UCLA Health System

Antimicrobial Susceptibility Summary 2014

Clinical Microbiology
Department of Pathology & Laboratory Medicine

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

http://www.asp.mednet.ucla.edu/pages/

Select “Antimicrobial Susceptibility Summary” on left side of homepage

Preface

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

Antimicrobials (IV, PO):
These tables summarize susceptibility data obtained for organisms isolated in the UCLA Clinical Microbiology Laboratory in 2013.
Percent Susceptible Data (Tables 1-14)

Empirical Antimicrobial Choices at UCLA (Table 20)

Antimicrobial Testing and Reporting Policies (Tables 27–28)

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
4. Therapeutically relevant antimicrobials
5. Formulary status of the antimicrobial

Non-formulary drugs are not routinely reported and controlled formulary agents (Table 26) 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.

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Zachary Rubin, MD, Division of Infectious Disease
Daniel Uslan, MD, Division of Infectious Diseases

Guidelines for Interpretation of Minimal Inhibitory Concentrations (MICs)

MICs are interpreted as susceptible, intermediate, resistant, or non-susceptible 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. A common rule of thumb is that antimicrobial concentrations at the site of infection should be at least 2–4 times the MIC.

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

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Frequently called numbers*:

Antimicrobial Stewardship Hotline	310-267-7566
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 (page 92528)	310-267-8510
Microbiology Fellow on-call	page 90103

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

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RRUMC – Ronald Reagan UCLA Medical Center
SMH-UCLA – Santa Monica Hospital-UCLA

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

Organism	Source	No. Isolates	Penicillins			Cephalosporins				Carbapenems			Aminoglycosides			Fluoroquinolone	Other
			Ampicillin	Ampicillin-sulbactam	Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin	Trimethoprim – sulfamethoxazole
Enterobacter cloacae	OP	66	R[1]	R[1]	92	R[1]	99	—	—	99	99	99	99	99	99	96	85
	IP	37	R[1]	R[1]	78	R[1]	89	—	—	94	94	95	99	92	89	92	81
	ICU	55	R[1]	R[1]	61	R[1]	86	—	—	84	98	99	99	98	99	95	89
Escherichia coli	OP	202	44	50	95	79	95	87	87	99	99	99	99	88	87	67	61
	IP	123	32	39	90	68	92	79	79	99	99	99	98	80	80	56	55
	ICU	88	33	39	75	57	88	72	72	98	97	98	97	76	78	56	56
Klebsiella pneumoniae	OP	97	R[1]	78	97	93	98	97	98	99	99	99	99	97	93	91	86
	IP	60	R[1]	60	80	77	90	81	83	92	95	93	95	90	80	77	68
	ICU	87	R[1]	65	84	74	85	81	81	87	91	91	95	86	81	79	77
Proteus mirabilis	OP	73	80	89	99	88	95	94	94	97	13	99	99	89	88	82	77
	IP	21[2]	62	71	99	81	99	85	85	99	10	99	99	81	86	67	67
	ICU	19[2]	63	74	99	74	95	79	84	99	33	99	99	79	84	53	63
Pseudomonas aeruginosa	OP	266	R[1]	R[1]	89	R[1]	87	91	R[1]	R[1]	85	91	94	90	95	83	R[1]
	IP	100	R[1]	R[1]	63	R[1]	72	66	R[1]	R[1]	61	70	93	86	89	63	R[1]
	ICU	116	R[1]	R[1]	55	R[1]	64	65	R[1]	R[1]	54	55	90	78	83	61	R[1]

OP, outpatient (excludes EMC); IP, inpatient (excludes ICU); ICU, intensive care unit

[1] R = intrinsic resistance (inherent or innate antimicrobial resistance).
[2] Calculated from fewer than the standard recommendation of 30 isolates

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

Organism	No. Isolates	Penicillins			Cephalosporins				Carbapenems			Aminoglycosides			Fluoroquinolone	Other
		Ampicillin	Ampicillin-sulbactam	Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin	Trimethoprim – sulfamethoxazole
Citrobacter freundii[2]	28	R[1]	R[1]	82	R[1]	82	—	—	86	90	90	93	86	82	89	79
Enterobacter aerogenes	64	R[1]	R[1]	89	R[1]	99	—	—	98	87	99	100	100	100	97	100
Enterobacter cloacae	159	R[1]	R[1]	80	R[1]	97	—	—	94	98	98	99	97	97	94	87
Escherichia coli	396	39	45	91	72	82	81	82	99	99	99	99	83	84	63	60
Klebsiella oxytoca	93	R[1]	60	86	75	93	93	92	98	99	99	100	96	97	96	93
Klebsiella pneumoniae	232	R[1]	70	89	83	89	88	89	93	96	95	97	92	87	85	80
Morganella morganii[2]	17	R[1]	R[1]	100	R[1]	100	—	—	100	30	100	100	77	82	65	59
Proteus mirabilis	111	74	84	99	86	91	91	92	98	15	99	99	87	87	76	73
Serratia marcescens	103	R[1]	R[1]	96	R[1]	99	—	—	98	84	99	99	99	97	97	98
Acinetobacter baumannii	50	R[1]	50	44	R[1]	42	41	—	R[1]	52	50	52	46	48	44	46
Pseudomonas aeruginosa	453	R[1]	R[1]	80	R[1]	83	84	R[1]	R[1]	76	82	95	89	92	77	R[1]
Stenotrophomonas maltophilia	70	R[1]	R[1]	R[1]	R[1]		30	R[1]	R[1]	R[1]	R[1]	R[1]	R[1]	R[1]	—	97

[1] R = intrinsic resistance (inherent or innate antimicrobial resistance).

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

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

Organism	Source	No. Isolates	Penicillin	Cephalosporins			Carbapenems			Amino-glycosid	Fluoroquin-olone	Other	
			Ampicillin	Cefazolin	Cefepime	Ceftriaxone [1]	Ertapenem	Imipenem	Meropenem	Gentamicin	Ciprofloxacin	Nitrofurantoin	Trimethoprim – sulfamethoxazole
Enterobacter cloacae	OP	87	R [2]	R [2]	99	—	89	95	99	99	98	20	84
	IP	32	R [2]	R [2]	93	—	87	97	97	94	91	13	66
Escherichia coli	OP	2916	53	88	94	93	99	99	99	91	78	92	72
	IP	381	39	71	82	80	99	99	99	83	59	91	59
Klebsiella pneumoniae	OP	448	R [2]	91	95	94	98	98	98	96	93	23	87
	IP	134	R [2]	89	92	90	99	99	99	95	90	20	80
Proteus mirabilis	OP	219	80	93	99	99	95	15	99	95	82	R [2]	77
	IP	54	70	89	94	94	98	4	99	76	74	R [2]	70
Pseudomonas aeruginosa [3]	OP	140	R [2]	R [2]	87	R [2]	R [2]	76	88	91	73	R [2]	R [2]
	IP	88	R [2]	R [2]	81	R [2]	R [2]	71	84	91	73	R [2]	R [2]

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

[1] Cefotaxime and ceftriaxone have comparable activity against *Enterobacteriaceae*

[2] R = intrinsic resistance (inherent or innate antimicrobial resistance)

[3] Ceftazidime: OP 86%, IP 81%, Piperacillin-tazobactam: OP 80%, IP 75%

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

Organism	Source	No. Isolates	Penicillins			Amino–glycosides			Other									
			Ampicillin	Oxacillin	Penicillin	Gentamicin	Gentamicin synergy	Streptomycin synergy	Ciprofloxacin	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Linezolid	Quinupristin-dalfopristin	Rifampin	Trimethoprim-sulfamethoxazole	Vancomycin
Staphylococcus aureus [1]	All	1392	—	67	<10	94	—	—	63	72	99	98	52	99	99	98	98	99
Oxacillin-resistant *S. aureus* (MRSA) [1]	OP	311	—	0	0	88	—	—	16	57	99	98	11	99	99	98	97	99
	IP	86	—	0	0	82	—	—	8	42	99	97	9	99	99	98	91	99
	ICU	94	—	0	0	85	—	—	9	49	99	97	14	99	99	87	97	99
Oxacillin-susceptible *S. aureus* (MSSA)	OP	649	—	100	<10	98	—	—	85	80	99	98	69	99	99	99	99	99
	IP	116	—	100	<10	97	—	—	84	81	99	98	70	99	99	99	99	99
	ICU	147	—	100	<10	98	—	—	94	81	99	99	78	99	99	97	99	99
Coagulase-negative *Staphylococcus* [1, 2]	All	353	—	39	<10	72	—	—	40	56	99	91	37	99	99	95	57	99
***Enterococcus* spp.**[3]	All	596	75	—	—	—	78	69	43	—	99	33	—	99	30	24	—	77
Enterococcus faecalis [4]	All	37	99	—	—	—	73	65	49	—	99	30	—	99	—	32	—	99
Enterococcus faecium [5]	All	58	9	—	—	—	95	52	3	—	93	52	3	98	95	5	—	16

OP, outpatient (includes EMC); IP, inpatient (excludes ICU); ICU, intensive care unit

[1] *Staphylococcus* resistant to oxacillin are resistant to cefazolin, cephalexin, ceftriaxone and all other beta-lactams except ceftaroline
[2] *S. saprophyticus* urinary tract infections respond to antibiotic concentrations achieved in urine with agents commonly used to treat acute uncomplicated UTIs
[3] Includes isolates identified to genus only (non-sterile sites) and those identified to species (sterile sites)
[4] Sterile sites; 22% High-level resistance to both gentamicin and streptomycin
[5] Sterile sites; 1% High-level resistance to both gentamicin and streptomycin

Table 4. RRUMC: 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	Vancomycin
Streptococcus pneumoniae	**33**	**88**		**—**	**—**	**76**	**67**	**55**	**94**	**67**	**100**
Meningitis [1]		**—**	**54**	**81**	**81**	**—**	**—**	**—**	**—**	**—**	**—**
Non-meningitis [2]		**—**	**93**	**90**	**93**	**—**	**—**	**—**	**—**	**—**	**—**
Viridans group *Streptococcus*	**64**	**—**	**80** [3]	**97**	**97**	**—**	**—**	**—**	**—**	**—**	**100**
beta-hemolytic group *Streptococcus* spp.	**All remain predictably susceptible to penicillin; resistance rates nationwide for Group B streptococci (*S. agalactiae*) are approximately 50% for erythromycin and 30% for clindamycin. Resistance rates for Group A streptococci *(S. pyogenes)* can be as high as 25% for erythromycin, 5% for clindamycin and 20% for tetracyclines.**										

[1] % susceptible for penicillin, cefotaxime and ceftriaxone applies to patients with meningitis.

[2] % susceptible for penicillin, cefotaxime and ceftriaxone applies to patients without meningitis.

[3] Resistant (R) includes 20% Intermediate (MIC 0.25-2 µg/ml) and 0% High-level (MIC >2 µg/m) R.

Table 5. RRUMC: Miscellaneous Gram-negative Bacteria

Organism	No. Strains	% beta-lactamase positive[1]
Haemophilus influenzae	**45 (pts. >21 y.o)** **19 (pts. ≤21 y.o.)**	**30** **26**
Moraxella catarrhalis	**32 (pts. >21 y.o)** **15 (pts. ≤21 y.o.)**	**90** **99**
Neisseria gonorrhoeae	Because of increasing incidence of fluoroquinolone (e.g. ciprofloxacin) resistance and concerns for cefixime resistance in California, the current therapy recommendation is ceftriaxone in combination with azithromycin or doxycycline. Routine susceptibility testing not performed due to low incidence of ceftriaxone resistance. However, culture and susceptibility testing should be performed in cases of treatment failure. See http://www.cdc.gov/std/Gonorrhea/	
Neisseria meningitidis	*Neisseria meningitidis* 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.	

[1] Resistant to ampicillin, amoxicillin, and penicillin

Table 6. RRUMC: *Pseudomonas aeruginosa* – %Susceptible to One or Two Antimicrobials

Information provided for two drugs does NOT imply synergism, antagonism or likely activity in vivo; 769 patients, included the most resistant result for each drug if patient had >1 isolate

	Amikacin (94)[1]	Gentamicin (88)	Tobramycin (92)	Ciprofloxacin (73)
Cefepime (77)	98[2]	95	97	94
Meropenem (72)	99	95	96	91
Piperacillin-tazobactam (74)	99	96	97	92
Ciprofloxacin (73)	99	95	96	–

[1] Percent susceptible for individual drug in parenthesis
[2] Percent susceptible for either or both drugs (e.g. %S to amikacin and/or cefepime)

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

Organism	No. Isolates	Penicillins			Cephalosporins				Carbapenems			Aminoglycosides			Fluoroquinolone	Other
		Ampicillin	Ampicillin-sulbactam	Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin	Trimethoprim – sulfamethoxazole
Citrobacter freundii[2]	28	R[1]	R[1]	82	R[1]	82	—	—	86	90	90	93	86	82	89	79
Enterobacter aerogenes	64	R[1]	R[1]	89	R[1]	99	—	—	98	87	99	100	100	100	97	100
Enterobacter cloacae	159	R[1]	R[1]	80	R[1]	97	—	—	94	98	98	99	97	97	94	87
Escherichia coli	396	39	45	91	72	82	81	82	99	99	99	99	83	84	63	60
Klebsiella oxytoca	93	R[1]	60	86	75	93	93	92	98	99	99	100	96	97	96	93
Klebsiella pneumoniae	232	R[1]	70	89	83	89	88	89	93	96	95	97	92	87	85	80
Morganella morganii[2]	17	R[1]	R[1]	100	R[1]	100	—	—	100	30	100	100	77	82	65	59
Proteus mirabilis	111	74	84	99	86	91	91	92	98	15	99	99	87	87	76	73
Serratia marcescens	103	R[1]	R[1]	96	R[1]	99	—	—	98	84	99	99	99	97	97	98
Acinetobacter baumannii	50	R[1]	50	44	R[1]	42	41	—	R[1]	52	50	52	46	48	44	46
Pseudomonas aeruginosa	453	R[1]	R[1]	80	R[1]	83	84	R[1]	R[1]	76	82	95	89	92	77	R[1]
Stenotrophomonas maltophilia	70	R[1]	R[1]	R[1]	R[1]		30	R[1]	R[1]	R[1]	R[1]	R[1]	R[1]	R[1]	—	97

[1] R = intrinsic resistance (inherent or innate antimicrobial resistance).

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

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

Organism	Source	No. Isolates	Penicillin	Cephalosporins			Carbapenems			Amino-glycosid	Fluoroquin-olone	Other	
			Ampicillin	Cefazolin	Cefepime	Ceftriaxone [1]	Ertapenem	Imipenem	Meropenem	Gentamicin	Ciprofloxacin	Nitrofurantoin	Trimethoprim – sulfamethoxazole
Enterobacter cloacae	OP	87	R [2]	R [2]	99	—	89	95	99	99	98	20	84
	IP	32	R [2]	R [2]	93	—	87	97	97	94	91	13	66
Escherichia coli	OP	2916	53	88	94	93	99	99	99	91	78	92	72
	IP	381	39	71	82	80	99	99	99	83	59	91	59
Klebsiella pneumoniae	OP	448	R [2]	91	95	94	98	98	98	96	93	23	87
	IP	134	R [2]	89	92	90	99	99	99	95	90	20	80
Proteus mirabilis	OP	219	80	93	99	99	95	15	99	95	82	R [2]	77
	IP	54	70	89	94	94	98	4	99	76	74	R [2]	70
Pseudomonas aeruginosa [3]	OP	140	R [2]	R [2]	87	R [2]	R [2]	76	88	91	73	R [2]	R [2]
	IP	88	R [2]	R [2]	81	R [2]	R [2]	71	84	91	73	R [2]	R [2]

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

[1] Cefotaxime and ceftriaxone have comparable activity against *Enterobacteriaceae*

[2] R = intrinsic resistance (inherent or innate antimicrobial resistance)

[3] Ceftazidime: OP 86%, IP 81%, Piperacillin-tazobactam: OP 80%, IP 75%

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

Organism	Source	No. Isolates	Penicillins			Amino–glycosides			Other									
			Ampicillin	Oxacillin	Penicillin	Gentamicin	Gentamicin synergy	Streptomycin synergy	Ciprofloxacin	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Linezolid	Quinupristin-dalfopristin	Rifampin	Trimethoprim-sulfamethoxazole	Vancomycin
Staphylococcus aureus [1]	All	1392	—	67	<10	94	—	—	63	72	99	98	52	99	99	98	98	99
Oxacillin-resistant *S. aureus* (MRSA) [1]	OP	311	—	0	0	88	—	—	16	57	99	98	11	99	99	98	97	99
	IP	86	—	0	0	82	—	—	8	42	99	97	9	99	99	98	91	99
	ICU	94	—	0	0	85	—	—	9	49	99	97	14	99	99	87	97	99
Oxacillin-susceptible *S. aureus* (MSSA)	OP	649	—	100	<10	98	—	—	85	80	99	98	69	99	99	99	99	99
	IP	116	—	100	<10	97	—	—	84	81	99	98	70	99	99	99	99	99
	ICU	147	—	100	<10	98	—	—	94	81	99	99	78	99	99	97	99	99
Coagulase-negative *Staphylococcus* [1, 2]	All	353	—	39	<10	72	—	—	40	56	99	91	37	99	99	95	57	99
***Enterococcus* spp.**[3]	All	596	75	—	—	—	78	69	43	—	99	33	—	99	30	24	—	77
Enterococcus faecalis [4]	All	37	99	—	—	—	73	65	49	—	99	30	—	99	—	32	—	99
Enterococcus faecium [5]	All	58	9	—	—	—	95	52	3	—	93	52	3	98	95	5	—	16

OP, outpatient (includes EMC); IP, inpatient (excludes ICU); ICU, intensive care unit

[1] *Staphylococcus* resistant to oxacillin are resistant to cefazolin, cephalexin, ceftriaxone and all other beta-lactams except ceftaroline
[2] *S. saprophyticus* urinary tract infections respond to antibiotic concentrations achieved in urine with agents commonly used to treat acute uncomplicated UTIs
[3] Includes isolates identified to genus only (non-sterile sites) and those identified to species (sterile sites)
[4] Sterile sites; 22% High-level resistance to both gentamicin and streptomycin
[5] Sterile sites; 1% High-level resistance to both gentamicin and streptomycin

Table 4. RRUMC: 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	Vancomycin
Streptococcus pneumoniae	**33**	**88**		**—**	**—**	**76**	**67**	**55**	**94**	**67**	**100**
Meningitis [1]		**—**	**54**	**81**	**81**	**—**	**—**	**—**	**—**	**—**	**—**
Non-meningitis [2]		**—**	**93**	**90**	**93**	**—**	**—**	**—**	**—**	**—**	**—**
Viridans group *Streptococcus*	**64**	**—**	**80** [3]	**97**	**97**	**—**	**—**	**—**	**—**	**—**	**100**
beta-hemolytic group *Streptococcus* spp.	**All remain predictably susceptible to penicillin; resistance rates nationwide for Group B streptococci (*S. agalactiae*) are approximately 50% for erythromycin and 30% for clindamycin. Resistance rates for Group A streptococci *(S. pyogenes)* can be as high as 25% for erythromycin, 5% for clindamycin and 20% for tetracyclines.**										

[1] % susceptible for penicillin, cefotaxime and ceftriaxone applies to patients with meningitis.

[2] % susceptible for penicillin, cefotaxime and ceftriaxone applies to patients without meningitis.

[3] Resistant (R) includes 20% Intermediate (MIC 0.25-2 µg/ml) and 0% High-level (MIC >2 µg/m) R.

Table 5. RRUMC: Miscellaneous Gram-negative Bacteria

Organism	No. Strains	% beta-lactamase positive[1]
Haemophilus influenzae	**45 (pts. >21 y.o)** **19 (pts. ≤21 y.o.)**	**30** **26**
Moraxella catarrhalis	**32 (pts. >21 y.o)** **15 (pts. ≤21 y.o.)**	**90** **99**
Neisseria gonorrhoeae	Because of increasing incidence of fluoroquinolone (e.g. ciprofloxacin) resistance and concerns for cefixime resistance in California, the current therapy recommendation is ceftriaxone in combination with azithromycin or doxycycline. Routine susceptibility testing not performed due to low incidence of ceftriaxone resistance. However, culture and susceptibility testing should be performed in cases of treatment failure. See http://www.cdc.gov/std/Gonorrhea/	
Neisseria meningitidis	*Neisseria meningitidis* 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.	

[1] Resistant to ampicillin, amoxicillin, and penicillin

Table 6. RRUMC: *Pseudomonas aeruginosa* – %Susceptible to One or Two Antimicrobials

Information provided for two drugs does NOT imply synergism, antagonism or likely activity in vivo; 769 patients, included the most resistant result for each drug if patient had >1 isolate

	Amikacin (94)[1]	Gentamicin (88)	Tobramycin (92)	Ciprofloxacin (73)
Cefepime (77)	98[2]	95	97	94
Meropenem (72)	99	95	96	91
Piperacillin-tazobactam (74)	99	96	97	92
Ciprofloxacin (73)	99	95	96	–

[1] Percent susceptible for individual drug in parenthesis
[2] Percent susceptible for either or both drugs (e.g. %S to amikacin and/or cefepime)

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

Organism	No. Isolates	Penicillins			Cephalosporins				Carbapenems		Aminoglycosides			Fluoroquin-olone	Other
		Ampicillin	Ampicillin-sulbactam	Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin [1]	Trimethoprim – sulfamethoxazole
Enterobacter cloacae [3]	27	R [2]	R [2]	93	R [2]	99	89	89	99	99	99	96	96	99	93
Escherichia coli	47	33	46	94	83	87	87	87	99	99	98	83	83	91	57
Klebsiella pneumoniae [3]	30	R [2]	67	90	93	97	97	97	96	97	97	97	97	97	90
Serratia marcescens [3]	18	R [2]	R	99	R [2]	99	86	93	82	99	99	88	82	94	94
Acinetobacter baumanii [3]	10	R [2]	78	44	R [2]	44	60	–	89	88	89	78	78	78	78
Pseudomonas aeruginosa	95	R [2]	R	83	R [2]	86	86	R [2]	88	89	96	90	93	87	R [2]

[1] Ciprofloxacin is associated with arthropathy and histological changes in weight-bearing joints of juvenile animals and is currently not FDA approved for pediatric use.
[2] R = intrinsic resistance (inherent or innate antimicrobial resistance).
[3] Calculated from fewer than the standard recommendation of 30 isolates

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

Organism	No. Isolates	Penicillins			Cephalosporins				Carbapenems		Aminoglycosides			Fluoroquin-olone	Other
		Ampicillin	Ampicillin-sulbactam	Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin [1]	Trimethoprim – sulfamethoxazole
Enterobacter cloacae [3]	27	R [2]	R [2]	93	R [2]	99	89	89	99	99	99	96	96	99	93
Escherichia coli	47	33	46	94	83	87	87	87	99	99	98	83	83	91	57
Klebsiella pneumoniae [3]	30	R [2]	67	90	93	97	97	97	96	97	97	97	97	97	90
Serratia marcescens [3]	18	R [2]	R	99	R [2]	99	86	93	82	99	99	88	82	94	94
Acinetobacter baumanii [3]	10	R [2]	78	44	R [2]	44	60	–	89	88	89	78	78	78	78
Pseudomonas aeruginosa	95	R [2]	R	83	R [2]	86	86	R [2]	88	89	96	90	93	87	R [2]

[1] Ciprofloxacin is associated with arthropathy and histological changes in weight-bearing joints of juvenile animals and is currently not FDA approved for pediatric use.
[2] R = intrinsic resistance (inherent or innate antimicrobial resistance).
[3] Calculated from fewer than the standard recommendation of 30 isolates

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

Organism	No. Isolates	Penicillins		Cephalosporins				Carbapenems		Aminoglycosides			Fluoroquin-olone	Other	
		Ampicillin	Ampicillin-sulbactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone [1]	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin [2]	Trimethoprim – sulfamethoxazole	Nitrofurantoin
Enterobacter cloacae [3]	18	R [4]	R [4]	R [4]	99	—	71	99	99	99	99	99	99	94	24
Escherichia coli	378	55	63	89	95	—	95	99	99	99	93	91	88	74	95
Klebsiella pneumoniae	54	R [4]	87	94	96	—	94	98	98	99	96	99	94	77	17
Proteus mirabilis	56	86	95	95	98	—	98	—	99	99	96	99	96	84	R [4]
Pseudomonas aeruginosa	33	R [4]	R [4]	R [4]	85	—	R [4]	78	87	99	94	97	94	R [4]	R [4]

[1] Cefotaxime and ceftriaxone have comparable activity against *Enterobacteriaceae.*
[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] Calculated from fewer than the standard recommendation of 30 isolates.
[4] R = intrinsic resistance (inherent or innate antimicrobial resistance).

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

Organism	Source	No. Isolates	Penicillins			Cephalo-sporins		Aminoglycosides		Other									
			Ampicillin	Oxacillin	Penicillin	Ceftriaxone	Cefotaxime	Gentamicin synergy	Streptomycin synergy	Ciprofloxacin[1]	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Linezolid	Quinupristin-dalfopristin	Rifampin	Trimethoprim-sulfamethoxazole	Vancomycin
Staphylococcus aureus (All)[2]	OP	179	–	80	<10	–	–	–	–	74	76	99	98	56	99	99	99	99	99
	IP	82	–	82	<10	–	–	–	–	78	73	99	99	68	99	99	99	99	99
Oxacillin-resistant *S. aureus* (MRSA)[2]	OP	39	–	0	0	–	–	–	–	23	66	97	97	13	99	99	97	99	99
	IP[3]	17	–	0	0	–	–	–	–	18	35	99	99	24	99	99	94	94	99
Oxacillin-susceptible *S. aureus* (MSSA)	OP	145	–	100	<10	–	–	–	–	88	79	99	98	68	99	99	99	99	99
	IP	67	–	100	<10	–	–	–	–	93	85	99	99	81	99	99	99	99	99
Coagulase negative Staphylococcus (sterile body sites)	OP[3]	27	–	30	<10	–	–	–	–	62	58	99	85	33	99	99	89	58	96
	IP	34	–	21	<10	–	–	–	–	71	50	99	94	18	99	99	91	65	99
Enterococcus spp.[4]	All	62	84	–	–	–	–	71	74	45	–	98	23	–	99	21	26	–	88
Enterococcus faecalis[3, 5]	All[3]	15	99	–	–	–	–	73	87	80	–	99	27	–	99	–	33	–	99
Enterococcus faecium[3, 5]	All[3]	5	20	–	–	–	–	99	40	0	–	99	60	–	99	99	60	–	20
Viridans group Streptococcus[3] *(sterile body sites)*	All[3]	18	–	–	67	94	100	–	–	–	–	–	–	–	–	–	–	–	100

OP, outpatient (includes EMC); IP, inpatient (includes ICU)

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

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

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

[4] Includes isolates identified to genus only (non-sterile body sites) and those identified to species (sterile body sites).

[5] Sterile sites; 1% High-level resistance to both gentamicin and streptomycin.

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

Organism	No. Isolates	Penicillins		Cephalosporins		Other				
		Amoxicillin	Penicillin	Cefotaxime	Ceftriaxone	Clindamycin	Doxycycline	Erythromycin	Trimethoprim – sulfamethoxazole	Vancomycin
Streptococcus pneumoniae	14[1]	92		—	—	93	100	71	69	100
Meningitis[2]		—	72	92	86	—	—	—	—	—
Non-meningitis[3]		—	93	92	86	—	—	—	—	—

[1] Calculated from fewer than 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. RRUMC: Yeasts, % Susceptible, 2011-2013

- When antifungal therapy is necessary, most yeast infections can be treated empirically. Antifungal testing of yeasts may be warranted for the following:
  1) oropharyngeal infections due to *Candida* spp. in patients who appear to be failing therapy
  2) 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 2009:48, 503. Clinical Practice Guidelines for the Management of Candidiasis: 2009
- Yeast isolates from sterile body sites are tested every 7 days; isolates from other sources are tested upon special request.
- Only fluconazole is reported unless fluconazole resistance is detected.

Organism	No. Isolates[2]	Percent Susceptible/Dose Dependent/Resistant at Breakpoints [1](µg/ml)							
		Fluconazole			Caspofungin	Voriconazole			Flucytosine
		≤ 8 S	16-32 S-DD	≥64 R	≤ 2 S	≤ 1 S	2 S-DD	≥4 R	≤ 4 S
C. albicans[3]	138	98	1	1	100	99	0	1	98
C. glabrata	146	42	33	25	100	76	3	21	100
C. parapsilosis	52	99	1	0	99	100	0	0	98
C. tropicalis	35	97	0	3	100	97	0	3	91
C. krusei [4]	17	R	R	R	100	94	6	0	7

[1] S = Susceptible. S-DD = Susceptible dose dependent; susceptibility dependent on achieving maximal possible blood level; no dose dependent category for flucytosine and caspofungin. R = Resistant
[2] Not all isolates were tested against all four antifungal agents.
[3] *C. albicans* usually susceptible to fluconazole
[4] Calculated from fewer than the standard recommendation of 30 isolates

Table 11. RRUMC: Yeasts, Cumulative % Susceptible at MIC, 2010-2013

Fluconazole (µg/ml)

Organism	No. Isolates	≤1	2.0	4.0	8.0	16.0	32.0	64.0	>64
C. albicans	138	23	95	97	98	99	99	99	100
C. glabrata	145	1	5	20	43	66	76	85	100
C. parapsilosis	52	86	98	98	98	98	100	98	100
C. tropicalis	35	88	97	97	97	97	97	100	100
C. krusei	—	intrinsically resistant to fluconazole							

Voriconazole (µg/ml)

Organism	No. Isolates	≤0.12	0.25	0.5	1.0	2.0	4.0	8	>8
C. albicans	138	93	94	97	98	98	98	98	100
C. glabrata	145	24	33	69	83	86	93	98	100
C. parapsilosis	52	98	98	100	97	97	97	97	100
C. tropicalis[1]	35	88	91	97	97	97	100	100	100
C. krusei[1]	17	12	30	82	94	100	—	—	—

Caspofungin (µg/ml)

Organism	No. Isolates	≤0.25	0.5	1.0	2.0	>2.0
C. albicans	138	92	97	99	100	—
C. glabrata	145	87	95	99	100	—
C. parapsilosis	52	4	53	92	100	—
C. tropicalis	35	91	94	97	100	100
C. krusei[1]	17	59	82	100	—	—

Amphotericin (µg/ml)

Organism	No. Isolates	≤0.03	0.06	0.12	0.25	0.5	1.0	2.0	>2.0
C. albicans	138	1	5	7	7	7	59	100	—
C. glabrata	145	0	1	2	2	3	17	100	—
C. parapsilosis	52	2	6	10	12	12	36	98	100
C. tropicalis	35	0	0	0	0	0	9	100	—
C. krusei[1]	17	0	0	0	12	12	12	82	100

1 Calculated from fewer than the standard recommendation of 30 isolates

Table 12. SMH-UCLA: Non-Urine Gram-negative Bacteria, % Susceptible

Outpatients

Organism	No. Isolates	Penicillins			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
Escherichia coli	111	48	51	96	75	–	82	81	99	99	99	99	86	83	66	60
Pseudomonas aeruginosa	72	R[2]	R[2]	78	R[2]	83	83	R[2]	R[2]	78	85	99	90	92	78	R[2]

Inpatients

Organism	No. Isolates	Penicillins			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
Enterobacter cloacae	19[3]	R[2]	R[2]	79	R[2]	99	–	–	95	99	99	99	99	99	95	99
Escherichia coli	68	43	50	94	78	87	87	87	99	99	99	99	88	88	56	60
Klesiella pneumoniae	44	R[2]	52	71	61	64	64	64	73	77	73	82	80	64	66	64
Proteus mirabilis	28[3]	43	64	99	57	86	82	86	99	18	99	99	71	79	46	54
Serratia marcescens	16[3]	R[2]	R[2]	75	R[2]	99	–	–	99	70	99	99	99	94	69	94
Pseudomonas aeruginosa	94	R[2]	R[2]	62	R[2]	67	67	R[2]	R[2]	54	56	99	86	88	51	R[2]

[1] Cefotaxime and ceftriaxone have comparable activity against *Enterobacteriaceae*
[2] R = intrinsic resistance (inherent or innate antimicrobial resistance).
[3] Calculated from fewer than the standard recommendation of 30 isolates

Table 13. SMH-UCLA: Urine Gram-negative Bacteria, % Susceptible

Organism	Source	No. Isolates	Penicillins		Cephalosporins				Carbapenems			Aminoglycosides			Fluoro-quinolone	Other	
			Ampicillin	Piperacillin-tazobactam	Cefazolin	Cefepime	Ceftriaxone[1]	Ceftazidime	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin	Nitrofurantoin	Trimethoprim – sulfamethoxazole
Escherichia coli	OP	1144	57	—	85	92	90	—	99	99	99	99	88	83	76	92	69
	IP	300	42	—	75	85	81	—	99	99	99	99	84	85	60	92	69
Klebsiella pneumoniae	OP	157	R[2]	—	94	97	97	—	98	98	98	99	97	94	96	28	92
	IP	69	R[2]	—	70	73	71	—	90	90	90	90	87	68	75	19	77
Proteus mirabilis	OP	114	80	—	89	98	98	—	95	—	99	99	89	88	70	R[2]	78
	IP	46	70	—	83	94	94	—	93	—	99	98	73	81	63	R[2]	59
Pseudomonas aeruginosa	OP	57	R[2]	72	R[2]	77	R[2]	74	R[2]	76	81	98	86	91	58	R[2]	R[2]
	IP	45	R[2]	69	R[2]	78	R[2]	73	R[2]	66	71	96	78	78	67	R[2]	R[2]

OP, outpatient (includes EMC); IP, inpatient (includes ICU)

[1] Cefotaxime and ceftriaxone have comparable activity against *Enterobacteriaceae*

[2] R = intrinsic resistance (inherent or innate antimicrobial resistance)

Table 14. SMH-UCLA (Inpatient): Gram-positive Cocci, % Susceptible

Organism	No. Isolates	Penicillins			Cephalo-sporin	Fluoroquin-olones		Tetracyc-lines		Other								
		Ampicillin	Oxacillin	Penicillin	Ceftriaxone	Ciprofloxacin	Levofloxacin	Doxycycline	Tetracycline	Clindamycin	Daptomycin	Erythromycin	Nitrofurantoin	Linezolid	Quinupristin-dalfopristin	Rifampin	Trimethoprim-sulfamethoxazole	Vancomycin
Staphylococcus aureus (All)	206	—	51	<10	—	44	—	98	—	55	99	34	—	99	99	98	98	99
oxacillin-resistant (MRSA)[1]	105	—	—	—	—	10	—	96	—	50	99	9	—	99	99	95	95	99
oxacillin-susceptible (MSSA)	104	—	100	<10	—	78	—	99	—	70	99	58	—	99	99	99	99	99
Staphylococcus, coagulase negative[2]	38	—	34	<10	—	40	—	92	—	61	97	45	—	99	99	97	55	99
Enterococcus spp. (all)[3,4]	134	69	—	69	—	—	—	39	—	—	99	—	—	99	56[5]	—	—	69
Enterococcus spp. (urine)	108	69	—	69	—	32	—	—	—	—	—	—	70	—	—	—	—	69

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

[2] *S. saprophyticus* urinary tract infections respond to antibiotic concentrations achieved in urine with agents commonly used to treat acute uncomplicated UTIs

[3] Includes 11 *E. faecalis,*96 *E. faecium*, and 114 isolates not identified to species level

[4] Gentamicin synergy 73% susceptible, streptomycin synergy 52% susceptible

[5] Only *E. faecium* are susceptible

Table 15. RRUMC: 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)	Inpatients (n=443) 41% Outpatients (n=960) 32%	vancomycin	Oxacillin-resistant *S. aureus* are clinically resistant to all ß-lactams, ß-lactam / ß-lactamase inhibitor combinations and carbapenems, excluding ceftaroline.[1] Fluoroquinolones are also usually inactive.
Streptococcus pneumoniae (non-meningitis)	penicillin (MIC > 2 µg/ml)	All isolates (n = 33) 9%	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.[1]
Streptococcus pneumoniae (non-meningitis)	cefotaxime, ceftriaxone (penicillin resistant always)	All isolates (n = 33) low level R 9% high level R 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.[1]

Table 15. RRUMC: 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*	penicillin	Blood isolates (n = 45) low level R 29% high level R 4%	penicillin + aminoglycoside or vancomycin	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.
Enterococcus spp.	vancomycin (VRE)	Blood isolates *E. faecium* (n = 59) 85% *E. faecalis* (n = 45) 0%	Check in vitro susceptibility results and contact ID.	Vancomycin-resistant *Enterococcus* (VRE) are often resistant to many potentially useful agents. Therapeutic management must be determined on a case-by-case basis.
	gentamicin synergy screen (GENT) streptomycin synergy screen (STR)	Blood isolates *E. faecium* (n = 59) GENT 5% STR 49% *E. faecalis* (n = 45) GENT 31% STR 29%	Check in vitro susceptibility results and contact ID.	Both aminoglycoside and cell wall active agent (ampicillin, penicillin, or vancomycin) must be susceptible for synergistic interaction.

Table 15. RRUMC: Emerging Resistance Concerns (cont.)

Organism	Resistant to:	Percent Resistant:	Therapeutic Options	Comments
Klebsiella spp. *E. coli*	ceftazidime or other 3rd generation cephalosporin	Blood isolates: *Klebsiella* spp. (n =63) 14% *E. coli* (n =130) 17%	ertapenem aminoglycoside ciprofloxacin	In vitro resistance to 3rd generation cephalosporins suggests the strain is producing extended-spectrum ß-lactamases (ESBL),
K. pneumoniae and other *Enterobacteriaceae*	carbapenem	All isolates: <1%	Check in vitro susceptibility results and contact ID.	Decreased susceptibility to carbapenems is increasing primarily among ICU patients' isolates. These isolates may be resistant to all available antimicrobial agents. See Table 16.
Acinetobacter spp. *Citrobacter freundii* *Enterobacter* spp. *Providencia* spp. / *Proteus* spp. (except *P. mirabilis*) *Serratia marcescens*	3rd generation cephalosporins (e.g. ceftriaxone)	See comments	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] Judicious use of 3rd generation cephalosporins is needed to curtail the increase in cephalosporin-resistant *Enterobacteriaceae*. (i. e. ceftazidime should be reserved for highly suspected or documented pseudomonal infections).
Pseudomonas aeruginosa	cefepime and/or piperacillin-tazobactam	All isolates: (n=838) 18%	Check in vitro susceptibility results and contact ID.	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.
Acinetobacter baumannii	amikacin, ampicillin-sulbactam, cefepime, ceftazidime, cipro-floxacin, meropenem, pip-tazo, trimeth-sulfa	All isolates: (n=73) 25%	Check in vitro susceptibility results and contact ID.	Therapeutic management must be determined on a case by case basis.

Table 15. RRUMC: Emerging Resistance Concerns (cont.)

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

Organism	Resistant to:	Therapeutic Options	Comments
Candida krusei	fluconazole	caspofungin amphotericin voriconazole	Typically resistant to fluconazole.[3, 4]
Candida glabrata	fluconazole	caspofungin amphotericin voriconazole	Typically resistant to fluconazole.[3, 4] Caspofungin resistance may be emerging.
Candida albicans	fluconazole	caspofungin amphotericin	Typically susceptible to fluconazole but resistance can develop during therapy. Amphotericin is the drug of choice for systemic infections in patients without baseline renal dysfunction.[3, 4]

For additional resistance data, see Tables 5-14.

1 The Sanford Guide. 2014
2 Circulation. 2005. **23:**e394
3 Clin. Infect. Dis. 2006. **42**:244–251
4 Treatment Guidelines from the Med. Letter-Antifungal Drugs. 2009. **7:**1–10

Table 16. Resistance Trends: RRUMC, 1990-2013

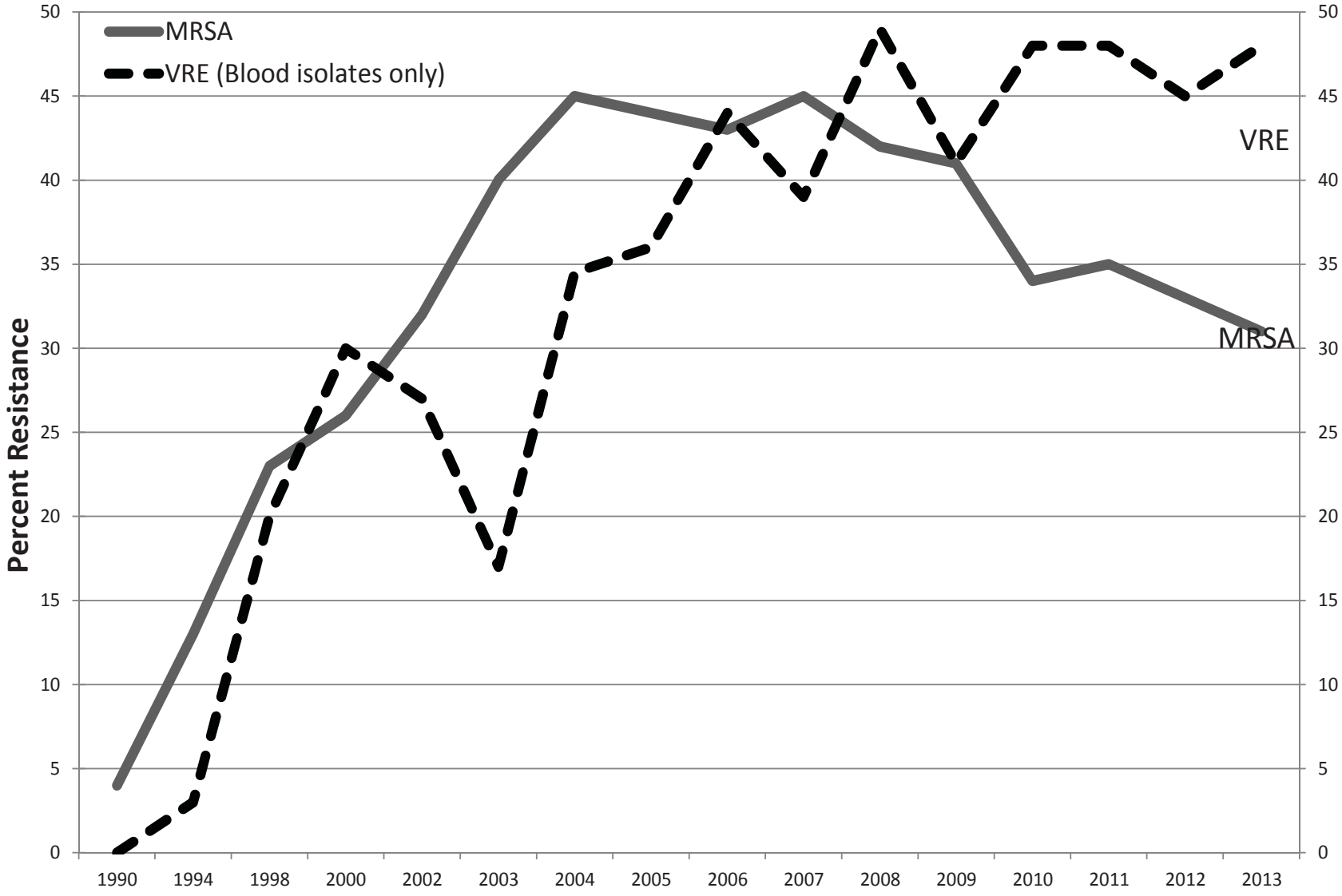


Table 16. Resistance Trends: RRUMC, 1990-2013 (cont.)

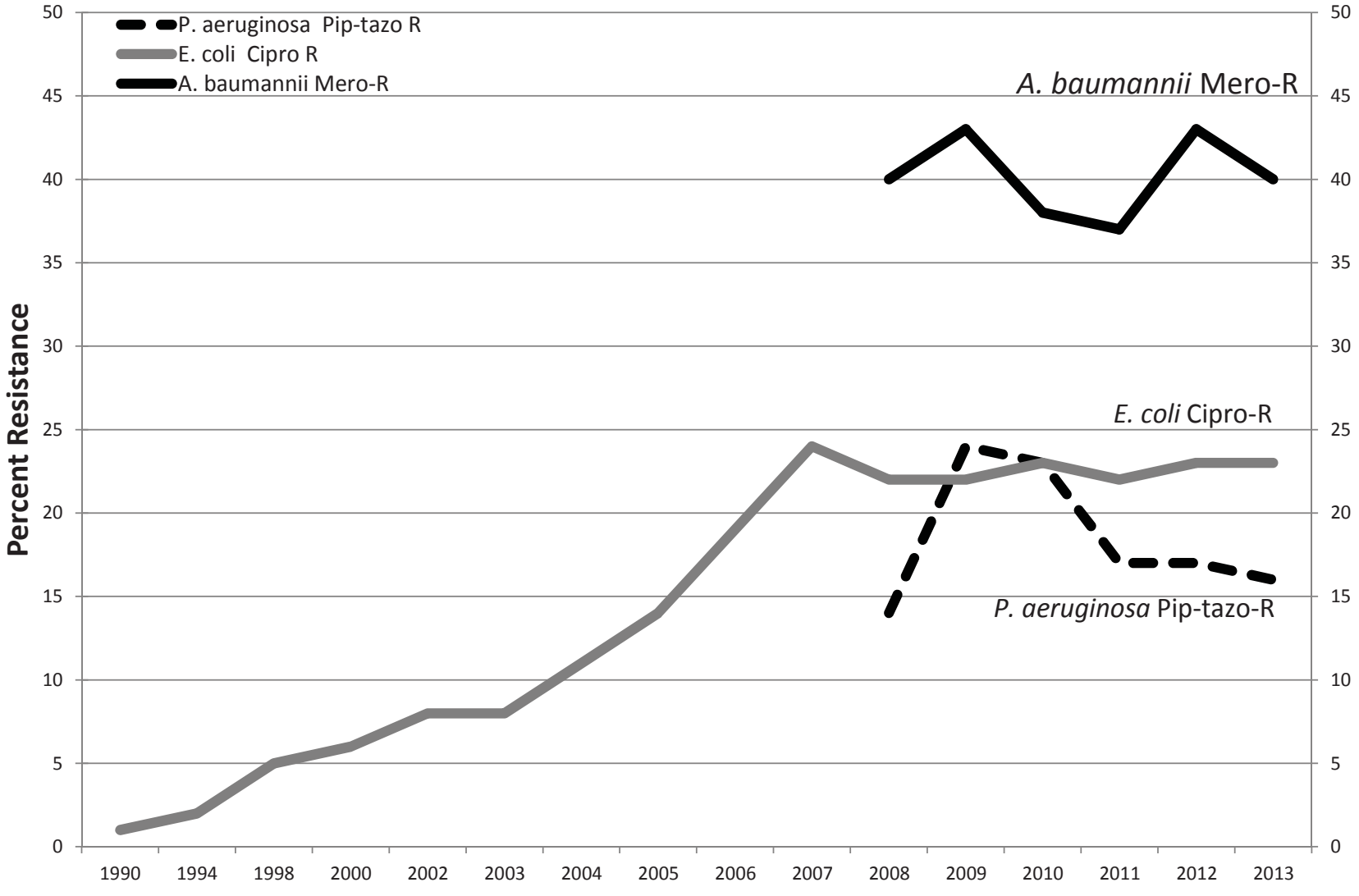
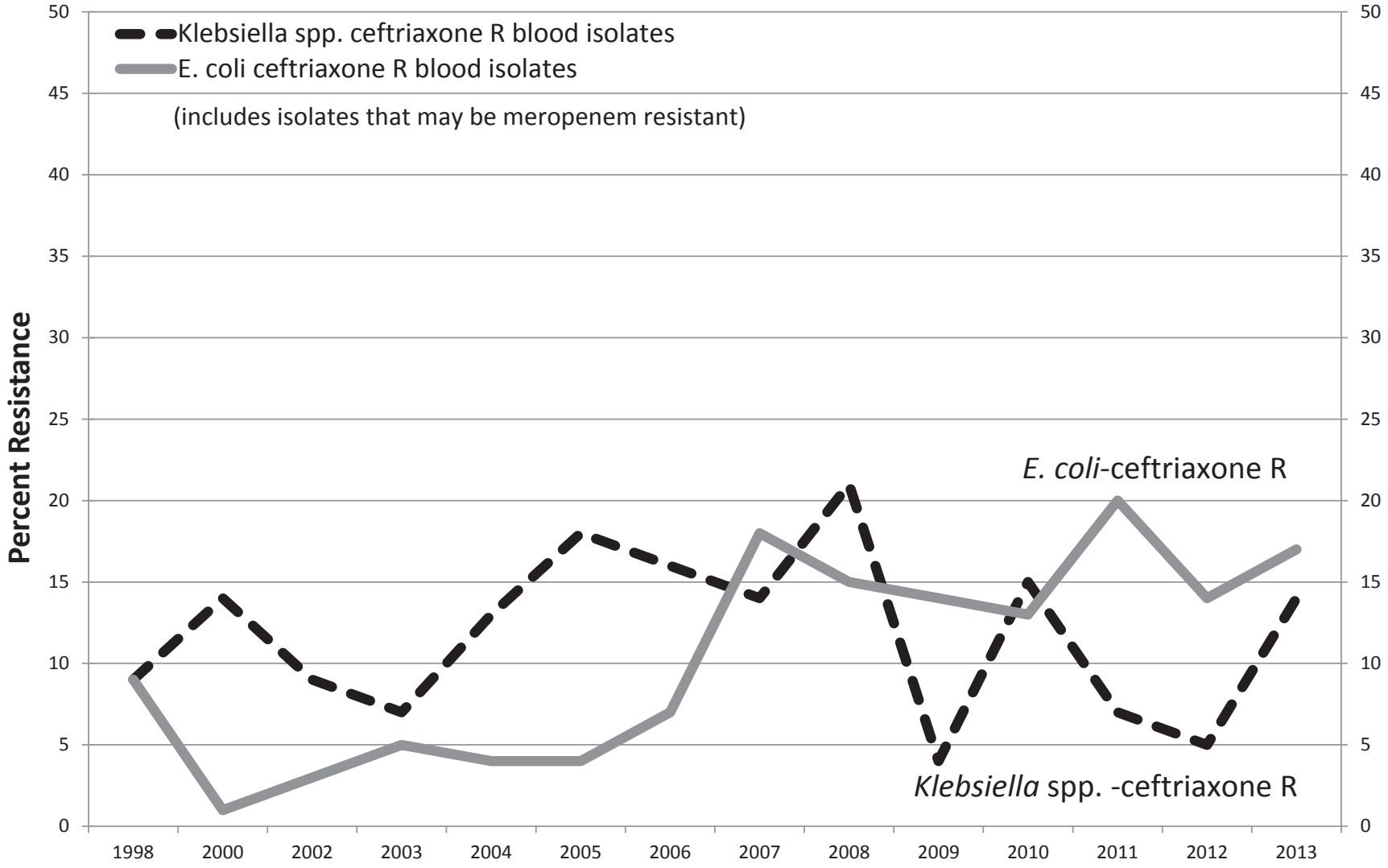
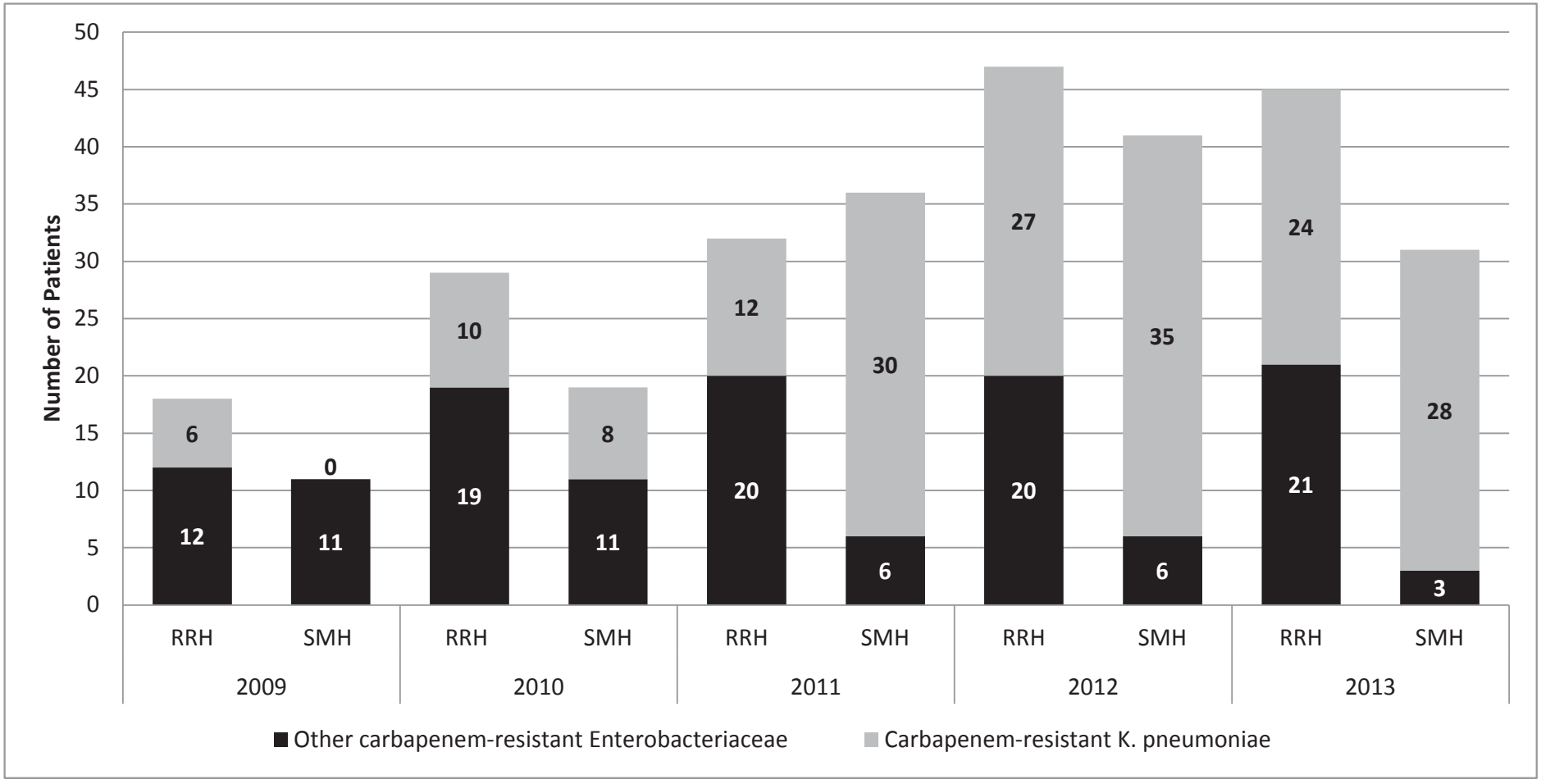


Table 16. Resistance Trends: RRUMC, 1990-2013 (cont.)



Note: No data prior to 1998

Table 17. Carbapenem-resistant *Enterobacteriaceae* (CRE): RRUMC and SMH-UCLA, 2009-2013



[1] Includes isolates that produce carbapenemases such as KPC and NDM

Table 18. Daptomycin Non-susceptible Gram positive Cocci: RRUMC and SMH-UCLA, 2009-2013

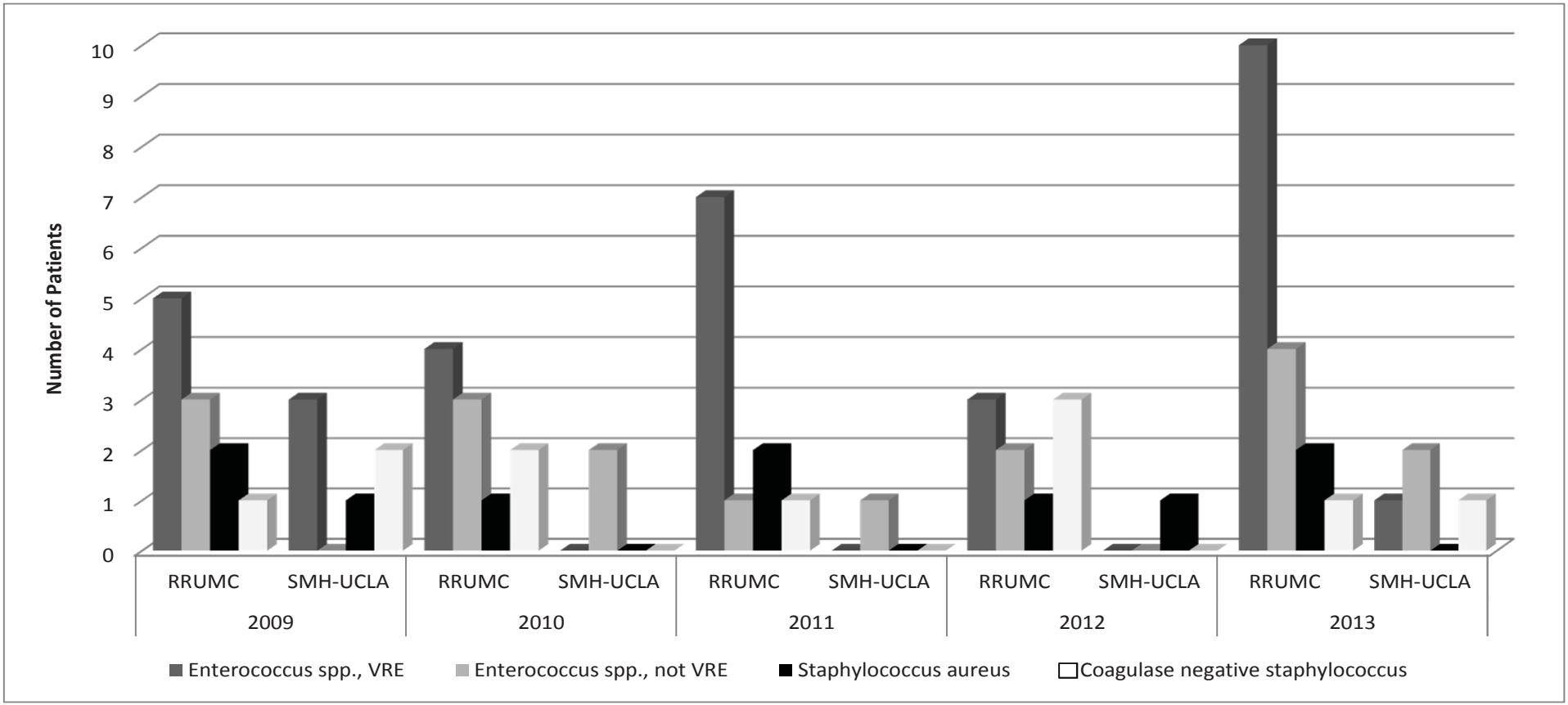


Table 19. SMH-UCLA: Emerging Resistance Concerns

Incidence of Resistant Organisms, 2013

Organism	No. Isolates	Resistant to:	% Resistant
Staphylococcus aureus		Methicillin (MRSA)	
• Outpatient	433		44
• Inpatient	206		50
Enterococcus spp. (blood isolates only)	34	Vancomycin (VRE)	24

Beta-lactamase Results for Respiratory Pathogens

Organism	No. Isolates	% beta-lactamase Positive[1]
Haemophilus influenzae	14[2]	31
Moraxella catarrhalis	7[2]	100

[1] Resistant to ampicillin, amoxicillin, penicillin

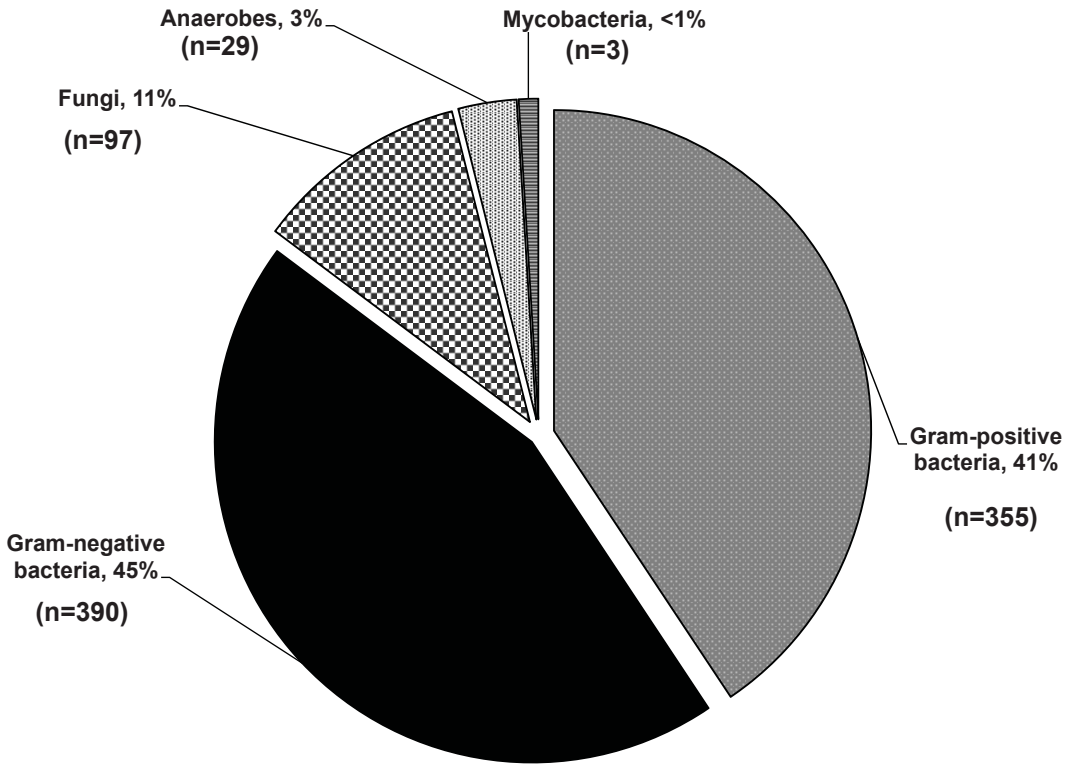
[2] Calculated from fewer than the standard recommendation of 30 isolates

Table 20. Treatment Suggestions for Organisms for which Susceptibility Testing is not Routinely Performed

Organism	First-line treatment	Alternate treatment
Bordetella pertussis	Macrolide	Trimethoprim-sulfamethoxazole
Campylobacter spp.	Erythromycin, azithromycin	Doxycycline, fluoroquinolone, gentamicin
Chlamydophila pneumoniae	Doxycycline, macrolide	Fluoroquinolone, tigecycline
Legionella spp.	Levofloxacin, azithromycin +/- rifampin	Clarithromycin or doxycycline or trimethoprim-sulfamethoxazole +/- rifampin
Mycoplasma pneumoniae	Azithromycin	Doxycycline, fluoroquinolone
Ureaplasma spp.	Macrolide, doxycycline	

For additional information, refer to the Antimicrobial Stewardship website, www.asp.mednet.ucla.edu

Table 21. RRUMC Blood: One Isolate per Patient, 2013



	Organism	n	% of Total Blood Isolates
1	*Escherichia coli,* 9% ceftriaxone R	129	15
2	*Enterococcus* spp., 47% VRE	111	13
3	*Staphylococcus aureus*, 33% MRSA	106	12
4	Viridans group *Streptococcus*	82	9
5	*Klebsiella* spp., 3% ceftriaxone R	79	9
6	*Pseudomonas aeruginosa*	43	5
7	Other *Enterobacteriaceae* spp.	36	4
8	*Candida albicans*	34	4
9	*Enterobacter cloacae*	25	3
10	*Candida glabrata*	30	3
	Other isolates	199	23
	Total blood isolates	**874***	

*Excludes coagulase-negative staphylococcus (n=383), *Corynebacterium* spp. (n=58), *Bacillus* spp. (n=12), *Micrococcus* spp. (n=8), *Propionibacterium* spp. (n=12)

Table 21. RRUMC Blood: One Isolate per Patient, 2013 (cont.)

By Organism Group

Gram-positive Bacterial Isolates	n	% of Gram-positive Isolates
Enterococcus spp., 45% VRE	111	31
Staphylococcus aureus, 27% MRSA	106	30
Viridans group *Streptococcus*	82	23
Other gram-positives (includes 6 *S. lugdunensis*)	35	10
Beta-hemolytic *Streptococcus*	17	5
Streptococcus pneumoniae	4	1
Total	**355**	

(excludes other coagulase –negative staphylococcus, *Corynebacterium* spp., *Bacillus* spp., *Micrococcus* spp.)

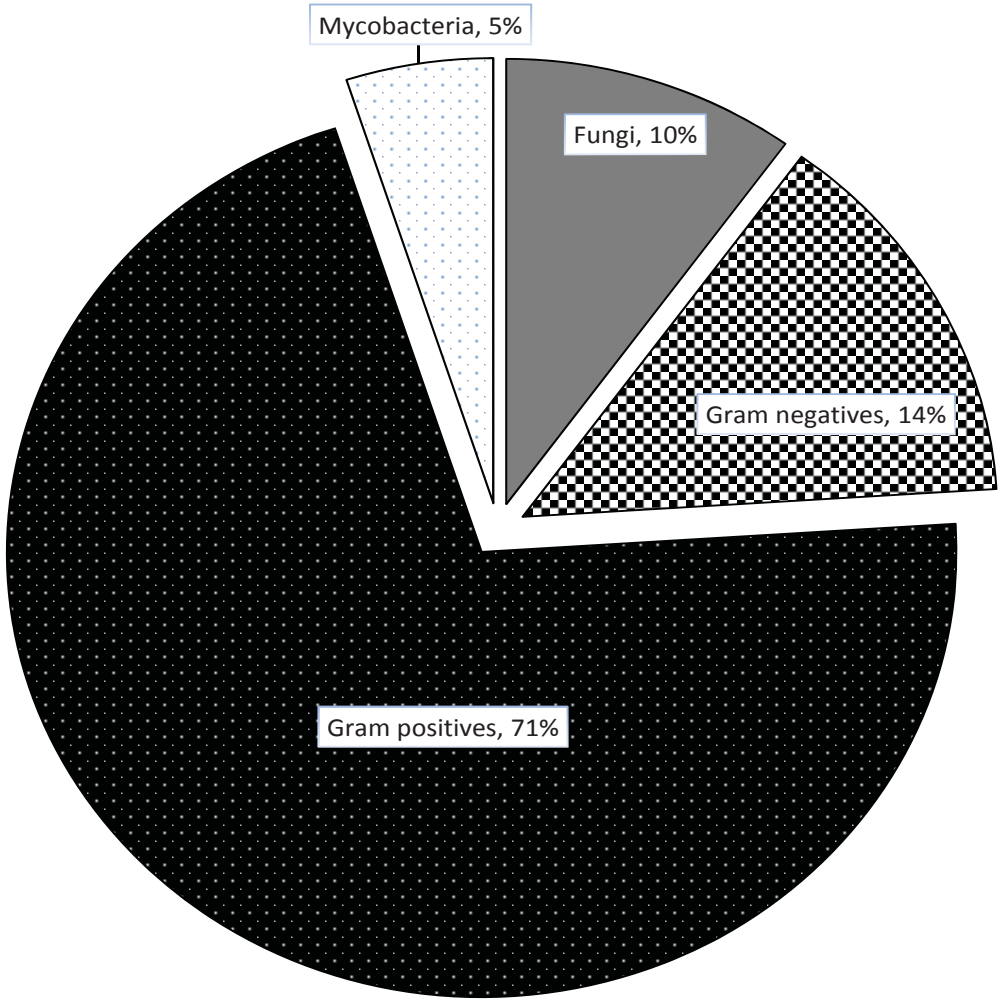
Gram-negative Bacterial Isolates	n	% of Gram-negative Isolates
Escherichia coli, 9% ceftriaxone R	129	33
Klebsiella spp., 3% ceftriaxone R	79	20
Pseudomonas aeruginosa	43	11
Other *Enterobacteriaceae* spp.	36	9
Enterobacter cloacae	25	6
Stenotrophomonas maltophilia	13	3
Acinetobacter spp.	10	3
Other gram-negatives	55	14
Total	**390**	

Fungal Isolates	n	% of Fungal Isolates
Candida albicans	34	35
Candida glabrata	30	32
Candida tropicalis	10	10
Candida parapsilosis	9	9
Candida lusitaniae	4	4
Candida krusei	4	4
Cryptococcus spp.	0	0
Other yeast	4	4
Malassezia furfur	1	1
Histoplasma capsulatum	1	1
Total	**97**	

Anaerobic Bacterial Isolates	n	% of Anaerobic Bacterial Isolates
Bacteroides spp.	12	41
Prevotella spp.	7	24
Clostridium spp.	5	17
Other anaerobes	5	17
Total	**29**	

Mycobacterial Isolates	n	% of Mycobacterial Isolates
Mycobacterium fortuitum	2	67
Mycobacterium avium complex	1	33
Total	**3**	

Table 22. RRUMC CSF: One Isolate per Patient, 2013



n = 21	Number of CSF Isolates
• **Gram positives (15)**	
Coagulase-negative *Staphylococcus*	6
Staphylococcus aureus	4
Micrococcus spp.	2
Propionibacterium acnes	2
Enterococcus spp.	1
• **Gram negative bacteria 3)**	
Pseudomonas aeruginosa	2
Enterobacteriaceae	1
• **Fungi (2)**	
Cryptococcus neoformans	2
• **Mycobacteria (1)**	
Mycobacterium tuberculosis	1

Table 23. Mycobacteria, One Isolate per Patient per Source, 2013

	# Patients By Source[1]					
	respiratory		blood		abscess/wound/ tissue/other	
	RRUMC	SMH-UCLA	RRUMC	SMH-UCLA	RRUMC	SMH-UCLA
Mycobacterium tuberculosis (8)	5	2	0	0	1[2]	0
Mycobacterium bovis (1)	0	0	0	0	1	0
M. avium complex (119)	74	32	2	0	4	7
M. gordonae (25)	19	4	0	0	2	0
M. simiae (6)	5	1	0	0	0	0
M. kansasii (3)	3	0	0	0	0	0
M. xenopi (2)	2	0	0	0	0	0
Rapid growers						
M. abscessus (11)	5	1	1	0	5	0
M. fortuitum (4)	2	0	0	0	0	1
M. porcinum (1)	0	1	0	0	0	0
M. peregrinum / septicum (1)	0	0	0	0	0	1
M. thermoresistibile (1)	0	0	0	0	1	0
M. mucogenicum (2)	2	0	0	0	0	0
Total mycobacteria (215)	117	41	2	0	14	9

[1] Some patients have isolates in more than one source
[2] Isolated from a CSF specimen.

Table 24. 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**
ethambutol	amikacin
isoniazid (INH)	capreomycin
pyrazinamide	ciprofloxacin
rifampin	ethionamide
	p-aminosalicylic acid
	streptomycin

   In 2012, 13 (0.8%) of 1,738 *M. tuberculosis* cases in the State of California were MDR TB (resistant to at least INH and rifampin).

2. ***Mycobacterium avium* complex*:***
   Performed by physician request, 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. abscesses*, *M. chelonae*, *M. fortuitum* and *M. mucogenicum*):**
   Performed on one isolate per patient, testing performed inhouse.

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

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

Table 25. Anaerobic Bacteria, % Susceptible

Gram-negative anaerobic bacteria – antimicrobials listed in alphabetical order within percent susceptible categories[1]

Percent Susceptible	*Bacteroides fragilis*	Other *B. fragilis* Group[2]	*Fusobacterium nucleatum* and *F. necrophorum*	*Prevotella* spp.
>95	ertapenem, imipenem, meropenem, metronidazole, piperacillin-tazobactam	ertapenem, imipenem, meropenem, metronidazole	ampicillin, ampicillin-sulbactam, cefoxitin, clindamycin, ertapenem, imipenem, meropenem, metronidazole, moxifloxacin, penicillin piperacillin-tazobactam	ampicillin-sulbactam, cefoxitin, ertapenem, imipenem, meropenem metronidazole, piperacillin-tazobactam
85–95	ampicillin-sulbactam, cefoxitin	piperacillin-tazobactam		
70–84				
50–69	clindamycin, moxifloxacin	ampicillin-sulbactam		clindamycin, moxifloxacin
<50		cefoxitin clindamycin, moxifloxacin		ampicillin, penicillin

[1] Adapted from West Los Angeles VA Medical Center and CLSI tables.
[2] *B. fragilis* group includes ssp. *distasonis, uniformis, vulgatus, ovatus*, and *thetaiotaomicron.*

Table 25. Anaerobic Bacteria, % Susceptible (cont.)

Gram-positive anaerobic bacteria – antimicrobials listed in alphabetical order within percent susceptible categories

Percent Susceptible	*Clostridium difficile*	*Clostridium perfringens*	Other *Clostridium* spp.	*Propionibacterium acnes*	Anaerobic gram positive cocci
>95	ampicillin-sulbactam, imipenem, meropenem, metronidazole[3], piperacillin-tazobactam	ampicillin, ampicllin-sulbactam, cefoxitin, clindamycin, ertapenem, imipenem, meropenem, metronidazole, moxifloxacin, penicillin, piperacillin-tazobactam	ampicillin-sulbactam, ertapenem, metronidazole, piperacillin-tazobactam	moxifloxacin penicillin	ampicillin, ampicillin sulbactam, cefoxitin, ertapenem, imipenem, meropenem, metronidazole, penicillin, piperacillin-tazobactam
85–95				clindamycin	
70–84			ampicillin, moxifloxacin, penicillin		clindamycin, moxifloxacin
50–69			clindamycin		
<50	ampicillin, clindamycin, cefoxitin,		cefoxitin	metronidazole	

[3] Oral therapy. In cases of extraintestinal infection, Infectious Disease Consultation strongly recommended.

Table 26. Antimicrobials (IV, PO), Formulary Status and Cost Reference

Drug	Usual Dose	Usual Interval	($)*Per Day
Penicillins			
Ampicillin	**1 gm**	**q6h**	**29.35**
Ampicillin	**2 gm**	**q6h**	**36.75**
Ampicillin- sulbactam	**3 gm**	**q6h**	**30.95**
Oxacillin	**1 gm**	**q6h**	**54.40**
Penicillin G	**$3x10^6$ units**	**q4h**	**41.70**
Piperacillin-tazobactam	**3.375 gm**	**q6h**	**43.30**
Ampicillin (PO)	**500 mg**	**q6h**	**0.40**
Amoxicillin (PO)	**250 mg**	**q8h**	**0.25**
Amoxicillin (PO)	**500 mg**	**q8h**	**0.40**
Amoxicillin-clavulanic acid (PO)	**250 mg**	**q8h**	**10.70**
Amoxicillin-clavulanic acid (PO)	**500 mg**	**q8h**	**2.30**
Dicloxacillin (PO)	**250 mg**	**q6h**	**0.85**
Dicloxacillin (PO)	**500 mg**	**q6h**	**1.35**
Cephalosporins			
Cefazolin	**1 gm**	**q8h**	**16.85**
Cefepime[1,2]	**1 gm**	**q12h**	**17.60**
Cefotaxime[1, 3]	**1 gm**	**q8h**	**18.15**
Cefoxitin[1, 4]	**1 gm**	**q6h**	**33.70**
Ceftriaxone	**1 gm**	**q24h**	**6.10**
Ceftriaxone	**2 gm**	**q24h**	**7.20**
Cephalexin (PO)	**500 mg**	**q6h**	**0.45**
Cefpodoxime (PO)	**100 mg**	**q12h**	**8.60**
Cefpodoxime (PO)	**200 mg**	**q12h**	**8.55**
Other ß-lactams/monobactam			
Aztreonam[1, 5]	**1 gm**	**q8h**	**113.8**
Ertapenem	**1 gm**	**q24h**	**68.40**
Meropenem[1, 6]	**1 gm**	**q8h**	**45.55**
Aminoglycosides			
Amikacin[1, 7]	**500 mg (7.5 mg/kg/dose)**	**q12h**	**21.90**
Gentamicin	**140 mg (1–2 mg/kg/dose)**	**q12h**	**13.35**
Tobramycin[1, 8]	**140 mg (1–2 mg/kg/dose)**	**q12h**	**12.60**

Table 26. (cont.) Antimicrobials (IV, PO), Formulary Status and Cost Reference

Drug	Usual Dose	Usual Interval	($)*Per Day
Others			
Azithromycin	**500 mg**	**q24h**	**9.00**
Ciprofloxacin	**400 mg**	**q12h**	**14.40**
Clindamycin	**600 mg**	**q8h**	**52.60**
Colistimethate	**150 mg**	**q8h**	**47.80**
Daptomycin[1, 9]	**500 mg**	**q24h**	**307.10**
Doxycycline	**100 mg**	**q12h**	**36.45**
Levofloxacin[1, 11]	**500 mg**	**q24h**	**9.40**
Levofloxacin[1, 11]	**750 mg**	**q24h**	**9.40**
Linezolid[1, 12]	**600 mg**	**q12h**	**234.10**
Metronidazole	**500 mg**	**q8h**	**18.00**
Quin-dalfopristin[1, 12] (7.5 mg/kg/dose)	**500 mg**	**q8h**	**554.20**
Rifampin[1, 13]	**600 mg**	**q24h**	**37.30**
Tigecycline[1, 9]	**50 mg**	**q12h**	**175.30**
Trimethoprim-sulfamethoxazole	**320 mg TMP**	**q12h**	**35.20**
Vancomycin	**1 gm**	**q12h**	**24.00**
Azithromycin (PO)	**500 mg**	**q24h**	**2.75**
Ciprofloxacin (PO)	**500 mg**	**q12h**	**0.35**
Clarithromycin (PO)	**500 mg**	**q12h**	**9.10**
Doxycycline (PO)	**100 mg**	**q12h**	**8.00**
Erythromycin (PO)	**500 mg**	**q6h**	**15.85**
Levofloxacin (PO)[1,11]	**500 mg**	**q24h**	**0.50**
Levofloxacin (PO)[1,11]	**750 mg**	**q24h**	**0.45**
Linezolid (PO)[1,12]	**600 mg**	**q12h**	**194.95**
Metronidazole (PO)	**500 mg**	**q8h**	**1.40**
Nitrofurantoin (PO) (macrocrystal formulation)	**50 mg**	**q6h**	**4.70**
Nitrofurantoin (PO) (macrocrystal formulation)	**100 mg**	**q6h**	**10.35**
Rifampin (PO)	**600 mg**	**q24h**	**3.20**
Trimeth-Sulfa (PO)	**160 mg/800 mg**	**q12h**	**0.25**
Vancomycin (PO)	**125 mg**	**q6h**	**24.20**

Table 26. Antimicrobials (IV, PO), Formulary Status and Cost Reference

Drug	Usual Dose	Usual Interval	($)*Per Day
Antifungal Agents			
Amphotericin B	**50 mg (avg)**	**q24h**	**18.30**
Amphotericin B Lipid Complex (ABLC)[1, 9]	**350 mg**	**q24h**	**237.80**
Caspofungin[1, 9]	**50 mg**	**q24h**	**62.15**
Fluconazole	**200 mg**	**q24h**	**8.70**
Fluconazole	**400 mg**	**q24h**	**10.15**
Voriconazole[1,10]	**300 mg**	**q12h**	**260.85**
Fluconazole (PO)	**200 mg**	**q24h**	**0.25**
Fluconazole (PO)	**400 mg**	**q24h**	**0.40**
Flucytosine (PO)	**2000 mg**	**q6h**	**457.75**
Voriconazole (PO)[1,10]	**200 mg**	**q12h**	**47.35**

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

1 Use of "controlled" 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 For neonatal use only

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

5 Restricted: aerobic gram-negative infections (ß-lactam allergic patients)

6 Restricted: organisms resistant to all other formulary agents or febrile neutropenic patients on Hematology-Oncology services.

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 to use by Adult or Pediatric Infectious Diseases Service approval.

10 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.

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). For Quinupristin-Dalfopristin, no activity against *E. faecalis.*

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

Table 27. Indications for Performing Routing Antimicrobial Susceptibility Tests - Aerobic Bacteria

Susceptibility tests will be performed as follows:

1. **Blood—all isolates except*:**
   Bacillus spp.[1]
   Corynebacterium spp. [1]
   Coagulase-negative *Staphylococcus* [1, 2]

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

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] (≤ 18 y.o. only)
   Shigella spp. (≤ 18 y.o. only)
   Yersinia spp.
   Vibrio spp.

[1] Susceptibilities performed if isolated from multiple cultures
[2] Susceptibilities performed on all isolates of *S. lugdunensis*
[3] Susceptibilities performed on all isolates of *S.* Typhi and *S.* Paratyphi
* neonates, susceptibilities performed on all isolates

Table 27. (cont.) Indications for Performing Routing 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 28. Antimicrobial Agents Routinely Reported - Aerobic Bacteria

Primary antimicrobials	Conditions for supplemental antimicrobial reporting	Supplemental antimicrobial(s)[1, 4]
***E. coli, Klebsiella* spp., *P. mirabilis* – Excludes urine isolates**		
ampicillin	Resistant to ampicillin	ampicillin-sulbactam
ceftriaxone	Resistant to ceftriaxone	ciprofloxacin (>11 y.o.), ertapenem (>18 y.o.) or 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.) or imipenem (≤18 y.o.) & meropenem (≤18 y.o.)
trimethoprim-sulfamethoxazole		
***E. coli, Klebsiella* spp., *P. mirabilis* – Urine isolates**		
ampicillin		
cefazolin[3]		
ceftriaxone	Resistant to ceftriaxone	ertapenem (>18 y.o.) or imipenem & meropenem (≤18 y.o.)
	Resistant to ertapenem (>18 y.o.)	imipenem, meropenem
ciprofloxacin(>11 y.o.)		
gentamicin	Resistant to gentamicin	amikacin
nitrofurantoin		
piperacillin-tazobactam	Resistant to piperacillin-tazobactam	ertapenem (>18 y.o.), imipenem (≤18 y.o.) & meropenem (≤18 y.o.)
trimethoprim-sulfamethoxazole		
SPICE organisms[2] – Excludes urine isolates		
ampicillin	Resistant to ampicillin	ampicillin sulbactam
ampicillin-sulbactam		
cefepime	Resistant to cefepime	imipenem & meropenem (≤18 y.o.), ertapenem (>18 y.o.), ciprofloxacin (>11 y.o.)
	Resistant to ertapenem (>18 y.o.)	ciprofloxacin, imipenem, meropenem
gentamicin	Resistant to gentamicin	amikacin, tobramycin
piperacillin-tazobactam	Resistant to piperacillin-tazobactam	ertapenem (>18 y.o.) or imipenem & meropenem (≤18 y.o.)
trimethoprim-sulfamethoxazole		
SPICE organisms[2] – Urine isolates		
ampicillin		
cefepime	Resistant to cefepime	imipenem & meropenem (≤18 y.o.) or ertapenem (>18 y.o.)
ciprofloxacin (>11 y.o.)		
	Resistant to ertapenem (>18 y.o.)	imipenem, meropenem
gentamicin	Resistant to gentamicin	amikacin
nitrofurantoin		
piperacillin-tazobactam	Resistant to piperacillin-tazobactam	imipenem & meropenem (≤18 y.o.) ertapenem (>18 y.o.)
trimethoprim-sulfamethoxazole		

[1] Colistin reported on carbapenem resistant gram-negative rods (resistant to meropenem and imipenem).
[2] *Enterobacteriaceae* 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.

Table 28. Antimicrobial Agents Routinely Reported - Aerobic Bacteria (cont.)

Primary antimicrobials	Conditions for supplemental antimicrobial reporting	Supplemental antimicrobial(s)[1]
***Salmonella* spp., *Shigella* spp. (if stool isolates, performed on patients ≤ 18 y.o. only)**		
ampicillin ciprofloxacin (>11 y.o) trimethoprim-sulfamethoxazole	Non-fecal sources/resistant to all primary antimicrobials	ceftriaxone
Pseudomonas aeruginosa		
cefepime	Resistant to cefepime and piperacillin-tazobactam	imipenem, meropenem
ciprofloxacin (>11 y.o.)		
gentamicin	If gentamicin > 1ug/ml	amikacin, tobramycin
piperacillin-tazobactam	Resistant to cefepime and piperacillin-tazobactam	imipenem, meropenem
***Acinetobacter* spp.**		
ampicillin-sulbactam cefepime ceftazidime	Resistant to ceftazidime	imipenem, meropenem
ciprofloxacin (>11 y.o.)	Resistant to meropenem or imipenem	minocycline & colistin
gentamicin	Resistant to gentamicin	amikacin, tobramycin
piperacillin-tazobactam trimethoprim-sulfamethoxazole		
Stenotrophomonas maltophilia*- Sterile body site isolates** ***Burkholderia cepacia		
ceftazidime levofloxacin (>11 y.o.) meropenem (*B. cepacia* only) minocycline ticarcillin-clavulanate trimethoprim-sulfamethoxazole		

Table 28. Antimicrobial Agents Routinely Reported - Aerobic Bacteria (cont.)

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

[1] Colistin reported on carbapenem (imipenem, meropenem) resistant gram-negative rods

Table 28. Antimicrobial Agents Routinely Reported - Aerobic Bacteria (cont.)

Primary antimicrobials	Conditions for supplemental antimicrobial reporting	Supplemental antimicrobial(s)
***Staphylococcus* spp.**		
clindamycin[3]		
erythromycin[3]		
oxacillin	Resistant to oxacillin (MRSA)	doxycycline, rifampin, trimethoprim-sulfamethoxazole; all beta-lactams reported as resistant except ceftaroline
penicillin		
vancomycin		
	Urine isolates	ciprofloxacin[4], 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 & streptomycin synergy screens
	Urine isolates	ciprofloxacin[4], doxycycline, nitrofurantoin
Streptococcus pneumoniae amoxicillin, cefotaxime, ceftriaxone, doxycycline, erythromycin[3], levofloxacin[4], penicillin, tetracycline, trimethoprim-sulfamethoxazole, vancomycin		
Viridans group *Streptococcus* cefotaxime, ceftriaxone, penicillin, vancomycin		
beta-hemolytic streptococci clindamycin[3], penicillin, vancomycin		
Listeria monocytogenes penicillin, trimethoprim-sulfamethoxazole		

[3] excluding urine and sterile body site isolates

[4] patients >11 y.o.

Table 29. Susceptible MIC (µg/ml) Breakpoints for Aerobic Gram-negative Cocci

Organism	Penicillins				Cephalosporins					Carbapenems			Aminoglycosides			Fluoroquinolones		Other				
	Ampicillin	Ampicillin-sulbactam	Piperacillin-tazobactam	Ticarcillin-clavulanate	Cefazolin	Cefepime	Cefotaxime	Ceftazidime	Ceftriaxone	Ertapenem	Imipenem	Meropenem	Amikacin	Gentamicin	Tobramycin	Ciprofloxacin[1]	Levofloxacin[2]	Colistin	Trimethoprim – sulfamethoxazole	Nitrofurantoin	Minocycline	Tigecycline
ENTEROBACTERIACEAE[3]	≤8	≤8	≤16	–	≤2[4]	≤1	≤1	≤4	≤1	≤.5	≤1	≤1	≤16	≤4	≤4	≤1	≤2	≤2	≤2/38	≤32	–	≤2
NONFERMENTERS																						
Acinetobacter baumannii	–	≤8	≤16	–	–	≤8	≤8	≤8	≤8	–	≤2	≤2	≤16	≤4	≤4	≤1	≤2	≤2	≤2/38	–	≤4	–
Burkholderia cepacia	–	–	–	≤16	–	–	–	≤8	–	–	–	≤4	–	–	–	–	≤2	–	≤2/38	–	≤4	–
Pseudomonas aeruginosa	–	–	≤16	–	–	≤8	–	≤8	–	–	≤2	≤2	≤16	≤4	≤4	≤1	≤2	≤2	–	–	–	–
Stenotrophomonas maltophilia	–	–	–	≤16	–	–	–	≤8	–	–	–	–	–	–	–	–	≤2	–	≤2/38	–	≤4	–
Other nonfermenters	–	–	≤16	–	–	≤8	≤8	≤8	≤8	–	≤4	≤4	≤16	≤4	≤4	≤1	≤2	≤2	≤2/38	–	–	–

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

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

[3] *Enterobacteriaceae*: *Citrobacter freundii, Enterobacter* spp., *Escherichia coli, Klebsiella* spp., *Morganella morganii, Proteus mirabilis, Salmonella* spp., *Serratia* spp., *Shigella* spp.

[4] Parenteral administration

Table 30. Susceptible MIC (µg/ml) Breakpoints for Aerobic Gram-negative Cocci

Organism	Penicillins			Cephalo-sporin	Aminoglycosides			Fluoroquin-olone	Other									
	Ampicillin	Oxacillin	Penicillin	Ceftaroline[1]	Gentamicin	Gentamicin synergy	Streptomycin synergy	Ciprofloxacin	Clindamycin	Daptomycin	Doxycycline	Erythromycin	Linezolid	Nitrofurantoin	Quinupristin-dalfopristin	Rifampin	Trimethoprim – sulfamethoxazole	Vancomycin
Staphylococcus aureus *Staphylocccus lugdunensis*	—	≤2	≤.12[2]	≤1	≤4	—	—	≤1	≤.5	≤1	≤4	≤.5	≤4	≤32	≤1	≤1	≤2/38	≤2
Coagulase-negative *Staphylococcus*	—	≤.25	≤.12[2]	—	≤4	—	—	≤1	≤.5	≤1	≤4	≤.5	≤4	≤32	≤1	≤1	≤2/38	≤4
Enterococcus spp.	≤8	—	≤8	—	—	≤500	≤1000	≤1	—	≤4	≤4	—	≤2	≤32	≤1	≤1	—	≤4

[1] *S. aureus* only, including MRSA
[2] beta-lactamase negative

Organism	Penicillins		Cephalosporins		Tetracyclines		Other		
	Amoxicillin	Penicillin	Cefotaxime	Ceftriaxone	Doxycycline	Tetracycline	Erythromycin	Levofloxacin	Vancomycin
Streptococcus pneumoniae	—	—	—	—	≤.25	≤1	—	≤2	≤1
Meningitis	—	≤.06	≤.5	≤.5	—	—	—	—	—
Non-meningitis	≤2	≤2	≤1	≤1	—	—	≤.25	—	—
Viridans group *Streptococcus*	—	≤.12	≤1	≤1	—	—	—	—	≤1

Table 31. 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**.
    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 *Clostridium difficile* infection
        2) clindamycin added to another agent with anaerobic activity when treating necrotizing fasciitis

For additional information, refer to the Antimicrobial Stewardship website, www.asp.mednet.ucla.edu

Rapid Reference

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Tables 20-26
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Lab Info

Table 31
Antimicrobial Stewardship Program

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: (310) 267-7567
Email: asp@ucla.edu
Website: http://www.asp.mednet.ucla.edu
Note that the website has a **guidebook**, with detailed information about specific clinical syndromes, interpretation of microbiology reports, and guidelines for treatment.
eConsult: http://www.asp.mednet.ucla.edu/pages/econsult

We encourage you to reach out to the program with questions. The program is staffed by Dr. Daniel Uslan (Adults), Dr. Lynn Ramirez (Pediatrics) and Dr. Meganne Kanatani.

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