VUMC Antimicrobial Susceptibility Summary: Adult Patients 2024

Clinical Microbiology
Department of Pathology, Microbiology and Immunology

Preface

This booklet contains up-to-date information to assist in decisions concerning antimicrobial therapy.

Tables summarize susceptibility data obtained for organisms isolated in the VUMC Clinical Microbiology Laboratory between January 1, 2023 – December 31, 2023.

Guidelines for Interpretation of Minimum 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 additional information, please call the microbiology laboratory, or the Antimicrobial Stewardship team.

Kendall Bryant, Ph.D., D(ABMM), Medical Director, Clinical Microbiology
Susan Sefers, M.T. (ASCP), Manager of Clinical Microbiology
Pamela Foster, M.T. (ASCP), Team Lead, Clinical Microbiology
Carmella Russo, M.T. (ASCP), Technical Specialist, Clinical Microbiology
Romney Humphries, PhD, Division Director, Laboratory Medicine

Frequently called numbers:
Antibiotic Approval Pager: 615-317-GERM (4376)
On Call VU ID Fellow Pager: 615-831-8872
Microbiology Lab: 615-322-3406

Microbiology Fellows (pager: 615- 835-9742)
VASP Website:
https://www.vumc.org/antimicrobial-stewardship-program

Contents

Table 1. Adults – Common Gram-Negative Bacteria, Urine Isolates, % Susceptible

Data represent first isolate per patient.

Organism	N	Amikacin	Amoxicillin-clavulanate	Ampicillin	Ampicillin-sulbactam	Aztreonam	Oral Cephalosporins*	Cefepime	Ceftazidime	Ceftriaxone	Ciprofloxacin	Ertapenem	Gentamicin	Levofloxacin	Meropenem	Nitrofurantoin	Piperacillin-tazobactam	Tobramycin	Trimethoprim sulfamethoxazole
Citrobacter freundii	172	99	R	R	R	80	R	97	78	77	85	98	96	91	100	92	84	97	88
Citrobacter koseri	130	100	99	R	99	99	99	99	99	99	98	100	100	99	100	42	99	99	99
Enterobacter cloacae	237	100	R	R	R	79	R	94	78	74	89	83	98	94	99	23	81	97	90
Escherichia coli	7031	100	89	59	82	93	88	93	94	91	73	100	92	80	100	98	98	91	78
Klebsiella aerogenes	204	100	R	R	R	84	R	97	84	83	93	96	99	95	100	18	85	99	98
Klebsiella oxytoca	222	100	91	R	84	91	73	96	94	89	88	100	96	92	100	90	94	95	87
Klebsiella pneumoniae	1487	100	92	R	83	89	87	90	89	89	83	99	93	86	100	31	93	92	83
Morganella morganii	67	100	R	R	54	98	R	100	79	91	81	97	92	81	100	R	98	91	79
Proteus mirabilis	614	100	98	86	97	99	92	96	99	96	85	100	94	87	ND	R	100	93	87
Proteus vulgaris	35	100	89	R	R	100	R	100	100	49	91	100	100	100	97	R	100	100	97
Providencia rettgeri	40	100	R	R	85	97	R	97	100	100	85	100	95	85	100	R	97	97	87
Pseudomonas aeruginosa	367	100	R	R	R	84	R	95	94	R	81	R	R	81	93	R	88	ND	R
Stenotrophomonas maltophilia	30	R	R	R	R	R	R	R	R	R	ND	R	R	67.9	R	R	R	R	92.3

*Oral cephalosporins include: cefaclor, cefdinir, cefpodoxime, cefprozil, cefuroxime, cephalexin, and loracarbef for treatment of uncomplicated urinary tract infections. R indicates intrinsic resistance, ND, no data.

***Enterobacter cloacae, Klebsiella aerogenes,* and *Citrobacter freundii* may develop resistance during therapy with 3rd-generation cephalosporins due to derepression of AmpC β-lactamase.

ⓘ Empiric guidance for the treatment of urinary tract infections, including pyelonephritis, can be found on the VASP website. Antibiotics should be narrowed once susceptibilities are known.

Table 2. Adults – Gram-Negative Bacteria, Urine Isolates, % Susceptible by Patient Location

Data represent first isolate per patient.

Organism		N	Amikacin	Amoxicillin-clavulanate	Ampicillin	Ampicillin-Sulbactam	Aztreonam	Oral cephalosporins*	Cefepime	Ceftazidime	Ceftriaxone	Ciprofloxacin	Ertapenem	Gentamicin	Levofloxacin	Meropenem	Nitrofurantoin	Piperacillin-tazobactam	Tobramycin	Trimethoprim-Sulfamethoxazole
*Enterobacter cloacae***	OP	141	100	R	R	R	80	R	94	79	ND	93	88	99	97	99	27	82	97	90
	IN	85	100	R	R	R	82	R	95	80	ND	86	79	98	92	99	21	81	98	88
	ICU	13**	100	R	R	R	54	R	77	54	ND	69	62	100	85	92	0	62	100	100
Escherichia coli	OP	5486	100	90	60	83	94	90	95	95	93	75	100	93	82	100	99	98	94	79
	IN	1407	100	86	54	78	89	82	89	90	87	67	100	89	73	100	97	96	89	74
	ICU	138	100	83	48	71	83	76	83	86	81	62	99	90	67	100	92	92	90	65
Klebsiella pneumoniae	OP	1001	100	94	R	86	93	91	93	92	93	87	99	95	90	100	33	94	95	86
	IN	436	100	89	R	78	82	80	84	82	81	75	98	89	79	100	28	91	88	77
	ICU	50	100	80	R	71	76	74	76	74	76	69	94	84	69	98	27	78	82	69
Proteus mirabilis	OP	413	100	98	89	97	99	95	98	99	97	88	100	94	90	ND	R	100	93	88
	IN	188	100	97	80	98	100	85	93	99	93	80	100	93	82	ND	R	99	92	86
	ICU	13**	100	100	85	100	100	85	85	100	85	69	100	92	69	ND	R	100	85	77
Pseudomonas aeruginosa	OP	173	100	R	R	R	88	R	97	96	R	80	R	R	81	95	R	89	ND	R
	IN	163	99	R	R	R	80	R	94	93	R	82	R	R	82	91	R	88	ND	R
	ICU	31	100	R	R	R	77	R	90	90	R	77	R	R	77	94	R	77	ND	R

*Oral cephalosporins: cefaclor, cefdinir, cefpodoxime, cefprozil, cefuroxime, cephalexin, and loracarbef for treatment of uncomplicated urinary tract infections.

**Calculated with <30 isolates, interpret data with caution.

****Enterobacter cloacae, Klebsiella aerogenes,* and *Citrobacter freundii* may develop resistance during therapy with 3rd-generation cephalosporins due to derepression of AmpC β-lactamase.

ICU, intensive care unit; IN, inpatient; OP, outpatient (includes emergency department); R, intrinsic resistance; ND, not tested.

ⓘ For inpatient locations, and in the absence of detected or recent history of resistance or severe beta-lactam allergy, ceftriaxone or cefepime (or piperacillin-tazobactam for *E. coli*) are preferred empiric gram-negative antibiotics. Antibiotic therapy should be narrowed once susceptibilities are known.

Table 3. Adults – Most Common Gram-Negative Bacteria, Non-Urine Isolates, % Susceptible

Data represent first isolate per patient.

Organism	N	Amikacin	Amoxicillin-Clavulanate	Ampicillin	Ampicillin-sulbactam¥	Aztreonam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Ciprofloxacin	Ertapenem	Gentamicin	Levofloxacin	Meropenem	Minocycline	Piperacillin-tazobactam	Tobramycin	Trimethoprim-sulfamethoxazole
Achromobacter xylosoxidans	36	R	R	R	R	R	R	R	76	R	ND	R	R	67	ND	ND	95	R	100
Acinetobacter baumannii	45	94	R	R	85	R	R	68	77	44	82	R	88	85	85	94	ND	94	82
*Citrobacter freundii**	102	100	R	R	R	67	R	88	67	ND	79	96	90	83	98	81	73	88	81
Citrobacter koseri	46	100	94	R	100	100	94	100	100	100	100	100	100	100	100	100	100	100	100
*Enterobacter cloacae**	373	100	R	R	R	79	R	91	78	ND	91	84	99	93	98	89	82	97	92
Escherichia coli	727	99	80	45	74	88	79	89	89	86	63	99	89	73	100	89	93	89	69
*Klebsiella aerogenes**	108	100	R	R	R	82	R	99	82	ND	95	98	99	97	100	93	81	99	99
Klebsiella oxytoca	199	100	93	R	89	92	79	96	92	91	91	99	94	99	100	97	96	94	92
Klebsiella pneumoniae	418	100	81	R	72	78	75	80	77	78	74	96	86	77	99	84	86	84	76
Morganella morganii	97	100	R	R	53	100	R	100	88	88	81	100	91	81	100	R	100	94	88
Proteus mirabilis	226	100	99	89	99	100	92	98	99	97	84	99	94	86	ND	R	100	94	89
Pseudomonas aeruginosa	971	R	R	R	R	88	R	94	94	R	83	R	R	82	94	R	91	ND	R
Serratia marcescens	216	100	R	R	R	100	R	99	100	96	91	99	99	94	99	91	98	62	ND
Stenotrophomonas maltophilia	163	R	R	R	R	R	R	R	R	R	ND	R	R	65	R	90	R	R	96

R, intrinsic resistance; ND, no data.

¥ Ampicillin-sulbactam dosing recommendation for *Acinetobacter* is at least 3g q4h (normal renal function)

**Enterobacter cloacae, Klebsiella aerogenes,* and *Citrobacter freundii* may develop resistance during therapy with 3rd-generation cephalosporins due to derepression of AmpC β-lactamase.

ⓘ In the absence of recent history of resistance or severe beta-lactam allergy, cefepime is the preferred empiric gram-negative antibiotic. Piperacillin-tazobactam is preferred for *E. coli* and trimethoprim-sulfamethoxazole for invasive *S. maltophilia* infections. Antibiotic therapy should be narrowed once susceptibilities are known.

Table 4. Adults – Gram-Negative Bacteria, Non-Urine Isolates, by Patient Location

Data represent first isolate per patient.

Organism		N	Amikacin	Amoxicillin- Clavulanate	Ampicillin	Ampicillin-sulbactam	Aztreonam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Ciprofloxacin	Ertapenem	Gentamicin	Levofloxacin	Meropenem	Piperacillin-tazobactam	Minocycline	Tobramycin	Trimethoprim-sulfamethoxazole
*Enterobacter cloacae**	OP	61	100	R	R	R	93	R	100	93	91	95	93	100	95	100	95	95	100	95
	IN	238	100	R	R	R	81	R	92	80	ND	91	85	100	93	98	83	90	96	92
	ICU	74	100	R	R	R	66	R	84	65	ND	87	77	98	92	97	71	89	95	89
Escherichia coli	OP	203	100	85	52	84	93	88	93	94	93	71	99	93	82	100	98	89	92	71
	IN	406	99	82	46	74	89	80	90	90	87	63	99	88	73	100	94	88	88	70
	ICU	122	99	70	34	65	78	69	81	82	76	57	98	86	64	99	85	84	87	66
Klebsiella pneumoniae	OP	58	100	85	R	78	78	78	81	78	78	73	100	90	85	100	90	86	88	76
	IN	228	100	80	R	71	77	73	80	77	77	73	96	84	76	99	89	87	82	74
	ICU	133	100	82	R	71	77	75	79	76	77	75	96	86	75	99	80	81	85	78
Pseudomonas aeruginosa	OP	319	R	R	R	R	92	R	98	97	R	86	R	98	85	96	95	R	ND	R
	IN	514	R	R	R	R	87	R	94	94	R	83	R	97	82	94	89	R	ND	R
	ICU	139	R	R	R	R	82	R	84	88	R	78	R	98	78	90	88	R	ND	R
Proteus mirabilis	OP	72	100	96	89	96	100	93	100	100	100	91	100	96	91	ND	100	R	96	96
	IN	124	100	100	89	100	100	92	97	99	95	81	99	92	84	ND	100	R	92	85
	ICU	30	100	100	92	100	100	92	96	100	96	84	100	96	84	ND	100	R	96	88

ICU, intensive care unit; IN, inpatient; OP, outpatient (includes emergency department); R, intrinsic resistance; ND, not tested.

**Enterobacter cloacae, Klebsiella aerogenes,* and *Citrobacter freundii* may develop resistance during therapy with 3rd-generation cephalosporins due to derepression of AmpC β-lactamase.

ⓘ In the absence of recent history of resistance or severe beta-lactam allergy, cefepime is considered the empiric gram-negative antibiotic of choice. Piperacillin-tazobactam is preferred for *E. coli.* Antibiotic therapy should be narrowed once susceptibilities are known.

Table 5. Adults – *Staphylococcus aureus*, % Susceptible

Data represent first isolate per patient.

Organism		N	Oxacillin	Ceftaroline	Clindamycin	Daptomycin	Doxycycline	Linezolid	Nitrofurantoin	Penicillin	Rifampin	Trimethoprim-sulfamethoxazole	Vancomycin
Staphylococcus aureus	All	2600	62	98	86	100	95	100	100	20	99	92	100
MRSA	OP	353	0	96	72	100	92	100	100	0	99	85	100
	IN	527	0	95	69	100	88	99	100	0	99	85	100
	ICU	122	0	94	71	99	93	100	100	0	100	86	99
MSSA	OP	695	100	100	96	100	99	100	100	32	99	97	100
	IN	738	100	100	94	100	98	100	100	33	99	97	100
	ICU	165	100	100	96	100	99	100	100	35	99	98	100

ICU, intensive care unit; IN, inpatient; OP, outpatient (includes emergency department)

ⓘ Isolation of *S. aureus* in the urine should be followed by a blood culture to confirm the patient is not bacteremic.
S. aureus bacteremia or suspected invasive infection should be treated with initial IV antibiotics in conjunction with ID consultation.

Table 6. Adults – *Staphylococcus* spp., % Susceptible

Data represent first isolate per patient. Only normally sterile site isolates included.

Organism*	N	Oxacillin	Clindamycin	Daptomycin	Doxycycline	Nitrofurantoin	Penicillin	Vancomycin
Staphylococcus capitis	152	91	84	97	100	100	31	100
Staphylococcus caprae	46	100	100	100	100	100	57	100
Staphylococcus epidermidis	1410	38	64	100	87	99	32	100
Staphylococcus haemolyticus	202	26	52	100	78	100	15	98
Staphylococcus hominis	214	73	73	100	91	100	41	100
Staphylococcus lugdunensis	262	85	90	100	99	100	53	100
Staphylococcus pseudintermedius	45	86	83	100	89	100	47	100
Staphylococcus saprophyticus	222	0	100	100	100	100	0	100
Staphylococcus simulans	66	62	92	100	100	100	31	100

*Trimethoprim-sulfamethoxazole susceptibility available on request

Table 7. Adults – *Enterococcus* spp., % Susceptible

Data represent first isolate per patient.

	N	Ampicillin	Daptomycin*	Gentamicin (Synergy)	Linezolid	Nitrofurantoin	Penicillin	Vancomycin
Enterococcus faecalis	1600	100	94	87	99	100	100	98
Vancomycin-R	38	100	97	24	100	100	100	0
Vancomycin-S	1559	100	94	88	99	100	100	100
Enterococcus faecium	256	22	95	95	95	ND	25	49
Vancomycin-R	129	0	94	96	96	ND	0	0
Vancomycin-S	123	45	94	94	94	ND	43	100

*Daptomycin susceptibility for *E. faecium* indicates percentage susceptible, dose dependent.
ND, not tested.

ⓘ Drugs of choice for *E. faecalis* include penicillin and ampicillin in the absence of severe penicillin allergy.
VRE infections often require treatment with restricted antibiotics such as daptomycin, which require ID approval for use.

Table 8. Adults – *Streptococcus pneumoniae,* % Susceptible

Data represent first isolate per patient.

	N	Penicillin			Amoxicillin, Non-meningitis	Ceftriaxone		Cefepime		Meropenem	Levofloxacin	Trimethoprim-Sulfamethoxazole	Clindamycin	Erythromycin*	Vancomycin	Tetracycline
		Meningitis	Non-meningitis	Oral		Meningitis	Non-meningitis	Meningitis	Non-meningitis							
Streptococcus pneumoniae	53	60	88	60	90	90	98	71	89	71	100	69	85	46	100	83

*Azithromycin results are inferred from erythromycin.

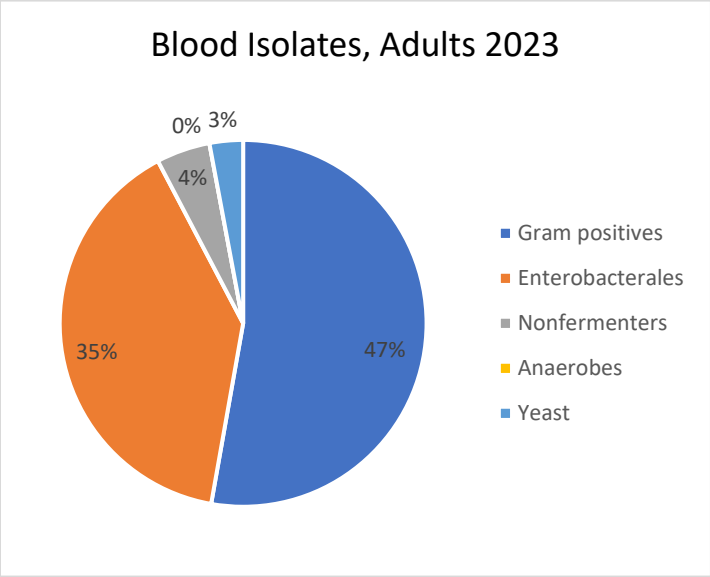
Table 9. Adults – *Streptococcus* spp., % Susceptible

Data represent first isolate per patient.

	N	Cefepime	Ceftriaxone	Clindamycin	Levofloxacin	Linezolid	Meropenem	Penicillin	Vancomycin
Streptococcus agalactiae	229	ND	ND	36	100	100	ND	100	100
Streptococcus pyogenes	56	ND	ND	82	98	98	ND	100	100
Streptococcus anginosus	210	100	100	65	97	100	ND	100	99
Streptococcus constellatus	114	84	100	57	100	100	ND	96	100
Streptococcus intermedius	95	99	99	56	99	100	ND	100	98
Streptococcus gallolyticus	40	100	100	50	88	100	100	100	100
Streptococcus mitis	40	84	100	87	76	100	95	68	100

ND, not tested.

Table 10. Adults – Most common microorganisms isolated in blood cultures (n=1077)



Data represents first isolate per patient.

Most common organisms in blood	**% Patients**	**Resistance**
Staphylococcus aureus	17.9%	46% MRSA
Escherichia coli	15.9%	16% ESBL
Klebsiella pneumoniae	8.8%	26% ESBL
Staphylococcus epidermidis	6.8%	88% MRSE
Enterococcus faecalis	5.3%	0% ampicillin-R
Streptococcus anginosus, intermedius, & mitis	5.1%	0% ceftriaxone-R
Streptococcus pyogenes & agalactiae	4.4%	0% penicillin-R
Enterococcus faecium	3.7%	50% vancomycin-R
Pseudomonas aeruginosa	3.4%	15% cefepime-R
Enterobacter cloacae	3.0%	9% cefepime-R
Klebsiella oxytoca	2.2%	20% ESBL
Proteus mirabilis	2.1%	0% ESBL
Serratia marcescens	1.9%	0% cefepime-R
Streptococcus pneumoniae	1.3%	7% ceftriaxone-R
Candida glabrata	1.1%	0% micafungin-R
Klebsiella aerogenes	0.9%	0% cefepime-R
Candida albicans	0.8%	0% fluconazole-R
Stenotrophomonas maltophilia	0.7%	0% trim-sulfa-R
Candida tropicalis	0.7%	10% fluconazole-R

Table 11. Adults – *Stenotrophomonas maltophilia*, % Susceptible to at least one of two antimicrobials

Data represent one isolate per patient; includes patients with cystic fibrosis.

Information provided for two drug combinations does not imply synergism, antagonism or likely activity in vivo; Includes the most resistant result for each drug if patient had >1 isolate.

	Minocycline (90)	Levofloxacin (65)
Levofloxacin (65)*	91**	-
Trimethoprim-sulfamethoxazole (96)	97	96

*% susceptible for individual drug in parenthesis.

**% susceptible for either one or both drugs in table (e.g., % S to levofloxacin and/or minocycline)

Table 12. Adults – *Acinetobacter baumannii*, % Susceptible to at least one of two antimicrobials

Data represent one isolate per patient; includes patients with cystic fibrosis.

Information provided for two drug combinations does not imply synergism, antagonism or likely activity in vivo; Includes the most resistant result for each drug if patient had >1 isolate.

	Gentamicin (81)	Amikacin (91)	Levofloxacin (85)	Minocycline (92)	Meropenem (85)	Trimethoprim-sulfamethoxazole (82)
Ampicillin-sulbactam (85)*	85**	93	85	92	86	88
Cefepime (68)	81	91	85	92	ND	88
Meropenem (81)	83	91	85	92	ND	88

*% susceptible for individual drug in parenthesis.

**% susceptible for either one or both drugs in table (e.g., % S to ampicillin/sulbactam and/or gentamicin)

Candida Susceptibility Summary

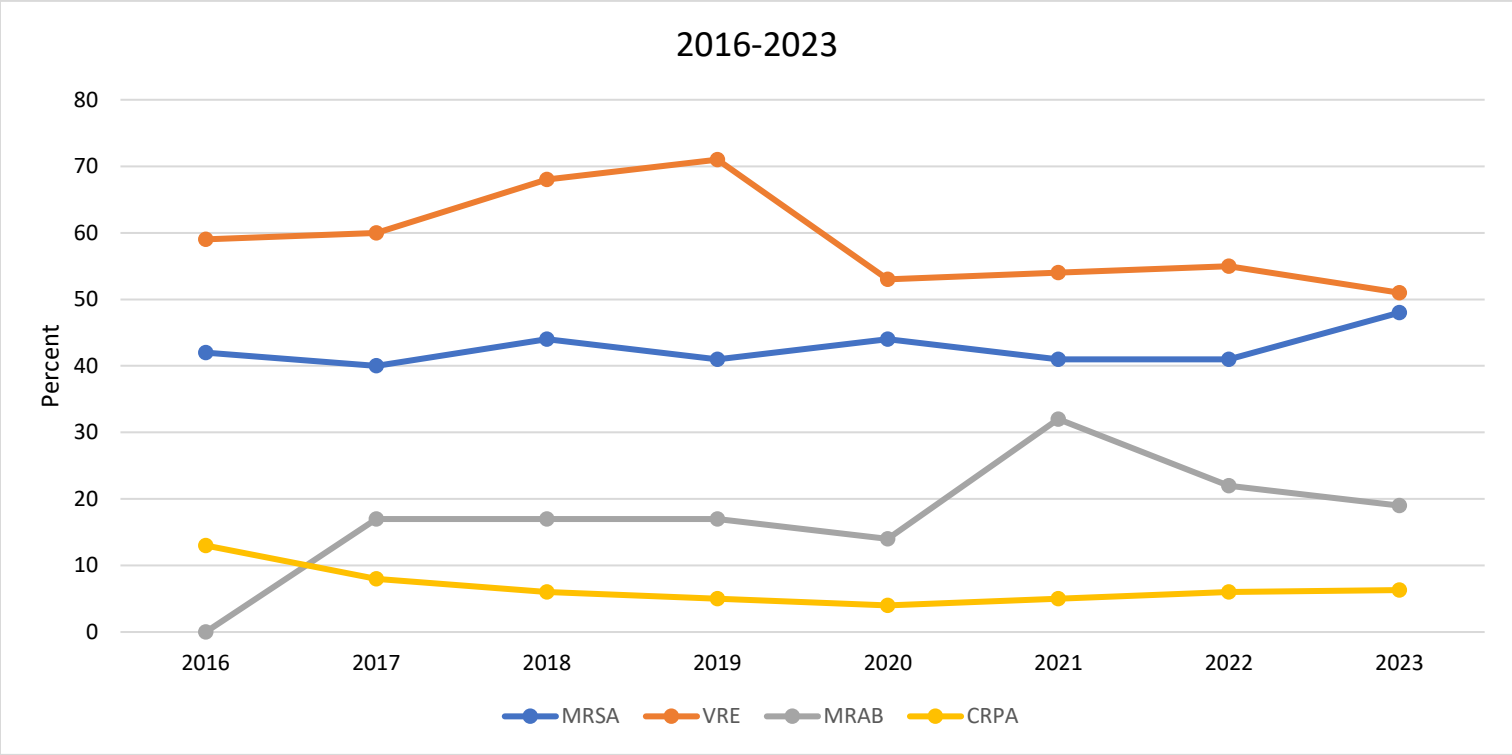
Table 13. Adults – *Candida* spp., % Susceptible

Data represent first isolate per patient.

	N	Fluconazole	Micafungin	Voriconazole
Candida albicans	67	93	100	89
Candida glabrata	32	81*	100	ND
Candida parapsilosis	20	100	78	100
Candida tropicalis	18	79	100	70

*Refers to % susceptible, dose dependent. ND, no data.

Figure 1. Multi-drug resistant Organism Trends, Adult Patients



Data exclude surveillance cultures

CRPA, carbapenem-resistant *Pseudomonas aeruginosa*; MRAB, meropenem-resistant *Acinetobacter baumannii* complex; MRSA, methicillin resistant *Staphylococcus aureus*; VRE, vancomycin resistant *Enterococcus faecium*

Figure 2. ESBL Trends, Blood Isolates in Adult Patients, 2016-2022