

## Example Practice-Level Antibiotic Drug Tiers and Selection List for Companion Animals

This document can be used as a reference for selection of antibiotics based on available veterinary guidelines and antibiotic importance in human medicine.

Clinic-Defined Classification	Antibiotic Drugs – Small Animals	Antibiotic Drugs – Equine
<p><b>First-line*</b> <b>(EMPIRICAL USE)</b> <i>Antibiotics that can be used to treat a range of common infections. Adherence to prescribing guidelines is recommended.</i></p>	<p>Penicillin, amoxicillin, ampicillin Metronidazole Amoxicillin-clavulanic acid Ampicillin-sulbactam Cephalexin, cefazolin, ceftioxin Doxycycline, minocycline (second-line for skin infections) Tylosin, clindamycin (second-line for skin - see note) Trimethoprim-sulfamethoxazole Topicals (excluding mupirocin and fluoroquinolone-containing)</p>	<p>Penicillin, ampicillin Trimethoprim-sulfa (sulfamethoxazole; sulfadiazine) Oxytetracycline Metronidazole Ceftiofur Cefazolin Gentamicin, amikacin (reserved for serious infections) Erythromycin</p>
<p><b>Second-line**</b> <b>(CULTURE/SUSCEPTIBILITY NEEDED)</b> <i>Use should be supported by bacterial susceptibility testing. Use caution when prescribing these second-line antimicrobials to avoid development of further resistance. Adherence to prescribing guidelines is recommended.</i></p>	<p>Cefovecin, cefpodoxime, ceftazidime Enrofloxacin, orbifloxacin, marbofloxacin, pradofloxacin Erythromycin, azithromycin Gentamicin, neomycin Amikacin Rifampin Chloramphenicol Fosfomycin Mupirocin- and fluoroquinolone-containing topicals (e.g., Baytril otic, Posatex) <i>- consider consultation for drug combinations</i></p>	<p>Azithromycin, clarithromycin Doxycycline, minocycline Rifampin Enrofloxacin</p>
<p><b>Consult***</b> <b>(CULTURE/SUSCEPTIBILITY NEEDED)</b> <i>Third-line (last-resort) antimicrobials should only be used in rare situations and be prescribed according to the following criteria: 1) when supported by susceptibility testing, 2) when no other option exists, 3) when there is a reasonable chance of a cure. These drugs should be obtained only if essential for use.</i></p>	<p>Imipenem-cilastatin, meropenem Ciprofloxacin (see note) Tigecycline Piperacillin-tazobactam Nitrofurantoin</p>	<p>Chloramphenicol Imipenem</p>
<p><b>Avoid****</b> <i>Drugs that should not be used, as they are reserved as last-line therapy for human infections.</i></p>	<p>Vancomycin Linezolid Teicoplanin Colistin, polymyxin B</p>	<p>Vancomycin</p>

\* This tiered prescribing guidance is intended to help reduce the risk of multidrug-resistant bacterial organisms. While bacterial culture and susceptibility is strongly encouraged, first-line antimicrobials can be considered for empiric prescribing. For conditions in which guidelines are available, adherence to these guidelines is recommended (see [arsi.umn.edu](http://arsi.umn.edu) for link to guidelines and other resources). Some exceptions exist. For example **tetracyclines** should be avoided as first-line agents for skin infections--bacterial culture and susceptibility is recommended. Similarly, for *Staphylococcus spp.* skin infections, bacterial culture and susceptibility testing should be performed prior to **clindamycin** use; use of clindamycin should be reserved for infections resistant to cephalexin and where susceptibility is confirmed for erythromycin (*Staphylococcus spp.* resistance to erythromycin indicates inducible resistance to clindamycin).

\*\* **Third-generation cephalosporins** and **fluoroquinolones**, though commonly used in companion animals, should be used cautiously, due to the risk of multidrug resistance. Third-generation cephalosporins can drive development of extended-spectrum beta-lactamase producing bacteria (ESBLs) that in addition to being resistant to all penicillins and cephalosporins, are often resistant to other classes of antimicrobials through genetic linkage to other resistance mechanisms.<sup>1</sup> ESBL-producing *E.coli* have been implicated in veterinary hospital-acquired infections including catheter-associated infections and surgical site infections.<sup>2,3</sup> Fluoroquinolone-resistance often also confers resistance to additional drug classes, as genes that cause fluoroquinolone resistance are often on the same plasmids as ESBL genes.<sup>4</sup> Therefore, fluoroquinolones should only be used when no other efficacious safe and less broad spectrum antibiotics are options. **Mupirocin** should be reserved for culture-confirmed methicillin-resistant *Staphylococcus* skin infections. There is no current guidance for other topical therapies, though given the concern for bacterial resistance to fluoroquinolones, gentamicin containing topicals could be considered first line therapy unless specific contraindications exist for a particular patient. See reference #5 below for treatment recommendations for otitis in dogs.<sup>5</sup>

\*\*\* Drugs in the **consult** category are used as last-line drugs for resistant infections in humans. Use of drugs listed under the **consult** category should fulfill the criteria outlined by ISCAID; they should be reserved for use in patients in which no alternative antibiotic choices exist and there is a reasonable chance of a cure.<sup>6</sup> Their use should be guided by consultation with an expert in infectious disease or pharmacy. **Ciprofloxacin** should be avoided, as bioavailability in dogs is low and unlikely to achieve efficacious serum levels.<sup>7</sup>

\*\*\*\* Drugs in the **avoid** category should be avoided as they are reserved as last-line drugs for life-threatening resistant infections in human medicine and alternatives exist for use in veterinary medicine for most situations.

## References

1. Pitout JD. Infections with extended-spectrum beta-lactamase-producing enterobacteriaceae: changing epidemiology and drug treatment choices. *Drugs* 2010;70(3):313–33.
2. Sanchez S, McCrackin Stevenson MA, Hudson CR, et al. Characterization of multidrug-resistant Escherichia coli isolates associated with nosocomial infections in dogs. *J Clin Microbiol* 2002;40(10):3586–95.
3. Sidjabat HE, Townsend KM, Lorentzen M, et al. Emergence and spread of two distinct clonal groups of multidrug-resistant Escherichia coli in a veterinary teaching hospital in Australia. *J Med Microbiol* 2006;55(Pt 8):1125–34.
4. García-Fulgueiras V, Bado I, Mota MI, et al. Extended-spectrum  $\beta$ -lactamases and plasmid-mediated quinolone resistance in enterobacterial clinical isolates in the paediatric hospital of Uruguay. *J Antimicrob Chemother.* 2011;66(8):1725–1729.
5. Koch S. The Challenge of Chronic Otitis in Dogs: from diagnosis to treatment. *Today's Veterinary Practice.* <https://todaysveterinarypractice.com/the-challenge-chronic-otitis-dogs-diagnosis-treatment/>
6. Weese JS, Blondeau JM, Boothe D, Breitschwerdt EB, Guardabassi L, Hillier A, Lloyd DH, Papich MG, Rankin SC, Turnidge JD, Sykes JE. Antimicrobial use guidelines for treatment of urinary tract disease in dogs and cats: antimicrobial guidelines working group of the international society for companion animal infectious diseases. *Vet Med Int.* 2011;2011:263768. doi: 10.4061/2011/263768. Epub 2011 Jun 27. PMID: 21776346; PMCID: PMC3134992.
7. Papich MG. Ciprofloxacin Pharmacokinetics in Clinical Canine Patients. *J Vet Intern Med.* 2017;31(5):1508-1513. doi:10.1111/jvim.14788.

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