

VUMC
Antimicrobial
Susceptibility Summary:
Pediatric Patients
2021

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 December 1, 2019 – November 30, 2020.

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.

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Table 1. Pediatrics – Most common Gram-negative Bacteria, Urine Cultures, % Susceptible

Data represent first isolate per patient.

Organism	N	Amoxicillin/ Clavulanate	Ampicillin/ Sulbactam	Piperacillin/ Tazobactam	Ampicillin	Aztreonam	Oral Cephalosporins*	Cefepime	Cefoxitin	Ceftazidime	Ceftriaxone	Ertapenem	Meropenem	Ciprofloxacin	Levofloxacin	Nitrofurantoin ¹	Tetracycline	Trimethoprim/ Sulfamethoxazole	Amikacin	Gentamicin	Tobramycin
<i>Citrobacter freundii</i>	14**	R	R	92	R	92	ND	100	R	77	77	100	100	77	85	100	77	77	100	92	92
<i>Klebsiella aerogenes</i>	10**	R	R	60	R	60	R	90	R	60	60	90	100	90	100	60	80	80	100	90	90
<i>Enterobacter cloacae</i>	21**	R	R	86	R	67	R	91	R	62	62	67	100	91	95	29	95	81	100	95	95
<i>Escherichia coli</i>	766	87	82	99	51	95	91	95	96	96	94	100	100	84	89	99	79	74	100	92	94
<i>Klebsiella oxytoca</i>	33	88	70	88	R	91	75	94	96	94	84	97	97	94	100	100	88	84	100	97	97
<i>Kleb. pneumoniae</i>	72	96	79	92	R	96	93	96	91	94	96	100	100	89	93	51	79	86	100	99	97
<i>Pseudo. aeruginosa</i>	23**	R	R	86	R	81	R	95	R	91	R	R	86	86	91	R	R	R	100	91	95
<i>Proteus mirabilis</i>	53	96	96	98	81	100	90	98	100	100	96	100	ND	96	98	R	R	90	100	98	96

*Preferred oral cephalosporin for uncomplicated urinary tract infection in children is cephalexin.

**Calculated with <30 isolates; interpret data with caution. R, intrinsic resistance; ND, not tested.

¹ Nitrofurantoin use is restricted to uncomplicated cystitis only.


 Urinary Tract Clinical Practices Guidelines are available [here](#).
For empiric treatment of uncomplicated UTI, first line therapy in children is oral cephalexin.

Table 2. Pediatrics – Gram-negative bacteria, Urine isolates, % Susceptible by Patient Location

Data represent first isolate per patient.

Organism		N	Amoxicillin/ Clavulanate	Ampicillin/ Sulbactam	Piperacillin/ Tazobactam	Ampicillin	Aztreonam	Oral Cephalosporins*	Cefepime	Cefoxitin	Ceftazidime	Ceftriaxone	Ertapenem	Meropenem	Ciprofloxacin	Levofloxacin	Nitrofurantoin ¹	Tetracycline	Trimethoprim/ Sulfamethoxazole	Amikacin	Gentamicin	Tobramycin
<i>Escherichia coli</i>	IN	135	84	76	99	44	93	89	94	94	94	92	100	100	81	86	99	78	71	100	90	93
	ICU	25**	88	61.9	96	28	92	84	88	95.2	92	88	100	100	88	92	96	72	64	100	92	96
	OP	606	88	84	99	54	96	92	96	97	97	95	100	100	84	90	99	80	75	100	93	94
<i>Klebsiella oxytoca</i>	IN	13**	83	70	83	R	92	75	92	100	92	83	92	92	92	100	100	92	83	100	100	100
	ICU	7**	100	75	100	R	100	67	100	75	100	100	100	100	100	100	100	83	100	100	100	100
	OP	14**	86	67	86	R	86	79	93	100	93	79	100	100	93	100	100	86	79	100	93	93
<i>Klebsiella pneumoniae</i>	IN	20**	95	64	95	R	95	95	100	82	95	95	100	100	90	95	70	85	90	100	100	100
	ICU	14**	93	67	79	R	93	86	86	89	86	93	100	100	86	93	64	71	93	100	93	93
	OP	38	97	91	95	R	97	95	97	96	97	97	100	100	90	92	37	79	82	100	100	97
<i>Pseudomonas aeruginosa</i>	IN	9**	R	R	75	R	75	R	100	R	88	R	R	75	75	88	R	R	R	100	100	100
	ICU	3**	R	R	67	R	67	R	67	R	67	R	R	67	67	67	R	R	R	100	33	67
	OP	11**	R	R	100	R	90	R	100	R	100	R	R	100	100	100	R	R	R	100	100	100
<i>Proteus mirabilis</i>	IN	11**	100	100	90	80	100	80	100	100	100	90	100	ND	90	90	R	R	90	100	90	90
	ICU	3**	100	67	100	100	100	100	100	100	100	100	100	ND	100	100	R	R	100	100	100	100
	OP	39	95	97	100	80	100	92	97	100	100	97	100	ND	97	100	R	R	90	100	100	97

*Preferred oral cephalosporin for uncomplicated urinary tract is cephalexin. ** Calculated with < 30 isolates; interpret data with caution.

R, intrinsic resistance; ND, not tested.

¹ Nitrofurantoin use is restricted to uncomplicated cystitis only.


 Urinary Tract Clinical Practices Guidelines are available [here](#).
For empiric treatment of uncomplicated UTI, first line therapy in children is oral cephalexin.

Table 3. Pediatrics – Most Common Gram-negative Bacteria, Non-Urine Isolates, % Susceptible

Data represent first isolate per patient.

Organism	N	Amoxicillin/ clavulanic acid	Ampicillin/ Sulbactam	Piperacillin/ tazobactam	Ampicillin	Aztreonam	Cefazolin	Cefepime	Cefoxitin	Ceftazidime	Ceftriaxone	Cefuroxime	Ertapenem	Meropenem	Ciprofloxacin	Levofloxacin	Tetracycline	Minocycline	Amikacin	Gentamicin	Tobramycin	Trimethoprim/ Sulfamethoxazole
<i>Acinetobacter baumannii</i>	18	47	100	ND	R	R	R	87	R	80	40	R	R	100	93	100	93	100	100	93	100	100
<i>Citrobacter freundii</i>	9	R	R	89	R	78	R	89	R	78	78	80	100	100	67	78	89	80	100	78	78	78
<i>Klebsiella aerogenes</i>	8	R	R	86	R	100	R	100	R	100	100	R	100	100	100	100	86	100	100	100	100	100
<i>Enterobacter cloacae</i>	63	R	R	85	R	85	R	86	R	83	78	R	83	97	92	93	92	96	100	98	98	90
<i>Escherichia coli</i>	109	69	58	95	31	88	79	88	89	89	86	81	99	100	69	77	66	87	100	82	80	69
<i>Klebsiella oxytoca</i>	29	96	95	96	R	96	88	96	95	96	96	100	96	100	92	100	92	100	100	96	96	92
<i>Klebsiella pneumoniae</i>	43	92	91	100	R	95	89	95	88	95	95	84	100	100	89	89	87	94	100	97	97	87
<i>Pseudomonas aeruginosa</i>	149	R	R	93	R	86	R	96	R	97	R	R	R	96	87	87	R	R	99	99	99	R
<i>Stenotrophomonas maltophilia</i>	71	R	R	R	R	R	R	R	R	42	R	R	R	R	ND	84	R	98	R	R	R	93
<i>Proteus mirabilis</i>	17	94	88	100	88	100	88	94	100	100	88	94	100	ND	88	94	R	R	100	94	88	82
<i>Serratia marcescens</i>	51	R	28	100	R	98	R	100	R	100	98	R	95	100	98	98	R	97	100	100	84	ND

R, intrinsic resistance; ND, not tested.

Table 4. Pediatrics –Gram-negative Bacteria, Non-Urine Isolates, % Susceptible by Location

Data represent first isolate per patient.

Organism		N	Amoxicillin/ clavulanic acid	Ampicillin/ Sulbactam	Piperacillin/ tazobactam	Ampicillin	Aztreonam	Cefazolin	Cefepime	Cefoxitin	Ceftazidime	Ceftriaxone	Cefuroxime	Ertapenem	Meropenem	Ciprofloxacin	Levofloxacin	Minocycline	Amikacin	Gentamicin	Tobramycin	Trimethoprim/ Sulfamethoxazole
<i>Enterobacter cloacae</i>	ICU	29	R	R	72	R	72	R	76	R	72	66	R	76	97	93	93	95	100	97	97	90
	IN	16*	R	R	93	R	93	R	100	R	93	80	R	87	100	87	87	92	100	100	100	80
	OP	19*	R	R	100	R	100	R	94	R	94	100	R	94	94	94	100	100	100	100	100	100
<i>Escherichia coli</i>	ICU	29*	68	46	93	18	93	86	96	88	93	93	92	96	100	71	86	88	100	93	89	75
	IN	29*	72	57	96	28	80	72	76	100	80	76	70	100	100	58	68	96	100	72	68	56
	OP	51	68	68	95	43	90	77	90	84	93	88	81	100	100	73	78	81	100	80	80	73
<i>Pseudomonas aeruginosa</i>	ICU	49	R	R	92	R	85	R	96	R	96	R	R	R	96	94	92	R	100	100	100	R
	IN	20*	R	R	100	R	90	R	95	R	100	R	R	R	100	90	85	R	100	100	95	R
	OP	80	R	R	91	R	85	R	97	R	97	R	R	R	94	81	85	R	99	99	100	R
<i>Steno. maltophilia</i>	ICU	27*	R	R	R	R	R	R	R	R	27	R	R	R	R	ND	77	100	R	R	R	92
	IN	9*	R	R	R	R	R	R	R	R	56	R	R	R	R	ND	89	100	R	R	R	89
	OP	35	R	R	R	R	R	R	R	R	50	R	R	R	R	ND	88	96	R	R	R	94
<i>Serratia marcescens</i>	ICU	18*	R	R	100	R	94	R	100	R	100	94	R	94	100	100	100	100	100	100	78	ND
	IN	10*	R	R	100	R	100	R	100	R	100	100	R	100	100	100	100	100	100	100	78	ND
	OP	23*	R	R	100	R	100	R	100	R	100	100	R	94	100	94	94	92	100	100	94	ND

ICU, intensive care unit; IN, inpatient, OP, outpatient

R, intrinsic resistance; ND, not tested.

*Calculated from <30 isolates; interpret data with caution.

Table 5. Pediatrics – *Staphylococcus aureus*, % Susceptible by Location

Data represent first isolate per patient.

Organism		N	Penicillin	Oxacillin	Ceftaroline	Doxycycline	Clindamycin	Gentamicin	Levofloxacin	Minocycline	Moxifloxacin	Nitrofurantoin ¹	Rifampin	Tetracycline	Trimethoprim/ Sulfamethoxazole	Vancomycin
All	All	818	16	63	100	100	95	99	84	100	84	100	100	98	96	100
MSSA	OP	280	23	99	100	100	99	99	91	100	91	100	100	99	96	100
	ICU	151	33	99	100	100	99	100	100	100	100	100	100	98	99	100
	IN	90	17	99	100	100	99	100	93	100	93	100	100	98	97	100
MRSA	OP	178	0	0	99	99	88	95	63	99	64	100	99	97	95	100
	ICU	58	0	0	100	100	95	100	79	100	79	100	100	98	98	100
	IN	62	0	0	100	98	89	98	66	98	66	100	100	95	90	100

ICU, intensive care unit; IN, inpatient, OP, outpatient

¹ Nitrofurantoin should only be used for treatment of uncomplicated cystitis.

i Clindamycin susceptibility is high for MRSA and MSSA in all settings.

Table 6. Pediatrics – *Enterococcus* spp., % Susceptible by Location

Data represent first isolate per patient.

		N	Ampicillin	Doxycycline	Gentamicin ¹	Streptomycin ¹	Minocycline	Nitrofurantoin ²	Penicillin	Tetracycline	Vancomycin
<i>Enterococcus faecalis</i>	OP	55	100	44	94	92	20	100	100	29	100
	ICU	29	100	33	78	85	20	100	95	22	96
	IN	42	100	28	80	90	26	100	100	23	100
<i>Enterococcus faecium</i>	ALL	8*	71	86	100	86	75	ND	80	71	100

R, intrinsic resistance; ND, not tested.

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

¹ High level gentamicin and streptomycin. Indicate % susceptible to these aminoglycosides, if combined with a susceptible cell-wall active agent, such as penicillin, ampicillin or vancomycin, for endocarditis.

² Nitrofurantoin should only be used for treatment of uncomplicated cystitis.

Table 7. Pediatrics – *Streptococcus pneumoniae*, % Susceptible

Data represent first isolate per patient.

	N	Amoxicillin-clavulanate	Cefepime (meningitis)	Cefepime (non-meningitis)	Cefotaxime (meningitis)	Cefotaxime (non-meningitis)	Ceftriaxone (meningitis)	Ceftriaxone (non-meningitis)	Clindamycin	Erythromycin ¹	Levofloxacin	Meropenem	Moxifloxacin	Penicillin (meningitis)	Penicillin (non-meningitis)	Penicillin (oral)	Tetracycline	Trimethoprim/ Sulfamethoxazole	Vancomycin
<i>Streptococcus pneumoniae</i>	68	95	71	89	94	98	95	98	86	48	98	73	100	56	94	56	81	72	100

¹ Predicts activity of azithromycin



Macrolides are not preferred therapy for pneumococcal pneumonia due to reduced susceptibility. Penicillin susceptibility remains high and is preferred for infections outside the central nervous system.

Table 8. Pediatrics – Beta-hemolytic *Streptococcus* spp., % Susceptible

Data represent first isolate per patient.

	N	Cefepime	Cefotaxime	Ceftriaxone	Clindamycin	Erythromycin ¹	Levofloxacin	Meropenem	Penicillin	Tetracycline	Trimethoprim/ Sulfamethoxazole	Vancomycin
<i>Streptococcus agalactiae</i>	34	100	100	100	47	21	95	100	100	11	R	100
<i>Streptococcus pyogenes</i>	21*	100	100	100	60	60	100	100	100	80	R	100

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

¹ Predicts activity of azithromycin


 For Group A *Streptococcus* pharyngitis, penicillin remains preferred therapy. Macrolides are not preferred therapy due to reduced susceptibility.

Table 9. Pediatrics – *Streptococcus anginosus* group, % Susceptible

Data represent first isolate per patient.

	N	Cefepime	Cefotaxime	Ceftriaxone	Clindamycin	Levofloxacin	Meropenem	Penicillin	Vancomycin
<i>Streptococcus anginosus</i> group	98	95	100	99	77	98	100	99	100

Table 10. Pediatrics – Viridans Group *Streptococcus* spp., % Susceptible

Data represent first isolate per patient.

Organism	N	Ampicillin	Penicillin	Ampicillin-sulbactam	Cefepime	Cefotaxime	Ceftaroline	Ceftriaxone	Clindamycin	Daptomycin	Doxycycline	Levofloxacin	Meropenem	Minocycline	Moxifloxacin	Nitrofurantoin	Tetracycline	Vancomycin
Viridans Streptococci	288	98	83	99	72	79	75	82	88	83	39	94	82	25	75	100	28	99

Table 11. *Haemophilus influenzae*, % Susceptible

	N	Ampicillin	Ampicillin-sulbactam	Cefotaxime	Levofloxacin	Azithromycin	Trimethoprim-sulfamethoxazole
All* patients, Beta-lactamase -	124	85	95	100	99	100	73
All* patients, Beta-lactamase +	50	0	90	100	100	98	54
Pediatrics (30% beta-lactamase +)	72	60	93	100	100	100	74

*includes adult patients

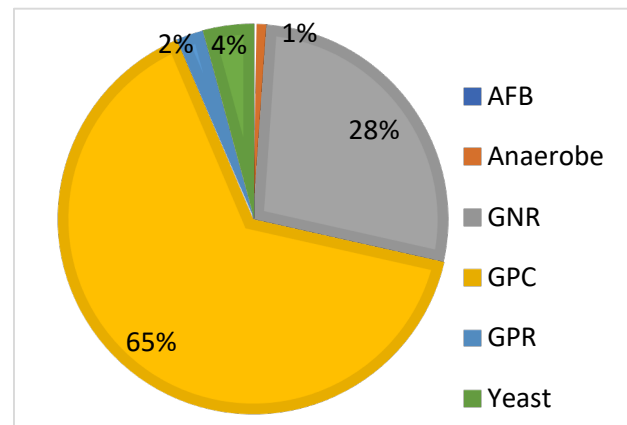
Table 12. Pediatrics – Blood Culture Isolates

Data represent first isolate per patient.

Most Common Organisms in Blood Cultures (1 per patient)

	N	(%)	Resistance
<i>Staphylococcus epidermidis</i>	84	23.3	75% oxacillin R
<i>Staphylococcus aureus</i>	31	8.6	20% MRSA
Other Coagulase-negative <i>Staphylococcus</i>	43	17	75% oxacillin R
<i>Escherichia coli</i>	23	6.4	19% cefazolin R 14% ceftriaxone R
<i>Enterococcus faecalis</i>	14	3.9	0% VRE
<i>Streptococcus mitis</i>	13	3.6	55% penicillin-R 0% vancomycin R
<i>Pseudomonas aeruginosa</i>	11	3.0	0% Piperacillin-tazobactam R
<i>Enterobacter cloacae</i>	9	2.5	0% cefepime R 45% ceftriaxone R
<i>Streptococcus agalactiae</i>	9	2.5	0% penicillin R
<i>Klebsiella pneumoniae</i>	8	2.2	15% ceftriaxone R
<i>Klebsiella oxytoca</i>	7	1.9	0% ceftriaxone R
<i>Streptococcus salivarius</i>	6	1.7	40% penicillin R
<i>Acinetobacter baumannii</i>	4	1.1	0% meropenem R

AFB, Acid Fast Bacilli
 GNR, Gram negative rods
 GPC, Gram positive cocci
 GPR, Gram positive rods



% Susceptible, one isolate per patient

	N	Amikacin	Ampicillin	Ampicillin/ sulbactam	Aztreonam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Ciprofloxacin	Ertapenem	Gentamicin	Levofloxacin	Meropenem	Piperacillin/ tazobactam	Tobramycin	Daptomycin	Doxycycline	Linezolid	Oxacillin	Penicillin	Vancomycin
Gram-negative bacilli	93	94	24	64	75	49	89	86	66	85	76	89	89	97	99	89	-	-	-	-	-	-
Gram-positive cocci in clusters	165	-	-	44	-	44	-	-	-	-	-	94	71	44	-	-	100	94	100	44	19	100

Patients with Cystic Fibrosis

Table 13. CF Patients, *Pseudomonas aeruginosa*, % Susceptible

Data represent first isolate per patient.

		N	Aztreonam	Amikacin	Gentamicin	Tobramycin	Ceftazidime	Cefepime	Meropenem	Piperacillin-tazobactam	Ciprofloxacin	Levofloxacin
Patients >18 years	All Isolates	129	80	72	72	84	89	84	86	89	64	62
	Mucoid Isolates	62	81	74	77	87	89	82	89	89	58	58
	Non-mucoid isolates	67	79	70	67	82	90	85	84	90	69	66
Patients ≤ 18 years		23*	91	70	39	96	91	91	83	91	83	96

*Calculated from < 30 isolates; interpret with caution.

Table 14. Pediatric CF Patients – *Pseudomonas aeruginosa*, % Susceptible to at least one of two antimicrobials

Data represent one isolate per patient.

Information provided for two drug combinations does not imply synergism, antagonism or likely activity in vivo.

	Cefepime (91)	Ceftazidime (91)	Meropenem (83)	Piperacillin- tazobactam (91)
Levofloxacin (96)	96 ¹	100	100	91
Amikacin (70)	91	96	96	96
Gentamicin (39)	91	91	96	91
Tobramycin (96)	96	96	100	96

¹% susceptible for either or both drugs in table (e.g., % S to levofloxacin and/or cefepime).

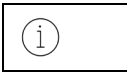
 For *Pseudomonas aeruginosa*, addition of a second antibiotic to a beta lactam does not increase susceptibility significantly compared to a beta-lactam alone.

Table 14. CF Patients, *Staphylococcus aureus*, % Susceptible

Data represent first isolate per patient.

N	Oxacillin	Ceftaroline	Clindamycin	Daptomycin	Doxycycline	Gentamicin	Levofloxacin	Linezolid	Minocycline	Rifampin	Trimethoprim-sulfamethoxazole	Vancomycin
35	74	97	97	97	100	94	91	100	100	97	100	100

Table 15. CF Patients, *Stenotrophomonas maltophilia*, % Susceptible

Data represent first isolate per patient.

N	Ceftazidime	Levofloxacin	Minocycline	Trimethoprim-sulfamethoxazole
18*	50	89	100	89

*Calculated with <30 isolates; interpret data with caution

Includes both adult and pediatric patients