

Antimicrobial Susceptibility Summary: Pediatric Patients 2023

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, 2022 – December 31, 2022.

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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VASP Website:

<https://www.vumc.org/antimicrobial-stewardship-program>

Pediatric ASP Website:

<https://pediatrics.vumc.org/antimicrobial-stewardship-program>

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General Antibiograms, 2022 Data

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	Gentamicin	Tobramycin
<i>Escherichia coli</i>	588	84	75	96	46	94	88	94	96	95	93	100	100	76	86	99	73	69	90	90
IN	116	84	76	97	44	94	89	94	92	96	93	100	100	75	84	99	75	72	93	93
ICU	49	76	63	96	41	88	78	88	90	88	86	100	100	76	82	98	76	80	92	90
OUT	423	85	76	96	47	95	89	95	97	96	94	100	100	77	87	98	73	67	89	89
<i>Klebsiella pneumoniae</i>	67	91	88	94	R	89	89	92	97	89	89	99	100	86	91	44	83	79	94	89
<i>Enterobacter cloacae</i> **	27	R	R	R	R	78	R	R	R	67	63	85	100	85	96	52	93	78	100	96
<i>Pseudomonas aeruginosa</i> **	25	R	R	R	R	84	R	R	R	R	R	R	R	76	76	R	R	R	R	ND

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

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

****Enterobacter doecae* may develop resistance during prolonged therapy with 3rd-generation cephalosporins as a result of derepression of AmpC beta-lactamase.

R, intrinsic resistance; ND, no data.

¹ Nitrofurantoin use is restricted to uncomplicated cystitis only.

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

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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 – 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	Trimethoprim/ Sulfamethoxazole	Gentamicin	Tobramycin
<i>Escherichia coli</i>	97	71	69	89	33	85	74	88	86	84	81	99	99	100	75	79	67	93	62	80	97
ICU	44	68	61	87	26	82	71	82	90	79	76	97	97	100	79	82	63	92	55	76	76
Non-ICU	53	74	77	91	40	89	77	94	83	89	86	100	100	100	71	77	71	94	69	83	83
<i>K. oxytoca</i>	45	95	95	98	R	95	90	98	93	93	95	100	100	100	93	98	88	95	93	90	88
<i>K. pneumoniae</i>	51	95	93	88	R	98	95	98	98	95	98	100	100	100	95	98	88	91	91	98	51
<i>P. aeruginosa</i>	121	R	R	87	R	85	R	96	R	93	R	R	R	94	90	91	R	R	R	R	ND
ICU	57	R	R	86	R	78	R	95	R	93	R	R	R	90	87	87	R	R	R	R	ND
Non-ICU	65	R	R	89	R	91	R	96	R	93	R	R	R	96	93	95	R	R	R	R	ND
<i>S. maltophilia</i>	59	R	R	R	R	R	R	R	R	R	R	R	R	R	ND	85	R	93	96	R	R
<i>E. cloacae</i>	58	R	R	87	R	81	R	92	R	81	83	92	92	98	89	96	94	94	87	100	100
<i>S. marcescens</i>	42	R	R	94	R	100	R	100	R	100	94	100	100	100	100	100	ND	ND	ND	100	60

R, intrinsic resistance; ND, not tested; ICU, intensive care unit

***Enterobacter cloacae may develop resistance during prolonged therapy with 3rd-generation cephalosporins as a result of derepression of AmpC beta-lactamase.

Table 3. Pediatrics – Staphylococcus aureus, % Susceptible by Location
Data represent first isolate per patient.

Organism	Location	N													
			Penicillin	Oxacillin	Ceftaroline	Doxycycline	Clindamycin	Gentamicin	Levofloxacin	Minocycline	Nitrofurantoin ¹	Rifampin	Tetracycline	Trimethoprim/ Sulfamethoxazole	Vancomycin
All		485	18	69	100	99	95	98	85	99	100	99	93	94	100
	ICU	117	29	100	100	100	98	98	95	100	100	99	95	97	100
	IN	90	22	100	100	100	99	98	96	100	99	100	92	98	100
	OP	127	28	100	100	98	98	100	94	99	100	100	94	94	100
MSSA	ICU	54	0	0	98	96	83	91	57	100	100	100	92	85	100
	IN	35	0	0	100	97	91	97	71	97	100	100	97	92	100
	OP	62	0	0	100	97	92	98	61	97	100	98	91	92	100
MRSA															

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

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

①

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

Table 4. Pediatrics – *Enterococcus* spp., % Susceptible by Location
Data represent first isolate per patient.

Organism	N	Ampicillin	Daptomycin	Doxycycline	Gentamicin ¹	Streptomycin ¹	Minocycline	Nitrofurantoin ²	Penicillin	Tetracycline	Vancomycin
<i>Enterococcus faecalis</i>	130	99	100	44	86	91	35	100	99	35	99
<i>Enterococcus faecium</i> *	7	0	100	71	86	43	0	ND	0	0	71

* 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 5. Pediatrics – *Streptococcus pneumoniae*, % Susceptible
Data represent first isolate per patient.

<i>Streptococcus pneumoniae</i>	N		
	57	91	Amoxicillin
	86		Cefepime (meningitis)
	88		Cefepime (non-meningitis)
	91		Cefotaxime (meningitis)
	91		Cefotaxime (non-meningitis)
	91		Ceftriaxone (meningitis)
	97		Ceftriaxone (non-meningitis)
	89		Clindamycin
	51		Erythromycin ¹
	100		Levofloxacin
	84		Meropenem
	100		Moxifloxacin
	72		Penicillin (meningitis)
	91		Penicillin (non-meningitis)
	72		Penicillin (oral)
	84		Tetracycline
	76		Trimethoprim/ Sulfamethoxazole
	100		Vancomycin

¹ Predicts activity of azithromycin

①

Macrolides are not preferred therapy for pneumococcal pneumonia due to reduced susceptibility.

①

Penicillin and amoxicillin susceptibility remains high and is preferred for infections outside the central nervous system.

①

Clinical Practice Guidelines for Community Acquired Pneumonia in Children can be found at the following link:

<https://www.vumc.org/childrens-quality-safety/clinical-practice-guidelines-community-acquired-pneumonia>

Table 6. Pediatrics – Beta-hemolytic *Streptococcus* spp., % Susceptible

Data represent first isolate per patient.

	N																					
<i>Streptococcus agalactiae</i>	46	100	100	100	100	100	100	100	38	15	100	100	100	100	100	100	100	100	15	R	R	100
<i>Streptococcus pyogenes</i>	21*	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	R	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 7. Pediatrics – *Streptococcus spp.*, % Susceptible

Data represent first isolate per patient.

	N																		
<i>Streptococcus anginosus</i>	22	93	100	88	88	81	94	100	100	100	100	100	100	100	100	100	100	100	100
<i>Streptococcus mitis</i>	21	81	88	88	88	94	88	88	88	53	100								

Table 8. All Patients – *Candida spp.*, % Susceptible

Data represent first isolate per patient.

	N																		
<i>C. albicans</i>	42	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
<i>C. glabrata</i>	8	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
<i>C. tropicalis</i>	9	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

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

Table 9. Pediatrics – Blood Culture Isolates

Data represent first isolate per patient.

N		
GNR	137	Amoxicillin/Clavulanate
GPC	264	56
		28
		61
		77
		35
		88
		67
		80
		80
		84
		94
		96
		74
		88
		96
		100
		51
		34
		99

Most Common Organisms in Blood Cultures

(1 per patient)

	N	(%)
<i>Staphylococcus epidermidis</i>	119	19.6
<i>Staphylococcus hominis</i>	54	8.9
<i>Staphylococcus aureus</i>	46	7.6
<i>Escherichia coli</i>	31	5.1
<i>Strep. mitis</i>	28	4.6
<i>Staph. capitis</i>	28	4.6
<i>Enterococcus faecalis</i>	24	4.0
<i>Strep. pneumoniae</i>	15	2.5
<i>Enterobacter cloacae</i>	14	2.3
<i>Pseudomonas aeruginosa</i>	11	1.8
<i>Strep. agalactiae</i>	9	1.5
<i>Kleb. oxytoca</i>	9	1.5
<i>Kleb. pneumoniae</i>	9	1.5

Blood Isolate Distribution, Pediatrics



- Gram positive Bacteria
- Enterobacterales
- Non-fermenting GNR
- Yeast

Patients with Cystic Fibrosis

Table 10. CF Patients, Gram negative bacteria, % Susceptible

Data represent first isolate per patient.

Organism	N																											
<i>Pseudomonas aeruginosa</i>	101	R	88	R	86	R	82	R	ND	R	82	R	65	ND	100	R	58	100	R	100	R	100	R	R	ND	R	R	ND
<i>Stenotrophomonas maltophilia</i>	4	R		R		R		R		R		ND			100	R		100	R		100	R		R		R		ND

*Calculated from < 30 isolates; interpret with caution.

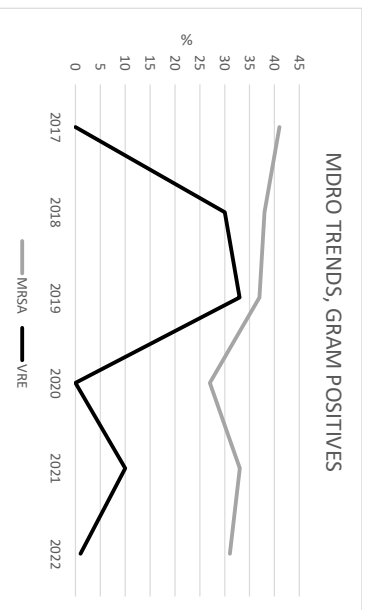
R, intrinsic resistance; ND, no data

Table 11. Pediatric CF Patients – *Staphylococcus aureus*, % Susceptible

Data represent one isolate per patient.

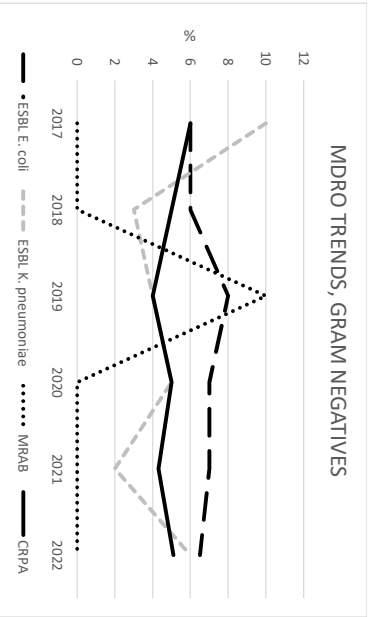
<i>Staphylococcus aureus</i>	37	84	97	97	97	100	97	97	100	100	100	100	100	100	100	100	100	95	100		
MRSA	6	0	83	83	100	83	83	83	100	100	100	100	100	100	83	100					
MSSA	31	100	97	97	100	97	97	100	100	100	100	100	100	97	100						
		Oxacillin	Ceftaroline	Clindamycin	Doxycycline	Gentamicin	Levofloxacin	Linezolid	Minocycline	Rifampin	Trimethoprim/ Sulfamethoxazole	Vancomycin									

Multidrug Resistant Organism (MDRO) Trends, Pediatric Patients



Data exclude surveillance cultures, 1 isolate per patient per year included. MRSA, methicillin-resistant *S. aureus*; VRE, vancomycin-resistant *Enterococcus*

MDRO TRENDS, GRAM NEGATIVES



Data exclude surveillance cultures, 1 isolate per patient per year included.

ESBL, extended spectrum beta-lactamase; CRPA, carbapenem-resistant *Pseudomonas aeruginosa*; MRAB, Meropenem-resistant *Acinetobacter baumannii*

Table 12. Pediatrics – Combination antibiograms

Stenotrophomonas maltophilia (n=62 isolates)

	Levofloxacin	Trimethoprim-sulfamethoxazole	Minocycline
Levofloxacin (69)			
Trimethoprim-sulfamethoxazole (92)	91		
Minocycline (94)	96	98	

Pseudomonas aeruginosa (n=146 isolates); excludes CF patients

	Ciprofloxacin (88)	Levofloxacin (88)
Meropenem (94)	97	97
Piperacillin-tazobactam (90)	95	95
Cefepime (96)	98	97

