Table 8. Adult parenteral antimicrobial dosage guidelines

Antibiotic	Usual Dosages[a]
ANTIBACTERIAL AGENTS	
Penicillins	
ampicillin	1-2 g q4-6h
cloxacillin	2 g q4-6h
penicillin G	2-4 million units q4-6h
piperacillin-tazobactam	3.375 g q6h
meropenem	500 mg q6h
Cephalosporins	
cefazolin	1-2 g q8h
cefoxitin	1-2 g q6-8h
cefuroxime	0.75-1.5 g q8h
ceftriaxone	1-2 g q24h
ceftazidime	1-2 g q8h
Fluoroquinolones	
ciprofloxacin	400 mg q12h
levofloxacin	500-750 mg q24h
moxifloxacin	400 mg q24h
Macrolides	
azithromycin	500 mg q24h
Aminoglycosides	
gentamicin or tobramycin	80 mg q8h
Others	
clindamycin	600 mg q8h
cotrimoxazole (TMP-SMX)	10-20 mg/kg/day trimethoprim in divided doses q6-8h
metronidazole	500 mg q8h
vancomycin	1 g q12h or 15 mg/kg q12h
ANTIFUNGAL AGENTS	
amphotericin B	0.5-1 mg/kg q24h
fluconazole	100-400 mg q24h
caspofungin	70 mg load then 50 mg q24h
ANTIVIRAL AGENTS	
acyclovir	5-10 mg/kg/dose q8h
ganciclovir	5 mg/kg/dose q12h

[a] Based on normal renal function in a 70 kg patient.

Table 9. Parenteral to oral conversion suggestions

Parenteral Drug	Oral Therapy Options[a]
ANTIBACTERIAL AGENTS	
Penicillins	
ampicillin	amoxicillin
cloxacillin	cloxacillin or cephalexin
penicillin G	penicillin V
piperacillin-tazobactam	amoxicillin-clavulanate or cotrimoxazole (TMP-SMX) +/- metronidazole or ciprofloxacin +/- metronidazole
Cephalosporins	
cefazolin	cephalexin or cloxacillin
cefoxitin	cephalexin + metronidazole or cotrimoxazole + metronidazole or amoxicillin-clavulanate
cefuroxime	cotrimoxazole or amoxicillin-clavulanate or azithromycin/clarithromycin
ceftriaxone	amoxicillin-clavulanate or cephalexin or ciprofloxacin/levofloxacin/moxifloxacin
ceftazidime	ciprofloxacin
Fluoroquinolones	
ciprofloxacin	ciprofloxacin
levofloxacin	levofloxacin
moxifloxacin	moxifloxacin
Macrolides	
azithromycin	azithromycin
Others	
clindamycin	cloxacillin +/- metronidazole or cephalexin +/- metronidazole or clindamycin
ANTIFUNGAL AGENTS	
fluconazole	fluconazole
ANTIVIRAL AGENTS	
acyclovir	acyclovir or valacyclovir

[a] Patients should be clinically stable, demonstrate clinical improvement, and be able to tolerate oral feeding and medications. Selection of oral therapy should be based on cultures and sensitivities. In absence of useful cultures, oral therapy may be selected based on potential pathogens, community- versus hospital-acquired infection, pharmacokinetics, spectrum of activity, and cost of each oral agent. Oral agents listed above represent those currently on the WRHA Formulary and ***does not*** represent all commercially available oral agents.

Table 10. Adult dosing recommendations in renal impairment[a]

Drug	Creatinine Clearance (CrCl) in mL/min[b] (suggested dosage adjustment based on normal dose)			
Penicillins				
ampicillin	> 30 (q6h)	10-30 (q6-12h)	< 10 (q12h)	
cloxacillin	NO CHANGE NECESSARY			
penicillin	> 50 (q4-6h)	10-50 (q6-8h)	< 10 (20-50% of usual dose)[a]	
piperacillin-tazobactam	> 40 (q6h)	20-40 (q8h)	< 20 (q12h)	
Carbapenems				
meropenem	> 50 (q6h)	30-49 (q8h)	10-29 (q12h)	< 10 (q24h)
Cephalosporins				
cefazolin	> 50 (q8h)	10-50 (q12h)	< 10 (q24h)	
cefoxitin	> 30 (q6-8h)	10-30 (q12-24h)	< 10 (q24h)	
cefuroxime	> 20 (q8h)	10-20 (q12h)	< 10 (q24h)	
ceftriaxone	NO CHANGE NECESSARY			
ceftazidime	> 50 (q8h)	30-50 (q12h)	10-30 (q24h)	< 10 (50% q24-48h)
Aminoglycosides[c]				
gentamicin/ tobramycin/ amikacin	Contact the Pharmacist at your facility for dosing assistance			
Fluoroquinolones				
ciprofloxacin	> 30 (q12h)	< 30 (q24h)		
levofloxacin (e.g. CAP)	> 50 (q24h)	20-49 (500 mg load, then 50% q24h)	10-19 (500 mg load, then 50% q48h)	
moxifloxacin	NO CHANGE NECESSARY			
Macrolides				
azithromycin	NO CHANGE NECESSARY			
Antifungal Agents				
fluconazole	> 50 (q24h)	20-50 (50% q24h)	< 20 (25% of usual dose q24h)	
caspofungin	NO CHANGE NECESSARY			
Antiviral Agents				
acyclovir	> 50 (q8h)	25-50 (q12h)	10-25 (q24h)	< 10 (50% q24h)
ganciclovir (induction doses)	50-69 2.5 mg/kg q12h	25-49 2.5 mg/kg q24h	10-25 1.25 mg/kg q24h	< 10 1.25 mg/kg 3x/wk
Miscellaneous				
clindamycin	NO CHANGE NECESSARY			
metronidazole	NO CHANGE NECESSARY			
cotrimoxazole (TMP-SMX)	> 25 (q6-8h)	15-25 (50% q6-8h)	< 15 (2.5-5 mg/kg, generally not recommended)[a]	
vancomycin[c]	Contact the Pharmacist at your facility for dosing assistance			

[a] Suggested dosages – for individualized dosage modifications or more information contact the Pharmacy Department at your facility.

[b] To estimate creatinine clearance (CL_{CR}) (mL/min) use the following calculation normalized for a 72 kilogram person.
CL_{CR} male = $\frac{(140\text{-age}) \times 88.4}{S_{CR}\ (\mu moles/L)}$ CL_{CR} female = 0.85 x CL_{CR} male

[c] Monitor serum concentrations.

Table 11. Antimicrobial Restrictions at Health Sciences Centre (revised 2017)

Antimicrobial (alphabetical order)	Status[a]	Exception Criteria	Criteria For Use[b]
Acyclovir IV	Consultation		
Amphotericin B Lipid Complex	Consultation		**Yes**
Caspofungin	Consultation		**Yes**
Ceftazidime	Consultation	Hemodialysis (HSC or SBH) or Peritoneal (SBH)	
Ertapenem	Consultation (CIVP[c] only)		
Fluconazole IV	Consultation		
Ganciclovir IV	Consultation	under protocol	
Linezolid	Consultation		**Yes**
Meropenem	Consultation		
Piperacillin-Tazobactam	Consultation		
Daptomycin	Consultation		**Yes**
Voriconazole	Consultation		**Yes**

[a] Consultation or verbal approval should be obtained from the Infectious Diseases consult service.

[b] Reviewed by the WRHA Antimicrobial Pharmacotherapy Subcommittee November 2014. Criteria for use may be obtained from a WRHA Pharmacy Department.

[c] CIVP = Community IV Program

Health Sciences Centre
Winnipeg

Health Sciences Centre Antibiogram for 2022

(Adult patients only - Based on data from 2021)

Prepared by:
Shared Health, Clinical Microbiology Discipline

For further information contact:

Andrew Walkty, MD, FRCPC
Medical Microbiologist, Health Sciences Centre/Shared Health

or

Heather J. Adam, PhD, D(ABMM), FCCM
Clinical Microbiologist, Health Sciences Centre/Shared Health

DISCLAIMERS

This guide is provided as an educational resource for physicians and other healthcare professionals caring for adult patients at the Health Sciences Centre. 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 Health Sciences Centre.
- 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.

SUGGESTED CRITERIA FOR IV TO ORAL ANTIBIOTIC CONVERSION IN ADULTS

- Clinical improvement of infectious signs and symptoms (e.g., temperature defervescence, decreased white blood cell count).
- Patient is clinically stable (excludes patients in the intensive care unit, patients with febrile neutropenia, or patients with life threatening infections).
- Patient can tolerate oral feeding and medications (bowel sounds, no diarrhea/nausea/vomiting).
- For rapid step-down, choose agents with high bioavailability (e.g., clindamycin, cotrimoxazole (TMP-SMX), fluoroquinolones).
- If anti-infective agent susceptibilities are known, anti-infective therapy should be tailored based on available data.

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	Ciprofloxacin	Trimethoprim-Sulfamethoxazole	Nitrofurantoin[c]
Acinetobacter baumannii complex (35)			89				57	77		n.d.	100	97	94	100	
Citrobacter spp. (65)			75				68	66	98	98	85	92	72	82	94
Enterobacter cloacae complex (218)			80				70	72	94	97	94	93	87	81	34
Escherichia coli (348) systemic	41	79	93	55			80	85	100	100	91	90	61	67	
Escherichia coli (828) urine	45	81	96	56	n.d.		82	89	100	100	92	91	59	64	96
Haemophilus influenzae (75)[d]	65	n.d.				97								64	
Klebsiella aerogenes (35)			71				71	74	100	100	100	100	97	100	3
Klebsiella pneumoniae (296)		87	92	79	n.d.		88	87	99	99	93	92	82	83	25
Klebsiella/Raoultella spp. (125)[e]		89	92	24			92	99	100	100	98	98	90	90	79
Morganella morganii (51)			100				94	84	100	100	92	96	75	82	
Proteus mirabilis (85)	81	96	100	n.d.	n.d.		100	100	100	100	94	96	92	85	
Pseudomonas aeruginosa (419)			90					87		89	96	99	82		
Serratia marcescens (80)			98				93	99	99	99	98	96	81	98	
Stenotrophomonas maltophilia (118)														98	

[a] Isolates tested and reported are from all sources combined, Jan 1 to Dec 31, 2021 with the exception of *Escherichia coli* (subdivided into systemic isolates and urine isolates); 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, Jan 1 to Dec 31, 2017. Sixty-one isolates were tested for Cefuroxime and 69 isolates were tested for Trimethoprim-Sulfamethoxazole. Data from adult and pediatric patients.
[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	Tetracycline	Nitrofurantoin[f]
Enterococcus faecalis (235)		100		98	100	85	91					98		99
Enterococcus faecium (119)		11		30	n.d.	85	89					87		n.d.
Staphylococcus aureus (1790)			64	100	100			53	73	99	99	100	96	96
Staphylococcus epidermidis (304)			31	100	100			33	56	65	99	100	87	99
Staphylococcus haemolyticus (39)			13	100	100			13	28	33	59	100	87	100
Staphylococcus hominis (39)			54	100	100			26	54	72	100	100	87	98
Staphylococcus lugdunensis (166)			89	100	100			83	85	99	100	100	93	99
Coagulase-negative staphylococci (35)			70	100	100			40	62	80	100	100	97	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) with the exception of *Enterococcus faecalis* and *Enterococcus faecium* (systemic isolates only), 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* 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 faecalis* or *Enterococcus faecium*.
[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	Levofloxacin	Clarithromycin	Doxycycline	Trimethoprim-Sulfamethoxazole
Systemic Isolates (Blood + CSF)[b]								
Meningitis (180)		83	96	100				86
Non-Meningitis infection (180)	83	98	99	100	99	68	92	86
Respiratory Isolates[c]								
Non-Meningitis infection (40)	78	95	98	100	100	68	83	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. CSF = cerebrospinal fluid.
[c] Respiratory isolates were obtained from patients 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	Tetracycline	Linezolid	Daptomycin
Methicillin-Susceptible *Staphylococcus aureus* (1121)	100		99	69	72	96		
Methicillin-Resistant *Staphylococcus aureus* (657)	0	100	99	23	75	96	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. Adult oral antimicrobial dosage guidelines

Antibiotic	Usual Dosages	Cost ($) per day[a]
ANTIBACTERIAL AGENTS		
Penicillins		
amoxicillin	500 mg tid	1.10
amoxicillin-clavulanate	500 mg tid or 875 mg bid	2.75 – 3.00
cloxacillin	500 mg qid	1.50
penicillin V	300 mg qid	0.30
Cephalosporins		
cephalexin	500 mg qid	1.80
Macrolides		
azithromycin	250 – 500 mg daily	1.25 – 2.50
clarithromycin	250 – 500 mg bid	2.25 – 3.25
Fluoroquinolones		
ciprofloxacin	250 – 750 mg bid	1.40 – 2.50
levofloxacin	500 – 750 mg daily	3.50 – 6.50
moxifloxacin	400 mg daily	1.50
Others		
clindamycin	450 – 600 mg tid	1.50 – 3.00
cotrimoxazole (TMP-SMX)	1 DS (double strength) tab bid	0.25
doxycycline	100 mg bid	1.30
nitrofurantoin (Macrobid®)	100 mg bid	1.50
metronidazole	500 mg tid	0.35
ANTIFUNGAL AGENTS		
fluconazole	100 – 400 mg daily	5.55 – 22.20
itraconazole	200 – 400 mg daily	8.00 – 16.00
ANTIVIRAL AGENTS		
acyclovir	200 – 800 mg 5x/day	5.00 – 16.00
valacyclovir	1 g tid	5.25

[a] Approximate cost per inpatient day excluding dispensing costs as of February 2017 based on the Manitoba Drug Interchangeability Formulary and Manufacturer's List Prices. Prices have been rounded.