4]	89	99	99	99	99	99	97	98	86
	ICU	58	R	R	R	62	R	93	—[4]	—[4]	72	93	98	98	95	95	88	91	88
Escherichia coli	OP	312	—	73	—	94	57	84	86	81	99	99	99	95	83	82	69	69	63
	IP	341	—	65	—	92	50	77	77	73	99	99	99	93	81	80	60	62	60
	ICU	139	—	57	—	82	37	69	64	58	96	99	99	87	84	79	52	56	51
Klebsiella pneumoniae	OP	164	R	83	—	88	80	83	84	82	96	98	98	98	90	85	77	84	76
	IP	227	R	83	—	80	79	83	83	81	96	97	97	97	91	89	74	82	75
	ICU	146	R	75	—	73	75	79	81	76	91	97	93	95	91	86	73	79	77
Proteus mirabilis	OP	136	—	91	—	98	6	92	97	85	99	—[5]	99	93	85	88	72	73	71
	IP	122	—	88	—	94	3	88	95	80	99	—[5]	99	83	78	79	61	62	62
	ICU	46	—	87	—	100	0	76	96	65	99	—[5]	99	96	76	83	46	46	57
Pseudomonas aeruginosa	OP	499	R	R	R	87	R	88	89	R	R	85	88	—[6]	—[6]	91	72	68	R
	IP	372	R	R	R	74	R	83	77	R	R	77	81	—[6]	—[6]	90	72	63	R
	ICU	149	R	R	R	53	R	70	61	R	R	51	53	—[6]	—[6]	89	64	52	R

[1] %S includes %SDD

[2] Cefotaxime and ceftriaxone have comparable activity against *Enterobacterales.*

[3] *Enterobacter cloacae* complex includes *E.cloacae, E.asburiae, and E.hormaecheii.*

[4] 3rd generation cephalosporins should not be used for serious infections.

[5] Proteus spp. may have elevated imipenem MIC by mechanisms other than production of carbapenemases.

[6] As of 2023, Pseudomonas aeruginosa breakpoints were revised, and tobramycin is now the only recommended aminoglycoside for systemic therapy. Amikacin is effective against P. aeruginosa only in urinary tract infections. Gentamicin is no longer recommended for P. aeruginosa infection at any site.

Table 2. Adults (> 21 y.o.) Gram-negative Bacteria – Non-Urine Isolates, % Susceptible

Organism	No. Isolates	Penicillin		Cephalosporins				Carbapenems			Aminoglycosides			Fluoro-quinolone		Other
		Amoxicillin-Clavulanic acid	Piperacillin-tazobactam	Cefazolin	Cefepime [1]	Ceftazidime	Ceftriaxone[2]	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin	Levofloxacin	Trimethoprim sulfamethoxazole
Citrobacter freundii complex[3]	79	R	72	R	99	—[4]	—[4]	97	99	100	99	95	93	90	90	89
Klebsiella (Enterobacter) aerogenes	147	R	76	R	96	—[4]	—[4]	93	95	95	99	98	98	95	97	94
Enterobacter cloacae complex[5]	235	R	76	R	96	—[4]	—[4]	93	95	95	99	98	98	95	96	94
Escherichia coli	730	67	91	51	84	79	74	98	99	99	92	83	81	62	65	60
Klebsiella oxytoca	162	90	94	11	99	96	91	99	99	99	99	97	96	96	98	94
Klebsiella pneumoniae	452	81	80	65	86	83	79	95	97	96	97	91	87	75	80	76
Morganella morganii	54	R	99	R	94	—[4]	—[4]	99	—[6]	99	99	91	96	67	99	70
Proteus mirabilis	248	91	97	4	96	97	82	99	—[6]	99	90	83	86	67	68	68
Serratia marcescens	182	R	93	R	99	—[4]	—[4]	98	97	99	97	96	88	73	82	95
Acinetobacter baumannii complex [7]	76	—	45	R	58	55	—	R	59	58	70	65	67	59	62	59
Pseudomonas aeruginosa	870	R	70	R	84	81	R	R	79	82	—[8]	—[8]	95	71	64	R
Stenotrophomonas maltophilia	71	R	R	R	—	—	R	R	R	R	R	R	R	—	42[9]	99
Achromobacter spp.	69	—	94	R	6	71	—	—	91	87	0	1	0	1	36	88

[1] %S includes %SDD
[2] Ceftriaxone and cefotaxime have comparable activity against *Enterobacterales.*
[3] *Citrobacter freundii complex* includes C. freundii, C. youngae, C. braakii, and C. werkmanii.
[4] 3rd generation cephalosporins should not be used for serious infections.
[5] *Enterobacter cloacae complex* includes *E. cloacae, E. asburiae* , and *E. hormaecheii.*
[6] *Proteus spp*. and *Morganella spp.* may have elevated imipenem MIC by mechanisms other than production of carbapenemases.
[7] *Acinetobacter baumannii complex* includes *A.baumannii, A. calcoaceticus, A. pittii,* and *A. nosocomialis.*
[8] As of 2023, Pseudomonas aeruginosa breakpoints were revised, and tobramycin is now the only recommended aminoglycoside for systemic therapy. Amikacin is effective against P. aeruginosa only in urinary tract infections. Gentamicin is no longer recommended for P. aeruginosa infection at any site.
[9] Levofloxacin should not be used alone for antimicrobial therapy.

Table 3. Adults (> 21 y.o.) Gram-negative Bacteria – Urine Isolates, % Susceptible

Organism	Location	No. Isolates	Penicillin		Cephalosporin			Carbapenem			Aminoglycoside			Fluoro-quinolone		Other	
			Ampicillin	Amoxicillin – Clavulanic acid	Oral Cephalosporin [1]	Cefepime [2]	Ceftriaxone [3]	Ertapenem	Imipenem	Meropenem	Gentamicin	Tobramycin	Amikacin	Ciprofloxacin	Levofloxacin	Nitrofurantoin	Trimethoprim – sulfamethoxazole
Enterobacter cloacae complex	OP	243	R	R	R	R	— [4]	92	98	98	97	97	—	88	88	43	87
	IP	26[5]	R	R	R	92	— [5]	92	99	99	96	92	—	85	85	42	77
Escherichia coli	OP	9039	56	86	87	—	89	99	99	99	90	89	—	75	70	97	74
	IP	421	40	74	72	—	73	99	99	99	84	82	—	55	50	94	65
Klebsiella pneumoniae	OP	1534	R	R	88	—	89	99	99	99	94	93	—	85	82	26	84
	IP	164	R	R	70	—	72	96	98	97	88	82	—	66	62	23	66
Proteus mirabilis	OP	851	80	83	92	—	94	99	—	99	92	92	—	84	84	R	80
	IP	74	66	74	80	—	85	99	—	99	86	86	—	65	65	R	69
Pseudomonas aeruginosa [6]	OP	489	R	R	R	94	R	R	88	92	—[7]	97	91	82	76	R	R
	IP	98	R	R	R	83	R	R	80	81	—[7]	97	86	76	72	R	R

[1] Oral cephalosporins include cefpodoxime and cephalexin for treatment of uncomplicated urinary tract infections.
[2] %S includes %SDD
[3] Ceftriaxone and cefotaxime have comparable activity against *Enterobacterales.*
[4] 3rd generation cephalosporin should not be used for serious infections.
[5] Calculated from fewer than the standard recommendation of 30 isolates.
[6] Ceftazidime: OP 92%, IP 80%, Piperacillin-tazobactam: OP 91%, IP 78%.
[7] As of 2023, Pseudomonas aeruginosa breakpoints were revised, and tobramycin is now the only recommended aminoglycoside for systemic therapy. Amikacin is effective against P. aeruginosa only in urinary tract infections. Gentamicin is no longer recommended for P. aeruginosa infection at any site.

Table 4. Adults (> 21 y.o.) Gram-positive Cocci, % Susceptible

Organism	Location	No. Isolates	Penicillins			Other										
			Ampicillin	Oxacillin	Penicillin	High Level Gentamicin [1]	Ciprofloxacin	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Linezolid	Rifampin [2]	Trimethoprim sulfamethoxazole	Vancomycin	Ceftaroline
Staphylococcus aureus	All	2204	—	73 [3]	25	—	73	70	99	99	53	99	99	99	99	99
Oxacillin-resistant *S. aureus* (MRSA)	OP	388	—	R [3]	R [3]	—	27	63	99	98	18	99	98	97	99	99
	IP	168	—	R [3]	R [3]	—	18	52	99	97	14	99	97	98	99	99
	ICU	75	—	R [3]	R [3]	—	20	52	99	95	17	99	99	99	99	99
Oxacillin-susceptible *S. aureus* (MSSA)	OP	1139	—	100	36	—	89	74	99	99	67	99	99	99	99	99
	IP	376	—	100	31	—	90	73	99	98	67	99	99	99	99	99
	ICU	157	—	100	29	—	91	74	99	99	66	99	99	99	99	99
Staphylococcus epidermidis	All	499	—	44	11	—	62	61	99	88	39	99	96	60	99	—
Staphylococcus haemolyticus	All	60	—	66	48	—	60	57	99	92	28	99	95	80	99	—
Staphylococcus lugdunensis [4]	All	267	—	94	48	—	97	85	99	99	82	99	99	99	99	—
Staphylococcus pseudintermedius/ intermedius	All	54	—	80	17	—	67	50	99	72	48	99	99	63	99	—
Coagulase negative *Staphylococcus* [5,6]	All	115	—	75	35	—	81	80	97	98	54	99	99	88	99	—
Enterococcus spp.[7] [8]	All	48	90	—	—	—[9]	63	R	79	65	R	100	54	R	78	R
Enterococcus faecalis [7]	All	664	99	—	—	81[10]	66	R	92	41	R	99	25	R	98	R
Enterococcus faecium [7]	All	193	12	—	—	85[10]	8	R	84[11]	59	R	99	6	R	37	R

[1] High level gentamicin 500µg/mL.
[2] Rifampin should not be used as monotherapy.
[3] Staphylococcus resistant to oxacillin are resistant to cefazolin, cephalexin, ceftriaxone and all other beta-lactams except ceftaroline.
[4] *S. lugdunensis* is best treated with a Beta-lactam agent.
[5] *S. saprophyticus* urinary tract infections respond to antibiotic concentrations achieved in urine with agents commonly used to treat acute uncomplicated UTIs.
[6] Excluding *S. epidermidis*, *S. lugdunensis* and *S. pseudintermedius.*
[7] Serious Enterococcal infections need combination therapy of ampicillin plus ceftriaxone or an aminoglycoside.
[8] Enterococcus spp. excludes *E.faecalis* and *E.faecium.*
[9] Insufficient data to calculate % susceptible.
[10] % susceptible calculated with isolated tested from sterile body sites. E. faecalis n=71 and E. faecium n=39.
[11] % susceptible includes susceptible dose dependent.

Table 4. Adults (> 21 y.o.) Gram-positive Cocci, % Susceptible (cont.)

Organism	No. Isolates	Penicillins		Cephalosporins			Other					
		Amoxicillin	Penicillin	Cefotaxime	Ceftriaxone	Clindamycin	Doxycycline	Erythromycin	Levofloxacin	Trimethoprim – sulfamethoxazole	Tetracycline	Vancomycin
Streptococcus pneumoniae	18 [1]	94	—	—	—	78	78	61	100	72	—	100
Meningitis [2]		—	56	89	84	—	—	—	—	—	—	—
Non-meningitis [3]		—	94	99	99	—	—	—	—	—	—	—
Viridans group *Streptococcus spp.* [4]	181	—	73 [5]	98	97	—	—	—	—	—	—	100
Streptococcus anginosus	71	—	97	99	99	—	—	—	—	—	—	100
Streptococcus agalactiae (Group B streptococci)	68	—	100	—	—	49	—	—	—	—	—	100
Streptococcus pyogenes (Group A streptococci)	25 [1]	—	100	—	—	80	—	72	—	—	60	100

[1] Calculated from fewer than the standard recommendation of 30 isolates.
[2] % susceptible for penicillin, cefotaxime and ceftriaxone applies to patients with meningitis.
[3] % susceptible for penicillin, cefotaxime and ceftriaxone applies to patients without meningitis.
[4] Excluding *Streptococcus anginosus group.*
[5] Resistant (R) includes 24% Intermediate (MIC 0.25-2 µg/ml) and 2% High-level (MIC >2 µg/ml) resistance.

Table 5. Miscellaneous Gram-negative Bacteria

Organism	No. Isolates	% beta-lactamase positive[1]
Haemophilus influenzae	73 (pts. >21 y.o) 24 (pts. ≤21 y.o.)	37 25
Moraxella catarrhalis	30 (pts. >21 y.o) 8 (pts. ≤21 y.o.)	100 87
Neisseria gonorrhoeae	The current therapy recommendation is ceftriaxone. Culture and susceptibility testing should be performed in cases of treatment failure. See http://www.cdc.gov/std/Gonorrhea/treatment.htm PER STD 2021 treatment guidelines, the recommended treatment for gonorrhea is ceftriaxone 500 mg IM x 1 for patients <150 kg, 1g for patients >= 150 kg. Doxycycline 100mg twice daily for 7 days is recommended if there is suspicion or confirmed Chlamydia co-infection	
Neisseria meningitidis	The current therapy recommendation is ceftriaxone for treating meningococcal infections. Penicillin may be considered after susceptibilities return and MIC is ≤0.12 µg/mL (Antimicrob Agents Chemother 56:2268, 2012). Reports have noted some isolates with resistance to fluoroquinolones, agents often used for prophylaxis (MMWR. 2008. 57:173-175). **Sanford guide 2022** Recommended: Ceftriaxone Alternative: Meropenem	

[1] Resistant to ampicillin, amoxicillin, and penicillin.

Table 6. Multiple Drug Resistant Gram-negative Bacteria – All sources % Susceptible

Organism	Amikacin		Aztreonam		Ceftazidime-Avibactam [1]		Ceftolozane-Tazobactam [1]		Tigecycline [2]		Meropenem-Vaborbactam [1]		Eravacycline [2, 3]		Omadacycline [2, 4]	
	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible
Carbapenem Resistant Enterobacterales (CRE) [5]	299	96	94	13	299	95	296	67	142	89	93	85	132	73	132	73

Organism	Number of Isolates	Amikacin	Gentamicin	Ciprofloxacin	Piperacillin-Tazobactam	Cefepime	Ceftazidime	Ceftazidime-Avibactam [1, 2]	Ceftolozane-Tazobactam [1, 2]	Colistin % Intermediate [1, 6]	Minocycline	Trimethoprim-sulfamethoxazole
***Pseudomonas aeruginosa*, Imipenem or Meropenem resistant**	202	65 [7]	—	40	25	52	46	77	84	100 [9]	0	R
***Pseudomonas aeruginosa*, Imipenem and Meropenem resistant**	140	60 [7]	—	33	6	38	31	68	78	100 [9]	0	R
***Acinetobacter baumannii complex* [8], Meropenem resistant**	27 [9]	30	22	11	0	0	15	—	—	100 [9]	62	22

[1] Restricted formulary. ID consult required.
[2] Interpretations are based on FDA breakpoints. There are no current CLSI breakpoints available for these drugs. Please refer to the FDA website at: https://www.fda.gov/drugs/development-resources/antibacterial-susceptibility-test-interpretive-criteria.
[3] FDA guidelines indicated that clinical efficacy was shown for *Citrobacter freundii, Enterobacter cloacae, Escherichia coli, Klebsiella oxytoca* & *Klebsiella pneumonia.*
[4] FDA breakpoint for Omadacycline applies to *Klebsiella pneumoniae* only and indicated for Community Acquired Bacterial Pneumonia (CABP) and Acute Bacterial Skin/Skin Structure Infections (ABSSSI).
[5] CRE: Enterobacterales resistant to one or more carbapenem i.e. Ertapenem, Imipenem or Meropenem
[6] Routine colistin testing was discontinued on December 2020.
[7] Amikacin for Pseudomonas aeruginosa is for Urine isolates only.
[8] Acinetobacter baumannii complex includes A. baumannii, A. calcoaceticus, A. pittii and A. nosocomialis.
[9] Calculated from fewer than the standard recommendation of 30 isolates.

Table 7. Pediatrics (≤ 21 y.o.) Gram-negative Bacteria – Non-Urine Isolates, % Susceptible

Organism	No. Isolates	Penicillins				Cephalosporins				Carbapenems			Aminoglycosides			Fluoroquin-olone	Other
		Ampicillin [1]	Amoxicillin-Clavulanic acid	Ampicillin-sulbactam [1]	Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone [2]	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin [3]	Trimethoprim – sulfamethoxazole
Enterobacter cloacae complex [4]	38	R	R	R	82	R	89	— [5]	— [5]	97	99	99	99	99	99	94	94
Escherichia coli	62	—	66	—	87	71	81	82	76	98	98	98	92	84	83	69	68
Klebsiella pneumoniae	44	R	93	—	95	91	91	93	89	99	99	99	99	95	95	89	84
Serratia marcescens	25 [6]	R	R	R	84	R	96	— [5]	— [5]	96	99	99	96	96	92	88	99
Pseudomonas aeruginosa	80	R	R	R	64	R	84	81	R	R	84	90	—[7]	—[7]	94	81	R

[1] Ampicillin and Ampicillin-sulbactam testing were discontinued on July 26, 2016.
[2] Ceftriaxone and cefotaxime have comparable activity against *Enterobacteriaceae*.
[3] Ciprofloxacin is associated with arthropathy and histological changes in weight-bearing joints of juvenile animals and should only be used when no safe and effective alternatives exist.
[4] *Enterobacter cloacae* complex includes *E.cloacae, E.asburiae, and E.hormaecheii.*
[5] 3rd generation cephalosporins should not be used for serious infections.
[6] Calculated from fewer than the standard recommendation of 30 isolates
[7] As of 2023, Pseudomonas aeruginosa breakpoints were revised, and tobramycin is now the only recommended aminoglycoside for systemic therapy. Amikacin is effective against P. aeruginosa only in urinary tract infections. Gentamicin is no longer recommended for P. aeruginosa infection at any site.

Table 8. Pediatrics (≤ 21 y.o.) Gram-negative Bacteria – Urine Isolates, % Susceptible

Organism	No. Isolates	Penicillins		Cephalosporins				Carbapenems			Amino-glycosides			Fluoroqui-nolone	Other	
		Ampicillin	Amoxicillin - Clavulanic acid	Oral Cephalosporins [1]	Cefepime	Ceftazidime	Ceftriaxone [2]	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin [3]	Trimethoprim – sulfamethoxazole	Nitrofurantoin
Enterobacter cloacae complex [4]	18 [5]	R	R	R	94	—	—	94	94	94	—	94	—	83	83	22
Escherichia coli	755	58	86	91	—	—	93	99	99	99	—	91	90	82	74	99
Klebsiella pneumoniae	65	R	95	95	—	—	95	99	99	99	—	97	96	91	86	18
Proteus mirabilis	64	91	89	97	—	—	97	99	—[6]	99	—	98	99	91	88	R
Pseudomonas aeruginosa	26 [5]	R	R	R	92	85	R	R	88	88	92	—[7]	99	85	R	R

[1] Oral Cephalosporins include Cefpodoxime and Cephalexin for treatment of uncomplicated urinary tract infections.
[2] Ceftriaxone and Cefotaxime have comparable activity against *Enterobacterales.*
[3] Ciprofloxacin is associated with arthropathy and histological changes in weight-bearing joints of juvenile animals and should only be used when no safe and effective alternatives exist.
[4] *Enterobacter cloacae* complex includes *E.cloacae, E.asburiae, and E.hormaecheii.*
[5] Calculated from fewer than the standard recommendation of 30 isolates.
[6] Proteus spp. may have elevated imipenem MIC by mechanisms other than production of carbapenemases.
[7] As of 2023, Pseudomonas aeruginosa breakpoints were revised, and tobramycin is now the only recommended aminoglycoside for systemic therapy. Amikacin is effective against P. aeruginosa only in urinary tract infections. Gentamicin is no longer recommended for P. aeruginosa infection at any site.

Table 9. Pediatrics (≤ 21 y.o.) Gram-positive Cocci, % Susceptible

Organism	Location	No. Isolates	Penicillins			Cephalos-porins		Others											
			Ampicillin	Oxacillin	Penicillin	Ceftriaxone	Cefotaxime	High Level Gentamicin [1]	Ciprofloxacin [2]	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Linezolid	Quinupristin-dalfopristin	Rifampin [3]	Trimethoprim-sulfamethoxazole	Vancomycin	Ceftaroline
Staphylococcus aureus (All)	OP	284	—	86	28	—	—	—	85	76	99	99	63	99	99	99	99	99	99
	IP	91	—	80	24	—	—	—	80	70	99	99	55	99	99	99	99	99	99
Oxacillin-resistant *S. aureus* (MRSA) [3]	OP	41	—	R[4]	R[4]	R[4]	R[4]	—	37	78	99	99	24	99	99	99	99	99	99
	IP	18 [5]	—	R[4]	R[4]	R[4]	R[4]	—	28	61	99	99	22	99	99	99	99	99	99
Oxacillin-susceptible *S. aureus* (MSSA)	OP	244	—	100	32	—	—	—	93	76	99	99	68	99	99	99	99	99	99
	IP	75	—	100	29	—	—	—	93	73	99	99	64	99	99	99	99	99	99
Coagulase negative *Staphylococcus*[6]	OP	16 [5]	—	75	44	—	—	—	99	88	99	99	63	99	94	88	99	—	—
	IP	17 [5]	—	65	41	—	—	—	94	65	99	94	35	99	99	99	99	—	—
Staphylococcus epidermidis	All	70	—	34	7	—	—	—	71	40	99	83	21	99	93	63	99	70	—
Staphylococcus lugdunensis	All	22 [5]	—	82	48	—	—	—	99	77	99	99	73	99	99	99	99	82	—
Enterococcus spp.[7]	All [8]	5 [5]	99	—	—	R	R	99	80	R	40	80	R	99	20	R	99	99	—
Enterococcus faecalis	All	55	99	—	—	R	R	78	67	R	98	31	R	98	24	R	99	99	—
Enterococcus faecium	All	6 [5]	0	—	—	R	R	99	0	R	83	83	R	99	17	R	33	0	—

[1] High level Gentamicin 500 µg/ml.

[2] Ciprofloxacin is associated with arthropathy and histological changes in weight bearing joints of juvenile animals and should only be used when no safe and effective alternatives exist.

[3] Rifampin should not be used as monotherapy.

[4] *Staphylococcus* resistant to oxacillin are resistant to cefazolin, cephalexin, ceftriaxone and all other beta-lactams except ceftaroline.

[5] Calculated from fewer than the standard recommendation of 30 isolates.

[6] Excludes *S. epidermidis* and *S. lugdunensis.*

[7] Excludes *E. faecalis* and *E. faecium.*

[8] Includes isolates tested from all body sites.

Table 9. Pediatrics (≤ 21 y.o.) Gram-positive Cocci, % Susceptible (cont.)

Organism	No. Isolates	Penicillins		Cephalosporins		Other				
		Amoxicillin	Penicillin	Cefotaxime	Ceftriaxone	Clindamycin	Doxycycline	Erythromycin	Trimethoprim – sulfamethoxazole	Vancomycin
Viridans group Streptococcus	14 [1]	—	43	79	79	—	—	—	—	100
Streptococcus anginosus	8 [1]	—	100	100	100	—	—	—	—	100
Streptococcus pneumoniae	6 [1]	100		—	—	100	100	100	50	100
Meningitis [2]		—	67	99	99	—	—	—	—	—
Non-meningitis [3]		—	99	99	99	—	—	—	—	—

[1] Calculated from fewer than the standard recommendation of 30 isolates.
[2] % susceptible for penicillin, cefotaxime and ceftriaxone applies to patients with meningitis.
[3] % susceptible for penicillin, cefotaxime and ceftriaxone applies to patients without meningitis.

Table 10. Yeasts, %S, %I, %SDD, %R, 2021-2022

1. Most yeast infections can be treated empirically. Antifungal testing of yeasts may be warranted for the following:
   - Oropharyngeal or vaginal infections due to *Candida* spp. in patients who appear to be failing therapy.
   - Management of invasive *Candida* spp. infections when utility of an azole agent is uncertain (e.g., *Candida* spp. other than *C. albicans*), per IDSA guidelines for candidiasis: CID 2016:62, E1-E50. Clinical Practice Guidelines for the Management of Candidiasis.
2. Isolation of Candida in respiratory specimens of immunocompetent patients should be interpreted as airway colonization.

		Percent Susceptible, Susceptible Dose Dependent, Intermediate, Resistant at Breakpoints[1], [2]														
Organism	**No. of Isolates**		**Fluconazole [3]**			**Voriconazole [3]**			**Caspofungin [3]**			**Micafungin [3]**			**Anidulafungin [3]**		
			S	SDD	R	S	I	R	S	I	R	S	I	R	S	I	R
Candida albicans	356	MIC µg/mL	≤ 2	4	≥ 8	≤ 0.12	0.25-0.5	≥ 1	≤ 0.25	0.5	≥ 1	≤ 0.25	0.5	≥ 1	≤ 0.25	0.5	≥ 1
		%	87	7	6	94	4	2	99	0	0	99	0	0	99	0	0
Candida glabrata	168	MIC µg/mL	—	≤ 32	≥ 64	— [4]	— [4]	— [4]	≤ 0.12	0.25	≥ 0.5	≤ 0.06	0.12	≥ 0.25	≤ 0.12	0.25	≥ 0.5
		%	—	90	10	— [4]	— [4]	— [4]	98	1	1	97	0	3	98	0	2
Candida parapsilosis	85	MIC µg/mL	≤ 2	4	≥ 8	≤ 0.12	0.25-0.5	≥ 1	≤ 2	4	≥ 8	≤ 2	4	≥ 8	≤ 2	4	≥ 8
		%	86	4	10	91	2	7	99	0	0	99	0	0	85	15	0
Candida tropicalis	39	MIC µg/mL	≤ 2	4	≥ 8	≤ 0.12	0.25-0.5	≥ 1	≤ 0.25	0.5	≥ 1	≤ 0.25	0.5	≥ 1	≤ 0.25	0.5	≥ 1
		%	90	4	6	88	8	4	98	0	2	99	0	0	99	0	0
Candida krusei	29 [5]	MIC µg/mL	—	—	—	≤ 0.5	1	≥ 2	≤ 0.25	0.5	≥ 1	≤ 0.25	0.5	≥ 1	≤ 0.25	0.5	≥ 1
		%	R	R	R	95	0	5	95	5	0	99	0	0	99	0	0
Candida guilliermondii	7 [5]	MIC µg/mL	—	—	—	—	—	—	≤ 2	4	≥ 8	≤ 2	4	≥ 8	≤ 2	4	≥ 8
		%	—	—	—	—	—	—	99	0	0	99	0	0	88	12	0

[1] CLSI. Reference Method for Broth Dilution Antifungal Susceptibility Testing of Yeast. 4th ed. CLSI Standard M27. Wayne, PA.: Clinical and Laboratory Standards Institute; 2017

[2] CLSI. Performance Standards for Antifungal Susceptibility Testing of Yeasts. 2nd ed. CLSI Standard M27. Wayne, PA.: Clinical and Laboratory Standards Institute; 2017

[3] Not all isolates were tested against all four antifungal agents.

[4] For *C. glabrata* and voriconazole, current data are insufficient to demonstrate correlation between *in –vitro* susceptibility testing and clinical outcome.

[5] Calculated from fewer than the standard recommendation of 30 isolates.

Table 11. Emerging Resistance Concerns

When unusual antimicrobial resistance (R) is observed, an Infectious Disease (ID) consult is strongly suggested to optimize therapy and prevent nosocomial transmission.

Organism	Resistant to:	Percent Resistant:	Therapeutic Options	Comments
Staphylococcus aureus	Oxacillin (MRSA)	Adults (>21 y.o.) Inpatients (n=729) [1] 30% Outpatients (n=1515) [1] 26% Pediatrics (≤21 y.o.) Inpatients (n=91) [1] 20% Outpatients (n=284) [1] 14%	vancomycin ceftaroline daptomycin	MRSA are clinically resistant to all ß-lactams, ß-lactam / ß-lactamase inhibitor combinations and carbapenems, excluding ceftaroline.[1] MRSA are also typically resistant to fluoroquinolones
Streptococcus pneumoniae (non-meningitis)	Penicillin (MIC > 2 µg/ml)	All isolates (n=24) Penicillin MIC >2 µg/ml 4%	ceftriaxone or cefotaxime or vancomycin	If susceptible (MIC ≤2.0 µg/ml), high dose penicillin has been shown to be effective for infections other than meningitis.[2]
Streptococcus pneumoniae (non-meningitis)	Cefotaxime, Ceftriaxone (Penicillin resistant always)	All isolates (n=19) Cefotaxime and ceftriaxone Low level R (n=1) 0% High level R (n=1) 0%	vancomycin levofloxacin	If low-level resistance (MIC=2.0 µg/ml), high dose cefotaxime or ceftriaxone may be effective for infections other than meningitis.[2]

[1] Isolates from all sources.
[2] The Sanford Guide to Antimicrobial Therapy. (2020). Sperryville, VA: Antimicrobial Therapy, Inc.

Table 11. Emerging Resistance Concerns
(cont.)

When unusual antimicrobial resistance (R) is observed, an Infectious Disease (ID) consult is strongly suggested to optimize therapy and prevent nosocomial transmission.

Organism	Resistant to:	Percent Resistant:	Therapeutic Options	Comments
Viridans group *Streptococcus* (excludes *S.anginosus* group [1])	penicillin	Blood isolates (n = 27) low level R 8% high level R 0%	vancomycin or penicillin + aminoglycoside	Level of penicillin resistance is particularly useful in guiding therapy for endocarditis. [2] For low level resistance, MICs are 0.25–2.0 µg/ml; for high level, MICs are >2.0 µg/ml.[3]
Enterococcus spp.	vancomycin (VRE)	Blood isolates *E. faecium* (n = 72) 69% *E. faecalis* (n = 93) 4%	Check in vitro susceptibility results and contact Infectious Diseases.	Vancomycin-resistant *Enterococcus* (VRE) are often resistant to many potentially useful agents. Therapeutic management must be determined on a case-by-case basis.
	High level gentamicin 500 µg/mL	Blood isolates *E. faecium* (n = 72) 14% *E. faecalis* (n = 93) 12%	Check in vitro susceptibility results and contact Infectious Diseases.	Both aminoglycoside and cell wall active agent (ampicillin, penicillin, or vancomycin) must be susceptible for synergistic interaction.

[1] Streptococcus anginosus, Streptococcus intermedius, and Streptococcus constellatus
[2] The Sanford Guide to Antimicrobial Therapy. (2020). Sperryville, VA: Antimicrobial Therapy, Inc.
[3] Baddour, L. M., et al. (2015). Infective Endocarditis in Adults: Diagnosis, Antimicrobial Therapy, and Management of Complications: A Scientific Statement for Healthcare Professionals From the American Heart Association. Circulation, 132(15), 1435–1486.

Table 11. Emerging Resistance Concerns (cont.)

Organism	Resistant to:	Percent Resistant:	Therapeutic Options	Comments
Klebsiella spp. *E. coli*	ceftriaxone or other 3rd generation cephalosporin	Blood isolates: *Klebsiella* spp.(n = 157) 21% *E. coli* (n = 314) 28%	ertapenem ciprofloxacin	In vitro resistance to 3rd generation cephalosporins suggests the strain is producing extended-spectrum ß-lactamases (ESBL), or AmpC
K. pneumoniae and other *Enterobacterales*	carbapenem	All isolates (n = 17680): 2% Blood isolates (n=625): 4%	Check in vitro susceptibility results and contact Infectious Diseases.	Decreased susceptibility to carbapenems is increasing primarily among ICU patients' isolates. These isolates may be resistant to all available antimicrobial agents.
Citrobacter freundii complex *Enterobacter* cloacae complex *Klebsiella aerogenes*	3rd generation cephalosporins (e.g. ceftriaxone)	See comments	cefepime aminoglycoside ciprofloxacin ertapenem meropenem trimeth-sulfa	Organisms listed typically produce inducible ß-lactamases. Isolates that appear susceptible to 3rd generation cephalosporins may develop resistance during therapy.[1]
Pseudomonas aeruginosa	cefepime and/or piperacillin-tazobactam	All isolates: (n=1510) 18%	Check in vitro susceptibility results and contact Infectious Diseases.	Therapeutic management must be determined on a case by case basis.
Acinetobacter baumannii complex	amikacin, cefepime, ceftazidime, ciprofloxacin, meropenem, piperacillin-tazobactam, and trimeth-sulfa	All isolates: (n=97) 19%	Check in vitro susceptibility results and contact Infectious Diseases.	Therapeutic management must be determined on a case by case basis.

[1] Tamma, P., Aitken, S., Bonomo, R., Mathers, A., van Duin, D., & Clancy, C. (2021). IDSA guidance on the treatment of antimicrobial-resistant gram-negative infections: version 2.0. Arlington, VA: IDSA

Table 11. Emerging Resistance Concerns
(cont.)

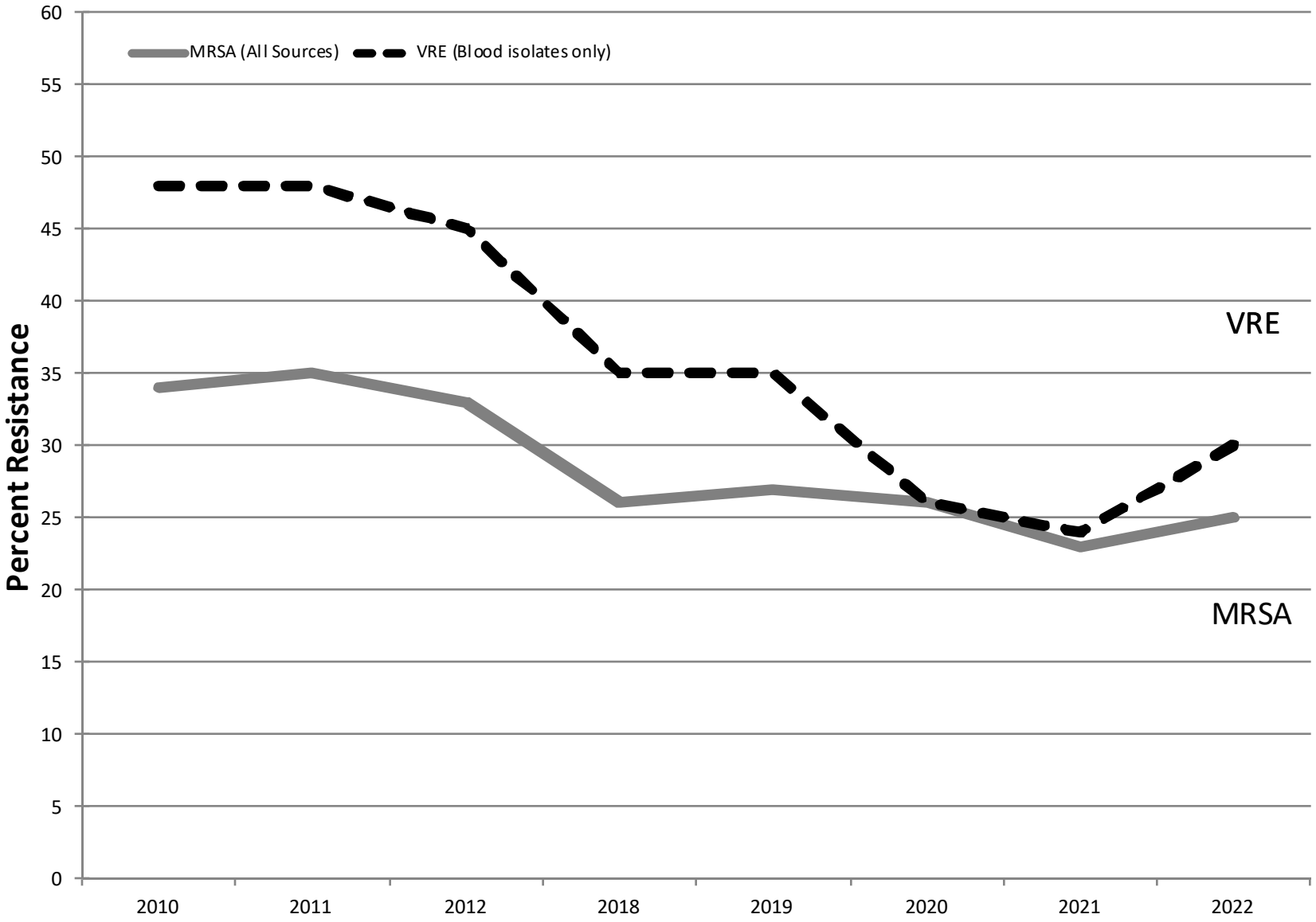
When specific antimicrobial resistance (R) is detected, an Infectious Disease (ID) consult is strongly suggested.

Organism	If Resistant to:	Therapeutic Options	Comments
Candida krusei	caspofungin	voriconazole[1] amphotericin[2]	Typically susceptible to caspofungin. Breakthrough infections have been reported.[3]
	voriconazole	caspofungin[4] amphotericin[2, 5]	Intrinsically resistant to fluconazole[6], [7] Typically susceptible to voriconazole[6, 7]
Candida glabrata	caspofungin	fluconazole[8] voriconazole[1] amphotericin[2, 5]	Caspofungin resistance may be emerging. [6]
	fluconazole	voriconazole[1] caspofungin[4] amphotericin[2, 5]	Typically resistant to fluconazole.[6, 7]
Candida albicans	caspofungin	fluconazole[8] amphotericin[2, 5]	Typically susceptible to caspofungin.[6, 7]
	fluconazole	caspofungin[4] amphotericin[2, 5]	Typically susceptible to fluconazole but resistance can develop during therapy.[6, 7]
Candida auris	Often resistant to azoles, amphotericin and some are echinocandin resistant	Infectious Disease consult is strongly suggested	*Candida auris* is an emerging multi-drug resistant organism, able to cause wide range of infections.

For additional resistance data, see Tables 5-13.
These are therapeutic options in adults. For therapeutic options in pediatric patients, please contact the Antimicrobial Stewardship.

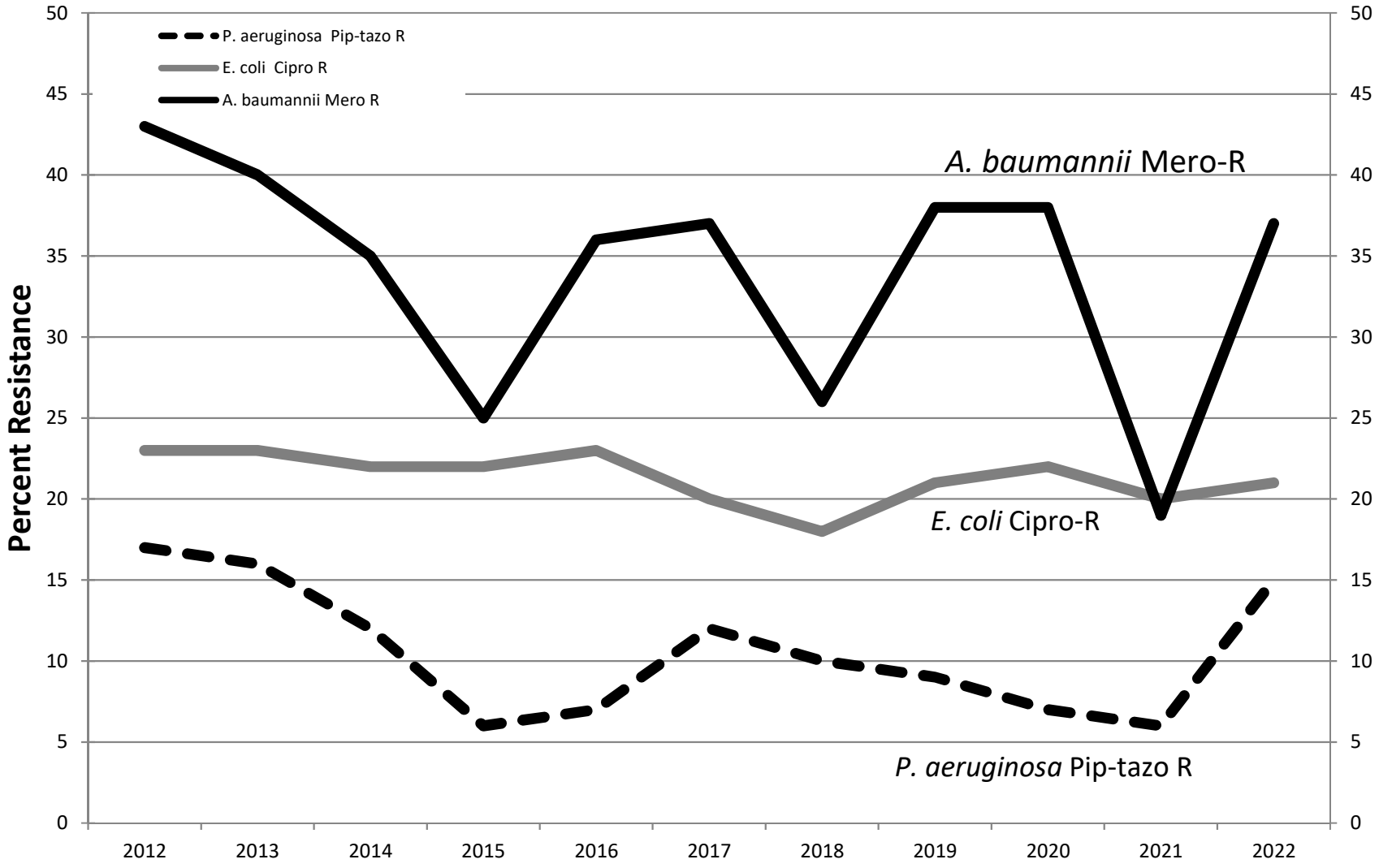
[1] Voriconazole has poor penetration in urine.
[2] Amphotericin has poor penetration in urine.
[3] Tavernier, E., et al. Development of echinocandin resistance in Candida krusei isolates following exposure to micafungin and caspofungin in a BM transplant unit. Bone Marrow Transplant 50, 158–160 (2015)
[4] Caspofungin may not reach therapeutic concentration in the CSF, vitreous fluid or urine.
[5] Among patients without baseline renal dysfunction and suspected azole- and echinocandin-resistant Candida infections, liposomal amphotericin B is recommended. Infectious Disease consult is highly recommended.
[6] Pappas, P. G., et al. (2016). Clinical Practice Guideline for the Management of Candidiasis: 2016 Update by the Infectious Diseases Society of America. Clinical infectious diseases: an official publication of the Infectious Diseases Society of America, 62(4), e1–e50.
[7] Treatment Guidelines from the Med. Letter-Antifungal Drugs. 2012;10(120);61-68
[8] For initial treatment with fluconazole, careful consideration should be given, especially in critically ill patients or those with prior azole exposure or prophylaxis. Infections Disease consult is highly recommended.

Table 12. Resistance Trends: 1990-2022



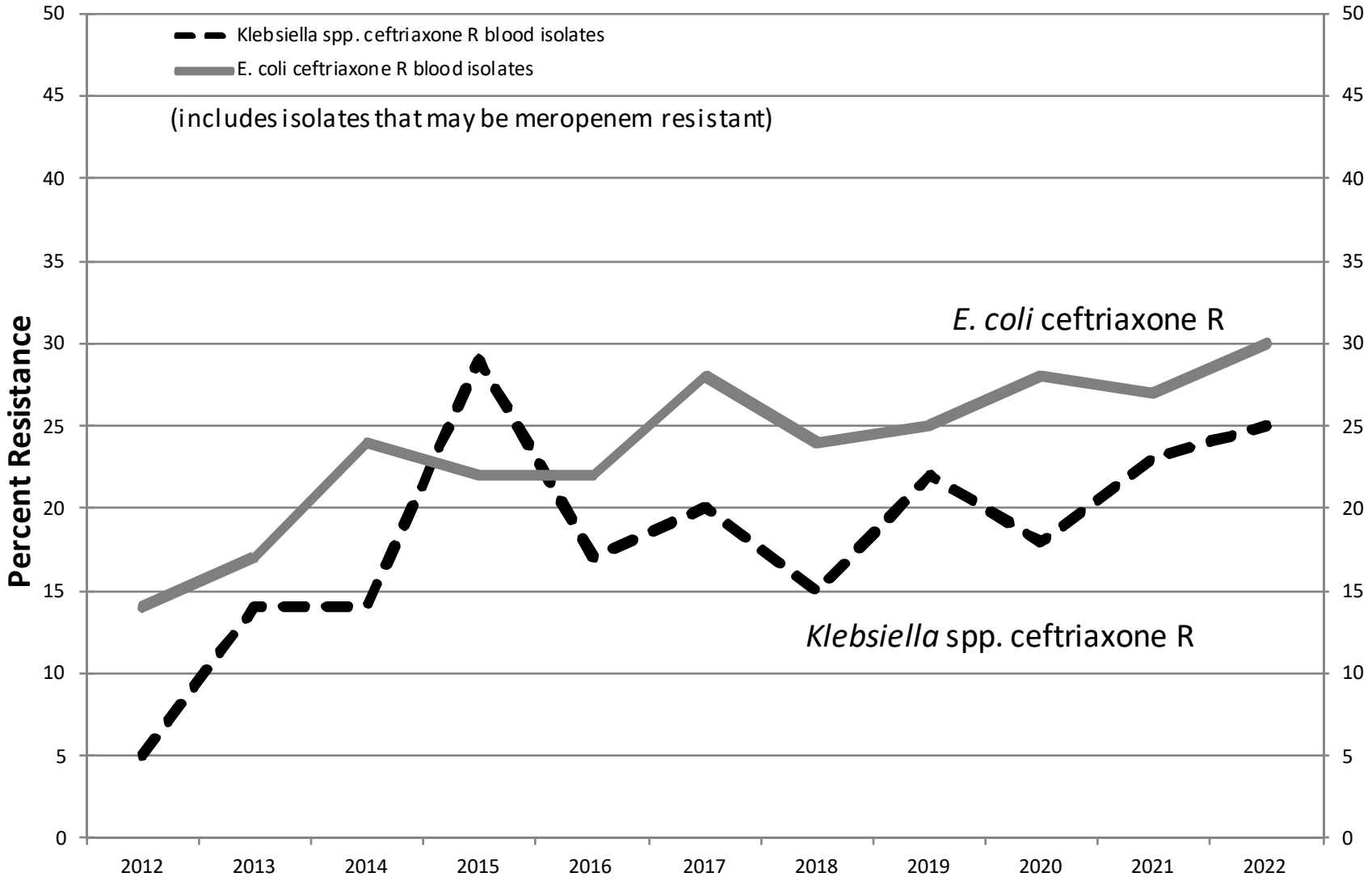
NOTE:
2010-2015: Derived from RRH data
2016-2022: Combined data from RRH and SMH

Table 12. Resistance Trends: 1990-2022
(cont.)



NOTE:
Resistance data trend from all sources
2012-2015: Derived from RRH data
2016-2022: Combined data from RRH and SMH

Table 12. Resistance Trends: 1990-2022
(cont.)



Note: No data prior to 1998
2012-2015: Derived from RRH data
2016-2022: Combined data from RRH and SMH

Table 13. Carbapenem-resistant Enterobacterales (CRE), 2017-2022

Year	Non-CP CRE	KPC	OXA	NDM	NDM & OXA	KPC & OXA	VIM	IMP
2017	42	38	3	1	1	0	0	0
2018	31	24	4	3	1	0	0	0
2019	25	32	0	2	1	0	0	0
2020	42	25	2	5	1	1	0	0
2021	67	25	2	5	0	1	0	0
2022	104	15	3	5	1	0	0	0

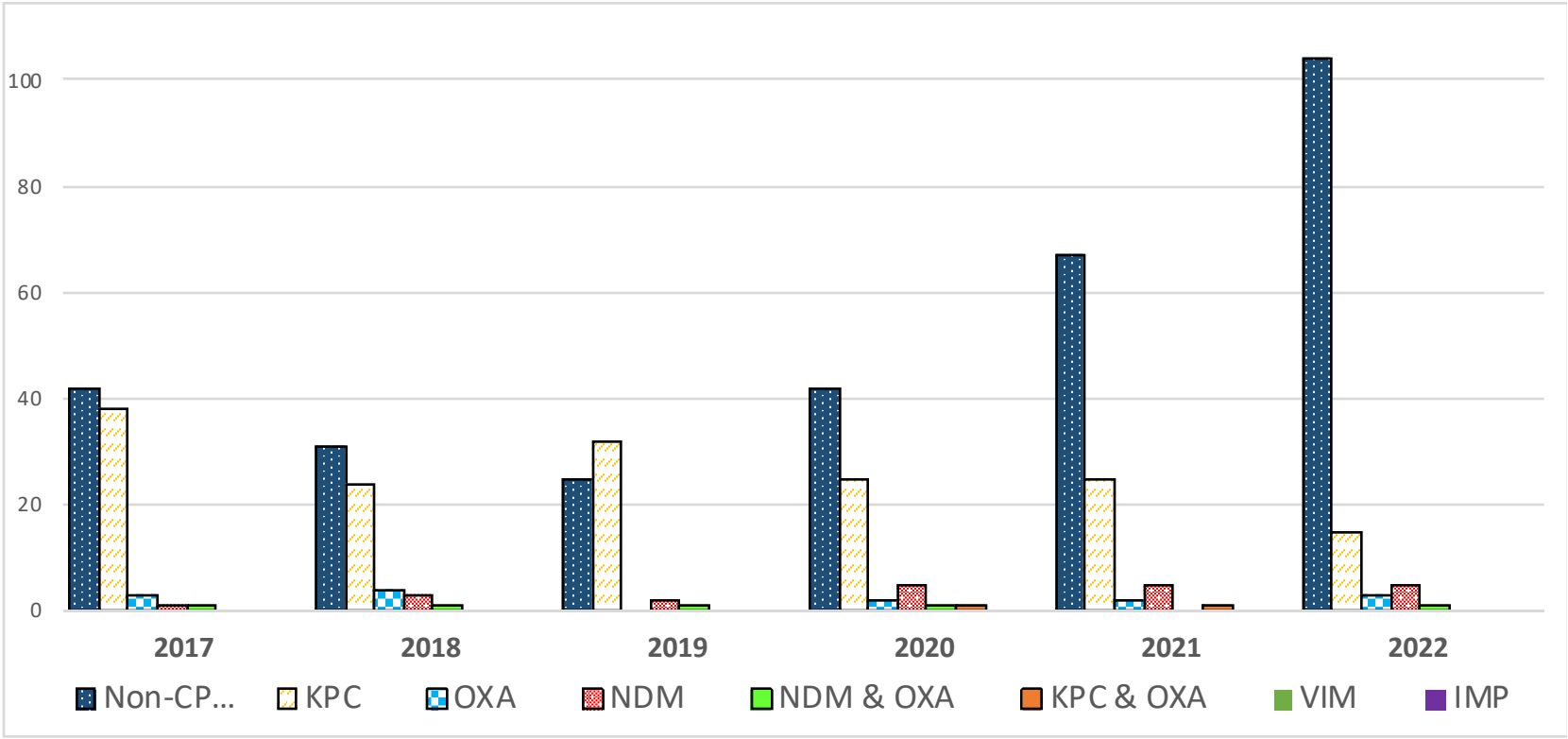


Table 14. Treatment Suggestions for Organisms for which Susceptibility Testing is not Routinely Performed

Organism	Recommended	Alternate treatment	Comments / Also Effective
Aerococcus urinae	Amoxicillin	Levofloxacin or Ciprofloxacin	Fluoroquinolones resistant strains (27%-33%) have been reported. [1]
Bordetella pertussis[2]	Azithromycin or Clarithromycin	Trimethoprim-sulfamethoxazole	
Campylobacter jejuni [2]	Azithromycin	Consult with ID	Trimethoprim-sulfamethoxazole, Penicillin & Cephalosporins **NOT Active**
Campylobacter fetus [2]	Gentamicin	Imipenem or Ceftriaxone	Ampicillin
Legionella spp. [2]	Levofloxacin or Azithromycin	Moxifloxacin or doxycycline	
Mycoplasma pneumoniae [2]	Doxycycline	Azithromycin, Minocycline	Clindamycin & B-lactams **NOT Effective**. Increasing macrolide resistance.
Mycoplasma hominis	Consult with ID	Consult with ID	**Resistant** to Erythromycin and azithromycin. Fluoroquinolone and Tetracycline resistant strains have been reported. [3]
Stenotrophomonas maltophilia [2],[4]	Trimethoprim-sulfamethoxazole	Minocycline [5] in high dose Consult with ID for serious infections.	Fluoroquinolone [5] Potential for resistance may emerge during levofloxacin therapy. Levofloxacin should not be used alone for antimicrobial therapy.
Streptococcus agalactiae (Group B Streptococcus)	Penicillin, Ampicillin, or Amoxicillin	Cefazolin or Vancomycin	
Cutibacterium (Proprionibacterium) acnes [2]	Penicillin, Ceftriaxone	Vancomycin, Daptomycin, Linezolid	Resistant to Metronidazole
Ureaplasma	Azithromycin, Doxycycline		Resistant to Clindamycin. Tetracycline resistant strains have been reported.[3]

[1] Berteau, T., Roy, F. É., Bestman-Smith, J., Lapierre, S. G., Longtin, J., Dufresne, S. F., ... & Leduc, J. M. (2018, November). 2001. Susceptibility of Aerococcus urinae to Fluoroquinolones: Broth Microdilution and Gradient Diffusion. In Open Forum Infectious Diseases (Vol. 5, No. suppl_1, pp. S582-S583). US: Oxford University Press.

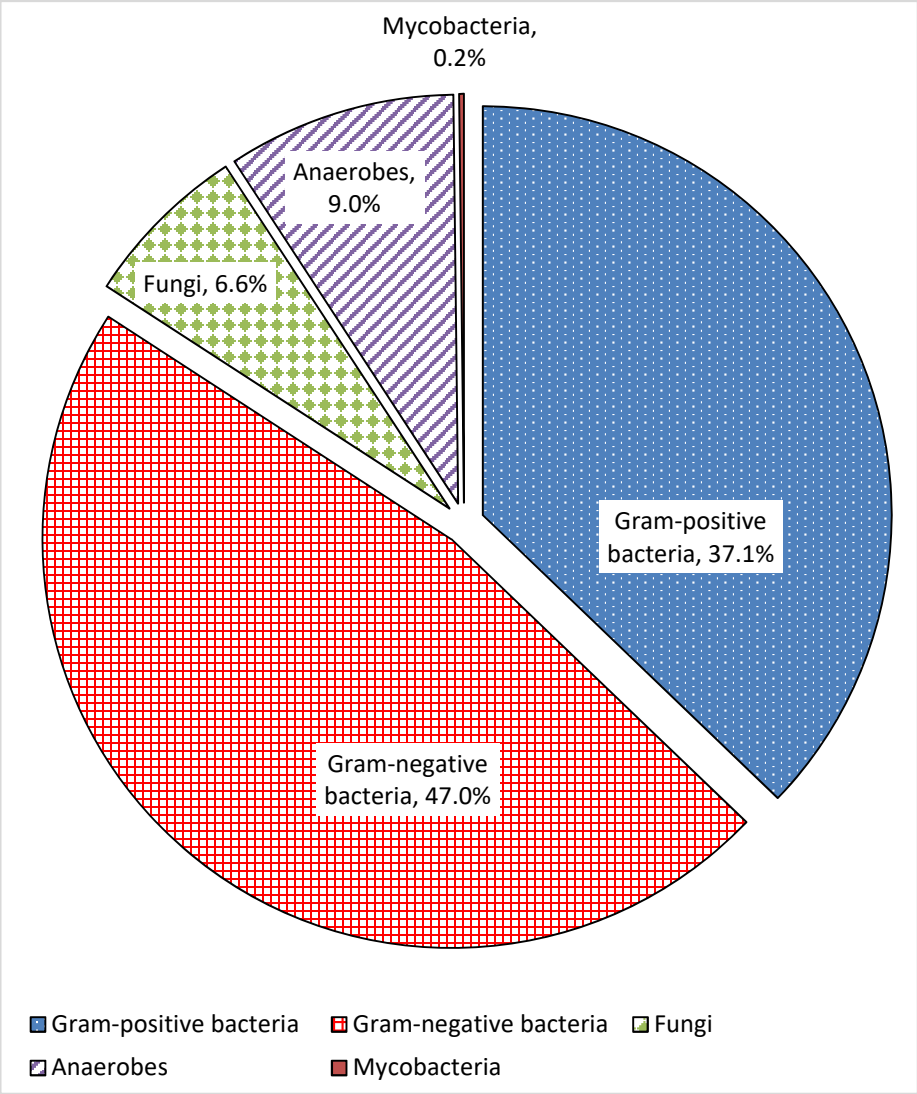
[2] The Sanford Guide to Antimicrobial Therapy. (2020). Sperryville, VA: Antimicrobial Therapy, Inc.

[3] Waites, K. B., Katz, B., & Schelonka, R. L. (2005). Mycoplasmas and Ureaplasma as neonatal pathogens. Clinical microbiology reviews, 18(4), 757–789.

[4] Susceptibility performed on Stenotrophomonas maltophilia isolates from sterile body sites and Cystic Fibrosis cases.

[5] Tamma, P., Aitken, S., Bonomo, R., Mathers, A., van Duin, D., & Clancy, C. (2021). IDSA guidance on the treatment of antimicrobial-resistant gram-negative infections: version 2.0. *Arlington, VA: IDSA*

Table 15. Blood: One Isolate per Patient, 2022



Most Common Organism	n	% of Total Blood Isolates
Escherichia coli , 28% ceftriaxone R	314	23%
Staphylococcus aureus , 29% MRSA	191	14%
Enterococcus spp., 30% VRE	180	13%
Klebsiella spp., 21% ceftriaxone R	157	12%
Viridans group *Streptococcus*	91	7%
Other *Enterobacteriaceae* spp.	54	4%
Pseudomonas aeruginosa	49	4%
Proteus mirabilis	47	3%
B-hemolytic *Streptococc* i (Groups A, B, C & G)	43	3%
Enterobacter cloacae complex	38	3%
Bacteroides spp.	38	3%
Candida albicans	34	3%
Candida glabrata	29	2%
Streptococcus anginosus group	24	2%
Candida parapsilosis	16	1%
Acinetobacter spp.	15	1%
Klebsiella (Enterobacter) aerogenes	15	1%
Stenotrophomonas maltophilia	15	1%
Serratia marcescens	14	1%
Total blood isolates *	**1661**	

*Excludes
Coagulase-negative *Staphylococcus* (n= 562)
Corynebacterium spp. (n= 65)
Bacillus spp. (n=21)
Micrococcus spp. (n= 28)
Cutibacterium (Propionibacterium) acnes (n=16)

Table 15. Blood: One Isolate per Patient, 2022 (cont.)

By Organism Group

Gram-positive Bacterial Isolates*	n	% of Gram-positive Isolates
Staphylococcus aureus, 29% MRSA	191	45%
Enterococcus spp., 30% VRE	180	42%
Viridans group Streptococcus	66	16%
Other gram-positives	44	10%
Beta-hemolytic *Streptococcus*	43	10%
Streptococcus anginosus group	24	6%
Granulicatella spp.	24	6%
Aerococcus spp.	30	7%
Staphylococcus lugdunensis	7	2%
Streptococcus pneumoniae	8	2%
Total	617	

*Excludes other coagulase – negative Staphylococcus, *Corynebacterium* spp., *Bacillus* spp., *Micrococcus* spp.

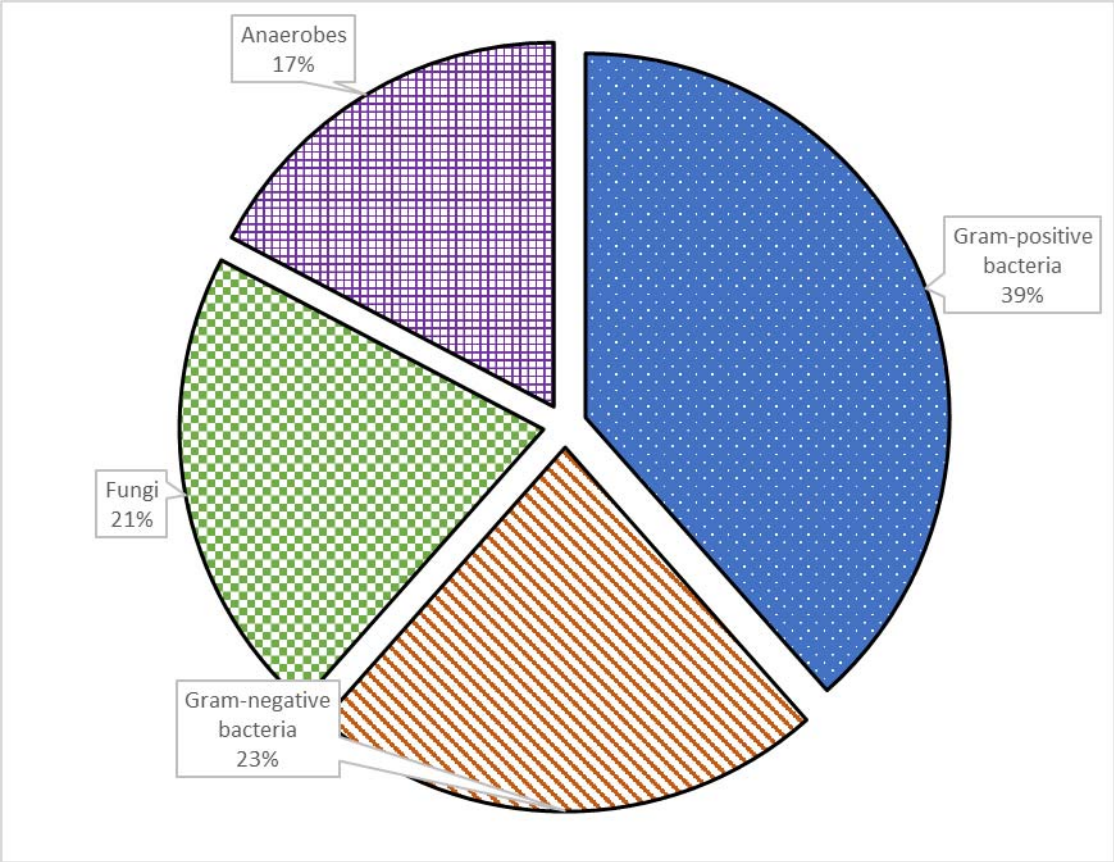
Gram-negative Bacterial Isolates	n	% of Gram-negative Isolates
Escherichia coli , 28% ceftriaxone R	314	46%
Klebsiella spp., 25% ceftriaxone R	119	17%
Other gram-negatives	81	12%
Other *Enterobacteriaceae* spp.	54	8%
Pseudomonas aeruginosa	49	7%
Enterobacter cloacae complex	38	6%
Proteus mirabilis	47	7%
Citrobacter spp.	19	3%
Serratia marcescens	14	2%
Stenotrophomonas maltophilia	15	2%
Acinetobacter spp.	15	2%
Klebsiella aerogenes	15	2%
Total	780	

Fungal Isolates	n	% of Fungal Isolates
Candida albicans	34	31%
Candida glabrata	29	27%
Candida parapsilosis	16	15%
Other Fungi	7	6%
Candida tropicalis	7	6%
Cryptococcus neoformans	3	3%
Candida auris	6	6%
Candida krusei	3	3%
Candida dubliniensis	3	3%
Candida guilliermondii	2	2%
Total	**110**	

Anaerobic Bacterial Isolates*	n	% of Anaerobic Bacterial Isolates
Bacteroides spp. (includes Parabacteroides spp.)	38	28%
Other anaerobes	25	19%
Clostridium spp.	13	10%
Lactobacillus spp.	17	13%
Other anaerobic Gram-negative rod	3	2%
Fusobacterium spp.	17	13%
Other anaerobic Gram-positive cocci	14	10%
Prevotella spp.	3	2%
Other anaerobeic Gram-positive rod	6	4%
Finegoldia magna	7	5%
Bifidobacterium species	2	1%
Veillonella Spp.	1	1%
Eggerthella lenta	1	1%
Parvimonas micra	3	2%
*Excludes Cutibacterium acnes		
Total	**150**	

Mycobacterial Isolates	n	% of Mycobacterial Isolates
Mycobacterium abscessus	1	33%
Mycobacterium chelonae	1	33%
Mycobacterium fortuitum group	1	33%
Total	**3**	

Table 16. CSF: One Isolate per Patient, 2022



The following antimicrobial agents are <u>not</u> the drug of choice and may not be effective for treating infections caused by bacteria isolated from CSF:

- Agents administered by oral route only
- First- and second-generation cephalosporins and cephamycins
- Doripenem, ertapenem, and imipenem
- Clindamycin
- Lefamulin
- Macrolides
- Tetracyclines
- Fluoroquinolones

n = 53	**Number of Isolates**
Gram-positive bacteria (20)	
Abiotrophia defectiva	1
Beta Streptococcus group G	1
Enterococcus faecalis	2
Enterococcus faecium	2
Staphylococcus aureus	3
Staphylococcus cohnii	1
Staphylococcus epidermidis	1
Staphylococcus hominis	1
Streptococcus parasanguinis	1
Gram-negative bacteria (12)	
Citrobacter freundii complex	1
Escherichia coli	3
Klebsiella oxytoca	1
Klebsiella pneumoniae	2
Acinetobacter baumannii	1
Proteus mirabilis	2
Pseudomonas aeruginosa	2
Fungi (11)	
Cryptococcus neoformans	6
Coccidioides immitis/posadasii	2
Candida albicans	1
Rhodotorula mucilaginosa	1
Candida parapsilosis	1
Anaerobic bacteria (9)	
Cutibacterium acnes (Propionibacterium acnes)	8
Actinomyces odontolyticus	1

Table 17. Mycobacteria, One Isolate per Patient per Source, 2022

Organisms	No. of Isolates	# Patients By Source[1]		
		Respiratory	Abscess/ wound/ tissue/other	Blood
Mycobacterium avium complex	255	230	20	5
Mycobacterium mucogenicum	108	100	8	
Mycobacterium chelonae	34	22	11	1
Mycobacterium abscessus	30	22	7	1
Mycobacterium gordonae	25	20	5	
Mycobacterium fortuitum group	17	12	4	1
Mycobacterium tuberculosis complex	12	9	3	
Mycobacterium lentiflavum	4	4		
Mycobacterium kansasii	3	2	1	
Mycobacterium mageritense	2	2		
Mycobacterium xenopi	2	1	1	
Mycobacterium colombiense	2		1	1
Mycobacterium immunogenum	2		2	
Mycobacterium szulgai	1	1		
Mycobacterium cosmeticum	1	1		
Mycobacterium fortuitum	1	1		
Mycobacterium tuberculosis	1	1		
Mycobacterium neoaurum	1	1		
Mycobacterium goodii	1	1		
Mycobacterium scrofulaceum	1	1		
Mycobacterium simiae	1	1		
Total Mycobacteria	**504**	**432**	**63**	**9**

[1] Some patients have isolates in more than one source.

Table 18. Mycobacteria Antimicrobial Susceptibility Testing

1. ***Mycobacterium tuberculosis complex:***
   Performed on first isolate per patient; performed on additional isolates recovered after 3 months, testing performed at reference lab.

Primary agents	**Secondary agents**
Rifampin	Amikacin
Isoniazid (INH)	Capreomycin
Pyrazinamide	Ciprofloxacin
Ethambutol	Ethionamide
	p-aminosalicylic acid
	Streptomycin

2. ***Mycobacterium avium* complex*:***
   Performed on first isolate per patient; performed on additional isolates recovered after 3 months, testing performed at reference lab.

   Correlation between in vitro susceptibility and clinical response has been demonstrated only for clarithromycin. Clarithromycin results predict azithromycin results. Susceptibility testing for clarithromycin should be performed on isolates from patients only when failing prior macrolide therapy or prophylaxis.

3. **Rapidly growing *Mycobacterium* spp. (e.g. *M. abscessus*, *M. chelonae*, and *M. fortuitum group*):**
   Performed on one isolate per patient, testing performed in-house.
   Additional agents on request.

Agents routinely reported	**Agents conditionally reported**
amikacin	imipenem
cefoxitin	linezolid
ciprofloxacin	meropenem
clarithromycin (inducible)	moxifloxacin
doxycycline	tigecycline
trimethoprim-sulfamethoxazole	tobramycin (*M. chelonae* isolates only)

   M. abscessus Clarithromycin and Amikacin drug resistance prediction and subspecies identification by Whole Genome Sequencing is performed by physician request only.

4. **Other Nontuberculous Mycobacteria (NTM):**
   M. kansasii – Performed on one isolate per patient, at reference lab.
   Other NTM by physician request.

Table 19. California Mycobacterium tuberculosis % Resistant, 2012-2022

Data derived from California Department of Public Health Annual report "Report on Tuberculosis in California"[1]

Antimicrobial Agent	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Isoniazid	10.0%	10.6%	9.8%	10.9%	10.9%	7.6% [2]	ND	ND	ND	ND	ND
Rifampin	0.9%	1.8%	1.3%	1.4%	1.8%	0.4% [2]	ND	ND	ND	ND	ND
Ethambutol	0.9%	1.1%	0.8%	0.7%	ND	ND	ND	ND	ND	ND	ND
Pyrazinamide	6.7%	6.7%	5.5%	5.1%	5.4%	4.5% [2]	ND	ND	ND	ND	ND
Multi-drug Resistant Tuberculosis rates [3]	0.8%	1.6%	1.1%	1.3%	1.8%	1.8%	1.2%	1.0%	1.0%	0.6%	0.9
MTB Case rate per 100,000 population	5.7	5.6	5.5	5.5	5.2	5.2	5.3	5.3	4.3	4.4	4.7
Number of new cases	2186	2163	2130	2131	2059	2058	2092	2115	1706	1750	1843

[1] https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/TB-Disease-Data.aspx
[2] Excludes multi-drug resistant cases.
[3] Multi-drug resistant = Resistant to isoniazid and rifampin.

Table 20. Rapid Grower – Mycobacteria % Susceptible 2021-2022

Organism	No. Isolates	Amikacin	Cefoxitin	Ciprofloxacin	Clarithromycin	Doxycycline	Imipenem	Trimethoprim-sulfamethoxazole	Tobramycin
Mycobacterium abscessus complex [1, 2, 3, 4]	51	90	2	R	50	R	0	R	—
Mycobacterium fortuitum	30	99	9	97	18	32	15	99	—
Mycobacterium chelonae	53	96	0	0	99	9	0	2	99
Mycobacterium mucogenicum	150	99	73	7	99	93	99	99	—

[1] M. abscessus complex is differentiated into 3 subspecies: M. abscessus subsp. abscessus, M. abscessus subsp. massiliense and M. abscessus subsp. bolletii.

[2] Some isolates of M. abscessus subsp. abscessus and M. abscessus subsp. bolletii may contain a functional erm(41) gene that confers inducible macrolide resistance. Resistance is detected in MIC at day 15, which is routinely tested for.

[3] M. abscessus Clarithromycin and Amikacin drug resistance prediction and subspecies identification by Whole Genome Sequencing is available by physician request.

[4] Subspecies identification by Whole Genome Sequencing (2020 – 2022) n = 17 *M. abscessus subsp. abscessus* = 59%, *M. abscessus subsp. massiliense* = 41%, *M. abscessus subsp. bolletii* = 0%.

Table 21. CLSI Anaerobic Bacteria Cumulative Antibiogram, % Susceptible

Data derived from CLSI M100S 33rd edition[1,2]

***Bacteroides* spp. and *Parabacteroides* spp.**	Ampicillin–Sulbactam		Piperacillin–Tazobactam		Cefoxitin		Ertapenem		Imipenem		Meropenem		Clindamycin		Moxifloxacin		Metronidazole	
	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S
Breakpoints %S		≤8/4		≤16/4		≤16		≤4		≤4		≤4		≤2		≤2		≤8
Bacteroides fragilis	129	84	1030	96	830	100	133	82	189	97	1505	93	1013	26	256	61	1140	100
Bacteroides thetaiotaomicron	76	82	252	87	258	13	—	—	70	100	328	99	328	28	70	54	322	100
Bacteroides ovatus	30	80	206	94	177	20	19[2]	84[2]	49	100	236	95	207	46	59	41	236	100
Bacteroides vulgatus	20[3]	45	168	92	153	73	—	—	35	97	171	96	171	53	29[2]	31	186	100
Bacteroides uniformis	19[2]	84	78	96	72	85	—	—	19[2]	100	93	100	87	45	25[2]	48	89	100
Parabacteroides distasonis	27[2]	59[2]	92	95	82	29	—	—	26[2]	100	119	97	108	43	37	62	118	100

Other Anaerobic Organisms	Ampicillin–Sulbactam		Piperacillin–Tazobactam		Imipenem		Meropenem		Penicillin		Clindamycin		Moxifloxacin		Metronidazole	
	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S	No. Isolates	%S
Breakpoints %S		≤8/4		≤32/4		≤4		≤4		≤0.5		≤2		≤2		≤8
Prevotella species	29[2]	97[2]	63	100	29	100	92	98	63	100	29[2]	69[2]	92	66	92	99
Fusobacterium species	20[2]	100[2]	55	96	75	95	20[2]	100[2]	—	—	75	77	75	68	75	95
Anaerobic gram-positive cocci [4]	—	—	1853	99	134	99	1647	100	1647	100	1826	97	300	72	1692	100
Cutibacterium (Propionibacterium) acnes	—	—	18[2]	100[2]	17[2]	94[2]	—	—	—	—	17[2]	53[2]	114	95	18[2]	0[2]
Clostridium perfringens	15[2]	100[2]	410	100	23[2]	100	417	100	402	90	425	83	23[2]	83	425	100
Other *Clostridium* species	—	—	439	94	71	99	390	100	390	69	461	67	71	62	461	100

[1] CLSI. Performance Standards for Antimicrobial Susceptibility Testing. 33rd ed. CLSI Supplement M100. Clinical and Laboratory Standards Institute; 2023.
[2] Isolates collected from selected US hospitals from January 1st, 2013 to December 31st, 2016.
[3] Calculated from fewer than the standard recommendation of 30 isolates.
[4] Anaerobic gram-positive cocci include *Peptococcus, Peptostreptococcus, Finegoldia, Peptoniphilus, and Anaerococcus* species.

Table 22. Antimicrobials (IV,PO) Formulary Status and Cost Reference

Drug	Usual Dose	Usual Interval	($)*Per Day
Penicillins			
Ampicillin	1 gm	Q6H	32.90
Ampicillin	2 gm	Q6H	35.35
Ampicillin-sulbactam	3 gm	Q6H	49.20
Oxacillin(24-hr infusion)	12 gm	Q24H	124.60
Penicillin G (24-hr infusion)	24 million units	Q24H	47.75
Piperacillin-tazobactam (Extended 4-hr infusion)	4.5 gm	Q8H	36.90
Amoxicillin (PO)	500 mg	Q8H	0.30
Amoxicillin-clavulanic acid (PO)	500 mg	Q8H	1.35
Amoxicillin-clavulanic acid (PO)	875 mg	Q12H	1.75
Cephalosporins			
Cefazolin	1 gm	Q8H	10.75
Cefazolin	2 gm	Q8H	21.10
Cefepime[1,2]	1 gm	Q8H	28.05
Cefepime[1,2]	2 gm	Q8H	44.00
Cefoxitin (peri-operative only)[1,3]	2 gm	once	10.40
Ceftriaxone	1 gm	Q24H	9.50
Ceftriaxone	2 gm	Q24H	18.35
Cephalexin (PO)	500 mg	Q6H	0.95
Cefpodoxime (PO-UTI)	100 mg	Q12H	6.85
Cefpodoxime (PO)	200 mg	Q12H	4.60
Carbapenems/monobactam			
Aztreonam[1,4]	2 gm	Q8H	172.30
Ertapenem[1,5]	1 gm	Q24H	28.25
Meropenem[1,6]	1 gm	Q8H	29.90
Aminoglycosides			
Amikacin[1,7]	1000 mg (15 mg/kg/dose)	Q24H	11.15
Gentamicin	500 mg (7 mg/kg/dose)	Q24H	21.50
Tobramycin[1,8]	500 mg (7 mg/kg/dose)	Q24H	11.15

Table 22. (cont.) Antimicrobials (IV,PO) Formulary Status and Cost Reference

Drug	Usual Dose	Usual Interval	($)*Per Day
Other Antimicrobials (Intravenous)			
Azithromycin	500 mg	Q24H	34.85
Ciprofloxacin	400 mg	Q12H	5.30
Clindamycin	600 mg	Q8H	27.50
Colistimethate[1,9]	150 mg (CBA)**	Q12H	52.60
Daptomycin[1,10]	500 mg	Q24H	32.85
Doxycycline	100 mg	Q12H	36.85
Levofloxacin[1,11]	750 mg	Q24H	2.00
Linezolid[1,12]	600 mg	Q12H	20.20
Metronidazole	500 mg	Q8H	4.30
Rifampin[1,13]	600 mg	Q24H	166.45
Tigecycline[1,9]	50 mg	Q12H	57.00
TMP/SMX***	320 mg TMP	Q12H	35.70
Vancomycin	1 gm	Q12H	17.55
Other Antimicrobials (Oral)			
Azithromycin (PO)	500 mg	Q24H	2.70
Ciprofloxacin (PO)	500 mg	Q12H	0.30
Clarithromycin (PO)	500 mg	Q12H	3.65
Clindamycin (PO)	600 mg	Q8H	1.15
Doxycycline (PO)	100 mg	Q12H	5.15
Levofloxacin (PO)[1,12]	750 mg	Q24H	0.35
Linezolid (PO)[1,13]	600 mg	Q12H	3.35
Metronidazole (PO)	500 mg	Q8H	1.25
Nitrofurantoin (PO) (monohydrate/ macrocrystal formulation)	100 mg	Q12H	4.00
Rifampin (PO)	600 mg	Q24H	1.30
TMP/SMX (PO)	160 mg/800 mg	Q12H	0.25
Vancomycin (PO-cap)	125 mg	Q6H	4.00
Vancomycin (PO-susp)	125 mg	Q6H	8.95

Table 22. (cont.) Antimicrobials (IV,PO) Formulary Status and Cost Reference

Drug	Usual Dose	Usual Interval	($)*Per Day
Antifungal Agents (Intravenous)			
Amphotericin B	50 mg	Q24H	36.60
Amphotericin B Liposomal (AmBisome)[1,10]	400 mg	Q24H	730.70
Micafungin[1,10]	50 mg	Q24H	19.40
Micafungin[1,10]	100 mg	Q24H	34.65
Fluconazole	400 mg	Q24H	15.60
Isavuconazonium[1,9]	372 mg	Q24H	316.05
Posaconazole[1,5,13,14]	300 mg	Q24H	484.60
Voriconazole[1,15]	300 mg	Q12H	80.50
Antifungal Agents (Oral)			
Fluconazole (PO)	400 mg	Q24H	3.25
Isavuconazonium (PO)[1,9]	372 mg	Q24H	182.55
Posaconazole (PO-DR) [1,5,14]	300 mg	Q24H	48.45
Voriconazole (PO)[1,15]	200 mg	Q12H	31.15

* Includes drug acquisition cost plus estimated preparation and administrative costs; charges rounded up to the nearest $0.05

** CBA: Colistin-base activity

*** TMP/SMX: Trimethoprim/Sulfamethoxazole

1 Use of Controlled Formulary (CF) antimicrobials is restricted to UCLA Health System-approved criteria.

2 Restricted: suspected or documented *Pseudomonas aeruginosa* infection and in the management of gram-negative meningitis.

3 Restricted: surgical prophylaxis; refer to Pre-incisional Antimicrobial Recommendations.

4 Restricted: aerobic gram-negative infections in beta-lactam allergic patients.

5 For Pediatric patients: restricted to use by Pediatric Infectious Diseases Service approval.

6 Restricted: clinical deterioration on concurrent/recent antimicrobials or febrile neutropenia and/or overt sepsis in an immunocompromised patient.

7 **Restricted: organisms with suspected/documented resistance to gentamicin and tobramycin.**

8 **Restricted: infections caused by organisms with suspected/documented resistance to gentamicin.**

9 **Restricted: requires formal consultation by an Infectious Diseases physician.**

10 **Restricted to use by Adult or Pediatric Infectious Diseases Service approval.**

11 **Restricted: all services, lower respiratory tract infections where RESISTANT organisms are suspected (e.g. penicillin- and cephalosporin-resistant *S. pneumoniae*).**

12 **Restricted: suspected or documented VRE infection, documented allergy to vancomycin (not Redman's Syndrome).**

13 **Injection: For use in patients unable to tolerate the oral formulations.**

14 **For prophylaxis of invasive *Aspergillus* and *Candida* infections in severely immunocompromised patients.**

15 **Restricted: treatment of suspected/documented invasive aspergillosis. For treatment of infections caused by *S. apiospermum*, *Fusarium* species (including *F. solani*) and non-albicans *Candida* species in patients intolerant of, or refractory to other therapy.**

Table 23. Indications for Performing Routine Antimicrobial Susceptibility Tests – Aerobic Bacteria

Susceptibility tests will be performed as follows:

1. **Blood—all isolates except*:**
   Aerococcus spp.[1] (excludes *Aerococcus urinae)*
   Bacillus spp.[1]
   Corynebacterium spp. [1] (excludes *Corynebacterium jeikeium* and *Corynebacterium striatum*)
   Coagulase-negative *Staphylococcus* [1, 2]
   Cutibacterium (Propionibacterium) acnes[1]
   Micrococcus spp.[1]
   Viridans group *Streptococcus*[1] (excludes Streptococcus anginosus group)

2. **Urine**
   >10^5 CFU/ml (1 or 2 species)
   >50,000 CFU/ml (pure culture):
   Gram-negative bacilli; *Staphylococcus aureus*

   Urine from Urology – Susceptibility performed based on the following criteria upon request
   Workup for up to 5 organisms;

   Any quantity of pathogens
   - Gram-negative bacilli
   - *Staphylococcus aureus*

   Potential pathogens – Colony count of ≥50K for ≤2 organisms
   - Coagulase Negative *Staphylococcus*
   - Viridans *Streptococcus*
   - *Corynebacterium* species
   - Yeast
   - *Staphylococcus saprophyticus*
   - *Aerococcus* species
   - Beta hemolytic *Streptococcus*

   Enterococcus species
   - ≤2 organism any quantity
   - Colony count of <50K Predominant in mix culture
   - Colony count of ≥50K Non-predominant in mixed culture

3. **Respiratory (sputum, nasopharynx, bronchial washing and tracheal aspirate):**
   Moderate /many growth ≤2 potential pathogens
   Cystic fibrosis patients: any quantity of gram-negative bacilli*, S. aureus, S. pneumoniae*

4. **Stool**
   Salmonella spp. (≤ 3 mo. only or susceptibilities performed on all isolates of *S. typhi* and *S. paratyphi*)
   Shigella spp.
   Yersinia spp.
   Vibrio spp.

* Neonates (≤3 months), susceptibilities performed on all isolates
[1] Susceptibilities performed if isolated from multiple cultures
[2] Susceptibilities performed on all isolates of *S. lugdunensis*

Table 23. (cont.) Indications for Performing Routine Antimicrobial Susceptibility Tests – Aerobic Bacteria

5. **Wounds, abscesses and other contaminated body sites, ≤2 potential pathogens.**

6. **If isolate is from sterile body site, susceptibility testing will be performed on subsequent isolates from similar site(s) every 3 days. Exception: *S. aureus* and *P. aeruginosa* tested each day of collection from blood.**

7. **If isolate is from non-sterile body site, susceptibility testing will be performed on subsequent isolates from similar site(s) every 5 days.**

Additional notes:

- **Susceptibility tests will not be performed on more than two potential pathogens per culture unless specifically requested following discussion with clinician.**
- **Blood and CSF isolates are held for 1 year.**
- **Other potentially significant isolates are held in lab for 7 days. Contact lab at (310) 794-2758 within 48 hours if susceptibilities are desired.**

Table 24. Antimicrobial Agents Routinely Reported – Aerobic Bacteria

Primary antimicrobials	Conditions for supplemental antimicrobial reporting	Supplemental antimicrobial(s)[1]
***E. coli, Klebsiella* spp., *P. mirabilis* – Excludes urine isolates**		
ceftriaxone	Resistant to ceftriaxone	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.)
	Resistant to ertapenem (>18 y.o.)	imipenem, meropenem
ciprofloxacin (>11 y.o.)		
gentamicin	Resistant to gentamicin	amikacin, tobramycin
piperacillin-tazobactam	Resistant to piperacillin-tazobactam	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.)
trimethoprim-sulfamethoxazole		
***E. coli, Klebsiella* spp., *P. mirabilis* – Urine isolates**		
ampicillin		
oral cephalosporins[2]		
ceftriaxone	Resistant to ceftriaxone	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.)
	Resistant to ertapenem (>18 y.o.)	imipenem, meropenem
ciprofloxacin (>11 y.o.)		
gentamicin	Resistant to gentamicin	tobramycin
nitrofurantoin		
piperacillin-tazobactam	Resistant to piperacillin-tazobactam	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.)
trimethoprim-sulfamethoxazole		
Other Enterobacterales organisms[3] – Excludes urine isolates		
cefepime	Resistant to cefepime	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.)
	Resistant to ertapenem (>18 y.o.)	imipenem, meropenem
ceftriaxone		
ciprofloxacin (>11 y.o.)		
gentamicin	Resistant to gentamicin	amikacin, tobramycin
piperacillin-tazobactam[5]	Resistant to piperacillin-tazobactam	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.)
trimethoprim-sulfamethoxazole		
Other Enterobacterales organisms[3] – Urine isolates		
ampicillin		
cefepime	Resistant to cefepime	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.)
	Resistant to ertapenem (>18 y.o.)	imipenem, meropenem
ceftriaxone	Not reported for some HECK-Yes organisms [4]	
ciprofloxacin (>11 y.o.)		
gentamicin	Resistant to gentamicin	amikacin
nitrofurantoin		
piperacillin-tazobactam[5]	Resistant to piperacillin-tazobactam	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.)
trimethoprim-sulfamethoxazole		

[1] The following additional antimicrobial agents are reported on carbapenem resistant Enterobacterales (resistant to meropenem and/or imipenem): azteonam, azithromycin, minocycline, moxifloxacin, tigecycline, ceftazidime-avibactam and ceftolozane-tazobactam.

[2] Cefazolin results should only be used to predict potential effectiveness of oral cephalosporins for uncomplicated UTIs.

[3] *Enterobacterales* other than *E. coli, Klebsiella* spp., *P. mirabilis*, *Salmonella* spp., *Shigella* spp.

[4] Ceftriaxone not reported *for Citrobacter freundii complex, Enterobacter cloacae complex* and *Klebsiella aerogenes.*

Table 24. Antimicrobial Agents Routinely Reported – Aerobic Bacteria (cont.)

Primary antimicrobials	Conditions for supplemental antimicrobial reporting	Supplemental antimicrobial(s)[1]
***Salmonella* spp.,[1] *Shigella* spp.[2]**		
ciprofloxacin (>11 y.o.) trimethoprim-sulfamethoxazole	 *Shigella spp*. Non-fecal sources/resistant to all primary antimicrobials	 azithromycin ceftriaxone
Pseudomonas aeruginosa		
cefepime	Resistant to cefepime	imipenem, meropenem, ceftolozane - tazobactam
	Resistant to imipenem or meropenem	ceftolozane - tazobactam
 ciprofloxacin (>11 y.o.) Tobramycin piperacillin-tazobactam ceftazidime	ceftolozane – tazobactam MIC ≥4 µg/mL Urine Resistant to piperacillin-tazobactam	cefiderocol amikacin imipenem, meropenem
***Acinetobacter* spp.**		
cefepime ceftazidime ciprofloxacin (>11 y.o.) gentamicin piperacillin-tazobactam trimethoprim-sulfamethoxazole	 Resistant to ceftazidime Resistant to meropenem or imipenem Resistant to gentamicin	 imipenem, meropenem minocycline amikacin, tobramycin
Stenotrophomonas maltophilia*- Sterile body site isolates** ***Burkholderia cepacia complex		
levofloxacin (>11 y.o.) minocycline trimethoprim-sulfamethoxazole	 *Burkholderia cepacia complex* *Burkholderia cepacia complex*	 meropenem ceftazidime

[1] If stool isolates, perform on patients ≤3 mo., or if isolate is *Salmonella typhi* or S*almonella paratyphi A*.

[2] Susceptibility performed on stool isolates.

Table 24. Antimicrobial Agents Routinely Reported – Aerobic Bacteria (cont.)

Primary antimicrobials	Conditions for supplemental antimicrobial reporting	Supplemental antimicrobial(s)
Nonfermenting Gram Negative Rods not otherwise listed		
cefepime		
ceftazidime	Resistant to ceftazidime	imipenem, meropenem
ciprofloxacin (>11 y.o.)		
gentamicin	If gentamicin >1 µg/ml	amikacin, tobramycin
piperacillin-tazobactam		
trimethoprim-sulfamethoxazole		
Haemophilus influenzae		
Beta-lactamase test	Sterile body site isolates:	Reported upon request:
	If beta-lactamase positive	ceftriaxone
	If beta-lactamase negative	ampicillin, ceftriaxone
	CSF only	Meropenem

Table 24. Antimicrobial Agents Routinely Reported – Aerobic Bacteria (cont.)

Primary antimicrobials	Conditions for supplemental antimicrobial reporting	Supplemental antimicrobial(s)
***Staphylococcus* spp.**		
clindamycin[1]		
oxacillin	S. aureus (exclude Blood and CSF)	tetracycline/doxycycline, trimethoprim-sulfamethoxazole
	Resistant to oxacillin (MRSA)	All beta-lactams considered resistant except ceftaroline
penicillin		
vancomycin	*S. aureus* on blood (vancomycin ≥2µg/ml)	daptomycin, linezolid
	Urine isolates	ciprofloxacin[2] , nitrofurantoin, trimethoprim-sulfamethoxazole
***Enterococcus* spp.**		
ampicillin		
vancomycin	Resistant to vancomycin (VRE) from sterile body sites	daptomycin, doxycycline, linezolid, quinupristin-dalfopristin (excluding *E. faecalis*), rifampin
	Sterile body site isolates	gentamicin (high level)
	Urine isolates	ciprofloxacin[2], doxycycline, nitrofurantoin
Streptococcus pneumoniae		
amoxicillin, cefotaxime, ceftriaxone, erythromycin[3], levofloxacin[2], penicillin, tetracycline[3], trimethoprim-sulfamethoxazole[3], vancomycin		
Viridans group *Streptococcus*		
cefotaxime, ceftriaxone, penicillin, vancomycin		
Beta-hemolytic *Streptococcus*		
Clindamycin[1], penicillin, vancomycin		
Listeria monocytogenes		
penicillin, trimethoprim-sulfamethoxazole (penicillin results predicts ampicillin results)		

[1] Excluding urine and CSF isolates
[2] Patients >11 y.o.
[3] Excluding CSF isolates

Table 25: CLSI M62 – Expected Antimicrobial Susceptibility Patterns of the Most Commonly Isolated Nocardia Data Derived from CLSI M62†

Organism	Amoxicillin/ clavulanic acid	Ceftriaxone	Imipenem	Ciprofloxacin	Minocycline	Linezolid	Trimethoprim – sulfamethoxazole	Amikacin	Tobramycin	Clarithromycin
N. cyriacigeorgica	R	S	S	R	V	S	S	S	S	R
N. abscessus	S	S	V	R	V	S	S	S	V	R
*N. nova complex**	R	S	S	R	V	S	S	S	R	S
*N. transvalensis complex***	V	S	V	S	V	S	S	R	R	R
N. farcinica	S	R	V	S	V	S	S	S	R	R
N. brasiliensis	S	V	R	R	S	S	S	S	S	R
N. pseudobrasiliensis	R	V	R	S	R	S	S	S	S	S
N. otitdiscaviarum	R	R	R	S	V	S	S	S	V	V

† Adapted from CLSI M62 1st edition, Nov 2018

* *N. nova complex* includes *N. africana, N. elegans, N., kruczakiae, N. nova,* and *N. veterana*

** *N. transvalensis complex* include *N. blacklockiae, N. transvalnesis,* and *N. wallacei*

Table 26. Susceptible MIC (µg/mL) Breakpoints for Aerobic Gram-negative Bacilli †

	Penicillins			Cephalosporins					Carbapenems			Amino-glycosides			Fluoro-quinolones		Other							
	Ampicillin	Ampicillin-sulbactam	Piperacillin-tazobactam	Cefazolin	Cefepime	Cefotaxime	Ceftazidime	Ceftriaxone	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin[1]	Levofloxacin[2]	Colistin[3]	Trimethoprim – sulfamethoxazole	Nitrofurantoin	Minocycline	Tigecycline	Ceftolozane-tazobactam	Ceftazidime-avibactam	Meropenem-vaborbactam
Enterobacterales	≤8	≤8	≤8	≤2	≤2	≤1	≤4	≤1	≤0.5	≤1	≤1	≤4	≤2	≤2	≤0.25	≤0.5	≤2	≤2/38	≤32	≤4	≤2	≤2/4	≤8/4	≤4/8
NONFERMENTERS																								
Acinetobacter species	R	≤8	≤16	R	≤8	≤8	≤8	≤8	R	≤2	≤2	≤16	≤4	≤4	≤1	≤2	≤2	≤2/38	–	≤4	–	–	–	–
Burkholderia cepacia complex	R	R	R	R	R	–	≤8	R	R	R	≤4	R	R	R	–	≤2	R	≤2/38	–	≤4	–	–	–	–
Pseudomonas aeruginosa	R	R	≤16	R	≤8	R	≤8	R	R	≤2	≤2	≤16[4]	≤4	≤4	≤0.5	≤1	≤2	R	–	–	R	≤4/4	≤8/4	–
Stenotrophomonas maltophilia	R	R	R	R	–	R	≤8	R	R	R	R	R	R	R	–	≤2	–	≤2/38	–	≤4	–	–	–	–
Other non-fermenters	–	–	≤16	–	≤8	≤8	≤8	≤8	–	≤4	≤4	≤16	≤4	≤4	≤1	≤2	–	≤2/38	–	≤4	–	–	–	–

† Data derived from CLSI M100 33rd edition.

[1] *Salmonella* spp. breakpoint for ciprofloxacin ≤ 0.06 µg/ml

[2] *Salmonella* spp. breakpoint for levofloxacin ≤ 0.12 µg/ml

[3] There are no susceptible category for colistin. The MIC is based on the new CLSI Intermediate breakpoint at for Colistin at ≤ 2 µg/mL

[4] Amikacin breakpoints for Pseudomonas aeruginosa for Urine sources only.

Table 27. Susceptible MIC (µg/mL) Breakpoints for Aerobic Gram-positive Cocci†

Organism	Penicillins			Cephalosporin	Aminoglycosides		Fluoroquinolone	Other									
	Ampicillin	Oxacillin	Penicillin	Ceftaroline[1]	Gentamicin	Gentamicin synergy	Ciprofloxacin	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Linezolid	Nitrofurantoin	Quinupristin-dalfopristin	Rifampin	Trimethoprim – sulfamethoxazole	Vancomycin
Staphylococcus aureus *Staphylococcus lugdunensis*	—[1]	≤2	≤0.12[2]	≤1	≤4	—	≤1	≤0.5	≤1	≤4	≤0.5	≤4	≤32	≤1	≤1	≤2/38	≤2[1]
Coagulase-negative *Staphylococcus*	—	≤0.5	≤0.12[2]	—	≤4	—	≤1	≤0.5	≤1	≤4	≤0.5	≤4	≤32	≤1	≤1	≤2/38	≤4
Enterococcus spp. Enterococcus faecalis	≤8	—	≤8	R	R	≤500	≤1	R	≤2	≤4	R	≤2	≤32	≤1	≤1	R	≤4
Enterococcus faecium	≤8	—	≤8	R	R	≤500	≤1	R	≤4	≤4	R	≤2	≤32	≤1	≤1	R	≤4

Organism	Penicillins		Cephalosporins		Tetracyclines		Other		
	Amoxicillin	Penicillin	Cefotaxime	Ceftriaxone	Doxycycline	Tetracycline	Erythromycin	Levofloxacin	Vancomycin
Streptococcus pneumoniae	—	—	—	—	≤0.25	≤1	—	≤2	≤1
Meningitis	—	≤0.06	≤0.5	≤0.5	—	—	—	—	—
Non-meningitis	≤2	≤2	≤1	≤1	—	—	≤0.25	—	—
Viridans group *Streptococcus*	—	≤0.12	≤1	≤1	—	—	—	—	≤1

† Data derived from CLSI M100 33rd edition.
1 S. aureus only, including MRSA
2 beta-lactamase negative

Table 28. Antimicrobial Stewardship

1) Treatment of asymptomatic bacteriuria
    a. A urine culture must ALWAYS be interpreted in the context of the urinalysis and patient symptoms.
    b. If a patient has no signs of infection on urinalysis and no symptoms of infection, but a positive urine culture, the patient by definition has **asymptomatic bacteriuria**.
    c. Patients with chronic indwelling catheters, urinary stoma, and neobladders will almost universally have positive urine cultures.
    d. The only patient populations for which it is recommended to screen for and treat asymptomatic bacteriuria are **pregnant women** and **patients scheduled for a genitourinary surgical procedure**. Screening during the first 2 months of renal transplant is acceptable.
    e. Avoid routine urine analysis and/or urine cultures for the sole purpose of screening for UTI in asymptomatic patients.
2) Treatment of VRE Isolated from stool cultures
    a. *Enterococcus* are normal bowel flora and do not cause enteric infections, regardless of vancomycin susceptibility.
    b. Antibiotic treatment of VRE in stool cultures is discouraged, and may lead to increased transmission by causing diarrhea and emergence of antimicrobial resistance among VRE.
3) Treatment of *Candida* isolated from bronchoscopic samples in non-neutropenic patients
    a. Isolation of *Candida*, even in high concentrations, from respiratory samples of immunocompetent patients, including bronchoscopy, should be interpreted as airway colonization.
    b. Antifungal therapy should not be initiated unless *Candida* is also isolated from sterile specimens or by histologic evidence in tissue from at-risk patients.
4) Use of “double coverage” for gram-negative bacteria
    a. “Double coverage” of suspected gram-negative infections serves the purpose of providing broad spectrum initial empiric coverage until susceptibility data are known.
    b. No evidence exists to support the superiority of combination therapy over monotherapy for gram-negative infections once susceptibilities are known.
    c. Once culture identification and susceptibilities have been reported, de-escalation to a single agent is strongly recommended.
5) Use of two agents with anaerobic activity to treat infections with potential anaerobic bacteria involvement
    a. Double anaerobic coverage is not necessary and puts the patient at risk for additional drug toxicities. No data or guidelines support double anaerobic coverage in clinical practice.
    b. Example: use of piperacillin/tazobactam + metronidazole.
    c. Two clinical exceptions are:
        i. Addition of metronidazole to another agent with anaerobic activity to treat *Clostridioides difficile* infection.
        ii. Clindamycin added to another agent with anaerobic activity when treating necrotizing fasciitis.

For additional information, refer to the Antimicrobial Stewardship website, https://asp.mednet.ucla.edu/pages/