Table 8. Pediatric parenteral antimicrobial dosage guidelines

Antibiotic	Usual Dosages[a, b]
ANTIBACTERIAL AGENTS	
Penicillins	
Ampicillin	100-400 mg/kg/day divided q6h
Cloxacillin	100-200 mg/kg/day divided q6h
Penicillin G Sodium	100,000-500,000 units/kg/day divided q4-6h
Piperacillin ± Tazobactam	300-400 mg/kg/day divided q6h[c]
Meropenem	60-120 mg/kg/day divided q8h
Cephalosporins	
Cefazolin	50-150 mg/kg/day divided q8h
Cefoxitin	80-160 mg/kg/day divided q8h
Cefuroxime	75-150 mg/kg/day divided q8h
Cefotaxime	100-300 mg/kg/day divided q6-8h
Ceftriaxone	50-100 mg/kg/day divided q12-24h
Ceftazidime	100-150 mg/kg/day divided q8h
Macrolides	
Azithromycin	5-10 mg/kg q24h
Aminoglycosides	
Gentamicin	5-9 mg/kg/day divided q8-24h[d,f]
Tobramycin	5-9 mg/kg/day divided q8-24h[d,f]
Others	
Clindamycin	25-40 mg/kg/day divided q8h
Cotrimoxazole	6-20 mg/kg/day divided q6-12h[e]
Metronidazole	30 mg/kg/day divided q8h
Vancomycin	60 mg/kg/day divided q6h
ANTIFUNGAL AGENTS	
Amphotericin B	0.25-1.5 mg/kg q24h
Amphotericin B liposomal	3-5 mg/kg q24h
Fluconazole	3-12 mg/kg q24h
Micafungin	1-3 mg/kg q24h
ANTIVIRAL AGENTS	
Acyclovir	15-60 mg/kg/day divided q8h
Ganciclovir (induction doses)	10 mg/kg/day divided q12h

[a] Typical doses in infants and children. Maximum doses should not exceed typical adult doses.

[b] Does not reflect dosing in neonates; refer to Pediatric Drug Dosage Handbook (Lexi-comp) for dosing information in this patient population.

[c] Dosing based on piperacillin component only.

[d] Dosing varies with patient age. Refer to Pediatric Drug Dosage Handbook (Lexi-comp) for more comprehensive dosing information.

[e] Dosing based on trimethoprim component only.

[f] Patients with cystic fibrosis may require higher doses.

Table 9. Pediatric dosing recommendations in renal impairment[a]

Drug	Creatinine Clearance (CL_{CR}) in mL/min/1.73 m^2[b] (suggested dosage adjustment based on normal dose)				Supplement for Dialysis
Penicillins					
Ampicillin	> 30 (q6h)	10-30 (q8-12h)	< 10 (q12h)		HD
Cloxacillin	NO CHANGE NECESSARY				NO
Penicillin	> 50 (q4-6h)	10-50 (75%)	< 10 (20 - 50%)		HD
Piperacillin	> 50 (q6h)	20-50 (q8h)	< 20 (q12h)		HD
Piperacillin/ Tazobactam	> 50 (q6h)	30-50 (65% q6h)	< 30 (50% q8h)		HD
Cephalosporins					
Cefazolin	> 30 (q8h)	10-30 (q12h)	< 10 (q24h)		HD
Cefotaxime	> 50 (q6-8h)	10-50 (q12h)	< 10 (q24h)		HD
Ceftriaxone	NO CHANGE NECESSARY				NO
Cefoxitin	> 50 (q6-8h)	30-50 (q8h)	10-29 (q12h)	< 10 (q24h)	HD
Ceftazidime	> 50 (q8h)	30-50 (q12h)	10-29 (q24h)	< 10 (q48h)	HD, PD
Cefuroxime	> 30 (q8h)	10-30 (q12h)	< 10 (q24h)		HD
Miscellaneous					
Acyclovir	> 50 (q8h)	30-50 (q12h)	10-29 (q24h)	< 10 (50% q24h)	HD
Aminoglycosides[c]	Refer to Pediatric Drug Dosage Handbook (Lexicomp) for more information				HD, PD
Azithromycin	NO CHANGE NECESSARY				NO
Clindamycin	NO CHANGE NECESSARY				NO
Fluconazole	> 50 (q24h)	10-50 (50% q24h)	< 10 (50% q48h)		HD
Ganciclovir (induction doses)	> 50 5 mg/kg q12h	30-50 2.5 mg/kg q24h	10-29 1.25 mg/kg q24h	< 10 1.25 mg/kg 3x/wk	HD
Meropenem	> 50 (q8h)	30-50 (q12h)	10-29 (50% q12h)	< 10 (50% q24h)	HD, PD
Metronidazole	> 10 (q8h)	< 10 (50% q8h)			HD
TMP-SMX[a]	> 50 (q6-8h)	30-50 (q8h)	10-29 (q12h)	< 10 (q24h) generally not recommended[a]	HD
Vancomycin[c]	> 50 (q6-8h)	30-50 (q12h)	10-29 (q24h)	< 10 dose as needed per serum concentration	NO

[a] Suggested dosages – for individualized dosage modifications or more information contact the Department of Pharmaceutical Services.

[b] To estimate creatinine clearance (CL_{CR}) (mL/min/1.73 m^2) use the following calculation:

$$CL_{CR} = \frac{36.5 \times \text{height (cm)}}{S_{CR}\ (\mu\text{moles/L})}$$ **(Only for patients 1–18 years old)**

[c] Monitor serum concentrations, for individualized dosage modifications contact Department of Pharmaceutical Services.

HD = Hemodialysis PD = Peritoneal Dialysis

Health Sciences Centre
Winnipeg

Children's Hospital Antibiogram for 2022

(Based on data from 2021)

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DISCLAIMERS

This guide is provided as an educational resource for physicians and other healthcare professionals caring for patients at the Winnipeg Children's Hospital. The authors of the guide have made every effort to ensure that the information contained in it was accurate at the time of publication. Users of the guide are encouraged to consult other references to confirm the information presented in it. The authors are not responsible for errors, omissions, inaccuracies, or the continued completeness of the information contained in the guide. The information in the guide should not be used or relied upon to replace the skill and professional judgment required to determine appropriate patient care and treatment. Also, the guide is not intended to replace or to be used as a substitute for the complete prescribing information prepared by each pharmaceutical manufacturer for their anti-infective agents. Because of possible changes in anti-infective indications, changes in dosage information, differences in patients' responses to therapy, newly described toxicities, drug-drug interactions, and other items of importance, reference to complete prescribing information is recommended before any of the anti-infective agents described in the guide are used.

HOW TO USE THE ANTIBIOGRAM PORTION OF THE GUIDE (Tables 1-6)

- The information presented in the antibiogram is intended only to guide initial empiric anti-infective agent therapy at the Winnipeg Children's Hospital.
- Initial broad-spectrum empiric therapy should be focused to the most appropriate narrow-spectrum agent(s) based on the laboratory identification of pathogen(s) and known susceptibility patterns/results, if the situation permits.
- Consideration should be given to equally efficacious but less expensive anti-infective agents for empiric therapy or when streamlining of therapy is desired, if the situation permits.

Table 1. In vitro activity of selected anti-infective agents tested against Gram-negative bacilli[a]

Organism (number tested): January through December 2021 ▭ = Not tested, not routinely reported, or not recommended	Percent Susceptible														
	Ampicillin	Amoxicillin-Clavulanate	Piperacillin-Tazobactam	Cefazolin	Cephalexin[b]	Cefuroxime	Ceftriaxone	Ceftazidime	Ertapenem	Meropenem	Gentamicin	Tobramycin	Trimethoprim-Sulfamethoxazole	Nitrofurantoin[c]
Enterobacter cloacae complex (63)			87				87	87	94	98	98	98	83	49
Escherichia coli (43) systemic	53	81	98	63			88	93	100	100	88	88	74	
Escherichia coli (406) urine	55	87	98	72	n.d.		93	95	100	100	93	94	74	98
Haemophilus influenzae (75)[d]	65	n.d.				97							64	
Klebsiella pneumoniae (48)		94	98	86	n.d.		95	95	100	100	96	98	94	36
Klebsiella/Raoultella spp. (44)[e]		93	95	27			98	100	100	100	100	100	98	75
Pseudomonas aeruginosa (46)			93					89		91	89	100		

[a] Isolates tested and reported are from all sources combined, with the exception of *Escherichia coli* (subdivided into systemic isolates and urine isolates); isolates were collected from Jan 1 to Dec 31, 2021 with the exception of *Enterobacter cloacae* complex and *Klebsiella/Raoultella* spp.(collected from Jan 2020 to Dec 2021); data compiled according to the recommendations of the Clinical and Laboratory Standards Institute (CLSI) in their document M39-A4 (2014).

[b] Cephalexin is only indicated for the treatment of uncomplicated lower urinary tract infections.

[c] Nitrofurantoin is only indicated for acute cystitis.

[d] *H. influenzae* data obtained from isolates tested at Health Sciences Centre (adult and pediatric patients), Jan 1 to Dec 31, 2017. Sixty-one isolates were tested for Cefuroxime and 69 isolates were tested for Trimethoprim-Sulfamethoxazole.

[e] The current laboratory identification system is unable to differentiate *Klebsiella oxytoca* from *Raoultella* spp.

n.d. = no data – absence of data for certain drug-organism combinations reflects limitations of the testing method currently used by Shared Health Clinical Microbiology laboratories.

Table 2. In vitro activity of selected anti-infective agents tested against Gram-positive cocci[a]

Organism (number tested): January through December 2021 ▭ = Not tested, not routinely reported, or not recommended	Percent Susceptible													
	Penicillin	Ampicillin	Oxacillin[b]	Vancomycin	Daptomycin	High-Level Gentamicin[c]	High-Level Streptomycin[c]	Erythromycin[d]	Clindamycin	Trimethoprim-Sulfamethoxazole	Rifampin[e]	Linezolid	Nitrofurantoin[f]
Enterococcus faecalis (235)		100		98	100	85	91					98	99
Staphylococcus aureus (371)			64	100	100			57	80	99	99	100	96
Staphylococcus epidermidis (51)			37	100	100			37	61	71	98	100	100
Streptococcus pyogenes (n.a.)[g] (Group A *Streptococcus*)	100												
Streptococcus agalactiae (162)[h] (Group B *Streptococcus*)	100			100					60				

[a] Isolates tested and reported are from all sources (surveillance isolates excluded), Jan to Dec, 2021 with the exception of *Enterococcus faecalis* (systemic isolates only, data obtained from adult patients); data compiled according to the recommendations of the Clinical and Laboratory Standards Institute (CLSI) in their document M39-A4 (2014).

[b] Oxacillin accurately predicts the activity of all semi-synthetic penicillins, including cloxacillin, beta-lactam/beta-lactamase inhibitor combinations, cephalosporins, and carbapenems for *Staphylococcus aureus* and coagulase-negative staphylococci.

[c] Susceptibility to high-level gentamicin or high-level streptomycin indicates that these agents can be used in combination with a cell wall active agent (e.g., ampicillin or vancomycin) for synergy. Gentamicin and streptomycin should never be used alone as treatment for *Enterococcus* spp.

[d] Erythromycin activity predicts the activity of azithromycin and clarithromycin for staphylococci and streptococci.

[e] Rifampin should NOT be used alone as treatment for infection.

[f] Nitrofurantoin is indicated for acute cystitis only.

[g] n.a. = not applicable – Susceptibility testing of *Streptococcus pyogenes* is not routinely performed as 100% are susceptible to penicillin. If treating infection in a penicillin allergic patient, contact the lab for testing of second line agents.

[h] *Streptococcus agalactiae* isolates were obtained from vaginal/rectal swabs submitted for Group B *Streptococcus* detection to the Health Sciences Centre, St. Boniface Hospital, and Westman Laboratory in 2012.

n.d. = no data – absence of data for certain drug-organism combinations reflects limitations of the testing method currently used by Shared Health Clinical Microbiology laboratories.

Table 3. In vitro activity of selected anti-infective agents tested against *Streptococcus pneumoniae*[a]

Infection Type (number tested) ▭ = Not tested, not routinely reported, or not recommended	Percent Susceptible					
	Penicillin (oral)	Penicillin (intravenous)	Ceftriaxone	Vancomycin	Clarithromycin	Trimethoprim-Sulfamethoxazole
Systemic Isolates (Blood + CSF)[b]						
Meningitis (180)		83	96	100		86
Non-Meningitis infection (180)	83	98	99	100	68	86
Respiratory Isolates[c]						
Non-Meningitis infection (40)	78	95	98	100	68	80

[a] For *Streptococcus pneumoniae*, different susceptibility breakpoints for penicillin and ceftriaxone exist depending on whether meningitis or a non-meningitis infection is being treated [CLSI, M100, 31st edition]. For penicillin, when treating a non-meningitis infection different breakpoints exist for oral and intravenous dosing. For non-meningitis infections, susceptibility to oral penicillin predicts susceptibility to amoxicillin. Oral agents are not appropriate for the treatment of bacterial meningitis.

[b] Systemic isolates were obtained from patients across Manitoba as part of the SAVE Study between January and December, 2017 (adult and pediatric data). CSF = cerebrospinal fluid.

[c] Respiratory isolates were obtained from patients (adult and pediatric) at the Health Sciences Centre (HSC) and St. Boniface Hospital (SBH) between January and December, 2018.

Table 4. In vitro activity of selected anti-infective agents tested against Methicillin-Susceptible and Methicillin-Resistant *Staphylococcus aureus* isolates[a]

Organism (number tested) ▭ = Not tested, not routinely reported, or not recommended	Percent Susceptible						
	Oxacillin[b]	Vancomycin	Trimethoprim-Sulfamethoxazole	Erythromycin	Clindamycin	Linezolid	Daptomycin
Methicillin-Susceptible *Staphylococcus aureus* (243)	100		99	68	75		
Methicillin-Resistant *Staphylococcus aureus* (138)	0	100	100	36	87	100	100

[a] Isolates tested and reported are from all sources (surveillance isolates excluded), Jan to Dec, 2021; data compiled according to the recommendations of the Clinical and Laboratory Standards Institute (CLSI) in their document M39-A4 (2014).

[b] Oxacillin accurately predicts the activity of all semi-synthetic penicillins, including cloxacillin, beta-lactam/beta-lactamase inhibitor combinations, cephalosporins, and carbapenems for *Staphylococcus aureus*.

Table 5. In vitro activity of selected anti-infective agents tested against anaerobic isolates collected from hospitals in Winnipeg[a]

Organism (number tested) ▭ = Not tested, not routinely reported, or not recommended	Percent Susceptible					
	Penicillin	Amoxicillin-Clavulanate	Piperacillin-Tazobactam	Clindamycin	Meropenem	Metronidazole
Bacteroides fragilis (108)		93	n.d.	44	93	100
Bacteroides thetaiotaomicron (37)		94	n.d.	14	97	100
Prevotella bivia (54)	7	100	n.d.	32	100	96
Prevotella disiens (34)	32	97	n.d.	18	100	100

[a] Isolates were obtained from WRHA hospitals between Jan 2019 and Dec 2020; data compiled according to the recommendations of the Clinical and Laboratory Standards Institute (CLSI) in their document M39-A4 (2014).

n.d. = no data – absence of data for certain drug-organism combinations reflects limitations of the testing method currently used by Shared Health Clinical Microbiology laboratories.

Table 6. In vitro activity of selected anti-fungal agents tested against *Candida* species collected from hospitals in Winnipeg[a]

Organism (number tested)	Percent Susceptible		
	Fluconazole[b]	Voriconazole	Micafungin
Candida albicans (33)	100	100	100
Candida glabrata (34)	91	n.d.	97

[a] Data obtained by testing a random sample of *C. albicans* and *C. glabrata* isolates from Health Sciences Centre and St. Boniface Hospital, collected between Jan 2017 and Dec 2018. Susceptibility interpretations are based on updated CLSI breakpoints (M60, 2nd Edition). Isolates tested and reported are from blood only.

[b] For fluconazole, there is only a susceptible-dose dependent (SDD) breakpoint for *C. glabrata*. The percentage of *C. glabrata* isolates that tested SDD to fluconazole was 91%. Susceptibility of SDD isolates to fluconazole is dependent on achieving the maximum blood level possible (i.e., should use the maximum dosage regimen). Consultation with infectious diseases is recommended for further guidance.

n.d. = breakpoints have not been defined for voriconazole versus *C. glabrata*.

Table 7. Pediatric oral antimicrobial dosage guidelines

Antibiotic	Usual Dosages[a, b]	Cost ($) per day[c]
ANTIBACTERIAL AGENTS		
Penicillins		
Amoxicillin	25–100 mg/kg/day divided bid-tid[d,g]	1.05–2.10
Amoxicillin-Clavulanate	25–100 mg/kg/day divided bid-tid[e,h]	3.10
Cloxacillin	50–100 mg/kg/day divided qid	0.65–1.30
Penicillin V	25–50 mg/kg/day divided tid-qid	0.40–0.80
Cephalosporins		
Cefprozil	15–30 mg/kg/day divided bid	2.25–4.50
Cephalexin	25–100 mg/kg/day divided tid-qid	0.9–1.80
Macrolides		
Azithromycin	5–10 mg/kg once daily	1.25–2.05
Clarithromycin	15 mg/kg/day divided bid	1.60–3.20
Others		
Clindamycin	20–40 mg/kg/day divided tid	1.50–3.00
Cotrimoxazole	6–12 mg/kg/day divided bid[f]	0.10–0.25
Nitrofurantoin	5–7 mg/kg/day divided qid	0.70–1.50
Metronidazole	30–40 mg/kg/day divided tid	0.30–0.60
ANTIFUNGAL AGENTS		
Fluconazole	6–12 mg/kg once daily	5.55–25.00
Itraconazole	3–10 mg/kg once daily	4.20–8.40
Ketoconazole	3.3–6.6 mg/kg once daily	1.30–2.60
ANTIVIRAL AGENTS		
Acyclovir	30–80 mg/kg/day divided 3-5x/day	7.60–12.60
Valacyclovir	40 mg/kg/day divided bid	1.70–7.00

[a] Typical doses in infants and children. Maximum doses generally should not exceed typical adult doses.

[b] Does not reflect dosing in neonates; refer to Pediatric Drug Dosage Handbook (Lexicomp) for dosing information in this patient population.

[c] Approximate cost per inpatient day excluding dispensing costs as of February 2010 based on the Manitoba Drug Interchangeability Formulary and Manufacturer's List Prices. Prices have been rounded and are based on typical adult daily doses.

[d] Use 25-50 mg/kg/day for infants ≤ 3 months

[e] Dosing based on amoxicillin component only

[f] Dosing based on trimethoprim component only

[g] BID dosing only for acute otitis media

[h] Use 30 mg/kg/day divided BID for infants ≤ 3 months