

UCLA

Health System

**Antimicrobial
Susceptibility
Summary
2021**

**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/>

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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 2020.

Percent Susceptible Data (Tables 1-10)

Emerging Resistance Trends at UCLA (Tables 11-21)

Antimicrobial Testing and Reporting Policies (Tables 22–28)

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 (Table 22) 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:

Matt Davis, PharmD, ID Pharmacist
Annabelle De St Maurice, MD, Co-Chief Infection Prevention
Meganne Kanatani, PharmD, ID Pharmacist
Ishminder Kaur, MD, Medical Director, Pediatric ASP
Christine Pham, PharmD, ID Pharmacist
Kavitha Prabaker, MD, Hospital Epidemiologist SMH
Amy Shayne, Administrative Specialist, Brentwood Annex
Daniel Uslan, MD, Co-Chief Infection Prevention
Tara Vijayan, MD, Medical Director, Adult ASP

Guidelines for Interpretation of Minimal Inhibitory Concentrations (MICs)

MICs are interpreted as susceptible, intermediate, resistant, non-susceptible or susceptible dose dependent according to Clinical and Laboratory Standards Institute (CLSI) 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
UCLA Health System
Department of Pathology and Laboratory Medicine
171315

Frequently called numbers*:

Antimicrobial Stewardship Hotline: 310-267-7567
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
Infectious Disease Pharmacist RRUMC: 310-267-8510, page 92528
Infectious Diseases Pharmacist SMH-UCLA: page 91059
Microbiology Fellow on-call: page 90103

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

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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	Carbapenem producing carbapenem resistant Enterobacterales
CRE	carbapenem resistant Enterobacterales
I	Intermediate
ICU	Intensive care unit
IP	Inpatient (excludes intensive care unit)
MDR	Multiple 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-Carbapenem 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	Ampicillin-sulbactam	Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone ¹	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin	Trimethoprim – sulfamethoxazole	Colistin ² %Intermediate
<i>Enterobacter cloacae</i>	OP	64	R	R	92	R	95	— ³	—	95	98	98	99	97	97	92	87	91
	IP	62	R	R	76	R	92	— ³	—	92	98	98	99	98	98	92	92	78
	ICU	46	R	R	76	R	91	— ³	—	94	97	99	99	99	99	96	89	85
<i>Escherichia coli</i>	OP	259	—	—	96	64	86	85	82	99	99	99	99	89	89	67	73	99
	IP	276	—	—	94	52	75	73	68	99	98	99	99	86	88	55	61	99
	ICU	109	—	—	86	42	72	73	69	96	98	97	99	81	75	45	58	99
<i>Klebsiella pneumoniae</i>	OP	113	R	—	95	77	88	90	85	99	99	99	99	93	94	79	86	97
	IP	135	R	—	85	65	79	79	76	96	95	96	99	91	89	72	77	99
	ICU	120	R	—	92	71	87	86	86	96	96	96	98	95	92	86	83	99
<i>Proteus mirabilis</i>	OP	80	—	—	99	9	95	99	91	99	22	99	99	89	91	72	73	R
	IP	62	—	—	97	8	88	98	83	99	17	99	98	86	81	58	68	R
	ICU	32	—	—	94	6	78	94	78	97	19	97	99	94	81	38	53	R
<i>Pseudomonas aeruginosa</i>	OP	378	R	R	86	R	88	87	R	R	82	88	93	89	95	75	R	99
	IP	216	R	R	80	R	84	81	R	R	80	85	96	94	96	76	R	99
	ICU	120	R	R	71	R	82	77	R	R	63	77	98	97	99	73	R	99

¹ Cefotaxime and ceftriaxone have comparable activity against *Enterobacterales*.

² There are no susceptible breakpoints for Colistin for *Enterobacterales* and *Pseudomonas aeruginosa*. These data represent the CLSI % Intermediate breakpoint at ≤ 2 $\mu\text{g/mL}$.

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

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

Organism	No. Isolates	Penicillin	Cephalosporins				Carbapenems			Aminoglycosides			Fluoro-quinolone	Other	
		Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone ¹	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin	Trimethoprim sulfamethoxazole	Colistin ² %Intermediate
<i>Citrobacter freundii</i>	45	86	R	99	— ³	— ³	99	92	99	99	88	91	82	80	99
<i>Klebsiella (Enterobacter) aerogenes</i>	103	87	R	99	— ³	— ³	99	94	99	99	99	99	98	99	99
<i>Enterobacter cloacae</i>	185	82	R	92	— ³	— ³	94	97	99	99	98	98	94	90	85
<i>Escherichia coli</i>	673	94	54	80	79	75	99	99	99	99	86	87	60	65	99
<i>Klebsiella oxytoca</i>	128	92	8	95	98	91	99	99	99	99	97	97	95	95	99
<i>Klebsiella pneumoniae</i>	384	91	72	85	86	84	97	96	97	99	94	92	81	83	81
<i>Morganella morganii</i>	44	99	R	98	— ³	— ³	99	—	99	99	76	91	66	67	R
<i>Proteus mirabilis</i>	180	97	7	91	98	88	99	—	99	99	90	88	66	71	R
<i>Serratia marcescens</i>	144	97	R	97	— ³	— ³	97	92	97	99	99	96	85	99	R
<i>Acinetobacter baumannii</i>	49	38	R	50	47	—	R	52	56	59	66	66	49	72	96
<i>Pseudomonas aeruginosa</i>	710	83	R	86	86	R	R	79	86	95	90	95	74	R	99
<i>Stenotrophomonas maltophilia</i>	89	R	R	—	22	R	R	R	R	R	R	R	—	99	81 ⁴
<i>Burkholderia spp.</i>	17 ⁵	R	R	R	24	R	R	R	13	R	R	R	—	94	R

¹ Ceftriaxone and cefotaxime have comparable activity against *Enterobacterales*.

² There are no susceptible breakpoints for Colistin for *Enterobacterales*, *Pseudomonas aeruginosa* and *Acinetobacter baumannii*. These data represent the CLSI % Intermediate breakpoint at $\leq 2 \mu\text{g/mL}$.

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

⁴ For *Stenotrophomonas maltophilia*, Colistin interpreted according to *Pseudomonas aeruginosa* %Intermediate breakpoint.

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

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

Organism	Location ¹	No. Isolates	Penicillin	Cephalosporin			Carbapenem			Amino-glycoside	Fluoro-quinolone	Other	
			Ampicillin	Oral Cephalosporins ²	Cefepime	Ceftriaxone ³	Ertapenem	Imipenem	Meropenem	Gentamicin	Ciprofloxacin	Nitrofurantoin	Trimethoprim – sulfamethoxazole
<i>Enterobacter cloacae</i>	OP	190	R	R	91	— ⁴	96	99	99	99	91	33	8
	IP	24 ⁵	R	R	83	— ⁴	86	95	99	99	99	26	83
<i>Escherichia coli</i>	OP	7290	55	88	—	90	99	99	99	91	74	97	74
	IP	341	43	73	—	76	99	99	99	88	59	96	62
<i>Klebsiella pneumoniae</i>	OP	1266	R	89	—	89	98	99	99	94	86	27	84
	IP	112	R	77	—	79	95	96	95	93	79	24	78
<i>Proteus mirabilis</i>	OP	624	87	93	—	94	99	—	99	91	72	R	78
	IP	55	78	90	—	94	99	—	99	83	67	R	67
<i>Pseudomonas aeruginosa</i> ⁶	OP	392	R	R	93	R	R	88	93	97	81	R	R
	IP	67	R	R	90	R	R	76	84	90	78	R	R

¹ OP, outpatient (includes EMC); IP, inpatient (includes all units and ICUs).

² Oral cephalosporins include cefpodoxime and cephalexin for treatment of uncomplicated urinary tract infections.

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 88%, Piperacillin-tazobactam: OP 88%, IP 84%.

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

Organism	Location	No. Isolates	Penicillins	Amino-glycosides	Other												
			Ampicillin	Oxacillin	Penicillin	High Level Gentamicin ¹	Ciprofloxacin	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Linezolid	Quinupristin-dalfopristin	Rifampin ²	Trimethoprim sulfamethoxazole	Vancomycin	Ceftaroline
<i>Staphylococcus aureus</i>	All	2012	—	73 ³	<10	—	68	73	99	98	54	100	99	99	99	99	99
Oxacillin-resistant <i>S. aureus</i> (MRSA)	OP	346	—	R ³	R ³	—	18	64	99	97	14	99	99	99	99	97	99
	IP	146	—	R ³	R ³	—	13	53	99	94	16	99	99	99	99	99	99
	ICU	52	—	R ³	R ³	—	10	47	99	97	21	99	98	99	99	99	98
Oxacillin-susceptible <i>S. aureus</i> (MSSA)	OP	1044	—	100	<10	—	87	76	99	99	67	99	99	99	99	99	99
	IP	293	—	100	<10	—	90	77	99	99	69	99	99	99	99	99	99
	ICU	131	—	100	<10	—	87	80	99	98	73	99	99	99	99	99	99
<i>Staphylococcus epidermidis</i>	All	427	—	52	<10	—	59	66	99	85	38	99	99	97	61	99	—
<i>Staphylococcus lugdunensis</i> ⁴	All	279	—	96	48	—	98	84	99	99	82	99	99	99	99	99	—
<i>Staphylococcus pseudintermedius/intermedius</i>	All	41	—	80	<10	—	71	49	99	75	48	99	99	99	63	99	—
Coagulase negative <i>Staphylococcus</i> ^{5,6}	All	125	—	66	<10	—	69	77	98	97	51	99	99	98	84	99	—
<i>Enterococcus</i> spp. ⁷	All	805	80	—	—	— ⁸	52	R	80	47	R	99	—	31	R	85	R
<i>Enterococcus faecalis</i> ⁷	All	316	99	—	—	68 ⁹	67	R	95	42	R	99	R	40	R	98	R
<i>Enterococcus faecium</i> ⁷	All	123	13	—	—	85 ⁹	5	R	89 ¹⁰	50	R	99	98	6	R	39	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 Insufficient data to calculate % susceptible.

⁹ % susceptible calculated with isolated tested from sterile body sites. *E. faecalis* n=53, *E. faecium* n=56, *Enterococcus* spp. n=1.

¹⁰ % susceptible includes susceptible dose dependent.

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

Organism	No. Isolates	Penicillins		Cephalosporins		Clindamycin	Other					
		Amoxicillin	Penicillin	Cefotaxime	Ceftriaxone		Doxycycline	Erythromycin	Levofloxacin	Trimethoprim – sulfamethoxazole	Tetracycline	Vancomycin
<i>Streptococcus pneumoniae</i>	20 ¹	95	—	—	—	88	86	69	96	77	—	100
Meningitis ²		—	85	95	95	—	—	—	—	—	—	—
Non-meningitis ³		—	95	95	99	—	—	—	—	—	—	—
Viridans group <i>Streptococcus spp.</i> ⁴	186	—	80 ⁵	99	99	—	—	—	—	—	—	100
<i>Streptococcus anginosus</i>	68	—	99	100	98	—	—	—	—	—	—	100
<i>Streptococcus agalactiae</i> (Group B streptococci)	99	—	100	—	—	51	—	—	—	—	—	100
<i>Streptococcus pyogenes</i> (Group A streptococci)	33	—	100	—	—	79	—	79	—	—	86	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 19.5% Intermediate (MIC 0.25-2 µg/ml) and 0.5% High-level (MIC >2 µg/ml) resistance.

Table 5. Miscellaneous Gram-negative Bacteria

Organism	No. Isolates	% beta-lactamase positive ¹
<i>Haemophilus influenzae</i>	60 (pts. >21 y.o)	21
	13 (pts. ≤21 y.o.)	15
<i>Moraxella catarrhalis</i>	23 (pts. >21 y.o)	100
	8 (pts. ≤21 y.o.)	100
<i>Neisseria gonorrhoeae</i>	<p>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</p> <p>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.</p> <p>Doxycycline 100mg twice daily for 7 days is recommended if there is suspicion or confirmed Chlamydia co-infection</p>	
<i>Neisseria meningitidis</i>	<p><i>Neisseria meningitidis</i> remain susceptible to penicillin and ceftriaxone, the drugs of choice for treating meningococcal infections. However, reports (MMWR. 2008. 57:173-175) have noted some isolates with resistance to fluoroquinolones, agents often used for prophylaxis.</p> <p>Sanford guide 2020 Recommended: Ceftriaxone Alternative: Meropenem</p>	

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		Colistin ²		Tigecycline ⁵		Meropenem-Vaborbactam ¹		Eravacycline ^{2,3,4}		Omadacycline ^{1,3,5}	
	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Intermediate	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible	Number of isolates tested	% Susceptible
Carbapenem Resistant Enterobacterales (CRE)	105	87	60	17	105	92	105	28	82	73	58	86	59	88	21 ⁶	57	21 ⁶	62

Organism	Number of Isolates	Amikacin	Gentamicin	Ciprofloxacin	Piperacillin-Tazobactam	Cefepime	Ceftazidime	Ceftazidime-Avibactam ²	Ceftolozane-Tazobactam ²	Colistin ² % Intermediate	Trimethoprim-sulfamethoxazole
<i>Pseudomonas aeruginosa</i> , Imipenem <u>or</u> Meropenem resistant	205	87	75	36	47	58	53	84	84	99	R
<i>Pseudomonas aeruginosa</i> , Imipenem <u>and</u> Meropenem resistant	116	83	72	33	24	39	35	74	75	99	R
<i>Acinetobacter baumannii</i> , Meropenem resistant	32	16	22	25	0	0	19	—	—	99	41

* Include pediatrics and adults.

¹ Restricted formulary. ID consult required.

² There are no susceptible breakpoints for Colistin for *Enterobacterales*, *Pseudomonas aeruginosa* or *Acinetobacter baumannii*. The data represent the CLSI % Intermediate breakpoint at ≤ 2 $\mu\text{g}/\text{mL}$.

³ 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>.

⁴ FDA guidelines indicated that clinical efficacy was shown for *Citrobacter freundii*, *Enterobacter cloacae*, *Escherichia coli*, *Klebsiella oxytoca* & *Klebsiella pneumoniae*.

⁵ FDA breakpoint for Omadacycline applies to *Klebsiella pneumoniae* only and indicated for Community Acquired Bacterial Pneumonia (CABP) and Acute Bacterial Skin/Skin Structure Infections (ABSSI).

⁶ 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			Fluoroquinolone	Other
		Ampicillin ¹	Ampicillin-sulbactam ¹	Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone ²	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin ³	Trimethoprim – sulfamethoxazole
<i>Enterobacter cloacae</i>	64	R	R	87	R	95	— ⁴	— ⁴	98	96	99	99	97	97	98	92
<i>Escherichia coli</i>	122	—	—	97	78	90	88	85	99	99	99	99	87	92	85	83
<i>Klebsiella pneumoniae</i>	67	R	—	92	87	92	92	91	99	99	99	99	95	95	91	87
<i>Serratia marcescens</i>	37	R	R	97	R	99	— ⁴	— ⁴	99	91	99	99	97	89	78	99
<i>Pseudomonas aeruginosa</i>	150	R	R	88	R	94	90	R	R	86	93	99	94	96	91	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 is currently not FDA approved for pediatric use.

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

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

Organism	No. Isolates	Penicillins		Cephalosporins			Carbapenems			Amino-glycosides			Fluoroquinolone	Other		
		Ampicillin	Ampicillin-sulbactam	Oral Cephalosporins ¹	Cefepime	Ceftazidime	Ceftriaxone ²	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin ³	Trimethoprim – sulfamethoxazole	Nitrofurantoin
<i>Enterobacter cloacae</i>	24 ⁴	R	R	R	92	—	—	96	99	99	—	99	—	88	83	42
<i>Escherichia coli</i>	759	60	—	94	—	—	95	99	99	99	—	93	93	84	76	98
<i>Klebsiella pneumoniae</i>	65	R	—	89	—	—	91	99	99	99	—	97	94	89	86	17
<i>Proteus mirabilis</i>	84	92	87	99	—	—	99	99	—	99	—	98	98	96	81	R
<i>Pseudomonas aeruginosa</i>	29 ⁴	R	R	R	97	99	R	R	96	97	99	90	97	86	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 is not FDA approved for pediatric use.

⁴ Calculated from fewer than the standard recommendation of 30 isolates.

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

Organism	Location	No. Isolates	Penicillins			Cephalosporins		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
<i>Staphylococcus aureus</i> (All)	OP	264	—	82	<10	—	—	—	78	74	99	99	57	99	99	99	99	99	100
	IP	79	—	86	<10	—	—	—	84	78	99	99	60	99	99	96	99	99	100
Oxacillin-resistant <i>S. aureus</i> (MRSA) ³	OP	49	—	R ⁴	R ⁴	R ⁴	R ⁴	—	18	82	99	99	18	99	99	98	99	99	100
	IP	12 ⁵	—	R ⁴	R ⁴	R ⁴	R ⁴	—	17	83	99	99	17	99	99	83	99	99	100
Oxacillin-susceptible <i>S. aureus</i> (MSSA)	OP	219	—	100	<10	—	—	—	90	70	99	99	65	99	99	99	99	99	100
	IP	67	—	100	<10	—	—	—	96	77	99	99	67	99	99	99	99	99	100
Coagulase negative <i>Staphylococcus</i> ⁶ (sterile body sites)	All	32	—	67	<10	—	—	—	91	91	99	97	34	99	99	99	81	99	—
	OP	17 ⁵	—	53	<10	—	—	—	82	82	99	94	18	99	99	99	71	99	—
	IP	15 ⁵	—	85	<10	—	—	—	99	99	99	99	53	99	99	99	99	99	—
<i>Staphylococcus epidermidis</i>	All	74	—	47	<10	—	—	—	69	52	99	92	31	99	99	95	73	99	—
<i>Staphylococcus lugdunensis</i>	All	27 ⁵	—	99	<10	—	—	—	96	67	99	99	84	99	99	99	99	99	—
<i>Enterococcus</i> spp.	All ⁷	61	98	—	—	R	R	— ⁸	66	R	85	41	R	98	—	27	R	99	—
<i>Enterococcus faecalis</i>	All	25 ⁵	99	—	—	R	R	99 ⁸	79	R	96	33	R	99	R	33	R	99	—
<i>Enterococcus faecium</i>	All	5 ⁵	99	—	—	R	R	99 ⁸	0	R	60	60	R	99	80	0	R	99	—

¹ High level Gentamicin 500 µg/ml.

² Ciprofloxacin is associated with arthropathy and histological changes in weight bearing joints of juvenile animals and is not FDA approved for pediatric use.

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 Includes isolates tested from all body sites.

⁸ % susceptible calculated with isolated tested from sterile body sites. *E. faecalis* n= 6, *E. faecium* n= 5, *Enterococcus* spp. n=0. Date collected from 2019-2020.

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

Organism	No. Isolates	Penicillins		Cephalosporins		Other				
		Amoxicillin	Penicillin	Cefotaxime	Ceftriaxone	Clindamycin	Doxycycline	Erythromycin	Trimethoprim – sulfamethoxazole	Vancomycin
<i>Viridans group Streptococcus</i> Sterile body sites	25 ¹	—	67	88	88	—	—	—	—	100
<i>Streptococcus anginosus</i>	7 ¹	—	100	100	100	—	—	—	—	100
<i>Streptococcus pneumoniae</i> Meningitis ²	3 ¹	100	—	—	—	100	100	33	67	100
Non-meningitis ³		—	33	100	67	—	—	—	—	—
		—	100	100	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.

Table 10. Yeasts, %S, %I, %SDD, %R, 2019-2020

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.

Organism	No. of Isolates	Percent Susceptible, Susceptible Dose Dependent, Intermediate, Resistant at Breakpoints ^{1, 2}												
			Fluconazole ³			Voriconazole ³			Caspofungin ³			Anidulafungin ³		
			S	SDD	R	S	I	R	S	I	R	S	I	R
<i>C.albicans</i>	322	MIC µg/mL	≤ 2	4	≥ 8	≤ 0.12	0.25-0.5	≥ 1	≤ 0.25	0.5	≥ 1	≤ 0.25	0.5	≥ 1
		%	88	7	5	87	11	2	100	0	0	100	0	0
<i>C.glabrata</i>	201	MIC µg/mL	—	≤ 32	≥ 64	— ⁴	— ⁴	— ⁴	≤ 0.12	0.25	≥ 0.5	≤ 0.12	0.25	≥ 0.5
		%	—	87	13	— ⁴	— ⁴	— ⁴	98	1	1	97	1	2
<i>C.parapsilosis</i>	81	MIC µg/mL	≤ 2	4	≥ 8	≤ 0.12	0.25-0.5	≥ 1	≤ 2	4	≥ 8	≤ 2	4	≥ 8
		%	85	3	12	89	3	8	100	0	0	78	22	0
<i>C.tropicalis</i>	50	MIC µg/mL	≤ 2	4	≥ 8	≤ 0.12	0.25-0.5	≥ 1	≤ 0.25	0.5	≥ 1	≤ 0.25	0.5	≥ 1
		%	86	4	10	88	8	4	98	0	2	100	0	0
<i>C.krusei</i>	27 ⁵	MIC µg/mL	—	—	—	≤ 0.5	1	≥ 2	≤ 0.25	0.5	≥ 1	≤ 0.25	0.5	≥ 1
		%	R	R	R	92	1	7	92	8	0	100	0	0
<i>C.guilliermondii</i>	11 ⁵	MIC µg/mL	—	—	—	—	—	—	≤ 2	4	≥ 8	≤ 2	4	≥ 8
		%	—	—	—	—	—	—	100	0	0	100	80	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
<i>Staphylococcus aureus</i>	oxacillin (MRSA)	Adults (>21 y.o.) (n=2012) ¹ Inpatients (n=622) 10% Outpatients (n=1390) 17% Pediatrics (<21 y.o.) ¹ Inpatients (n=79) 18% Outpatients (n=264) 14%	vancomycin ceftaroline daptomycin	MRSA are clinically resistant to all β -lactams, β -lactam / β -lactamase inhibitor combinations and carbapenems, excluding ceftaroline. ¹ MRSA are also typically resistant to fluoroquinolones
<i>Streptococcus pneumoniae</i> (non-meningitis)	penicillin (MIC > 2 μ g/ml)	All isolates (n=23) 4%	ceftriaxone or cefotaxime or vancomycin	If susceptible (MIC \leq 2.0 μ g/ml), high dose penicillin has been shown to be effective for infections other than meningitis. ²
<i>Streptococcus pneumoniae</i> (non-meningitis)	cefotaxime, ceftriaxone (penicillin resistant always)	All isolates (n=23) Low level R 4% High level R 0%	vancomycin levofloxacin	If low-level resistance (MIC=2.0 μ g/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 <i>Streptococcus</i>	penicillin	Blood isolates (n = 86) low level R 21% high level R 3%	vancomycin or penicillin + aminoglycoside	Level of penicillin resistance is particularly useful in guiding therapy for endocarditis. ¹ For low level resistance, MICs are 0.25–2.0 µg/ml; for high level, MICs are >2.0 µg/ml. ²
<i>Enterococcus</i> spp.	vancomycin (VRE)	Blood isolates <i>E. faecium</i> (n = 54) 56% <i>E. faecalis</i> (n = 57) 2%	Check in vitro susceptibility results and contact Infectious Diseases.	Vancomycin-resistant <i>Enterococcus</i> (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 <i>E. faecium</i> (n = 54) 15% <i>E. faecalis</i> (n = 57) 30%	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 The Sanford Guide to Antimicrobial Therapy. (2020). Sperryville, VA: Antimicrobial Therapy, Inc.

² 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
<i>Klebsiella</i> spp. <i>E. coli</i>	ceftriaxone or other 3rd generation cephalosporin	Blood isolates: <i>Klebsiella</i> spp. (n = 132) 14% <i>E. coli</i> (n = 283) 28%	ertapenem ciprofloxacin	In vitro resistance to 3rd generation cephalosporins suggests the strain is producing extended-spectrum β -lactamases (ESBL), or AmpC
<i>K. pneumoniae</i> and other <i>Enterobacterales</i>	carbapenem	All isolates: <1%	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.
<i>Citrobacter freundii</i> <i>Enterobacter</i> spp. <i>Providencia</i> spp. <i>Proteus</i> spp. (except <i>P. mirabilis</i>) <i>Serratia marcescens</i>	3rd generation cephalosporins (e.g. ceftriaxone)	See comments	aminoglycoside ciprofloxacin ertapenem meropenem trimeth-sulfa	Organisms listed typically produce inducible β -lactamases. Isolates that appear susceptible to 3rd generation cephalosporins may develop resistance during therapy. ¹
<i>Pseudomonas aeruginosa</i>	cefepime and/or piperacillin-tazobactam	All isolates: (n=1119) 11%	Check in vitro susceptibility results and contact Infectious Diseases.	Combination therapy with a beta-lactam plus ciprofloxacin or an aminoglycoside (with susceptible results in vitro) should be considered. Therapeutic management must be determined on a case by case basis.
<i>Acinetobacter baumannii</i>	amikacin, cefepime, ceftazidime, ciprofloxacin, meropenem, piperacillin-tazobactam, trimethoprim-sulfa	All isolates: (n=66) 17%	Check in vitro susceptibility results and contact Infectious Diseases.	Therapeutic management must be determined on a case by case basis.

¹ The Sanford Guide to Antimicrobial Therapy. (2020). Sperryville, VA: Antimicrobial Therapy, Inc.

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
<i>Candida krusei</i>	casprofungin	voriconazole ¹ amphotericin ²	Typically susceptible to casprofungin. Breakthrough infections have been reported. ³
	voriconazole	casprofungin ⁴ amphotericin ^{2, 5}	Intrinsically resistant to fluconazole ^{6, 7} Typically susceptible to voriconazole ^{6, 7}
<i>Candida glabrata</i>	casprofungin	fluconazole ⁸ voriconazole ¹ amphotericin ^{2, 5}	Caspofungin resistance may be emerging. ⁶
	fluconazole	voriconazole ¹ casprofungin ⁴ amphotericin ^{2, 5}	Typically resistant to fluconazole. ^{6, 7}
<i>Candida albicans</i>	casprofungin	fluconazole ⁸ amphotericin ^{2, 5}	Typically susceptible to casprofungin. ^{6, 7}
	fluconazole	casprofungin ⁴ amphotericin ^{2, 5}	Typically susceptible to fluconazole but resistance can develop during therapy. ^{6, 7}
<i>Candida auris</i>	Often resistant to azoles, amphotericin and some are echinocandin resistant	Infectious Disease consult is strongly suggested	<i>Candida auris</i> 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 casprofungin in a BM transplant unit. *Bone Marrow Transplant* 50, 158–160 (2015)

⁴ Casprofungin may not reach therapeutic concentration in the CSF, vitreous fluid or urine.

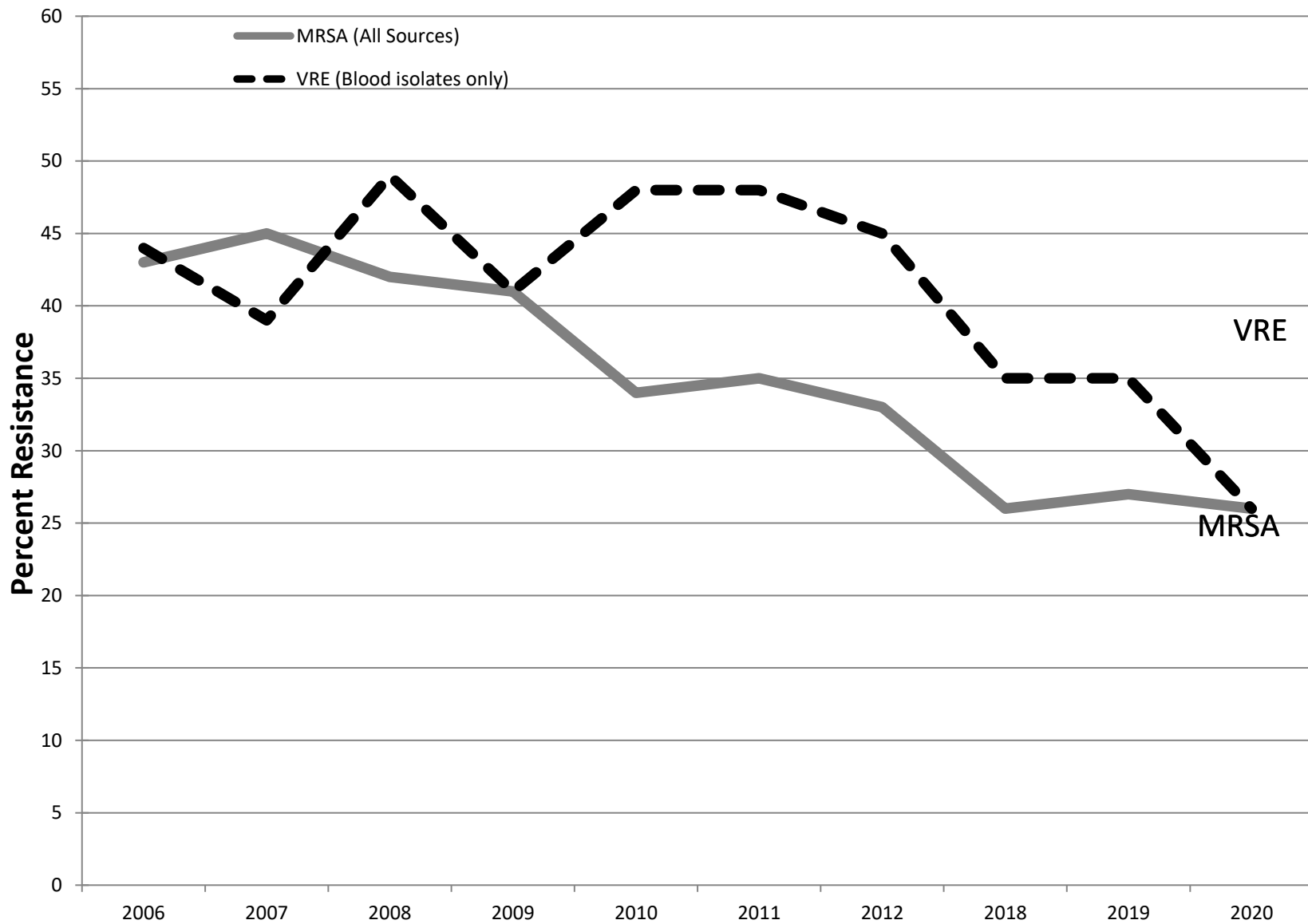
⁵ Among patients without baseline renal dysfunction and suspected azole- and echinocandin-resistant *Candida* infections, liposomal amphotericin B is recommended. Infectious Disease consult is highly recommended.

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. Infectious Disease consult is highly recommended.

Table 12. Resistance Trends: 1990-2020

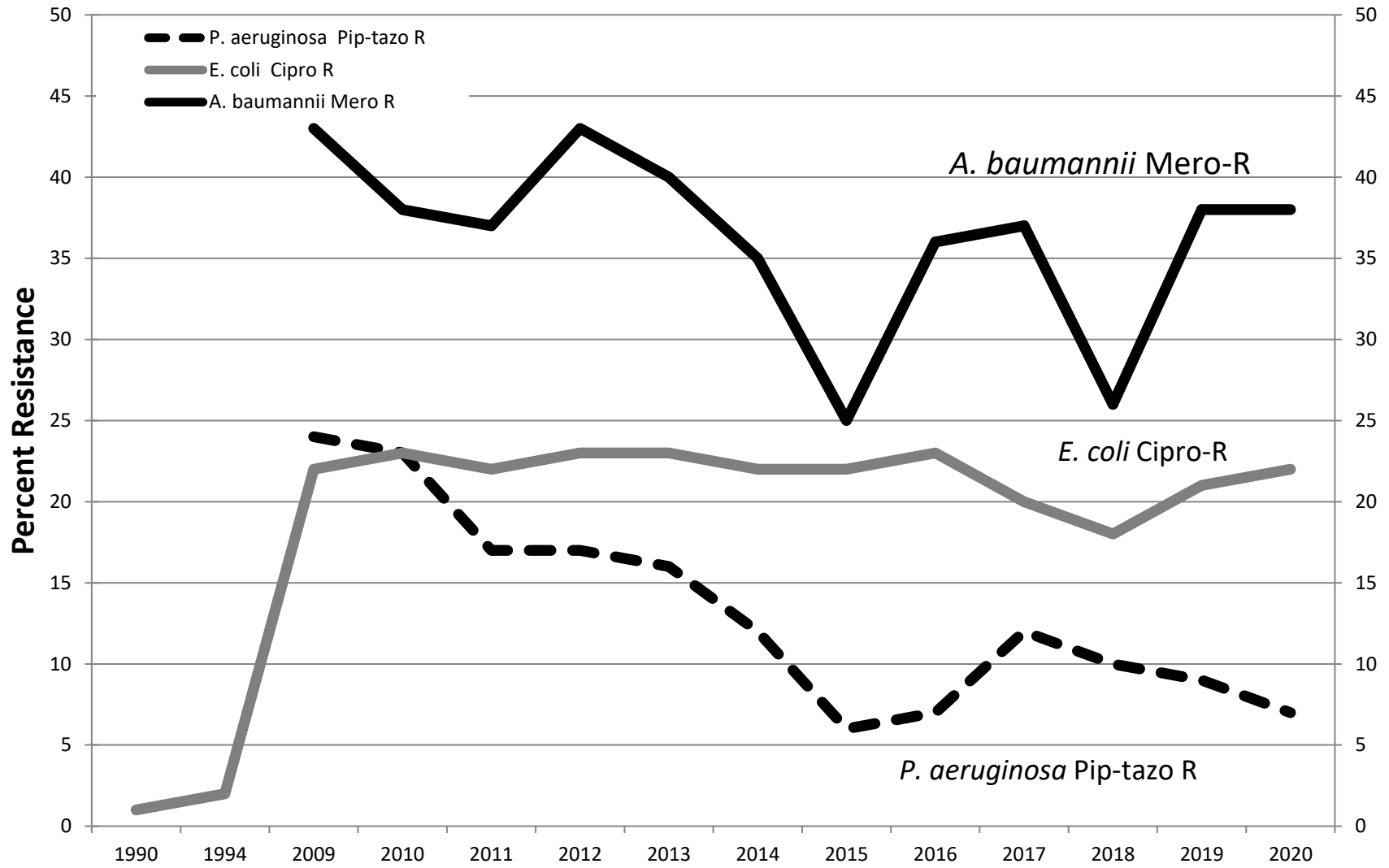


NOTE:

1990-2015: Derived from RRH data

2016-2020 Combined data from RRH and SMH

Table 12. Resistance Trends: 1990-2020
(cont.)



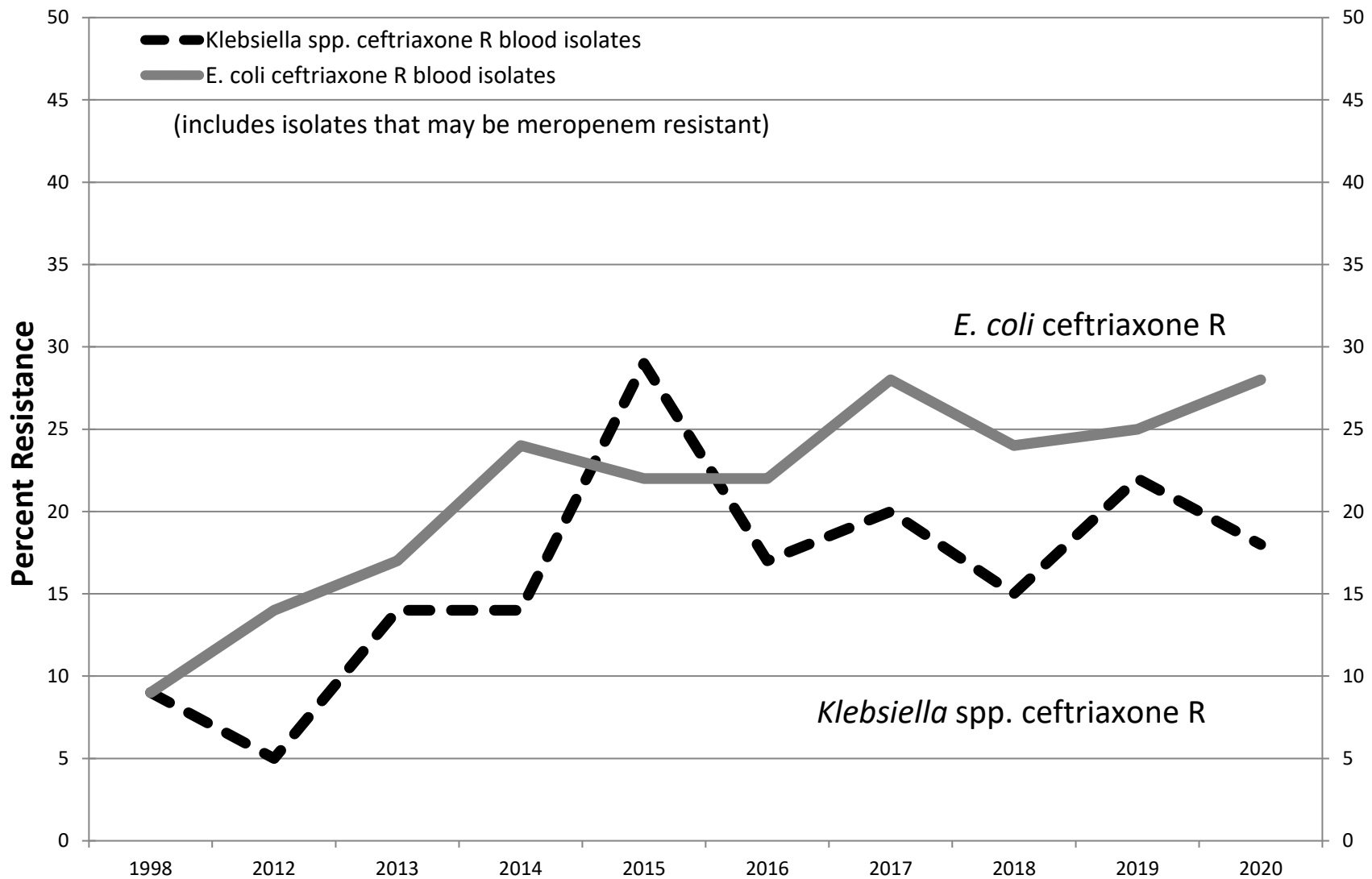
NOTE:

Resistance data trend from all sources

1990-2015: Derived from RRH data

2016-2020: Combined data from RRH and SMH

Table 12. Resistance Trends: 1990-2020
(cont.)



Note: No data prior to 1998
 1998-2015: Derived from RRH data
 2016-2020: Combined data from RRH and SMH

Table 13. Carbapenem-resistant Enterobacterales (CRE), 2017 - 2020

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

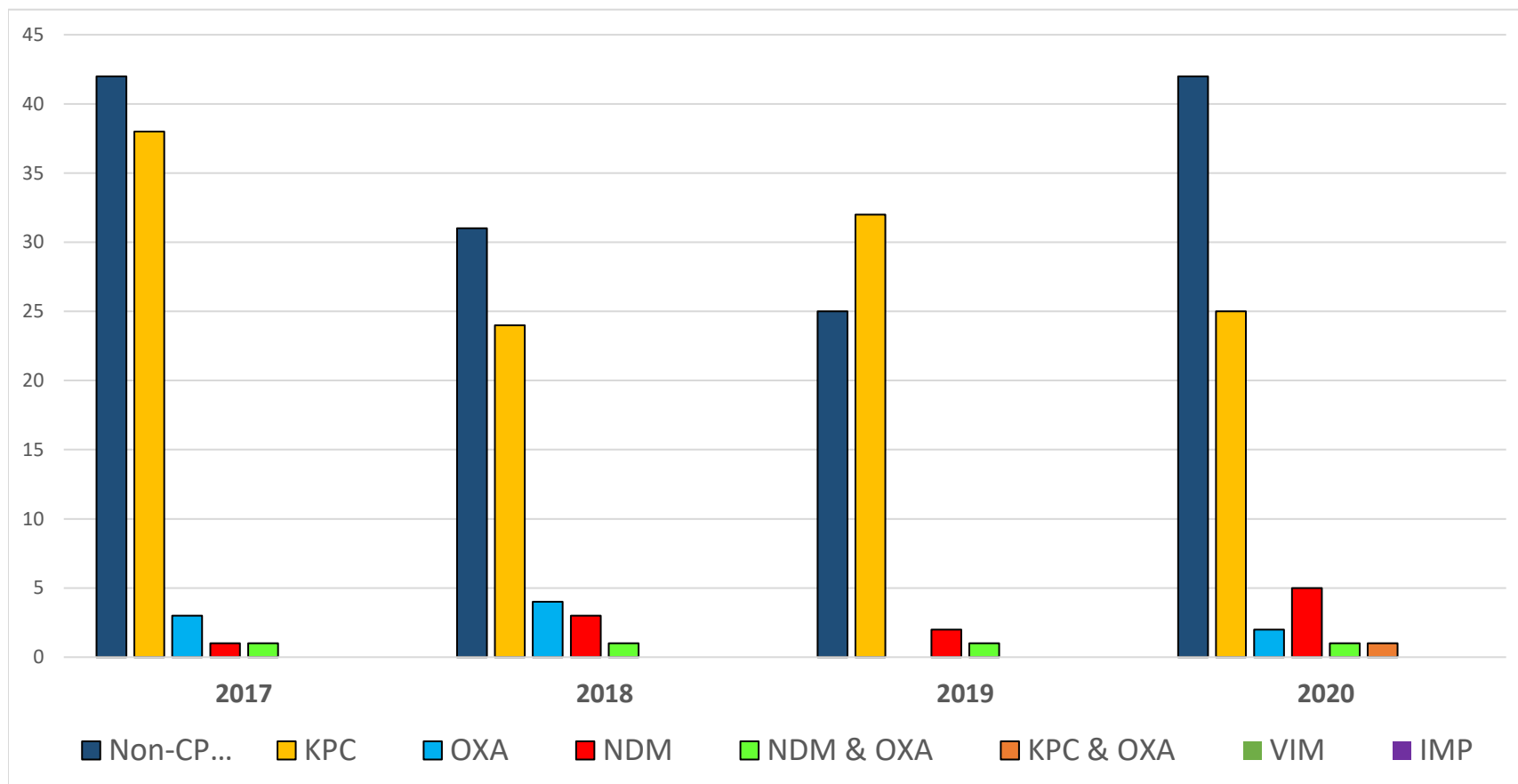


Table 14. Treatment Suggestions for Organisms for which Susceptibility Testing is not Routinely Performed

Organism	Recommended	Alternate treatment	Comments / Also Effective
<i>Bordetella pertussis</i> ¹	Azithromycin or Clarithromycin	Trimethoprim-sulfamethoxazole	
<i>Campylobacter jejuni</i> ¹	Azithromycin	Consult with ID	Trimethoprim-sulfamethoxazole, Penicillin & Cephalosporins NOT Active
<i>Campylobacter fetus</i> ¹	Gentamicin	Imipenem or Ceftriaxone	Ampicillin
<i>Legionella spp.</i> ¹	Levofloxacin or Azithromycin	Moxifloxacin, doxycycline	
<i>Mycoplasma pneumoniae</i> ¹	Doxycycline	Azithromycin, Minocycline	Clindamycin & B-lactams NOT Effective . Increasing macrolide resistance.
<i>Mycoplasma hominis</i>	Consult with ID	Consult with ID	Resistant to Erythromycin and azithromycin. Fluoroquinolone and Tetracycline resistant strains have been reported. ²
<i>Stenotrophomonas maltophilia</i> ^{1,3}	Trimethoprim-sulfamethoxazole	Minocycline ⁴ (if in vitro susceptibility)	Fluoroquinolone ⁵
<i>Cutibacterium (Propionibacterium) acnes</i> ¹	Penicillin, Ceftriaxone	Vancomycin, Daptomycin, Linezolid	Resistant to Metronidazole
<i>Ureaplasma</i>	Azithromycin, Doxycycline		Resistant to Clindamycin. Tetracycline resistant strains have been reported. ²

¹ The Sanford Guide to Antimicrobial Therapy. (2020). Sperryville, VA: Antimicrobial Therapy, Inc.

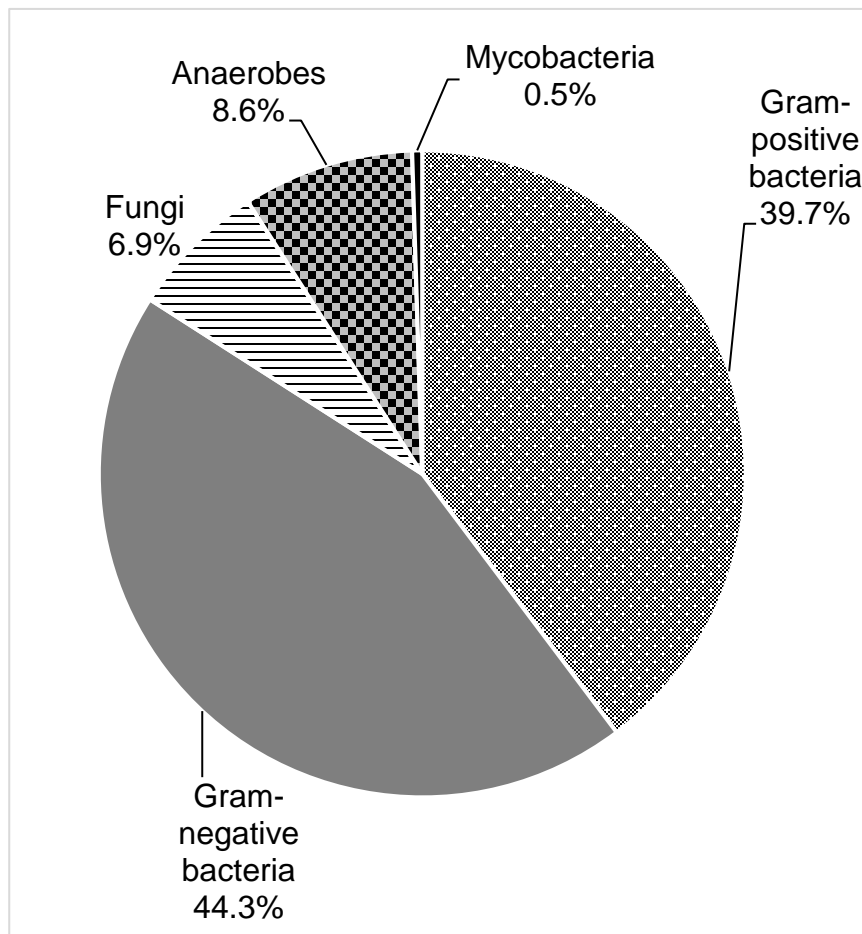
² Waites, K. B., Katz, B., & Schelonka, R. L. (2005). Mycoplasmas and Ureaplasma as neonatal pathogens. Clinical microbiology reviews, 18(4), 757–789.

³ Susceptibility performed on *Stenotrophomonas maltophilia* isolates from sterile body sites and Cystic Fibrosis cases.

⁴ Hand, E., Davis, H., Kim, T., & Duhon, B. (2016). Monotherapy with minocycline or trimethoprim/sulfamethoxazole for treatment of *Stenotrophomonas maltophilia* infections. The Journal of antimicrobial chemotherapy, 71(4), 1071–1075.

⁵ Wang, Y. L., Scipione, M. R., Dubrovskaya, Y., & Papadopoulos, J. (2014). Monotherapy with fluoroquinolone or trimethoprim-sulfamethoxazole for treatment of *Stenotrophomonas maltophilia* infections. Antimicrobial agents and chemotherapy, 58(1), 176–182.

Table 15. Blood: One Isolate per Patient, 2020



Organism	n	% of Total Blood Isolates
<i>Escherichia coli</i> , 28% ceftriaxone R	310	20
<i>Staphylococcus aureus</i> , 37% MRSA	205	13
<i>Klebsiella</i> spp., 17% ceftriaxone R	144	9
Viridans group <i>Streptococcus</i>	131	8
<i>Enterococcus</i> spp., 26% VRE	129	8
B-hemolytic <i>Streptococci</i> (Groups A, B, C & G)	60	4
<i>Pseudomonas aeruginosa</i>	54	3
Other <i>Enterobacteriaceae</i> spp.	39	2
<i>Enterobacter cloacae</i>	39	2
<i>Candida glabrata</i>	29	2
<i>Candida albicans</i>	24	2
<i>Proteus mirabilis</i>	24	2
<i>Bacteroides</i> spp.	17	1
<i>Serratia marcescens</i>	13	1
<i>Klebsiella aerogenes</i>	10	1
<i>Stenotrophomonas maltophilia</i>	10	1
<i>Acinetobacter</i> spp.	5	<1%
Total blood isolates	*1588	

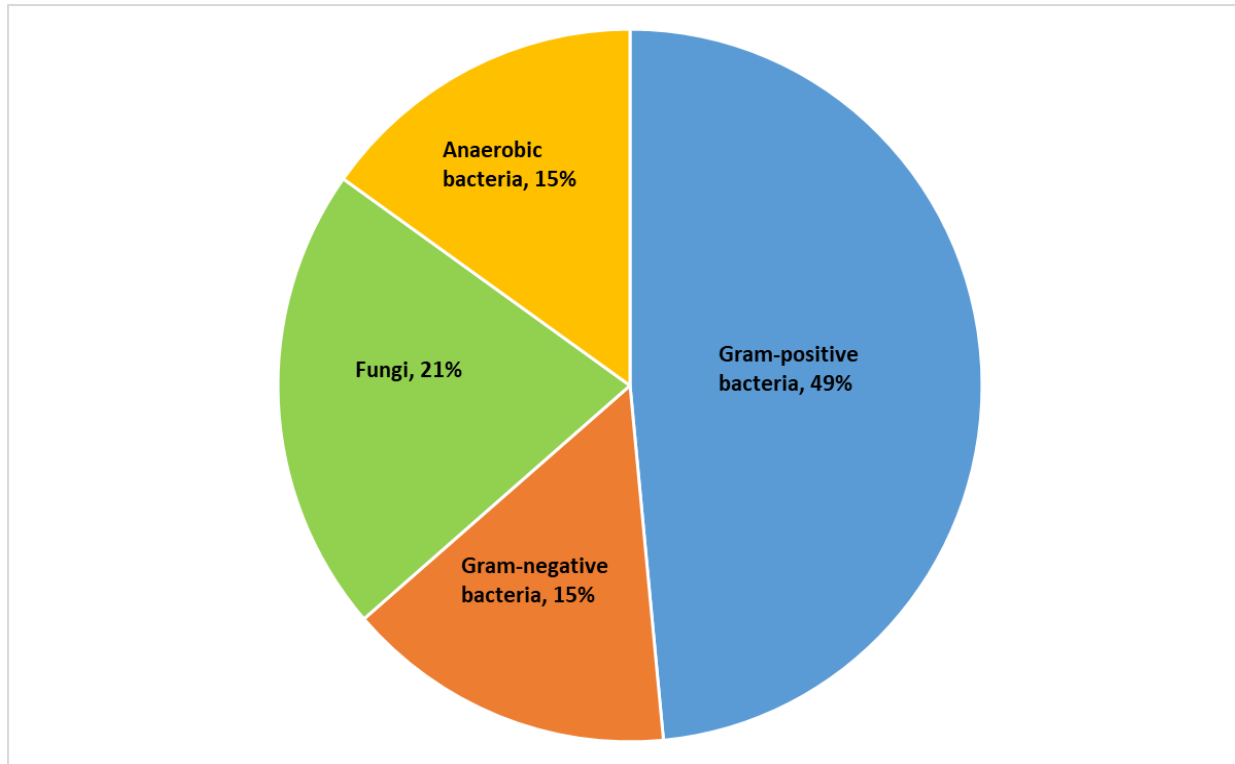
*Excludes
 Coagulase-negative *Staphylococcus* (n= 607)
Corynebacterium spp. (n= 46)
Bacillus spp. (n=18)
Micrococcus spp. (n= 9)
Propionibacterium acnes (n=14)

Table 15. Blood: One Isolate per Patient, 2020
(cont.)

By Organism Group

Gram-positive Bacterial Isolates*			Fungal Isolates		
	n	% of Gram-positive Isolates		n	% of Fungal Isolates
<i>Staphylococcus aureus</i> , 34% MRSA	205	32	<i>Candida glabrata</i>	29	27
Viridans group <i>Streptococcus</i>	131	21	<i>Candida albicans</i>	24	22
<i>Enterococcus</i> spp., 35% VRE	129	20	<i>Candida tropicalis</i>	14	13
Beta-hemolytic <i>Streptococcus</i>	60	10	Other yeast	10	9
Other gram-positives (includes <i>S. lugdunensis</i>)	44	7	<i>Candida parapsilosis</i>	9	8
<i>Granulicatella</i> spp.	25	4	<i>Cryptococcus neoformans</i>	5	5
<i>Lactobacillus</i> spp.	16	3	<i>Candida krusei</i>	4	4
<i>Streptococcus pneumoniae</i>	8	1	<i>Candida kefyr</i>	3	3
<i>Aerococcus</i> spp.	8	1	<i>Candida lusitanae</i>	3	3
<i>Abiotrophia</i> spp.	5	1	<i>Fusarium</i> sp.	3	3
			Trichosporon asahii	3	3
Total	631		<i>Candida dubliniensis</i>	2	2
*Excludes other coagulase –negative staphylococcus, <i>Corynebacterium</i> spp., <i>Bacillus</i> spp., <i>Micrococcus</i> spp.			Total	109	
Gram-negative Bacterial Isolates			Anaerobic Bacterial Isolates*		
	n	% of Gram-negative Isolates		n	% of Anaerobic Bacterial Isolates
<i>Escherichia coli</i> , 25% ceftriaxone R	310	44	<i>Bacteroides</i> spp. (includes Parabacteroides spp.)	36	
<i>Klebsiella</i> spp., 22% ceftriaxone R	146	21	<i>Clostridium</i> spp.	19	
<i>Pseudomonas aeruginosa</i>	54	8	<i>Fusobacterium</i> spp.	9	
Other gram-negatives	48	7	<i>Prevotella</i> spp.	8	
<i>Enterobacter cloacae</i>	39	6	<i>Veillonella</i> Spp.	1	
Other <i>Enterobacteriaceae</i> spp.	31	4	<i>Parvimonas micra</i>	4	
<i>Proteus mirabilis</i>	24	3	<i>Finegoldia magna</i>	3	
<i>Serratia marcescens</i>	13	2	<i>Eggerthella lenta</i>	3	
<i>Acinetobacter</i> spp.	10	1	<i>Bifidobacterium species</i>	3	
<i>Klebsiella aerogenes</i>	10	1	<i>Peptostreptococcus</i> sp.	4	
<i>Stenotrophomonas maltophilia</i>	10	1	Other anaerobes	32	
<i>Citrobacter</i> spp.	9	1	*Excludes Cutibacterium acnes		
Total	704		Total	136	
			Mycobacterial Isolates		
	n	% of Gram-negative Isolates		n	% of Mycobacterial Isolates
			<i>Mycobacterium avium</i> complex	3	38
			<i>Mycobacterium mucogenicum</i>	2	25
			<i>Mycobacterium abscessus</i> group	1	13
			<i>Mycobacterium canariense</i>	1	13
			Other <i>Mycobacterium</i> spp. Rapid Grower	1	13
			Total	8	

Table 16. CSF: One Isolate per Patient, 2020



n = 33		Number of Isolates
Gram-positive bacteria (16)		
• <i>Staphylococcus aureus</i>		8
• <i>Staphylococcus lugdunensis</i>		1
• <i>Staphylococcus capitis</i>		1
• <i>Staphylococcus epidermidis</i>		1
• <i>Staphylococcus haemolyticus</i>		1
• <i>Staphylococcus hominis</i>		1
• <i>Streptococcus agalactiae</i>		1
• Viridans group <i>Streptococcus</i>		1
• <i>Abiotrophia defectiva</i>		1
Gram-negative bacteria (5)		
• <i>Pseudomonas aeruginosa</i>		2
• <i>Acinetobacter baumannii</i>		1
• <i>Pantoea agglomerans</i>		1
• <i>Klebsiella aerogenes</i> (<i>Enterobacter aerogenes</i>)		1
Fungi (7)		
• <i>Cryptococcus neoformans</i>		3
• <i>Coccidioides immitis</i>		2
• <i>Candida albicans</i>		1
• <i>Candida glabrata</i>		1
Anaerobic bacteria (5)		
• <i>Cutibacterium acnes</i> (<i>Propionibacterium acnes</i>)		4
• <i>Bacteroides fragilis</i>		1

The following antimicrobial agents are not 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

Table 17. Mycobacteria, One Isolate per Patient per Source, 2020

Organisms	No. of Isolates	# Patients By Source ¹		
		Respiratory	Abscess/ wound/ tissue/other	Blood
<i>Mycobacterium avium complex</i>	273	240	30	3
<i>Mycobacterium mucogenicum</i>	65	62	1	2
<i>Mycobacterium abscessus</i>	57	42	13	2
<i>Mycobacterium gordonae</i>	30	29	1	
<i>Mycobacterium chelonae</i>	25	13	12	
<i>Mycobacterium fortuitum</i> / <i>Mycobacterium fortuitum group</i>	25	18	6	1
<i>Mycobacterium tuberculosis</i> / <i>Mycobacterium tuberculosis complex</i>	19	16	3	
<i>Mycobacterium bovis</i>	1	1		
<i>Mycobacterium simiae</i>	4	4		
<i>Mycobacterium immunogenum</i>	3	2	1	
<i>Mycobacterium lentiflavum</i>	2	2		
<i>Mycobacterium kansasii</i>	2	2		
<i>Mycobacterium canariense</i>	2	1		1
<i>Mycobacterium arupense</i>	2	2		
<i>Mycobacterium iranicum</i>	1			1
<i>Mycobacterium goodii</i>	1	1		
<i>Mycobacterium marinum</i>	1		1	
<i>Mycobacterium szulgai</i>	1	1		
<i>Mycobacterium parafortuitum</i>	1		1	
<i>Mycobacterium terrae</i>	1	1		
<i>Mycobacterium xenopi</i>	1	1		
Total Mycobacteria	517	438	69	10

¹ Some patients have isolates in more than one source.

Table 18. Mycobacteria Antimicrobial Susceptibility Testing

1. *Mycobacterium tuberculosis*:

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*, *M. fortuitum* group and *M. mucogenicum*):

Performed on one isolate per patient, testing performed inhouse. Additional agents on request.

Agents routinely reported	Agents conditionally reported
amikacin	imipenem
cefoxitin	linezolid
ciprofloxacin	meropenem
clarithromycin (inducible)	moxifloxacin
doxycycline	tigecycline
trimethoprim-sulfamethoxazole	tobramycin (<i>M. chelonae</i> 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, 2011- 2019

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

Antimicrobial Agent	2011	2012	2013	2014	2015	2016	2017	2018	2019
Isoniazid	10.9%	10.0%	10.6%	9.8%	10.9%	10.9%	7.6% ¹	ND	ND
Rifampin	2.2%	0.9%	1.8%	1.3%	1.4%	1.8%	0.4% ¹	ND	ND
Ethambutol	1.6%	0.9%	1.1%	0.8%	0.7%	ND	ND	ND	ND
Pyrazinamide	7.0%	6.7%	6.7%	5.5%	5.1%	5.4%	4.5% ¹	ND	ND
Multi-drug Resistant Tuberculosis rates ²	2.0%	0.8%	1.6%	1.1%	1.3%	1.8%	1.8%	1.2%	1.0%
MTB Case rate per 100,000 population	6.2	5.7	5.6	5.5	5.5	5.2	5.2	5.3	5.3
Number of new cases	2321	2186	2163	2130	2131	2059	2058	2092	2115

¹ Excludes multi-drug resistant cases.

² Multi-drug resistant = Resistant to isoniazid and rifampin.

Table 20. Rapid Grower - Mycobacteria % Susceptible

Organism	No. Isolates	Amikacin	Cefoxitin	Ciprofloxacin	Clarithromycin	Doxycycline	Imipenem	Trimethoprim-sulfamethoxazole	Tobramycin
<i>Mycobacterium abscessus</i> complex ^{1, 2, 3}	47	78	2	R	51	R	0	R	—
<i>Mycobacterium fortuitum</i>	19 ⁴	100	0	94	17	44	6	100	—
<i>Mycobacterium chelonae</i>	23 ⁴	87	0	4	100	26	0	0	96
<i>Mycobacterium mucogenicum</i>	52	100	73	100	100	94	90	100	—

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 Calculated from fewer than the standard recommendation of 30 isolates.

Table 21. CLSI Anaerobic Bacteria Cumulative Antibiogram, % Susceptible

Data derived from CLSI M100S 30th edition¹

<i>Bacteroides</i> spp. and <i>Parabacteroides</i> 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
<i>Bacteroides fragilis</i>	129	84	1030	96	830	100	133	82	189	97	1505	93	1013	26	256	61	1140	100
<i>Bacteroides thetaiotaomicron</i>	76	82	252	87	258	13	—	—	70	100	328	99	328	28	70	54	322	100
<i>Bacteroides ovatus</i>	30	80	206	94	177	20	19 ²	84 ²	49	100	236	95	207	46	59	41	236	100
<i>Bacteroides vulgatus</i>	20 ²	45	168	92	153	73	—	—	35	97	171	96	171	53	29 ²	31	186	100
<i>Bacteroides uniformis</i>	19 ²	84	78	96	72	85	—	—	19 ²	100	93	100	87	45	25 ²	48	89	100
<i>Parabacteroides distasonis</i>	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
<i>Prevotella</i> species	29 ²	97 ²	63	100	29	100	92	98	63	100	29 ²	69 ²	92	66	92	99
<i>Fusobacterium</i> species	20 ²	100 ²	55	96	75	95	20 ²	100 ²	—	—	75	77	75	68	75	95
Anaerobic gram-positive cocci ³	—	—	1853	99	134	99	1647	100	1647	100	1826	97	300	72	1692	100
<i>Cutibacterium (Propionibacterium) acnes</i>	—	—	18 ²	100 ²	17 ²	94 ²	—	—	—	—	17 ²	53 ²	114	95	18 ²	0 ²
<i>Clostridium perfringens</i>	15 ²	100 ²	410	100	23 ²	100	417	100	402	90	425	83	23 ²	83	425	100
<i>Clostridioides (Clostridium) difficile</i> ⁴	76	99	542	93	480	69	609	99	533	6	1013	32	480	74	1343	100
Other <i>Clostridium</i> species	—	—	439	94	71	99	390	100	390	69	461	67	71	62	461	100

¹ CLSI. Performance Standards for Antimicrobial Susceptibility Testing. 31st ed. CLSI Supplement M100. Clinical and Laboratory Standards Institute; 2021.

² Calculated from fewer than the standard recommendation of 30 isolates.

³ Anaerobic gram-positive cocci include *Peptococcus*, *Peptostreptococcus*, *Fingoldia*, *Peptoniphilus*, and *Anaerococcus* species.

⁴ *Clostridioides (Clostridium) difficile* isolates are from an intestinal source; these results do not imply efficacy for intraluminal infections. Vancomycin minimum inhibitory concentrations for isolates were <4 µg/mL.

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

Drug	Usual Dose	Usual Interval	(\$)*Per Day
Penicillins			
Ampicillin	1 gm	q6h	25.50
Ampicillin	2 gm	q6h	32.60
Ampicillin-sulbactam	3 gm	q6h	34.30
Oxacillin(24-hr infusion)	12 gm	q24h	57.20
Penicillin G (24-hr infusion)	24 million units	q24h	32.40
Piperacillin-tazobactam (Extended 4-hr infusion)	3.375 gm	q8h	29.55
Amoxicillin (PO)	500 mg	q8h	0.25
Amoxicillin- clavulanic acid (PO)	500 mg	q8h	0.75
Amoxicillin- clavulanic acid (PO)	875 mg	q12h	0.60
Dicloxacillin (PO)	500 mg	q6h	2.75
Cephalosporins			
Cefazolin	1 gm	q8h	9.75
Cefazolin	2 gm	Q8h	19.35
Cefepime ^{1,2}	1 gm	q8h	26.05
Cefepime ^{1,2}	2 gm	q8h	40.05
Cefoxitin ^{1,3}	2 gm	q6h	44.60
Ceftriaxone	1 gm	q24h	8.70
Ceftriaxone	2 gm	q24h	16.60
Cephalexin (PO)	500 mg	q6h	0.80
Cefpodoxime (PO-UTI)	100 mg	q12h	5.35
Cefpodoxime (PO)	200 mg	q12h	5.70
Carbapenems/monobactam			
Aztreonam ^{1,4}	2 gm	q8h	172.30
Ertapenem ^{1,5}	1 gm	q24h	48.75
Meropenem ^{1,6}	1 gm	q8h	29.90
Aminoglycosides			
Amikacin ^{1,7}	1000 mg (15 mg/kg/dose)	q24h	13.00
Gentamicin	500 mg (7 mg/kg/dose)	q24h	24.55
Tobramycin ^{1,8}	500 mg (7 mg/kg/dose)	q24h	27.15

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

Drug	Usual Dose	Usual Interval	(\$)*Per Day
Others			
Azithromycin	500 mg	q24h	7.65
Ciprofloxacin	400 mg	q12h	5.30
Clindamycin	600 mg	q8h	15.25
Colistimethate ^{1,9}	150 mg (CBA)**	q12h	29.00
Daptomycin ^{1,10}	500 mg	q24h	32.15
Doxycycline	100 mg	q12h	39.80
Levofloxacin ^{1,11}	750 mg	q24h	1.95
Linezolid ^{1,12}	600 mg	q12h	40.70
Metronidazole	500 mg	q8h	4.30
Rifampin ^{1,13}	600 mg	q24h	143.35
Tigecycline ^{1,9}	50 mg	q12h	84.55
TMP/SMX***	320 mg TMP	q12h	38.30
Vancomycin	1 gm	q12h	16.75
Azithromycin (PO)	500 mg	q24h	1.05
Ciprofloxacin (PO)	500 mg	q12h	0.25
Clarithromycin (PO)	500 mg	q12h	4.20
Clindamycin (PO)	600 mg	q8h	1.85
Doxycycline (PO)	100 mg	q12h	2.70
Levofloxacin (PO) ^{1,12}	750 mg	q24h	0.35
Linezolid (PO) ^{1,13}	600 mg	q12h	10.65
Metronidazole (PO)	500 mg	q8h	1.10
Nitrofurantoin (PO) (monohydrate/ macrocrystal formulation)	100 mg	q12h	3.65
Rifampin (PO)	600 mg	q24h	1.15
TMP/SMX (PO)	160 mg/800 mg	q12h	0.30
Vancomycin (PO-cap)	125 mg	q6h	6.55
Vancomycin (PO-susp)	125 mg	q6h	7.55

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

Drug	Usual Dose	Usual Interval	(\$)*Per Day
Antifungal Agents			
Amphotericin B	50 mg	q24h	37.50
Amphotericin B ^{1,10} Liposomal (AmBisome)	400 mg	q24h	651.55
Caspofungin ^{1,10}	50 mg	q24h	56.90
Fluconazole	400 mg	q24h	3.60
Isavuconazonium ^{1,9}	372 mg	q24h	240.00
Posaconazole ^{1,5,13,14}	300 mg	q24h	316.75
Voriconazole ^{1,15}	300 mg	q12h	116.90
Fluconazole (PO)	400 mg	q24h	2.70
Isavuconazonium (PO) ^{1,9}	372 mg	q24h	137.95
Posaconazole (PO-susp) ^{1,5,14}	200 mg	TID	185.95
Posaconazole (PO-DR) ^{1,5,14}	300 mg	q24h	88.15
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/documentated resistance to gentamicin and tobramycin.

8 Restricted: infections caused by organisms with suspected/documentated 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/documentated 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
Bacillus spp.¹
Corynebacterium spp.¹
Coagulase-negative *Staphylococcus*^{1,2}
*Cutibacterium (Propionibacterium) acnes*¹
Micrococcus spp.¹
Viridans group *Streptococcus*¹

2. Urine

>10⁵ 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

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, susceptibilities performed on all isolates

¹ Susceptibilities performed if isolated from multiple cultures

² Susceptibilities performed on all isolates of *S. lugdunensis*

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

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, 4}
<i>E. coli</i>, <i>Klebsiella</i> spp., <i>P. mirabilis</i> – Excludes urine isolates		
ceftriaxone ⁵ ciprofloxacin (>11 y.o.) gentamicin piperacillin-tazobactam ⁵ trimethoprim-sulfamethoxazole	Resistant to ceftriaxone Resistant to ertapenem (>18 y.o.) Resistant to gentamicin Resistant to piperacillin-tazobactam Resistant to meropenem or imipenem	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.) imipenem, meropenem amikacin, tobramycin ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.) ceftazidime-avibactam
<i>E. coli</i>, <i>Klebsiella</i> spp., <i>P. mirabilis</i> – Urine isolates		
ampicillin oral cephalosporins ³ ceftriaxone ⁵ ciprofloxacin(>11 y.o.) gentamicin nitrofurantoin piperacillin-tazobactam ⁵ trimethoprim-sulfamethoxazole	Resistant to ceftriaxone Resistant to ertapenem (>18 y.o.) Resistant to gentamicin Resistant to piperacillin-tazobactam Resistant to meropenem or imipenem	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.) imipenem, meropenem amikacin ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.) ceftazidime-avibactam
SPICE organisms² – Excludes urine isolates		
cefepime ⁵ ciprofloxacin (>11 y.o.) gentamicin piperacillin-tazobactam ⁵ trimethoprim-sulfamethoxazole	Resistant to cefepime Resistant to ertapenem (>18 y.o.) Resistant to gentamicin Resistant to piperacillin-tazobactam Resistant to meropenem or imipenem	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.) imipenem, meropenem amikacin, tobramycin ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.) ceftazidime-avibactam
SPICE organisms² – Urine isolates		
ampicillin cefepime ⁵ ciprofloxacin (>11 y.o.) gentamicin nitrofurantoin piperacillin-tazobactam ⁵ trimethoprim-sulfamethoxazole	Resistant to cefepime Resistant to ertapenem (>18 y.o.) Resistant to gentamicin Resistant to piperacillin-tazobactam Resistant to meropenem or imipenem	ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.) imipenem, meropenem amikacin ertapenem (>18 y.o.), imipenem & meropenem (≤18 y.o.) ceftazidime-avibactam

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

² *Enterobacterales* other than *E. coli*, *Klebsiella* spp., *P. mirabilis*, *Salmonella* spp., *Shigella* spp.

³ Cefazolin results should only be used to predict potential effectiveness of oral cephalosporins for uncomplicated UTIs.

⁴ Colistin is not reported on *Serratia marcesens*, *Proteus* spp., *Providencia* spp. and *Morganella morganii* because these organisms are intermediate/resistant to colistin.

⁵ If result is intermediate (I) or resistant (R): ertapenem, imipenem (≤ 18 y.o.) and meropenem (≤ 18 y.o.) are reported.

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

Primary antimicrobials	Conditions for supplemental antimicrobial reporting	Supplemental antimicrobial(s) ¹
<i>Salmonella</i> spp.,¹ <i>Shigella</i> spp.²		
ciprofloxacin (>11 y.o.) trimethoprim-sulfamethoxazole	Non-fecal sources/resistant to all primary antimicrobials	azithromycin (<i>S. flexneri</i> and <i>S. sonnei</i>) ceftriaxone
<i>Pseudomonas aeruginosa</i>		
cefepime ciprofloxacin (>11 y.o.) gentamicin piperacillin-tazobactam ceftazidime	Resistant to cefepime Resistant to imipenem or meropenem If gentamicin > 1 ug/ml Resistant to piperacillin-tazobactam	imipenem, meropenem, ceftolozane - tazobactam colistin, ceftolozane - tazobactam amikacin, tobramycin imipenem, meropenem
<i>Acinetobacter</i> 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, colistin amikacin, tobramycin
<i>Stenotrophomonas maltophilia</i>- Sterile body site isolates		
<i>Burkholderia cepacia</i>		
ceftazidime levofloxacin (>11 y.o.) meropenem (<i>B. cepacia</i> only) minocycline trimethoprim-sulfamethoxazole		

¹ If stool isolates, perform on patients ≤3 mo., or if isolate is *Salmonella typhi* or *Salmonella 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 ciprofloxacin (>11 y.o.) gentamicin piperacillin-tazobactam trimethoprim-sulfamethoxazole	Resistant to ceftazidime Resistant to imipenem or meropenem If gentamicin >1 µg/ml	imipenem, meropenem colistin amikacin, tobramycin
<i>Haemophilus influenzae</i>		
Beta-lactamase test	Sterile body site isolates: If beta-lactamase positive If beta-lactamase negative CSF only	ceftriaxone ampicillin, ceftriaxone Meropenem

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

Primary antimicrobials	Conditions for supplemental antimicrobial reporting	Supplemental antimicrobial(s)
<i>Staphylococcus</i> spp. clindamycin ³ oxacillin penicillin vancomycin	Resistant to oxacillin (MRSA) <i>S. aureus</i> on blood (vancomycin ≥ 2µg/ml) Urine isolates	doxycycline, trimethoprim-sulfamethoxazole; all beta-lactams considered resistant except ceftaroline daptomycin, linezolid Ciprofloxacin, ⁴ nitrofurantoin, trimethoprim-sulfamethoxazole
<i>Enterococcus</i> spp. ampicillin vancomycin	Resistant to vancomycin (VRE) from sterile body sites Sterile body site isolates Urine isolates	daptomycin, doxycycline, linezolid, quinupristin-dalfopristin (excluding <i>E. faecalis</i>), rifampin gentamicin (high level) Ciprofloxacin, ⁴ doxycycline, nitrofurantoin
<i>Streptococcus pneumoniae</i> amoxicillin, cefotaxime, ceftriaxone, erythromycin, ³ levofloxacin, ⁴ penicillin, tetracycline, ⁵ trimethoprim-sulfamethoxazole, ⁵ vancomycin		
Viridans group <i>Streptococcus</i> cefotaxime, ceftriaxone, penicillin, vancomycin		
Beta-hemolytic <i>Streptococcus</i> Clindamycin, ³ penicillin, vancomycin		
<i>Listeria monocytogenes</i> penicillin, trimethoprim-sulfamethoxazole (penicillin results predicts ampicillin results)		

³ Excluding urine and CSF isolates

⁴ Patients >11 y.o.

⁵ 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	Sulfonamides, including Trimethoprim – sulfamethoxazole	Amikacin	Tobramycin	Clarithromycin
<i>N. cyriacigeorgica</i>	R	S	S	R	V	S	S	S	S	R
<i>N. abscessus</i>	S	S	V	R	V	S	S	S	V	R
<i>N. nova complex*</i>	R	S	S	R	V	S	S	S	R	S
<i>N. transvalensis complex**</i>	V	S	V	S	V	S	S	R	R	R
<i>N. farcinica</i>	S	R	V	S	V	S	S	S	R	R
<i>N. brasiliensis</i>	S	V	R	R	S	S	S	S	S	R
<i>N. pseudobrasiliensis</i>	R	V	R	S	R	S	S	S	S	S
<i>N. otitiscaviarum</i>	R	R	R	S	V	S	S	S	V	V

† Adopted 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 ($\mu\text{g/mL}$) 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 ⁴	Trimethoprim – sulfamethoxazole	Nitrofurantoin	Minocycline	Tigecycline	Ceftolozane-tazobactam	Ceftazidime-avibactam	Meropenem-vaborbactam
ENTEROBACTERALES³	≤ 8	≤ 8	≤ 16	≤ 2	≤ 2	≤ 1	≤ 4	≤ 1	≤ 5	≤ 1	≤ 1	≤ 16	≤ 4	≤ 4	≤ 0.25	≤ 0.5	≤ 2	$\leq 2/38$	≤ 32	≤ 4	≤ 2	$\leq 2/4$	$\leq 8/4$	$\leq 4/8$
NONFERMENTERS																								
<i>Acinetobacter baumannii</i>	R	≤ 8	≤ 16	R	≤ 8	≤ 8	≤ 8	≤ 8	R	≤ 2	≤ 2	≤ 16	≤ 4	≤ 4	≤ 1	≤ 2	≤ 2	$\leq 2/38$	–	≤ 4	–	–	–	–
<i>Burkholderia cepacia</i>	R	R	R	R	R	–	≤ 8	R	R	R	≤ 4	R	R	R	–	≤ 2	R	$\leq 2/38$	–	≤ 4	–	–	–	–
<i>Pseudomonas aeruginosa</i>	R	R	≤ 16	R	≤ 8	R	≤ 8	R	R	≤ 2	≤ 2	≤ 16	≤ 4	≤ 4	≤ 0.5	≤ 1	≤ 2	R	–	–	R	$\leq 4/4$	$\leq 8/4$	–
<i>Stenotrophomonas maltophilia</i>	R	R	R	R	–	R	≤ 8	R	R	R	R	R	R	R	–	≤ 2	–	$\leq 2/38$	–	≤ 4	–	–	–	–
Other non-fermenters	–	–	≤ 16	–	≤ 8	≤ 8	≤ 8	≤ 8	–	≤ 4	≤ 4	≤ 16	≤ 4	≤ 4	≤ 1	≤ 2	–	$\leq 2/38$	–	≤ 4	–	–	–	–

† Data derived from CLSI M100 30th edition.

¹ *Salmonella* spp. breakpoint for ciprofloxacin $\leq 0.06 \mu\text{g/ml}$

² *Salmonella* spp. breakpoint for levofloxacin $\leq 0.12 \mu\text{g/ml}$

³ *Enterobacterales*: *Citrobacter*, *Enterobacter* spp., *Escherichia coli*, *Klebsiella* spp., *Morganella*, *Proteus* spp., *Providencia* spp., *Salmonella* spp., *Serratia* spp., *Shigella* spp.

⁴ There are no susceptible category for colistin. The MIC is based on the new CLSI Intermediate breakpoint at for Colistin at $\leq 2 \mu\text{g/mL}$.

Table 27. Susceptible MIC ($\mu\text{g/mL}$) Breakpoints for Aerobic Gram-positive Cocci†

Organism	Penicillins			Cephalo- sporin	Aminogly- cosides		Fluoro- quinolone	Other									
	Ampicillin	Oxacillin	Penicillin	Ceftaroline ¹	Gentamicin	Gentamicin synergy	Ciprofloxacin	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Linezolid	Nitrofurantoin	Quinupristin- dalfopristin	Rifampin	Trimethoprim – sulfamethoxazole	Vancomycin
<i>Staphylococcus aureus</i> <i>Staphylococcus lugdunensis</i>	– ^{1,4}	≤ 2	$\leq 12^2$	≤ 1	≤ 4	–	≤ 1	≤ 5	≤ 1	≤ 4	≤ 5	≤ 4	≤ 32	≤ 1	≤ 1	$\leq 2/38$	≤ 2
Coagulase-negative <i>Staphylococcus</i>	–	≤ 25	$\leq 12^2$	–	≤ 4	–	≤ 1	≤ 5	≤ 1	≤ 4	≤ 5	≤ 4	≤ 32	≤ 1	≤ 1	$\leq 2/38$	≤ 4
<i>Enterococcus</i> spp.	≤ 8	–	≤ 8	R ³	R	≤ 500	≤ 1	R ²	≤ 2	≤ 4	R	≤ 2	≤ 32	≤ 1	≤ 1	R	≤ 4

Organism	Penicillins		Cephalosporins		Tetracyclines		Other		
	Amoxicillin	Penicillin	Cefotaxime	Ceftriaxone	Doxycycline	Tetracycline	Erythromycin	Levofloxacin	Vancomycin
<i>Streptococcus pneumoniae</i>	–	–	–	–	≤ 25	≤ 1	–	≤ 2	≤ 1
Meningitis	–	≤ 06	≤ 5	≤ 5	–	–	–	–	–
Non-meningitis	≤ 2	≤ 2	≤ 1	≤ 1	–	–	≤ 25	–	–
Viridans group <i>Streptococcus</i>	–	≤ 12	≤ 1	≤ 1	–	–	–	–	≤ 1

† Data derived from CLSI M100 30th edition.

1 *S. aureus* only, including MRSA

2 beta-lactamase negative

3 R - Intrinsic resistance

4 – Not routinely tested and/or not applicable.

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, consider adding UA with reflex to culture (LAB).
 - 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**.
 - 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:
 - 1) Addition of metronidazole to another agent with anaerobic activity to treat *Clostridioides difficile* infection.
 - 2) 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/>

Tables 1-4
Adults

Resources at UCLA through the Antimicrobial Stewardship Program (ASP)

Tables 5-6
Adults/Peds

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:

Tables 7-9
Peds

Tables 10
Yeasts

ASP helpdesk: (310) 267-7567

Email: antimicrobialstewardship@mednet.ucla.edu

Website: <http://www.asp.mednet.ucla.edu>

Tables 11-14
**Emerging
Resist.
Concerns**

Note that the website has a **guidebook**, with detailed information about specific clinical syndromes, interpretation of microbiology reports, and guidelines for treatment.

For an eConsultation, email:

antimicrobialstewardship@mednet.ucla.edu

Tables 15-21
Misc

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

Tables 22-27
Lab Info

- Sukantha Chandrasekaran, PhD, D(ABMM), Associate Director, Clinical Microbiology
- Matt Davis, PharmD, ID Pharmacist
- Annabelle De St Maurice, MD, Co-Chief Infection Prevention

Table 28
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