27
PHARMACEUTICALS AND FORMULARIES

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Introduction

This chapter aims to provide clinicians and scientists working with marine mammals with a convenient and rapidly accessible single source on the subject. A compilation of the available pharmacological information on cetaceans, pinnipeds, sirenians, sea otters (*Enhydra lutris*), and polar bears (*Ursus maritimus*) is provided. Readers must be aware at all times that drugs discussed in this chapter may have only been used on a limited number of individual animals from a narrow range of species, so all information must be interpreted with caution. No drugs have been licensed for use in marine mammals.

The authors have relied heavily on published documentation, which is included relatively uncritically, but they have also included unpublished information from clinicians and institutions with experience with some of the less frequently encountered species. Even so, numerous gaps remain. Most of the drug regimens included have been supported by documented clinical response, although only rarely have detailed pharmacokinetic studies been published (**Table 27.1**). Clinicians should be aware that undocumented effects may still occur when these drugs are used on larger numbers of individuals.

The tabular format was selected for the convenience of clinicians needing information quickly. There are advantages and limitations to this presentation. The primary advantage is accessibility. The primary weakness is the limited amount of information presented with each entry. The tables are not intended to replace a background in clinical veterinary medicine and pharmacology. Readers are directed to individual references for further information and are cautioned to read, understand, and discuss with colleagues the pharmacological properties of the drugs they intend to administer to a marine mammal, even though dose

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Table 27.1 Drugs for which Pharmacokinetics Studies Have Been Undertaken in Marine Mammal Species

Drug	Dosage	Species/Comments	References
Amikacin	10 mg/kg IM BID	*Orcinus orca*	KuKanich et al. 2004
	13 mg/kg IM Q24h	*Delphinapterus leucas*	KuKanich et al. 2004
Aminocaproic acid	100 mg/kg PO	*Mirounga angustirostris*	Kaye et al. 2016
Amoxicillin	20 mg/kg IV once	*Mirounga angustirostris*	Gulland et al. 2000
	20 mg/kg IV once	*Phoca vitulina*	Gulland et al. 2000
Buprenorphine	0.12 mg/kg SC Q72h	*Mirounga angustirostris*	Molter et al. 2015
Cefovecin	1–2 mg/kg SC, IM once	*Otaria flavesecens*	Garcia Parraga et al. 2016
	2 mg/kg IM once	*Odobenus rosmarus*	Garcia-Parraga, unpubl. data
	4 mg/kg SC once	*Zalophus californianus*	Garcia-Parraga, unpubl. data
	4 mg/kg SC once	*Phoca vitulina*	Garcia-Parraga, unpubl. data
	8 mg/kg SC once	*Halichoerus grypus*	Garcia-Parraga, unpubl. data
	8 mg/kg IM once	*Tursiops truncatus*	Garcia Parraga et al. 2012
	8 mg/kg SC Q5-7d	*Enhydra lutris*	Lee et al. 2016
Ceftazidime	17.4 mg/kg IM once	*Tursiops truncatus*	Chow et al. 1992
Ceftiofur	6.6 mg/kg IM Q5d	*Zalophus californianus*	Meegan et al. 2013
Ciprofloxacin	10 mg/kg PO Q24h	*Zalophus californianus*	Barbosa et al. 2015
Doxycycline	10–20 mg/kg PO Q24h	*Mirounga angustirostris*	Freeman et al. 2013
Enrofloxacin	5 mg/kg PO once	*Tursiops truncatus*	Linnehan, Ulrich, and Ridgway 1999
Marbofloxacin	5 mg/kg PO once	*Phoca vitulina*	KuKanich et al. 2007
Meloxicam	0.1 mg/kg PO Q7d	*Tursiops truncatus*	Simeone et al. 2014
Tramadol	2–4 mg/kg PO Q6-12h	*Zalophus californianus*	Boonstra et al. 2015
Vitamin A	300–600 IU/day PO	*Callorhinus ursinus*	Mazzaro et al. 1995a, 1995b

regimens appear in the tables (Benet et al. 1996; Riviere 2011). Dosages and adverse effects of anesthetic agents are discussed in **Chapter 26**. Always be cautious when administering drugs or drug combinations for the first time in a marine mammal. If the decision is made to adopt a novel treatment regime, only one animal should be treated and then observed for an appropriate time to ascertain whether adverse reactions occur. Certain drug effects, such as sedation from opioids, may be dramatic in marine species. Sea otters, for example, may have difficulty in the water after receiving butorphanol or buprenorphine (Monterey Bay Aquarium Pharmacopeia). Finally, always check with colleagues working with marine mammals before using an unfamiliar drug, as they may be aware of adverse reactions that have not been reported.

Routes for Administering Drugs to Marine Mammals

Essentially all of the routes used to deliver drugs to domestic animals are available for delivering drugs to marine mammals. Practical considerations, however, frequently limit the choice of routes in a clinical situation, and anatomical adaptations can make delivery by some routes particularly challenging. Details of choice of route are discussed in each species medicine chapter (see **Chapters 40 through 45**), but some precautions to take are given below.

From a practical standpoint, oral (PO) administration of drugs is often the preferred route in an animal still taking feed regularly or being tube-fed routinely for nutritional support. Few special caveats for oral administration of drugs to marine mammals have been discovered, and a good knowledge of human or domestic animal pharmacology provides excellent guidance for the appropriate selection of this route. The major considerations are food interactions and factors that might affect absorption. These factors include specific physiochemical properties of the drug, stomach pH, gastrointestinal microflora, and anatomy (Riviere 2011). For example, phosphorus binders are commonly used in California sea lions (*Zaophus californianus*) to treat renal disease associated with leptospirosis, as is tetracycline, yet the absorption of this antibiotic will be reduced by chelating agents (Gulland 1999). Palatability issues may make PO administration difficult with some drugs that have a strong taste or smell. This is of particular importance in sea otters, for which PO administration of certain drugs like enrofloxacin is a great challenge.

Subcutaneous (SC) administration may be technically difficult because of the blubber layer in some phocids, walrus (*Odobenus rosmarus*), and most cetaceans, but can be effective in sea otters and otariids. Prior to the development of the thick blubber layer, young pinnipeds, especially neonates, can also adequately absorb even lipophilic medications

delivered by this route, which avoids muscle trauma or necrosis. Although subcutaneous administration of fluids is often avoided in cetaceans, experienced clinicians have successfully administered higher volumes of fluids to these animals by this route by ensuring that the fluids are given between the blubber and muscle layers (see **Chapter 40**). Long-acting depot injections using poloxamer gels or other long-acting formulations have been successful in treating localized infections via both subcutaneous and subconjunctival routes (Simeone et al. 2016, 2017). Abscesses have been reported in pinnipeds, in particular with long-acting drugs such as extended-release buprenorphine (Molter et al. 2015).

Intramuscular (IM) administration is frequently utilized in marine mammals that are difficult to restrain and are inappetent. Be cautious and avoid superficial injection into the extensive subcutaneous blubber, which has dramatically different vascularization and drug-partitioning properties than does muscle (Fowler 1995; Nielsen 1996). Accidental delivery into the blubber can result in failure to achieve any appreciable systemic distribution of highly lipid-soluble medications. Certain drugs, such as diazepam, have inconsistent absorption via the IM route (Hung et al. 1996). The irritation caused by some injectable drugs is a local effect. This may be due to the irritating nature of the drug or the volume of injection. The recommended total volume injected per site does not increase in scale with the mass of the animal. Very large marine mammals may require large volumes of drug. The drug volume per injection site should be reasonable, and multiple injection sites may be necessary with larger volumes. Care should also be taken to have injection sites as dry as possible, free of any gross contamination prior to any injection, and always using sterile needles. This is particularly important when injecting anthelminthic and non-antibiotics of any kind. However, clinicians should be aware that sterile or even infected abscesses can occur when injecting traditional antibiotics if care is not taken to avoid contaminating the needle.

Many venipuncture approaches (IV) are nearly perpendicular to the blood vessel and quite deep, thus complicating catheterization. Wire-reinforced epidural catheters can be used to catheterize the epidural sinus in phocids. Needles with side ports for directing a catheter at right angles can help avoid perivascular leakage of irritating drugs. Administration of IV drugs into the peri-arterial venous rete of the peduncle in a cetacean holds a risk of injection into the surrounding arteries, so IV medications should be diluted and administered slowly. Signs of nausea are reported with IV drug administration and often resolve after slowing the rate of administration.

Nonirritating drugs can often be delivered intraperitoneally (IP). The difficulties of this route are generally related to the size of the patient and the availability of needles suitable to penetrate the abdominal wall. Placing a flexible catheter through a cannula for intraperitoneal administration avoids the problem of accidental organ laceration with a rigid needle. In species like otariids for which vascular access and IV catheter maintenance is a challenge, IP administration of medications like dextrose is a viable option, particularly during a medical crisis (Fravel et al. 2016). Sterility is of great importance to avoid introducing microorganisms into the peritoneal cavity.

Intratracheal (IT) and inhalation (IH) administration of drugs have been employed in marine mammals, primarily for induction of anesthesia and targeted delivery of medications to the lungs (see **Chapter 26**). Nebulization and aerosolization can be used very effectively, either by holding a mask on a restrained animal or by placing it in a nebulization chamber, if drug delivery times are elongated to accommodate an animal's tendency to hold its breath. The efficacy of aerosol absorption in the lungs depends largely on the particle or droplet size, and should be taken into consideration when choosing a drug and method for nebulization.

The major challenge with topical administration in marine mammals is to achieve appropriate contact time for drug efficacy in an aquatic environment. Baths and dips are possible for some of the smaller species, and behavioral modification can augment dipping body parts into smaller containers for large species. However, the most desirable application in some cases would be an ointment or salve that would remain in place; thus, ointments for marine mammals are often specially compounded. The use of human dental bases has had some success, but can be prohibitively expensive. Less expensive lipid bases such as lanolin and petroleum gels have been used with varying success.

Dose Scaling

Extrapolation of doses and pharmacokinetic parameters across species is often necessary, as pharmacological data for drugs in most species of marine mammal do not exist (Riviere 2011). Even for drugs that have been studied in marine mammals, sample sizes are often small, and consideration of covariates such as body weight, enzymatic composition, and genetics is necessary to give a full picture of allometric relationships (Riviere 2011). Allometric equations usually compare parameters of interest (e.g., half-life, volume of distribution, clearance) to body weight (Riviere 2011), and a dizzying array of exponential equations can be found in the literature. Choosing which equation to use can be daunting. The reader should be cautioned that not all drugs scale well by body mass, even when theoretical metabolic rates are figured into the equation (see **Chapter 29**). It is important to know the expected metabolism and excretion routes of the drug when making decisions on scaling a dose between species. Studies on species of phocids of different size suggest that effective doses based on body weight, rather than on a complex allometric equation, may not be that unreasonable for some drugs (Gulland et al. 2000; Barbosa et al. 2015; Boonstra et al. 2015). **Table 27.1** shows the limited number of studies that have explored pharmacokinetic parameters for drugs in marine mammals.

Drug Interactions and Adverse Effects

When new combinations are considered, it is best if there has been some experience with the drugs individually in the species. If not, the consideration should be made to administer one drug at a time in an individual animal. It is not feasible to present a comprehensive list of all possible drug interactions in marine mammals in this chapter. The reader should be prepared for the possibility of any drug interaction described in any species occurring. However, it is particularly important to be aware of some of the potential interactions of more commonly used medications. At present, little documentation exists concerning drug interactions in marine mammals, and the majority of these reports are intuitive from knowledge of terrestrial animal pharmacology. Texts on veterinary and human pharmacology should be consulted, and discussions with colleagues undertaken, when planning a mixed medication treatment for any marine mammal.

Life-Threatening Adverse Reactions

Several drugs have been associated with fatal reactions. While causation is difficult to prove in an isolated case, clinicians should be aware that administration of certain drugs has been associated with potentially lethal effects in marine mammals. Additional severe reactions are discussed in the sections that follow. In the tables, these drugs are accompanied by the symbol:

(☠): SEE TEXT—POTENTIAL LETHAL REACTIONS

Trimethoprim-sulfadiazine, carprofen, cefovecin, and iohexol have been associated with sudden death within close temporal association of drug administration. Trimethoprim-sulfadiazine has been associated with anaphylaxis in a bottlenose dolphin (*Tursiops truncatus*), and fatal bone marrow suppression and pancytopenia in bottlenose dolphins and a killer whale (*Orcinus orca*; SeaWorld Pharmacopeia). Additionally, a bottlenose dolphin died within 15 minutes of parenteral administration of carprofen (Martelli, unpubl. data). A white-beaked dolphin (*Lagenorhyncus albirostris*) died shortly after IM administration of cefovecin and had lesions consistent with shock on necropsy (Nollens, unpubl. data). This drug has been associated with anaphylaxis in terrestrial species. A California sea lion experienced cardiorespiratory arrest immediately following iohexol administration, and the death was attributed to iohexol (Dennison, Gulland, and Braselton 2010).

Haloperidol has been associated with fatal neuroleptic malignant seizures in a harbor seal (*Phoca vitulina*), walrus, and Pacific white-sided dolphin (*Lagenorhynchus obliquidens*; SeaWorld Pharmacopeia). Two fatalities in belugas (*Delphinapterus leucas*) occurred after intramuscular administration of levamisole (Boehm, unpubl. data). Both whales were treated with levamisole; only one was treated concomitantly with ivermectin. Fatalities occurring in both animals strongly suggested that levamisole alone was the cause of the mortalities. Levamisole has also been associated with toxicity in sea otters (Kollias and Fernandez-Moran 2015).

Several drugs that were listed in previous editions of this chapter have been associated with severe adverse effects in humans or other species, and may have been removed from markets in various countries. The doses remain on this list, so clinicians are aware that they have been used in marine mammals, but the authors strongly suggest that all drugs are researched prior to use, as this list is not exhaustive. Organophosphate toxicity has been reported with dichlorvos use. Potent photosensitization effects have been reported with bithionol. Dihydrostreptomycin has been associated with ototoxicity in humans. Disophenol has a narrow safety range and has been associated with fatalities in humans. Thromboembolism has been reported with thiacetarcemide use. Hetacillin has been found to form formaldehyde in the gut in humans and has no documented benefit over ampicillin (Jusko and Lewis 1973).

Hepatic Effects

Evaluation of a patient's clinical response to therapy is vital throughout a course of therapy, to determine whether the treatment is having a therapeutic effect, and to ensure that no adverse effects are occurring. Several drugs have been associated with elevations in hepatic enzymes. In marine mammals, reversible elevations in transaminases have been reported with the azole antifungals, as well as ceftriaxone, florfenicol, and azithromycin (Dalton, Robeck, and Campbell 1995; Reidarson and McBain 1995; Dalton and Robeck 1998; Romanov, Chelysheva, and Romanova 2011; Levine, unpubl. data). Azole antifungal use, in particular itraconazole, ketoconazole, or fluconazole in bottlenose dolphins, has led to mild and reversible liver pathology and 2- to 25-fold increases in aspartate aminotransferase (AST), alanine transaminase (ALT), and lactate dehydrogenase (LDH) concentrations (Reidarson and McBain 1994; Reidarson et al. 1998). Itraconazole has also been associated with hypocholesterolemia in a pilot whale (*Globicephala* sp.; SeaWorld Pharmacopeia).

Irreversible hepatotoxicity has been associated with voriconazole and ketoconazole in cetaceans (Schroeder 1983; SeaWorld Pharmacopeia). Voriconazole, in particular, has the potential for severe hepatic, cardiac, and neurological effects. Frequent monitoring of drug peak and trough levels and hepatic enzymes is strongly recommended when administering these drugs, and dosing should be adjusted as needed.

Flucytosine should be administered in a combination therapy with an azole to prevent resistance to flucytosine (Reidarson et al. 1999). Premature cessation of the azole may lead to flucytosine resistance (Poelma et al. 1974). Both drugs should be administered beyond the elimination of infection,

as determined by physical examination, cytology, cultures, radiology, and endoscopy (Reidarson et al. 1999).

Renal Effects

Several drugs have the potential to be directly nephrotoxic (gentamicin, amikacin, sulfonamides). Amikacin has been associated with renal tubular necrosis in a bottlenose dolphin (SeaWorld Pharmacopeia). Significant toxicity has been reported in sea otters with gentamicin in particular, particularly with repeated doses. Acute renal failure has been reported with amphotericin B and liposomal nystatin in a bottlenose dolphin and Pacific white-sided dolphin (Robeck and Dalton 2002). Some drugs, such as nonsteroidal anti-inflammatory drugs (NSAIDs), may cause hemodynamically mediated renal impairment and should be used cautiously in dehydrated patients or those with renal dysfunction.

Other drugs whose primary route of excretion is through the urinary tract, such as most cephalosporins or fluconazole, should be used with caution in patients with renal compromise or dehydration, as clearance in the urine may be reduced and dose may need to be adjusted. Platelet dysfunction and CNS signs have been noted with use of ticarcillin in humans with concurrent renal disease due to reduced drug clearance. Cephalosporins and aminoglycosides are frequently administered to marine mammals. Clinicians should be aware that concurrent administration of aminoglycosides and cephalosporins increases the risk of renal toxicity because the renal effects of these drug groups are additive. Concurrent administration of aminoglycosides and flunixin meglumine has also been linked to renal papillary necrosis in a pilot whale (McBain, pers. comm.). Aminoglycosides and flunixin meglumine may be contraindicated in cases of toxemia because they both have antiprostaglandin activity. The nephrotoxicity of gentamicin, as well as of cephalosporins, is also exacerbated with concurrent furosemide administration. Additionally, furosemide diuresis results in increased renal loss of thiamine and pyridoxine, which can be important in situations where nutrition or oral supplementation is marginal. Administration of aminoglycosides, such as amikacin, in a single daily dose increases bactericidal activity and post-antibiotic effect, allows more rapid attainment of high serum concentrations, and decreases risk of nephrotoxicity compared with administering multiple lower doses each day (Townsend, Materese, and Sips 1996; Riviere 2011).

Leptospirosis causes acute renal failure and therapy typically includes antibiotics in the penicillin and tetracycline families. A study in California sea lions showed that although clinical evidence of renal failure resolved, leptospiruria persisted after treatment with penicillin, amoxicillin, doxycycline, or oxytetracycle (Prager et al. 2015). Longer courses of therapy may be required to clear carriers.

The increased potassium loss in the urine caused by furosemide administration may be exacerbated by concurrent steroid administration. This is particularly a problem if sodium intake is high, as is often the case in marine mammals being fed with supplemental salt in the diet. If a diuretic is indicated in a marine mammal receiving steroid therapy, alternatives to furosemide should be considered.

Gastrointestinal Effects

Gastrointestinal (GI) effects are exceedingly common, particularly with oral drug administration. Anorexia and GI discomfort are most commonly reported with antibiotic use. Aminoglycosides, cephalosporins, fluoroquinolones, macrolides, penicillins, sulfonamides, and tetracyclines have reported GI effects in marine mammals (Sweeney 1986a; SeaWorld Pharmacopeia; TMMC Pharmacopeia). Azole antifungals are frequently associated with GI upset and inappetence, and aminophylline and leuprolide have similar reports. Fluconazole is considered less likely to cause inappetence than ketoconazole or itraconazole, when administered to bottlenose dolphins (Reidarson et al. 1999). If inappetence occurs as a result of itraconazole administration, appetite may return by reducing the dose. Some clinicians advocate concomitant administration of prednisolone with ketoconazole to reduce the impact of inappetence.

Constipation has been noted in both cetaceans and pinnipeds with ferrous sulfate, sucralfate, and tramadol use, and diarrhea has been noted during treatment with tylosin (Thurman and Windsor 1984; SeaWorld Pharmacopeia; TMMC Pharmacopeia). In addition to GI discomfort, a range of GI signs from ulcers to gastritis and enteritis are reported with aspirin, steroids, and NSAIDs. As with terrestrial species, steroids and NSAIDs should not be combined, and they have been associated with fatal perforation of the connecting channel in several cetaceans (Van Bonn 2002).

Clinicians may utilize drugs that have secondary effects on the GI tract, and must be aware of the potential for adverse effects. For instance, prostaglandin F_2 alpha works on the smooth muscle of the uterus, but has GI, musculoskeletal, and cardiac effects, in addition to its intended target.

Nervous System Effects

Transient neurologic signs have been reported in odontocetes with ivermectin use (Townsend 1999). Tremors have been noted with ivermectin in Guadalupe fur seals (*Arctocephalus townsendii*; TMMC Pharmacopeia). Seizures and visual deficits were noted in a California sea lion receiving voriconazole, which was also associated with hepatotoxicity (Field, Tuttle, and Sidor 2012). Enrofloxacin administration has also been associated with neurologic signs and muscle fasciculations in bottlenose dolphins and rough-toothed dolphins (*Steno bredanensis*; SeaWorld Pharmacopeia; Staggs, unpubl. data). Tremors of the flukes have been noted with chronic

parenteral amikacin therapy in bottlenose dolphins, killer whales, and belugas (SeaWorld Pharmacopeia). The etiology of this effect is unknown.

Dermal Effects

Hypersensitivity reactions characterized by ulcerations of the mucocutaneous junctions have been reported with trimethoprim-sulfadiazine use in a beluga (Schmitt, Nollens, and McBain 2013). Minocycline has been associated with hyperpigmentation in a killer whale (SeaWorld Pharmacopeia). Enrofloxacin has been reported to be associated with photosensitivity in bottlenose dolphins for 4–8 weeks following cessation of treatment (Levine, unpubl. data). While photosensitization has not been reported with bithionol use in marine mammals, the drug has potent photosensitization effects in humans.

Otic Effects

Amikacin has been reported to cause hearing loss in belugas, and it is known to be toxic to cochlear hair cells (Finneran et al. 2005). Furosemide may also increase the ototoxicity of gentamicin. Ototoxicity has not been reported in marine mammals, but dihydrostreptomycin has been associated with ototoxicity in humans.

Hematologic Effects

A variety of adverse effects have been noted with sulfonamide use in cetaceans. In addition to the dermal and GI effects noted above, hematologic effects have also been reported. A moderate reaction is characterized by neutrophilia (Cornell 1978). A severe reaction noted in belugas, killer whales, and bottlenose dolphins includes both neutropenia and thrombocytopenia (SeaWorld Pharmacopeia). Anemia and leukopenia has been noted with linezolid in combination with sulfonamides in a killer whale (SeaWorld Pharmacopeia). The exceptionally long half-life of some sulfonamides in cetaceans is likely a contributing factor in producing adverse reactions. Sulfamethoxazole was found to have a half-life of 5.3 to 7.2 days in killer whales (McBain 1984). This extremely long half-life has not been noted in other sulfa drugs, but the possibility that other sulfas may also have prolonged excretion times must be considered. Trimethoprim-sulfamethoxazole has been associated with severe bone marrow suppression and death in several cetaceans (SeaWorld Pharmacopeia). Most of the cases of adverse reactions to sulfas have occurred with sulfa-trimethoprim combination drugs. Though the mechanisms of these reactions are not well studied, many clinicians suspect sulfa drugs to be the culprits when reactions occur. Folic acid should be administered to any cetaceans receiving sulfa-trimethoprim combination drugs to mitigate the risk of a drug-induced deficiency of the vitamin.

Ferrous sulfate can be used to treat severe anemia or low serum iron, or when hand-raising a neonate cetacean. Clinicians should monitor for iron overload during therapy (Staggs and Townsend, pers. comm.; see **Chapter 40**).

Musculoskeletal Effects

Certain drugs, including ceftriaxone, ceftiofur, imipenem, leuprolide, and ondansetron, are associated with pain and irritation at the site of injection (Calle et al. 1997, 1999; Townsend 1999; SeaWorld Pharmacopeia; TMMC Pharmacopeia). Abscesses have been reported with IM ampicillin/sulbactam, ceftiofur, enrofloxacin, and praziquantel use in pinnipeds, and muscle necrosis has been associated with tetracycline and enrofloxacin injections in sea otters (Gobush, Baker, and Gulland 2011; Innis, unpubl. data; Monterey Bay Pharmacopeia; TMMC Pharmacopeia). Florfenicol has been shown to cause an increase in aspartate transaminase (AST) and lactate dehydrogenase (LDH) due to muscle trauma at injection sites in bottlenose dolphins and belugas (Dalton and Robeck 1998).

Fluoroquinolones have been reported to cause cartilage damage in weight-bearing joints of young, rapidly growing animals (Burkhardt, Hill, and Carlton, 1990; Burkhardt 1996; Burkhardt, Walterspiel, and Schaad 1997; Yoshida et al. 1998). Fluoroquinolones inhibit cell proliferation and induce morphological changes in tendon cells (Yoon et al. 2004). The clinical responses of marine mammals to fluoroquinolone treatments have often been favorable, so they are often the broad-spectrum antibiotic of choice for many experienced clinicians in treating neonatal marine mammals suffering from severe infections of unknown origin. However, it is still wise to use caution when administering fluoroquinolones to juvenile marine mammals, and these patients should be carefully monitored for any signs that might be attributable to joint pain.

Antiulcer Medications

The use of antacids, histamine receptor (H2) blockers, proton-pump inhibitors, and gastroprotectants in the treatment of gastric ulcers is routine. Several important drug interactions can be expected with concurrent use of these compounds, based on knowledge gained in human medicine. Simultaneous administration of antacids with H2 blockers will significantly decrease the absorption and effectiveness of these drugs. To avoid this complication, administering either antacids or H2 blockers at least 1 hour prior to the other will allow adequate absorption. The use of antacids may alter stomach pH, to the point that requirements for dissolution

and subsequent absorption of drugs are not met. To maximize absorption, steroids, azoles, tetracyclines, and iron should be administered at least 2 to 3 hours before or after administration of antiulcer medications. Antacids with di- and trivalent cations also decrease the absorption of oral steroids, such as prednisolone and dexamethasone. In fact, the presence of multivalent cations such as calcium, magnesium, iron, and zinc from either other medications or ingesta in the stomach can decrease absorption of tetracyclines, fluoroquinolones, and sulfonamides.

McBain (1985) has documented a negative impact of cimetidine on absorption of tetracycline from the stomach in killer whales. Either these two drugs should be administered concurrently or the tetracycline should be administered first. Cimetidine and ranitidine can also impair metabolism of certain drugs such as benzodiazepines in terrestrial mammals by inhibiting the cytochrome P450 pathway. Famotidine does not inhibit this pathway.

A common problem encountered in cetaceans administered with antiulcer medications is vomiting, when the gastric pH becomes too high to demineralize and digest fish bones. These bones can be seen in the vomitus or via endoscopy. Prolonged administration (i.e., for weeks) of these medications in pinnipeds can also cause an impaction of fish bones within the stomach. Changes in pH are more pronounced with proton pump inhibitors than antacids or H2 blockers. Normally, the acidic pH of the stomach will demineralize and digest fish bones within 30 minutes. During antiulcer therapy, the stomach should be frequently assessed as is feasible by closely monitoring gastric pH and motility. In addition, a necrotizing dermatitis of unknown etiology has been observed in several bottlenose dolphins receiving ranitidine (SeaWorld Pharmacopeia).

Sucralfate is a commonly administered gastroprotectant in marine mammals. It may decrease absorption of other drugs if given concurrently and may be inactivated by tetracyclines. Administration should be separated for these drugs.

Steroids

Steroid administration can have complex metabolic effects on marine mammals, particularly on electrolyte balance. Dexamethasone or prednisolone administration reduces calcium and phosphate absorption and increases the urine output of calcium and potassium in terrestrial animals. Prolonged therapy could predispose an animal to hypocalcemia. Steroids also increase circulating serum glucose, triglyceride, and cholesterol concentrations. Dexamethasone administration in bottlenose dolphins can cause neutrophilia, lymphopenia, eosinopenia, elevated insulin, depressed ACTH and cortisol concentrations, and enhanced appetite (Reidarson and McBain 1999). These changes in hematology and serum chemistry may return to normal upon cessation of steroid therapy. Supplemental vitamin D, folate, ascorbic acid, and pyridoxine may be appropriate during prolonged steroid administration, because serum content of these vitamins can be depleted. When administered in close temporal association with NSAIDs, steroids have been associated with fatal perforation of the connecting chamber in several cetaceans (Van Bonn 2002). Gradual reduction in steroids is recommended to allow the adrenal gland to resume normal function.

Rifampin stimulates microsomal enzymes that are involved in the metabolism of steroids. Therefore, administration with oral or parenteral steroids may prevent the effects of steroids. This inhibition of steroid action through increased metabolic inactivation can have long-lasting effects, even after discontinuation of rifampin therapy. Rifampin administration enhances the elimination of both exogenous and endogenous steroids, compromising the ability of an animal to maintain metabolic homeostasis. Rifampin has also been documented to cause an idiopathic thrombocyte dysfunction that can result in prolonged bleeding times (Marcus 1982; Stoskopf et al. 1987). Rifampin turns the urine a red-orange color in dolphins. This should not be misinterpreted as hematuria.

Although estrogen therapy is not common in marine mammals, the seasonal or iatrogenically induced cycling of females should be considered when evaluating steroid therapy. High estrogen levels will increase the anti-inflammatory effects of steroids by approximately 20-fold (Hansten 1985). Corticosteroids will not be metabolized properly in animals undergoing estrogen therapy (Hansten 1985). Megestrol acetate administration has been associated with adrenal cortical dysfunction in bottlenose dolphins. The effect is prominent at dosages as low as 10 mg (Houser et al. 2017).

Drug Dosages

Some published drug dosages, and dosages from institutional pharmacopeias, are listed in **Tables 27.2 through 27.6**. When reading these tables, it is important to remember that these drugs have only been used in a limited number of individuals and have not been exhaustively tested for efficacy or potential side effects. The column describing the number of animals treated was added primarily to highlight that for many published reports, the dose listed was used in a single animal. Use of the world "multiple" was employed to share that the dose had been used in more than a few animals, although the total number is unknown, and varies by drug. Drugs listed in previous editions such as diphenylhydantoin and primidone, which have largely been replaced by phenobarbital and newer anticonvulsants, remain in the tables to guide clinicians around the world that may have different access to pharmaceuticals. The tables are compiled so that readers have easy access to existing information used by practitioners.

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Table 27.2 Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Acetylsalicylic acid	3–5 mg/kg PO PRN	*Orcinus orca*	SeaWorld Pharmacopeia	Analgesia			Multiple
Aluminum/ magnesium/ simethicone	125 mg (1 tab)/70 kg TID	Cetaceans	SeaWorld Pharmacopeia	Gas relief			Multiple
Altrenogest	0.044 mg/kg PO Q24h	*Orcinus orca, Delphinapterus leucas, Lagenorhyncus obliquidens, Tursiops truncates*	Robeck et al. 2004, 2005, 2009, 2010	Estrus suppression			Multiple
Amikacin*	5.0 mg/kg IM BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	5.8 mg/kg BID	*Globicephala macrorhyncus*	SeaWorld Pharmacopeia				Multiple
	7 mg/kg IM BID	Small odontocetes	Townsend 1999				Unspecified
	7 mg/kg IM BID	*Tursiops truncatus*	SeaWorld Pharmacopeia			☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Multiple
	7.2 mg/kg IM BID	*Lagenorhyncus obliquidens*	Robeck et al. 2002		Animal died (final dx of fungal disease)		1
	7.5–12 mg/kg IM Q24h	*Orcinus orca*	SeaWorld Pharmacopeia				
	7.7 mg/kg IM BID*	*Delphinapterus leucas*	SeaWorld Pharmacopeia			☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Multiple
	8.27 mg/kg BID × 23d, followed by 15 mg/kg Q24h × 34d*	*Delphinapterus leucas*	Finneran et al. 2005	For tx of *Nocardia*	Clinical resolution	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	1
	10 mg/kg IM Q24h	*Tursiops truncatus*	Gearhart, Walsh, and Chittick 2005	Adjunct tx for *Erysipelothrix* septicemia	Clinical resolution		1
	10 mg/kg IM BID	*Orcinus orca*	KuKanich et al. 2004	For tx of gram-negative bacterial infection	Clinical resolution	✪	1
	13 mg/kg IM Q24h	*Delphinapterus leucas*	KuKanich et al. 2004	For tx of gram-negative bacterial infection	Clinical resolution	✪	1

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	12–14 mg/kg IM Q24h	*Tursiops truncatus*	Clayton et al. 2012		Animal died (final dx of *M. abscessus*)		1
	14 mg/kg IM Q24h	*Tursiops truncatus*	SeaWorld Pharmacopeia				
	14 mg/kg IM Q24h	Small odontocetes	Townsend 1999				Unspecified
	15 mg/kg IM Q24h	*Delphinapterus leucas*	Robeck, Dalton, and Young 1996	For tx of *Nocardia*	Clinical resolution		1
	15 mg/kg IM Q24h	*Tursiops truncatus*	Robeck and Dalton 2002		Animal died (final dx of fungal disease)		1
	250 mg diluted in 20 mL 0.9% saline, intralesional injection	*Tursiops truncatus*	Cassle et al. 2013	Adjunct tx for *Brucella* pulmonary abscess	Clinical resolution		1
Amoxicillin	5 mg/kg PO BID	*Orcinus orca*	Dunn, Buck, and Spotte 1982	Adjunct tx for disseminated *Candida*	Clinical resolution (with ketoconazole)	☠	1
	5–7 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	5–10 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	10 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	10.5 mg/kg PO BID	*Tursiops truncatus*	Clayton et al. 2012				1
	20 mg/kg PO Q24h × 14d	*Tursiops truncatus*	Guzman Gonzalez and Gastelum 2006	For tx of *Erysipelothrix* dermal lesions	Clinical resolution		1
	22 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
Amoxicillin/ clavulanic acid	5–7 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	5–10 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	10–22 mg/kg PO BID	*Delphinapterus leucas*	SeaWorld Pharmacopeia				Multiple
	15 mg/kg PO TID	*Kogia breviceps*	Ohishi et al. 2007				2
	15.5 mg/kg PO BID	*Delphinapterus leucas*	Choczynski and Mergl 2007	Adjunct tx for *Erysipelothrix* septicemia	Clinical resolution (with penicillin G procaine)		1

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	22.5 mg/kg PO BID	*Kogia breviceps*	Ohishi et al. 2007				
Amphotericin-B	1–2 mg/kg/d PO Q24h (liposomal)	*Tursiops truncatus*	Townsend, Materese, and Sips 1996		Animal died (final dx of zygomycosis)	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified
	1–2 mg/kg/d PO Q24h (microencapsulated), 2.5 g cumulative dose	*Tursiops truncatus*	Reidarson et al. 1999				Unspecified
	20 mg TOTAL DOSE nebulized BID with distilled water	*Tursiops truncatus*	Staggs, unpubl. data	No levels found systemically in blood			Multiple
Ampicillin	2.25 mg/kg PO BID	*Orcinus orca*	Sweeney 1985				Unspecified
	6.25 mg/kg PO BID	*Inia geoffrensis*	Bonar and Wagner 2003	Adjunct tx for *Streptococcus iniae*	Clinical resolution (with erythromycin)		1
	10 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Unspecified
Ampicillin-cloxacillin	10 mg/kg IM Q24h × 3d	*Kogia breviceps*	Ohishi et al. 2007				2
Apomorphine	CONTRAINDICATED	*Tursiops truncatus*	Ridgway 1965	CONTRAINDICATED	Causes marked excitement and does not cause vomiting	CONTRAINDICATED	Unspecified
Atropine	0.02 mg/kg IV, IM	Cetaceans	SeaWorld Pharmacopeia	EMERGENCY DOSE	c.f., **Chapter 26**		Multiple
Azithromycin	2.7 mg/kg PO loading dose, then 1.7 mg/kg PO Q24h	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	6.7 mg/kg PO loading dose, then 3.7 mg/kg PO Q24h × 10d	*Orcinus orca*, *Tursiops truncatus*, *Delphinapterus leucas*	Dalton, Roebeck, and Campbell 1995			☠	Unspecified
	9.6 mg/kg PO loading dose, then 5.2 mg/kg PO Q24h	*Tursiops truncatus*	SeaWorld Pharmacopeia			☠	Multiple
	9.6 mg/kg PO loading dose, then 5.3 mg/kg PO Q24h	Small odontocetes	Townsend 1999				Unspecified

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Bithionol	4 mg/kg PO Q3d × 5 doses		Sweeney 1986b			☠	
Carbenicillin	9.5 mg/kg PO Q6h	*Inia geoffrensis*	Bonar and Wagner 2003	Adjunct tx for *Streptococcus iniae*	Clinical resolution (with erythromycin)		1
	11 mg/kg PO BID	*Orcinus orca*	Robeck and Dalton 2002		Animal died (final dx of fungal disease)		1
	11 mg/kg PO TID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	22–44 mg/kg PO TID	Small odontocetes	SeaWorld Pharmacopeia				Multiple
	31 mg/kg PO TID	*Tursiops truncatus*	Gearhart, Walsh, and Chittick 2005	Adjunct tx for *Erysipelothrix* septicemia	Clinical resolution		1
Carprofen	100 mg TOTAL DOSE PO Q24h × 3d	*Steno bredanensis*	Staggs and Townsend, unpubl. data		GI ulcerations noted with >3d tx		Multiple
Cefadroxil	11 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	22 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	22 mg/kg PO BID	*Cephalorhyncus commersonii*	SeaWorld Pharmacopeia				Multiple
Cefdinir	3.75 mg/kg PO BID	*Orcinus orca*	Abdo et al. 2012		Animal died (final dx of fungal disease)		1
Cefepime	22 mg/kg IM BID	*Tursiops truncatus*	Romanov, Chelysheva, and Romanova 2011	Adjunct tx for MRSA	Clinical resolution (with moxifloxacin)		1
Cefixime	2 mg/kg PO BID	*Tursiops truncatus*	Clayton et al. 2012		Animal died (final dx of *M. abscessus*)		1
Cefovecin*	8 mg/kg IM once, repeat in 14 days if necessary	Cetaceans	SeaWorld Pharmacopeia		Plasma concentrations above 1.0 mcg/mL 17d in adults, 13d in neonates	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	
	8 mg/kg IM once	*Tursiops truncatus*	García-Párraga et al. 2012			✪	1
Cefpodoxime	7.5 mg/kg PO BID	*Tursiops truncatus*	Cassle et al. 2013	Adjunct tx for *Brucella* pulmonary abscess	Clinical resolution		1

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	10 mg/kg PO Q24h	*Tursiops truncatus, Delphinapterus leucas*	SeaWorld Pharmacopeia				Multiple
Ceftazidime	17.4 mg/kg IM once	*Tursiops truncatus*	Chow et al. 1992		Plasma concentrations above 1.56 mcg/mL = 8h	✪	3
	20 mg/kg IM Q24h	*Orcinus orca*	Kukanich et al. 2004	For tx of gram-negative bacterial infection	Clinical resolution		1
	20 mg/kg IM Q24h	*Orcinus orca, Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	30 mg/kg IV QID	*Tursiops aduncus*	Martelli, unpubl. data		Single IV dose stays above MIC 4mcg/mL for 6h		1
Ceftiofur	1.3–2.3 mg/kg IM once	*Megaptera novaeangliae*	Gulland et al. 2008				2
	6.6 mg/kg IM once	*Tursiops truncatus*	SeaWorld Pharmacopeia				1
	17.6 g TOTAL once	*Eubalaena glacialis*	Moore et al. 2013		Animal died of entanglement		1
Ceftriaxone	20 mg/kg IM Q24h	Small odontocetes	Townsend 1999			☠	Unspecified
	20 mg/kg IM Q24h	*Tursiops truncatus*	Gearhart et al. 2005	Adjunct tx for *Erysipelothrix* septicemia	Clinical resolution		1
	20 mg/kg IM Q24h × 2d	*Tursiops truncatus*	Meegan et al. 2012		No improvement (final dx of ureteral calculus)		1
	20 mg/kg PO Q24h	*Tursiops truncatus*, *Delphinapterus leucas*	SeaWorld Pharmacopeia				Multiple
Cefuroxime	10 mg/kg BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	20 mg/kg BID	Small odontocetes	Townsend 1999				Unspecified
	20 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	25 mg/kg BID	*Cephalorhyncus commersonii*	SeaWorld Pharmacopeia				Unspecified
Cephalexin monohydrate	10 mg/kg PO BID	*Delphinapterus leucas*	Choczynski and Mergl 2007	Adjunct tx for *Erysipelothrix* septicemia	Clinical resolution		1

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	11 mg/kg PO TID	*Orcinus orca*	Abdo et al. 2012; SeaWorld Pharmacopeia		Animal died (final dx of fungal disease)		1
	15 mg/kg PO TID	*Globicephala macrorhynchus, Delphinapterus leucas*	SeaWorld Pharmacopeia				Unspecified
	20 mg/kg PO BID × 14d	*Delphinapterus leucas*	Naples, Poll, and Berzins 2012	Adjunct tx for fusariomycosis	Clinical resolution (with voriconazole)		1
	22 mg/kg PO TID	Small odontocetes	Townsend 1999				Unspecified
	22 mg/kg PO TID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	24 mg/kg PO BID	*Tursiops truncatus*	Colgrove et al. 1975	Adjunct tx for necrotic stomatitis	Clinical resolution		Unspecified
	33 mg/kg PO TID	*Cephalorhyncus commersonii*	SeaWorld Pharmacopeia				Unspecified
Cephloridine	6.6 mg/kg IT once	*Tursiops truncatus*	Sweeney 1977				Unspecified
Chloramphenicol	22 mg/kg PO BID		Sweeney 1986a			☠	Unspecified
Chlordiazepoxide HCl	0.5 mg/kg IM		Geraci and Sweeney 1986	Anxiolytic			Unspecified
Cimetidine	4.5 mg/kg PO BID	Small odontocetes	Townsend 1999				Unspecified
	6 mg/kg PO TID		Sweeney 1986a				Unspecified
	2,100 mg TOTAL DOSE PO QID	*Orcinus orca*	Hoey, McBain, and Green 1982				Unspecified
Ciprofloxacin	4.8 mg/kg PO BID	*Tursiops truncatus*	Clayton et al. 2012		Animal died (final dx of *M. abscessus*)		1
	6 mg/kg PO BID	*Tursiops truncatus*	Dougherty and Bossart 2001	Adjunct tx for zygomycosis	Clinical resolution (with terbinafine)		7
	6–9 mg/kg PO BID	*Delphinapterus leucas*	SeaWorld Pharmacopeia				Multiple
	8 mg/kg PO BID	*Orcinus orca*	Abdo et al. 2012		Animal died (final dx of fungal disease)		1
	10 mg/kg PO BID	*Steno bredanensis*	Staggs, unpubl. data				Multiple
	8–12 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	13.3 mg/kg PO BID	*Kogia breviceps*	Ohishi et al. 2007				2
	15–29 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	20 mg/kg PO BID	*Tursiops truncatus*	Romanov et al. 2011	Adjunct tx for MRSA	Clinical resolution (with moxifloxacin)		2
Clarithromycin	3.5 mg/kg PO BID	*Tursiops truncatus*	Clayton et al. 2012		Animal died (final dx of *M. abscessus*)		1
	8 mg/kg PO TID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
Clindamycin	4.4–7.7 mg/kg PO BID	*Globicephala macrorhynchus*	SeaWorld Pharmacopeia				Unspecified
	4.5–5.5 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	7.5 mg/kg PO BID	*Delphinapterus leucas*	Kukanich et al. 2004	For tx of Gram-negative bacterial infection	Clinical resolution		1
	7.7 mg/kg PO BID	*Delphinapterus leucas*	SeaWorld Pharmacopeia				Unspecified
	7.7–9.6 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	9–10 mg/kg PO BID	*Steno bredanensis*	Staggs, unpubl. obs.				Multiple
	11 mg/kg PO BID	*Cephalorhyncus commersonii*	SeaWorld Pharmacopeia				Unspecified
Copper sulfate	4 ppm bath immersion		Needham 1978				Unspecified
Danofloxacin	8 mg/kg IM Q24h	*Tursiops truncatus, Delphinapterus leucas*	SeaWorld Pharmacopeia				Multiple
Deslorelin implant	9.4 mg Q12mo	*Tursiops truncatus*	SeaWorld Pharmacopeia	Estrus suppression			Multiple
Dexamethasone	0.05 mg/kg PO Q24h	*Tursiops truncatus*	SeaWorld Pharmacopeia	Anti-inflammatory dose for use with anthelmintics		☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Multiple
	0.1 mg/kg IV, IM	Cetaceans	SeaWorld Pharmacopeia	EMERGENCY DOSE			Multiple
	0.11 mg/kg PO once	*Tursiops truncatus*	Reidarson and McBain 1999	For appetite stimulation		☠	Unspecified

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	0.12 mg/kg IM Q24h, tapering dose	*Tursiops truncatus*	Romanov, Chelysheva, and Romanova 2011	Adjunct tx for MRSA	Clinical resolution (with moxifloxacin)		1
	0.22 mg/kg IM once	Small odontocetes	Sharp et al. 2016				34
Diazepam	0.1–0.15 mg/kg IM, PO PRN	*Orcinus orca*	SeaWorld Pharmacopeia	Anxiolytic	Mild sedation, consider use in combination with tramadol		Multiple
	0.15–0.2 mg/kg IM, PO PRN	*Tursiops truncatus*	SeaWorld Pharmacopeia	Anxiolytic	Mild sedation, consider use in combination with tramadol		Multiple
	0.25–1 mg/kg PO PRN	*Tursiops truncatus*	Ridgway et al. 2006	Larger doses reserved for animals that have become refractory to smaller oral doses of diazepam	See **Chapter 26**		Unspecified
Dichlorvos	13.2–16.5 mg/kg PO, repeat 7-10d		Sweeney 1986b			☠	
Dihydrostreptomycin*	11 mg/kg IM Q24h		Needham 1978			☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	
Dimercaptosuccinic acid	11 mg/kg PO BID × 5-7d, 9 cycles	*Tursiops truncatus*	Stetter et al. 1999	For chelation of lead toxicosis	Clinical resolution		1
Diphenhydramine	100 mg TOTAL DOSE PO BID	*Steno bredanensis*	Staggs, unpubl. data	Allergic reaction			Multiple
Doxycycline	1.0 mg/kg IV	Cetaceans	SeaWorld Pharmacopeia	EMERGENCY DOSE—to stimulate respiration			Multiple
	1.25 mg/kg PO Q24h	*Inia geoffrensis*	Bonar and Wagner 2003	Adjunct tx for *Streptococcus iniae*	Clinical resolution (with erythromycin)		1
	1.5 mg/kg PO BID	Small odontocetes	Townsend 1999				Unspecified
	1.5 mg/kg PO BID	*Orcinus orca, Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
Enrofloxacin	2.5 mg/kg PO BID × 8 weeks	*Tursiops truncatus*	Cassle et al. 2013	Adjunct tx for *Brucella* pulmonary abscess	Clinical resolution		1

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	2.5 mg/kg PO BID	*Orcinus orca*, *Delphinapterus leucas*	SeaWorld Pharmacopeia			☠	Unspecified
	2.5 mg/kg PO BID	*Orcinus orca*	Robeck and Dalton 2002		Animal died (final dx of fungal disease)		1
	4.5 mg/kg PO BID	*Globicephala macrorhynchus*	SeaWorld Pharmacopeia				Unspecified
	5 mg/kg PO Q24h	*Tursiops truncatus*	Linnehan, Ulrich, and Ridgway 1999		Plasma concentrations above 1.0 mcg/mL = 8h	✪	8
	5 mg/kg PO BID × 10d	*Delphinapterus leucas* calf	Osborn et al. 2012		Clinical resolution		1
	5 mg/kg PO BID	Small odontocetes	SeaWorld Pharmacopeia			☠	Multiple
	5 mg/kg PO BID	*Lagenorhyncus obliquidens*	Robeck and Dalton 2002		Animal died (final dx of fungal disease)		2
	5 mg/kg PO BID	*Tursiops truncatus*	Clayton et al. 2012		Animal died (final dx of *M. abscessus*)		1
	5 mg/kg PO BID	*Steno bredanensis*	Staggs, unpubl. data			☠	Multiple
Epinephrine	5 mg/kg PO BID × 60d	*Delphinus delphis*	Reidarson et al. 1998	Adjunct tx for *Aspergillus*	Clinical resolution (with itraconazole)		1
	0.02 mg/kg IM once	Small odontocetes	Townsend 1999				Unspecified
Erythromycin	0.05 mg/kg IV, IM	Cetaceans	SeaWorld Pharmacopeia	EMERGENCY DOSE			Multiple
Erythropoietin	6.25 mg/kg PO BID	*Inia geoffrensis*	Bonar and Wagner 2003	For tx of *Streptococcus iniae*	Clinical resolution		1
Esomeprazole	63 U/kg twice 48h apart IM	*Steno bredanensis*	Manire and Rhinehart 2000	For tx of nonregenerative anemia	Clinical resolution	☠	Unspecified
	0.05-0.1 mg/kg PO Q24h-BID	*Orcinus orca*	SeaWorld Pharmacopeia	Gastritis		☠	Multiple
Famotidine	0.1–0.2 mg/kg PO Q24h-BID	*Tursiops truncatus*	SeaWorld Pharmacopeia	Gastritis		☠	Multiple
Faropenem	0.5 mg/kg IM Q24h-BID	*Tursiops truncatus, Delphinapterus leucas*	Erlacher-Reid, unpubl. data			☠	
	3.5 mg/kg PO TID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Fenbendazole	4.3–8.6 mg/kg PO BID-TID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	10 mg/kg PO once	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
Florfenicol	11 mg/kg	Small odontocetes	Townsend 1999				Unspecified
Fluconazole	20 mg/kg IM Q48h, <20 mL per site	*Tursiops truncatus, Delphinapterus leucas*	Dalton and Robeck 1998			☠	Unspecified
	2 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia			☠	Multiple
	2 mg/kg PO BID	Small odontocetes	Townsend 1999				Unspecified
	2.5 mg/kg PO BID	*Tursiops truncatus*	Romanov, Chelysheva, and Romanova 2011	Adjunct tx for MRSA	Clinical resolution (with moxifloxacin)	☠	1
Flucytosine with triazole antifungal	2.8 mg/kg PO Q24h	*Tursiops truncatus*	Jensen et al. 1998	For tx of histoplasmosis	Animal died despite tx		1
Furosemide	20 mg/kg PO TID	*Tursiops truncatus*	SeaWorld Pharmacopeia			☠	Unspecified
	2–4 mg/kg IM	Small odontocetes	Townsend 1999				Unspecified
Gentamicin	0.5–1 mg/kg IV over 1-2 minutes	*Tursiops truncatus*	Stamper, unpubl. Data		May be increased to 1–2 mg/kg IV if there is no adequate response within 1 hour. Do not exceed 5 mg/kg/dose.		
	1.1 mg/kg IT		Sweeney 1977				Unspecified
	2.5 mg/kg PO TID	*Steno bredanensis*	Townsend and Petro 1998	Adjunct tx for duodenitis			Unspecified
	4 mg/kg IM Q24h	*Tursiops truncatus*	Colgrove et al. 1975	Adjunct tx for necrotic stomatitis	Clinical resolution		Unspecified
	5 mg/kg IM BID		Needham 1978				Unspecified
Haloperidol*	80 mg TOTAL DOSE nebulized BID with saline	*Steno bredanensis, Tursiops truncatus*	Staggs, unpubl. data	Sinusitis			Multiple
Imipenem		**CONTRAINDICATED**	SeaWorld Pharmacopeia		**CONTRAINDICATED**	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	4 mg/kg IM BID	*Tursiops truncatus*	Clayton et al. 2012		Animal died (final dx of *M. abscessus*)		1
	7.5 mg/kg IM BID	*Tursiops truncatus*	SeaWorld Pharmacopeia			☠	Multiple
	7.7–11.6 mg/kg IM BID	*Delphinapterus leucas*	SeaWorld Pharmacopeia				Unspecified
Itraconazole	14 mg/kg IM BID	*Tursiops truncatus*	Romanov, Chelysheva, and Romanova 2011	Adjunct tx for MRSA	Clinical resolution (with moxifloxacin)		2
	1.25 mg/kg PO BID	*Globicephala macrorhynchus*	SeaWorld Pharmacopeia			☠	Multiple
	2.4 mg/kg PO BID	*Orcinus orca*	Robeck and Dalton 2002		Animal died (final dx of fungal disease)		1
	2.5 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				
	2.5 mg/kg PO BID	*Tursiops truncatus*	Reidarson and McBain 1995	For tx of candidiasis, with flucytosine adjunct		☠	Unspecified
	2.5 mg/kg PO BID	*Tursiops truncatus*, *Delphinapterus leucas*	SeaWorld Pharmacopeia				Multiple
	2.5 mg/kg PO BID	*Delphinapterus leucas*	Reidarson et al. 1999				Unspecified
	2.5 mg/kg PO BID	Small odontocetes	Townsend 1999				Unspecified
	2.5 mg/kg PO BID	*Steno bredanensis*	Staggs, unpubl. data				Multiple
	2.5–5 mg/kg PO BID	*Tursiops truncatus*	Reidarson et al. 1999				Unspecified
	5 mg/kg PO BID	*Tursiops truncatus*	Reidarson et al. 1998	Adjunct tx for *Aspergillus*	Clinical resolution	☠	Unspecified
	5 mg/kg PO BID	*Cephalorhyncus commersonii*	Reidarson et al. 1999				Unspecified
Ivermectin	14.7 mg/kg once, 7.4 mg/kg once, then 3.7 mg/kg PO Q24h	*Lagenorhyncus obliquidens*	Robeck and Dalton 2002		Animal died (final dx of fungal disease)		2
Ketoconazole*	0.2 mg/kg (200 μg/kg)	Small odontocetes	Townsend 1999		For tx of Crassicauda	☠	Unspecified

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	1.9 mg/kg PO BID	*Delphinapterus leucas*	Reidarson et al. 1999				Unspecified
	1.9 mg/kg PO BID	*Delphinapterus leucas*	SeaWorld Pharmacopeia				Multiple
	2.5 mg/kg PO BID	*Tursiops truncatus*	Dunn, Buck, and Spotte 1982	For tx of disseminated *Candida*			1
	5 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Unspecified
	5 mg/kg PO BID	Small odontocetes	Townsend 1999				Unspecified
	6 mg/kg PO BID	*Delphinapterus leucas*	Dunn, Buck, and Spotte 1982	For tx of disseminated *Candida*			1
Leuprolide acetate	18 mg/kg PO Q24h*	*Tursiops truncatus*	Schroeder 1983		Clinical lesion resolution after 5 months, but EM revealed budding yeast	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified
Levamisole	0.075 mg/kg IM Q28d	*Tursiops truncatus*	SeaWorld Pharmacopeia	Suppressing sexual behavior			Multiple
Levofloxacin	15 mg/kg PO Q24h		Dunn, Buck, and Spotte 1982			☠	Unspecified
	3.75 mg/kg PO BID	*Orcinus orca*	Abdo et al. 2012		Animal died (final dx of fungal disease)		1
	5 mg/kg PO Q24h	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	5 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
Lidocaine HCl	10 mg/kg PO Q24h	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	2 mg/kg IV	Cetaceans	SeaWorld Pharmacopeia	EMERGENCY DOSE			Multiple
	10–20 mL 2% concentration, regional block	*Tursiops truncatus*	Ridgway, Green, and Sweeney 1975	For infra-alveolar nerve block			Unspecified
Lidocaine, viscous	1–2.5 mL 2% concentration, regional block	*Tursiops truncatus*	Simeone et al. 2017	For peri-orbital nerve block			1

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Linezolid	10 mL TOTAL DOSE PO Q24h-BID	*Steno bredanensis, Tursiops truncatus*	Staggs and Townsend, unpubl. data	For gastric ulceration	Give in first fish in the AM, and mid-day		Multiple
Maropitant	7.5 mg/kg PO BID	*Tursiops truncatus*	Romanov, Chelysheva, and Romanova 2011	Adjunct tx for MRSA	Clinical resolution (with moxifloxacin)	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	1
Megestrol acetate*	0.5–1 mg/kg IM, PO once	Cetaceans	SeaWorld Pharmacopeia				Multiple
Meloxicam	**CONTRAINDICATED**	*Tursiops truncatus*	Houser et al. 2017	**CONTRAINDICATED**	Not a reliable contraceptive in male dolphins	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified
	0.05–0.1 mg/kg PO Q4-7d	*Tursiops truncatus, Orcinus orca*	SeaWorld Pharmacopeia				Multiple
Metoclopramide	0.1 mg/kg PO Q7d	*Tursiops truncatus*	Simeone et al. 2014			✪	10
Metronidazole	0.1 mg/kg PO, IM BID	*Tursiops truncatus*	SeaWorld Pharmacopeia	To stimulate motility of the upper GI tract			Multiple
	2.5 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia	Clostridial overgrowth			Multiple
	7 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia	Clostridial overgrowth			Multiple
	7 mg/kg PO BID × 7-14d	*Tursiops truncatus*	Doescher et al. 2008	For tx of dermal ciliates	Tx did not affect the density of the organisms in wounds		7
	7 mg/kg PO BID × up to 21d	*Steno bredanensis*	Staggs, unpubl. data				Multiple
Miconazole	7 mg/kg PO TID	Small odontocetes	Townsend 1999				Unspecified
Minocycline	4.5 mg/kg PO QID	*Tursiops truncatus*	Dudok van Heel 1977	For tx of lobomycosis			Unspecified
	4 mg/kg PO loading; 2 mg/kg PO BID maintenance	Small odontocetes	Townsend 1999				Unspecified
	4 mg/kg PO loading; 2 mg/kg PO BID maintenance	*Tursiops truncatus*, *Delphinapterus leucas*	SeaWorld Pharmacopeia			☠	Multiple

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Misoprostol	4–6.7 mg/kg PO BID	*Kogia breviceps*	Ohishi et al. 2007				2
	0.0007 mg/kg (0.7 μg/kg) PO BID	Cetaceans	SeaWorld Pharmacopeia	For gastric ulceration			Multiple
	0.025–0.05 mg (25–50 μg) TOTAL DOSE PO BID	*Steno bredanensis, Tursiops truncatus*	Staggs and Townsend, unpubl. data	For gastric ulceration			Multiple
	0.025 mg (25 μg) intravaginally	*Tursiops truncatus*	Staggs, unpubl. data	For dilation of cervix during dystocia			1
Morphine	0.05 mg (50 μg) TOTAL DOSE PO BID	*Steno bredanensis*	Staggs, unpubl. data	Metritis			2
Moxifloxacin	5 mg/kg	*Tursiops truncatus*	Ridgway 1965	For analgesia	Marked excitement noted even at small doses	☠	Unspecified
Nystatin	7 mg/kg PO Q24h × 21d	*Tursiops truncatus*	Romanov, Chelysheva, and Romanova 2011	For MRSA infection	Clinical resolution		2
	7,000–14,00 IU/kg BID-TID	Cetaceans	SeaWorld Pharmacopeia	For enteric yeast overgrowth			Multiple
	7,000 IU/kg PO BID	*Orcinus orca*	Abdo et al. 2012		Animal died (final dx of fungal disease)		1
	600,000 IU TOTAL DOSE PO TID	*Tursiops truncatus*	Dunn, Buck, and Spotte 1982	For tx of disseminated *Candida*	Clinical success in *Tursiops truncatus*, but *Phocoena phocoena* and *Globicephala melaena* died despite tx		4
	600,000 IU TOTAL DOSE PO TID	*Steno bredanensis*	Townsend and Petro 1998	Adjunct tx for duodenitis			Unspecified
Nystatin, liposomal	750,000 IU TOTAL DOSE PO TID	*Tursiops truncatus*	Clayton et al. 2012		Animal died (final dx of *M. abscessus*)		1
Ofloxacin	4.2 mg/kg IV Q24h	*Tursiops truncatus* calf	Robeck and Dalton 2002		Animal died (final dx of fungal disease)	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	1
	2.5 mg/kg PO BID	*Orcinus orca*	Abdo et al. 2012		Animal died (final dx of fungal disease)		1

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Omeprazole	5 mg/kg PO BID	Small odontocetes	Townsend 1999				Unspecified
	10–40 mg TOTAL DOSE PO Q24h	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	0.1 mg/kg PO Q24h	Small odontocetes	Stamper, unpubl. data			☠	
Oxytetracycline	0.15 mg/kg PO Q24h	*Delphinapterus leucas*	Erlacher-Reid, unpubl. Data			☠	
Oxytocin	4 mg/kg PO Q24h	*Delphinapterus leucas*	Choczynski and Mergl 2007	Adjunct tx for Erysipelothrix septicemia	Clinical resolution		1
Penicillamine	20 IU IM	*Tursiops truncatus*	See **Chapter 10**	To induce abortion	CL must be lysed prior to oxytocin administration		Unspecified
Penicillin G benzathine/ procaine	250 mg/kg PO TID × 5d	*Tursiops truncatus*	Shlosberg et al. 1997	For chelation of lead toxicosis			2
	8,899 IU/kg IM Q24h	*Tursiops truncatus*	Sweeney 1986a				Unspecified
	9,000 IU/kg IM	*Delphinapterus leucas*	Choczynski and Mergl 2007	Adjunct tx for Erysipelothrix septicemia	Clinical resolution		1
Posaconazole	47,000 IU/kg IM	*Tursiops truncatus*	Colgrove et al. 1975	Adjunct tx for necrotic stomatitis	Clinical resolution		Unspecified
	5 mg/kg PO BID	*Tursiops truncatus, Lagenorrhynchus obliquidens*	SeaWorld Pharmacopeia				
Praziquantel	5 mg/kg PO BID	*Steno bredanensis, Tursiops truncatus*	Staggs and Townsend, unpubl. data		Titers should be evaluated for peak and trough after 14d of tx		Multiple
	3 mg/kg	Small odontocetes	Townsend 1999	For tx of cestodes			Unspecified
Prednisolone	10 mg/kg	Small odontocetes	Townsend 1999	For tx of *Nasitrema*			Unspecified
Prednisolone sodium succinate	0.01 mg/kg PO Q24h		Reidarson et al. 1999				Unspecified
	1–10 mg/kg IM, IV	Small odontocetes	Townsend 1999	For tx of shock			Unspecified
	3.3 mg/kg IM	*Tursiops truncatus*	Driscoll et al. 2007		Animal died despite therapy		1
Prostaglandin F2A (dinoprost)	5 mg/kg IV, IM	Cetaceans	SeaWorld Pharmacopeia	EMERGENCY DOSE			Multiple

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Ranitidine	10–25 mg TOTAL DOSE IM BID × 3d	*Tursiops truncatus*	See **Chapter 10** Reproduction	To lyse the corpus luteum			Multiple
	0.5–1 mg/kg PO Q24h-BID	*Steno bredanensis*	Staggs, unpubl. data			☠	Multiple
	0.5 mg/kg PO Q24h	*Delphinapterus leucas*	Erlacher-Reid, unpubl. data			☠	
	2 mg/kg PO BID	Small odontocetes	Townsend 1999				Unspecified
Rifampin	3 mg/kg PO Q24h-BID	*Tursiops truncatus*	Clayton et al. 2012		Animal died (final dx of *M. abscessus*)		1
	2.2 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Unspecified
	2.5 mg/kg PO BID	Small odontocetes	Townsend 1999				Unspecified
	2.5 mg/kg PO BID or 3–4 mg/kg Q24h	*Tursiops truncatus*	SeaWorld Pharmacopeia			☠	Multiple
	2.8 mg/kg PO BID	*Tursiops truncatus*	Romanov, Chelysheva, and Romanova 2011	Adjunct tx for MRSA	Clinical resolution (with moxifloxacin)		1
Simethicone	4 mg/kg PO Q24h × 8 weeks	*Tursiops truncatus*	Cassle et al. 2013	Adjunct tx for *Brucella* pulmonary abscess	Clinical resolution		1
	60 mg total dose PO QID	*Stenella* sp.	Byrd and Stamper, unpubl. obs.	For GI gas	Do not exceed four doses in 24 hours		
	120 mg TOTAL DOSE PO TID	*Tursiops truncatus*	Levine, unpubl. data	For gastritis			Multiple
Sodium bicarbonate	125 mg total dose PO QID	*Tursiops truncates*	Byrd and Stamper, unpubl. obs.	For GI gas	Do not exceed four doses in 24 hours		
Streptomycin	1.0 meq/kg IV	Cetaceans	SeaWorld Pharmacopeia	EMERGENCY DOSE—for metabolic acidosis			Multiple
Sucralfate	11 mg/kg IM Q24h		Needham 1978				Unspecified
	1 g PO QID	*Steno bredanensis*	Townsend and Petro 1998	Adjunct tx for duodenitis		☠	Unspecified
	1–2 g PO BID-QID	Small odontocetes	Townsend 1999				Unspecified
Terbinafine	2 g PO BID	*Tursiops truncatus*	Clayton et al. 2012		Animal died (final dx of *M. abscessus*)		1
	1.25–1.5 mg/kg PO Q24h	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Tetracycline	2 mg/kg PO Q24h	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	5 mg/kg PO TID	*Kogia breviceps*	Ohishi et al. 2007				2
	6.7 mg/kg PO BID	*Orcinus orca*	McBain 1985				Unspecified
	20 mg/kg PO BID × 3d	*Tursiops truncatus*	Levine, unpubl. data	For tx of primary gastritis			Multiple
	22–25 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	55 mg/kg PO BID	*Delphinapterus leucas*	SeaWorld Pharmacopeia				Multiple
	55–65 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
Tramadol	77 mg/kg PO BID	*Cephalorhyncus commersonii*	SeaWorld Pharmacopeia				Multiple
	0.05–0.1 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia	For analgesia		☠	
	0.1 mg/kg PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia	For analgesia		☠	
	0.2 mg/kg PO Q24h	*Orcinus orca*	SeaWorld Pharmacopeia	For analgesia needed for >5 d		☠	Multiple
	0.25–0.5 mg/kg PO Q24h-BID	*Orcinus orca*	SeaWorld Pharmacopeia	For short-term analgesia (<5 d). Start at lower dose and increase as needed.		☠	Multiple
	0.5 mg/kg PO once	*Orcinus orca*	SeaWorld Pharmacopeia	For bronchoscopy procedure, in conjunction with diazepam			1
Trimethoprim-sulfadiazine (TMS)*	25 mg TOTAL DOSE PO BID	*Steno bredanensis*	Staggs, unpubl. data			☠	Multiple
(1:5 formulation typical;	7.7–11 mg/kg PO Q24h	*Orcinus orca*	SeaWorld Pharmacopeia			☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Multiple
1:2 formulation for treatment of *Nocardia*)	7.7 mg/kg PO Q24h	*Globicephala macrorhynchus*	SeaWorld Pharmacopeia			☠	Unspecified

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	11 mg/kg Q24h (1:2 ratio TM:S)	*Delphinapterus leucas*	Schmitt et al. 2007	For tx of *Nocardia*	Clinical resolution	☠	1
	12 mg/kg PO Q24h	*Inia geoffrensis*	Bonar and Wagner 2003	Adjunct tx for *Streptococcus iniae*	Clinical resolution (with erythromycin)		1
	15 mg/kg PO Q24h × 30d	*Delphinus delphis*	Reidarson et al. 1998	Adjunct tx for *Aspergillus*	Clinical resolution (with itraconazole)		1
	15.7 mg/kg Q48h	*Delphinapterus leucas* calf	Cook et al. 1992				Unspecified
	16 mg/kg PO Q24h	*Cephalorhyncus commersonii*	SeaWorld Pharmacopeia			☠	Unspecified
	16–22 mg/kg PO Q24h (20–50 mg BID TOTAL DOSE)	*Tursiops truncatus*	SeaWorld Pharmacopeia			☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Multiple
	22 mg/kg PO Q24h	*Delphinapterus leucas*	SeaWorld Pharmacopeia			☠	Unspecified
	25 mg/kg PO Q24h	*Lagenorhyncus obliquidens*	Robeck and Dalton 2002		Animal died (final dx of fungal disease)		2
Tylosin	30 mg/kg PO Q24h	*Tursiops truncatus*	Schroeder et al. 1984				Unspecified
	32 mg/kg IM Q24h	*Tursiops aduncus*	Thurman and Windsor 1984		Clinical resolution	☠	Unspecified
Vancomycin	50 mg/kg PO TID	*Tursiops aduncus*	Thurman and Windsor 1984			☠	Unspecified
	1–1.5 mg/kg TID	Small odontocetes	Townsend 1999				Unspecified
	1.5–2.0 mg/kg TID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
Voriconazole*	2.0–3.0 mg/kg TID	*Tursiops truncatus*	SeaWorld Pharmacopeia				Multiple
	0.27–0.3 mg/kg PO Q24h, with serum voriconazole monitoring	*Orcinus orca*	SeaWorld Pharmacopeia				

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	2.5–3.3 mg/kg PO BID × 3d, followed by 2.5–3.3 mg/kg PO Q3-7d with serum voriconazole monitoring	*Tursiops truncatus*	SeaWorld Pharmacopeia			☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Multiple
Vitamins/Minerals/ Supplements	3 mg/kg PO BID × 5d, followed by serum voriconazole monitoring	*Delphinapterus leucas*	Naples, Poll, and Berzins 2012	For fusariomycosis	Clinical resolution		1
Artichoke heart	150 mg total dose PO BID	*Stenella* sp.	Byrd and Stamper, unpubl. obs.	For treatment of hepatitis			
Calcium glycerophosphate/ calcium lactate	22 mg/kg IM once	Small odontocetes	Sharp et al. 2016				
Iron (ferrous sulfate)	325 mg tablet (65 mg iron) PO Q24h-BID		Staggs and Townsend, unpubl. data	Severe anemia, low serum iron, or hand-raised calves			34
Milk thistle (70–80% silymarin)	175 mg TOTAL DOSE PO TID for 50 kg animal	*Stenella* sp.	Byrd and Stamper, unpubl. obs.	For treatment of hepatitis		☠	
SAMe (S-Adenosyl-E) and silymarin	425 mg TOTAL DOSE PO BID for 50 kg animal	*Stenella* sp.	Byrd and Stamper, unpubl. obs.	For treatment of hepatitis			
Yunnan Paiyao	5 mg/kg PO Q24h (1 cap/100 pounds)	*Tursiops truncatus*	SeaWorld Pharmacopeia	For hemostasis			Multiple
	1 capsule PO QID	*Delphinapterus leucas*	Choczynski and Mergl 2007	Adjunct tx for *Erysipelothrix septicemia*	Clinical resolution		1
Vitamin B1 (thiamine)	2 capsules PO BID	*Steno bredanensis, Tursiops truncatus*	Staggs and Townsend, unpubl. data	For gastric ulceration			Multiple
	1 mg/kg IM Q24h. Follow with oral dosing.		Geraci 1986	For tx of thiamine deficiency			Common practice
	2–4 mg/kcal feed PO Q24h. Give 2 h before feeding.		Geraci 1986	For supplementation when supplements are administered prior to feeding	Empirically effective with reasonably handled food fish		Common practice

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Table 27.2 (Continued) Drug Dosages Reported for Cetaceans (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Vitamin B9 (folinic acid)	25–35 mg/kg fish PO Q24h. Give at main feeding.		Geraci 1986	For supplementation when supplements are administered at time of feeding	Empirically effective with reasonably handled food fish		Common practice
	0.04–0.06 mg/kg PO BID	*Orcinus orca*	SeaWorld Pharmacopeia				Multiple
	0.1 mg/kg PO BID	*Delphinapterus leucas*	SeaWorld Pharmacopeia				Multiple
	10–20 mg TOTAL DOSE PO BID	*Cephalorhyncus commersonii*	SeaWorld Pharmacopeia	For supplementation during TMS use			
	20–50 mg TOTAL DOSE PO BID	*Tursiops truncatus*	SeaWorld Pharmacopeia	For supplementation during TMS use			
	25–100 mg TOTAL DOSE PO BID	*Delphinapterus leucas*	SeaWorld Pharmacopeia	For supplementation during TMS use			
	50–100 mg TOTAL DOSE PO BID	*Globicephala macrorhynchus*	SeaWorld Pharmacopeia	For supplementation during TMS use			
Vitamin C (ascorbic acid)	50–150 mg TOTAL DOSE PO BID	*Orcinus orca*	SeaWorld Pharmacopeia	For supplementation during TMS use			
Vitamin E	8 mg/kg PO Q24h	*Tursiops truncatus*	Colgrove et al. 1975	Adjunct tx for necrotic stomatitis	Clinical resolution		1
Vitamin E/selenium	100 IU/kg fish PO Q24h	Cetaceans	Geraci 1986		Empirically effective with reasonably handled food fish		Common practice
Vitamin K1	0.06 mg/kg selenium IM	Small odontocetes	Sharp et al. 2016		To prevent exertional myopathy		34
	0.1 mg/kg PO Q24h	*Delphinapterus leucas*	Choczynski and Mergl 2007	Adjunct tx for *Erysipelothrix* septicemia	Clinical resolution		1
	0.3–0.5 mg/kg PO BID	*Tursiops truncatus, Stenella* sp.	Byrd and Stamper, unpubl. obs.	For treatment of thrombocytopenia			Multiple

Note: dx = diagnosis; tx = treatment; ☠ = read text for important cautions; ✪ = see **Table 27.1** for pharmacokinetic information.
*Adverse effects observed.

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Table 27.3 Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Acetylcysteine	20% solution nebulized BID-QID		Stoskopf et al. 2001				Unspecified
Acetylcysteine + isoproterenol	400 mg IH BID-QID, nebulized in 12–15 mL of saline with 1:50,000 isoproterenol		Sweeney 1986a				Unspecified
Aluminum hydroxide	30–90 mg/kg PO	*Zalophus californianus*	Gulland 1999	To bind phosphorus for cases of leptospirosis-associated renal disease		☠	
Amikacin	5 mg/kg IM BID × 5–7d	Pinnipeds	Thornton, unpubl. data				
	6.8 mg/kg IM BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal disease)		1
	7.7 mg/kg BID	*Odobenus rosmarus*	McBain, unpubl. data				Unspecified
Aminocaproic acid	100 mg/kg IV, PO BID-QID	*Mirounga angustirostris*	Kaye et al. 2016	Antifibrinolytic	Therapeutic plasma concentrations maintained for 8 hours	✪	27
Aminophylline	2 mg/kg IM	*Phoca groenlandica*	Piche et al. 2010		Used for premedication prior to anesthesia for bronchoalveolar lavage		14
	5.5 mg/kg IV, IM, PO; BID-TID	*Zalophus californianus*, *Phoca vitulina*, *Mirounga angustirostris*	Stoskopf et al. 2001				Unspecified
	6–12 mg/kg IM TID	Pinnipeds	TMMC Pharmacopeia	Bronchodilator		☠	Multiple
Amoxicillin	12 mg/kg PO BID	*Neomonachus schauinslandi*	Norris et al. 2011	Empirical therapy for gastrointestinal signs	Clinical resolution		1
	12 mg/kg PO BID	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		1

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	15 mg/kg PO BID	*Zalophus californianus*	Van Bonn et al. 2000	Adjunct therapy for calicivirus ulcers	Clinical resolution		1
	20 mg/kg IV once	*Phoca vitulina*	Gulland et al. 2000		Serum concentrations maintained above 10 mcg/mL for 1.75h	✪	20
	20 mg/kg IV once	*Mirounga angustirostris*	Gulland et al. 2000		Serum concentrations maintained above 10 mcg/mL for 4.5h	✪	20
	22 mg/kg PO BID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Amoxicillin/clavulanic acid	10–15 mg/kg PO BID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	11 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal disease)		1
	14 mg/kg PO BID	*Odobenus rosmarus*	Schmitt and Proctor 2014		Animal died (final diagnosis of fungal disease)		1
	20 mg/kg PO BID	*Zalophus californianus*	Braun et al. 2015		Animal died despite therapy (final diagnosis of bacterial meningitis)		1
	20 mg/kg PO BID × 7–10d	*Phoca vitulina*	Rubio-Garcia et al. 2015	For tx of wounds	Mixed clinical resolution		19
	Ophthalmic TID-QID	*Phoca vitulina*	Borkowski et al. 1999	For tx of keratitis. Subpalpebral lavage with ciprofloxacin and fluconazole.			Unspecified
Ampicillin/sulbactam sodium	22–50 mg/kg IV, IM TID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Aspirin (buffered)	0.15 mg/kg PO BID	*Phoca vitulina*	Flower et al. 2014	For uveitis			1
	0.5 mg/kg PO Q24h-BID	*Mirounga angustirostris*	TMMC Pharmacopeia	For tx of DIC associated with *Otostrongylus circumlitis* infection		☠	Multiple
	5 mg/kg PO BID × 5d	*Zalophus californianus*	Haulena et al. 2006	Adjunct therapy for soft tissue wounds	Clinical resolution		1
Aspirin (gastric coated)	5.5 mg/kg PO BID	*Phoca vitulina*	Flower et al. 2014	For uveitis			1

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Barium sulfate	1 mg/kg PO	*Phoca vitulina*	Flower et al. 2014	For gastrointestinal contrast series			2
Bupivacaine	Maximum of 2 mg/kg SQ/intradermal	Pinnipeds	TMMC Pharmacopeia	For local, or regional nerve blocks, including epidural			
Buprenorphine	0.01–0.02 mg/kg IM, IV TID-QID	Pinnipeds	TMMC Pharmacopeia	For analgesia			Multiple
Buprenorphine SR (extended release)	0.12 mg/kg SC Q72h	*Mirounga angustirostris*	Molter et al. 2015			☠✪	26
	0.2–0.25 mg/kg SC Q72h	Pinnipeds	TMMC Pharmacopeia	For analgesia		☠	Multiple
Buspirone	0.5–1.0 mg/kg PO BID	Pinnipeds	TMMC Pharmacopeia	Anxiolytic	Start at low dose and increase. May take 1–3 weeks to see effect		Multiple
Butorphanol	0.1–0.2 mg/kg IM, IV TID-QID	Pinnipeds	TMMC Pharmacopeia	For analgesia			Multiple
Carprofen	1.25 mg/kg PO Q24h	*Zalophus californianus*	Kelly et al. 2005		Animal died (final diagnosis of *Otostrongylus)*		1
	1.8 mg/kg PO Q24h	*Zalophus californianus*	Field et al. 2012				1
	2 mg/kg PO BID × 10d	*Phoca vitulina*	Rubio-Garcia et al. 2015	Adjunct therapy for wounds	Mixed clinical resolution		19
	2 mg/kg PO BID	Pinnipeds	TMMC Pharmacopeia				
	4 mg/kg PO Q24h	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	4 mg/kg PO BID × 5d	*Otaria flavescens*	Biancani et al. 2010		Animal died (final diagnosis of neoplasia)		1
	4 mg/kg PO Q24h	*Phoca vitulina*	Fravel et al. 2011	Adjunct therapy for MRSA	Clinical resolution		1
	4 mg/kg PO Q24h	*Zalophus californianus*	Braun et al. 2015		Not effective in controlling pain associated with wounds/meningitis		1
	4.4 mg/kg PO Q24h	*Zalophus californianus*	Dennison et al. 2011	For tx of lungworm infestation/ inflammation			1

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	4.4 mg/kg IM once	*Eumetopias jubatus*	Walker et al. 2010		Not effective in controlling post-operative pain		5
	5 mg/kg PO Q24h × 7d	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		1
Cefazolin	20 mg/kg IM, IV TID	Pinnipeds	TMMC Pharmacopeia		For perioperative use	☠	Multiple
Cefovecin	1–2 mg/kg SC, IM once	*Otaria flavescens*	García-Párraga, unpubl. data		Plasma concentrations above 1.0 mcg/mL >26d	✪	10
	2 mg/kg IM once	*Odobenus rosmarus*	García-Párraga, unpubl. data		Plasma concentrations above 1.0 mcg/mL >60d	✪	3
	4 mg/kg SC once	*Zalophus californianus*	García-Párraga, unpubl. data		Plasma concentrations above 1.0 mcg/mL = 57d	✪	1
	4 mg/kg SC once	*Phoca vitulina*	García-Párraga, unpubl. data		Plasma concentrations above 1.0 mcg/mL >10d	✪	2
	4 mg/kg SC once	*Halichoerus grypus*	García-Párraga, unpubl. data		Plasma concentrations above 1.0 mcg/mL = 20d		
Ceftiofur	5 mg/kg IM	*Mirounga angustirostris*	Fauquier et al. 2003		Animal died (final diagnosis of neoplasia)		1
	6.6 mg/kg IM once	*Zalophus californianus*	Prager et al. 2015	For tx of leptospirosis	Clinical resolution	☠	14
	6.6 mg/kg IM Q5d	*Zalophus californianus*	Meegan et al. 2013			✪	12
	6.6 mg/kg IM Q5d	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Cefuroxime	10–15 mg/kg PO BID	*Odobenus rosmarus*	McBain, unpubl. data				Unspecified
Cephalexin	15 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal)		1

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	20 mg/kg PO TID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	25 mg/kg PO BID	*Zalophus californianus*	Braun et al. 2015		Animal died despite therapy (final diagnosis of bacterial meningitis)		1
Cephaloridine	8.8 mg/kg IT BID	*Zalophus californianus*	Sweeney 1977				Unspecified
Chloramphenicol	4.1 mg/kg IV, PO TID	*Phoca vitulina*	Koski and Vandenbroek 1986				Unspecified
	20–30 mg/kg PO BID-TID	*Zalophus californianus*	McBain, unpubl. data				Unspecified
Cimetidine	5 mg/kg PO	*Zalophus californianus*	Gulland 1999	For tx of gastric ulcers associated with uremia in patients with leptospirosis		☠	Unspecified
Ciprofloxacin	5–10 mg/kg PO BID	*Zalophus californianus*	Prager et al. 2015	For tx of leptospirosis	Clinical resolution	☠	14
	7.5 mg/kg PO BID	*Odobenus rosmarus*	McBain, unpubl. data				Unspecified
	10 mg/kg PO Q24h	*Zalophus californianus*	Barbosa et al. 2015			✪	20
	10 mg/kg PO Q24h × 5d	*Mirounga angustirostris*	Greene et al. 2015	Prophylactic post-operative administration			1
	15 mg/kg PO Q24h	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	Ophthalmic TID-QID	*Phoca vitulina*	Borkowski et al. 1999	For tx of keratitis. Subpalpebral lavage with fluconazole and atropine			Unspecified
Clindamycin	5.5 mg/kg IM, PO BID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	6 mg/kg PO BID	*Phoca vitulina*	Zabka et al. 2006		Animal died (final diagnosis of lead toxicosis)		1
	7.3 mg/kg PO BID	*Odobenus rosmarus*	McBain, unpubl. data				Unspecified

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	8–11 mg/kg PO BID	*Zalophus californianus*	McBain, unpubl. data				Unspecified
	10 mg/kg PO BID × 14d	*Phoca vitulina*	Rubio-Garcia et al. 2015	For tx of wounds	Mixed clinical resolution		19
	10–15 mg/kg IM, PO BID	Pinnipeds	TMMC Pharmacopeia	For tx of protozoal infections (*Toxoplasma, Sarcocystis, Neospora*)		☠	Multiple
	12 mg/kg PO BID	*Zalophus californianus*	Van Bonn et al. 2000	Adjunct therapy for calicivirus ulcers	Clinical resolution		1
Dexamethasone	0.1 mg/kg PO Q24h × 14d, then 0.05 mg/kg Q24h × 4d	*Phoca vitulina*	Esson et al. 2015	As anti-inflammatory post-lensectomy	Clinical resolution		1
	0.1–0.2 mg/kg IM Q24h	Pinnipeds	TMMC Pharmacopeia	Anti-inflammatory dose		☠	Multiple
	0.2–1.0 mg/kg IM, PO Q24h	*Zalophus californianus Mirounga angustirostris*	Gage et al. 1985				Unspecified
	0.25 mg/kg PO BID, tapering dose	*Mirounga angustirostris*	Haulena et al. 2002				1
	0.25 mg/kg IM Q24h	*Zalophus californianus*	TMMC Pharmacopeia	Abortifacient dose for pregnant animals with domoic acid intoxication	Typically abort after 3–5 days of tx. If no result consider dinoprost.	☠	Multiple
	40 mg IM TOTAL DOSE	*Zalophus californianus*	Brodie et al. 2006	Abortifacient dose for pregnant animals with domoic acid intoxication			13
	2.2 mg/kg IV	*Zalophus californianus*	Stoskopf et al. 2001	For tx of shock			Unspecified
Dextrose (5% in LRS)	100 mL/kg/d	*Zalophus californianus*	Gulland 1999				Unspecified
Dextrose 20%	500 mg/kg (2.5 mL/kg of 20% administered intraperitoneally)	*Zalophus californianus*	Fravel et al. 2016	For hypoglycemic crisis	Hyperglycemia persists for ~2hr.		5

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Dextrose 25%	500 mg/kg (2 mL/kg of 25% administered intravenously)	*Zalophus californianus*	Fravel et al. 2016	For hypoglycemic crisis	Hyperglycemia persists for ~2hr.		5
Diazepam	0.15 mg/kg IV	*Phoca vitulina*	Zabka et al. 2006	Anticonvulsant	Inconsistent absorption via IM route (Hung et al. 1996); consider lorazepam for IM anticonvulsant		1
Dichlorvos	9.7–11.5 mg/kg tablet PO	*Callorhinus ursinus*	Bigg and Lyons 1981			☠	Unspecified
	29.3–32.8 mg/kg capsule PO	*Callorhinus ursinus*	Lyons et al. 1978				Unspecified
Diphenhydramine	0.55 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal)		1
Disophenol*	9.9 mg/kg SC BID, Q24h	Northern fur seal	Lyons et al. 1978	For tx of *Uncinaria* hookworms		☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	
	12.5 mg/kg SC	Northern fur seal, associated diarrhea	Lyons et al. 1980	For tx of *Uncinaria* hookworms			
Doxycycline	2.2 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal)		1
	5 mg/kg PO BID	*Phoca vitulina*	Flower et al. 2014		For pinniped keratitis		1
	5 mg/kg PO BID	*Zalophus californianus*	Prager et al. 2013	For tx of leptospirosis	Clinical resolution		1
	5–10 mg/kg PO BID	*Zalophus californianus*	Prager et al. 2015	For tx of leptospirosis	Clinical resolution	☠	14
	7.5 mg/kg PO BID × 7 weeks, then 1 mg/kg PO Q24h × 5 weeks	*Zalophus californianus*	Fitzpatrick et al. 2011	For tx of periodontal disease	Clinical resolution		1
	10 mg/kg PO Q24h-BID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	10 mg/kg PO BID	*Phoca vitulina*	Esson et al. 2015	Post-lensectomy	Clinical resolution		1

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	10–20 mg/kg PO Q24h	*Mirounga angustirostris*	Freeman et al. 2013		Doxycycline penetrates the tear film at both 10 and 20 mg/kg doses and can be used for ophthalmic indications	✪	18
Enalapril	0.5 mg/kg PO BID	*Phoca vitulina*	TMMC Pharmacopeia	For tx of heart failure and fluid overload in pups with patent ductus arteriosus			Multiple
Enilconazole	0.2% topical solution	*Zalophus californianus*	Guillot et al. 1998	For tx of fungal dermatitis	Clinical resolution		1
Enrofloxacin	3 mg/kg PO BID	*Phoca vitulina*	Esson et al. 2015		Clinical resolution		1
	3.3 mg/kg PO BID	*Odobenus rosmarus*	McBain, unpubl. data				Unspecified
	5 mg/kg PO Q24h	*Phoca vitulina*	Fravel et al. 2011		Clinical resolution		1
	5 mg/kg PO Q24h	*Zalophus californianus*	Braun et al. 2015		Animal died despite therapy (anesthetic death)		1
	5 mg/kg PO Q24h	*Zalophus californianus*	Kelly et al. 2005		Animal died of *Otostrongylus*		1
	5 mg/kg PO Q24h	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal)		1
	5 mg/kg PO BID × 10d	*Otaria flavesecens*	Biancani et al. 2010		Animal died (final diagnosis of neoplasia)		1
	5–10 mg/kg IM Q24h	*Zalophus californianus*	Prager et al. 2015	For tx of leptospirosis	Clinical resolution	☠	14
	5–10 mg/kg IM, SQ	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		4
	2% solution in poloxamer gel, applied subconjunctivally	*Zalophus californianus*	Simeone et al. 2016	For tx of superficial corneal ulcers	Clinical resolution		26
Erythromycin	5.5 mg/kg PO BID		Sweeney 1974a				Unspecified
	15 mg/kg PO BID × 25d	*Zalophus californianus*	Haulena et al. 2006		Clinical resolution		1

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	15 mg/kg PO TID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Famciclovir	15–30 mg/kg PO Q24h-BID	Pinnipeds	TMMC Pharmacopeia				Multiple
Famotidine	0.5 mg/kg IM, PO BID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	0.5 mg/kg PO BID	*Phoca vitulina*	Biancani et al. 2012		Animal died (final diagnosis of neoplasia)		1
	0.5–0.8 mg/kg PO Q24h	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		4
	0.9 mg/kg IM Q24h	*Mirounga angustirostris*	Greene et al. 2015		Animal died (final diagnosis of hernia)		1
	1.0 mg/kg IM, PO Q24h	Pinnipeds	TMMC Pharmacopeia				Multiple
Fenbendazole	10 mg/kg PO	*Neomonachus schauinslandi*	Gobush et al. 2011	For tx of nematodes			7
	10 mg/kg PO Q24h × 3d	*Neomonachus schauinslandi*	Norris et al. 2011	For tx of nematodes	Clinical resolution		3
	10 mg/kg PO Q24h × 3d	Pinnipeds	TMMC Pharmacopeia	For tx of nematodes			Multiple
	10 mg/kg PO Q24h × 5d	Pinnipeds	TMMC Pharmacopeia	For tx of *Otostrongylus circumlitis*			Multiple
	11 mg/kg PO Q24h × 2d	*Zalophus californianus*, *Mirounga angustirostris*	Gage et al. 1985				Unspecified
	50 mg/kg PO Q24h × 10-30d	*Mirounga angustirostris*	Beckmen et al. 1993	For tx of *Otostrongylus circumlitis*	Intermittent clinical resolution		39
Ferrous sulfate	1–2 tab (325 mg) PO TID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Florfenicol	20 mg/kg SQ, IM Q48h	Pinnipeds	TMMC Pharmacopeia				
Florfenicol, extended release	40 mg/kg SQ Q7d	Pinnipeds	TMMC Pharmacopeia				
Fluconazole	0.5 mg/kg PO BID		Reidarson et al. 1999				Unspecified

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	2 mg/kg PO BID loading dose, then 1 mg/kg PO BID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	Ophthalmic TID-QID	*Phoca vitulina*	Borkowski et al. 1999	For tx of keratitis. Subpalpebral lavage with ciprofloxacin and atropine			Unspecified
Fluoxitine HCl	0.2–1.2 mg/kg PO Q24h	*Zalophus californianus*	Dalton et al. 1997	For tx of regurgitation and stereotypic behavior	Controlled behavior for 4 months; slow recurrence after that point.		Unspecified
Flunixin meglumine	1 mg/kg IM Q24h	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	1 mg/kg IM once	*Eumetopias jubatus*	Walker et al. 2010, 2011		Not effective in controlling post-operative pain		15
	1.1 mg/kg IM × 7d	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		1
Flurbiprofen	0.05% ophthalmic solution	*Phoca vitulina*	Flower et al. 2014	For tx of uveitis	Clinical resolution		1
Furosemide	2–4 mg/kg PO, SQ, IM, IV BID-TID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Gentamicin	2 mg/kg IM Q24h × 6d	*Phoca vitulina*	Rubio-Garcia et al. 2015		Clinical resolution		4
	0.75 mg/kg IT BID × 2d, then Q24h		Sweeney, unpubl. data				Unspecified
	1 mg/kg IV TID (SLOWLY)	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Griseofulvin	15 mg/kg PO Q24h × 45d		Farnsworth et al. 1975				Unspecified
	5000 mg/d PO TOTAL DOSE × 4 weeks	*Neophoca cinerea*	Phillips et al. 1986				Unspecified
Haloperidol*	**CONTRAINDICATED**	**CONTRAINDICATED**	SeaWorld Pharmacopeia		**CONTRAINDICATED**	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Heparin sodium	50–100 IU/kg SQ TID (give first dose IV)	Pinnipeds	TMMC Pharmacopeia	Anticoagulant for tx of DIC			Multiple
Hydrocodone	0.08 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal)		1
Hydrogen peroxide	5 mL/kg PO PRN		Geraci and Sweeney 1986				Unspecified
Indomethacin	0.1–0.3 mg/kg PO initial dose; 0.1–0.2 mg/kg 12–24h maintenance; 0.45 mg/kg 48h tapering dose	*Zalophus californianus*, *Mirounga angustirostris*	Stoskopf et al. 2001				Unspecified
Iohexol*	300 mgI/kg IV	*Zalophus californianus*	Dennison et al. 2010	For CT contrast		**SEE TEXT—POTENTIAL LETHAL REACTIONS**	8
	60 mL of 300 mgI/mL IV	*Zalophus californianus*	Dennison et al. 2011	For CT contrast			1
Iron dextran	10 mg/kg IM Q2–3 weeks	Pinnipeds	TMMC Pharmacopeia				Multiple
Isoetharine	90 mg nebulized in 1% soln. PRN	For tx of bronchospasm	Stoskopf et al. 2001	For tx of bronchospasm			Unspecified
Isoniazid	2 mg/kg PO Q24h	*Halichoerus grypus*	Stoskopf, unpubl. data				Unspecified
Isoproterenol	0.4 mg/kg PO BID, TID	*Zalophus californianus*	Stoskopf et al. 2001				Unspecified
	0.5 mL nebulized BID-QID	*Zalophus californianus*	Stoskopf et al. 2001				Unspecified
Itraconazole	0.5–1 mg/kg PO BID	Nonwalrus pinnipeds	Reidarson et al. 1999				Unspecified
	1.5–2 mg/kg PO Q24h	*Odobenus rosmarus*	Reidarson et al. 1999				Unspecified
	2.5 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		No clinical improvement (final diagnosis of fungal)		1

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Ivermectin	0.2 mg/kg (200 μg/kg) SC once	*Callorhinus ursinus*	DeLong et al. 2009	For *Uncinaria* hookworm	Reduced mortality and increased growth rate among treated pups. Repeat after 10 days.	☠	Unspecified
	0.2 mg/kg (200 μg/kg) IM	*Zalophus californianus*	Dennison et al. 2011	For *Parafilaroides* lungworm			1
	0.2 mg/kg (200 μg/kg) IM, SQ once	Pinnipeds	TMMC Pharmacopeia	For tx of GI nematodes, *Parafilaroides*, lice, and mites	May require anti-inflammatory for tx of *Parafilaroides* or *Otostrongylus*. Repeat in 2 weeks for heavy parasite loads	☠	Multiple
Ketoconazole	1 mg/kg PO BID	Nonwalrus pinnipeds	Reidarson et al. 1999				Unspecified
	4.4 mg/kg PO BID	*Odobenus rosmarus*	Reidarson et al. 1999				Unspecified
	10 mg/kg IM, PO Q24h		Dunn et al. 1984			☠	Unspecified
	10 mg/kg PO Q24h	*Zalophus californianus*	Guillot et al. 1998		Mild clinical improvement, better with combined enilconazole therapy		1
	10 mg/kg PO BID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	20 mg/kg PO Q24h	Pinnipeds	TMMC Pharmacopeia				
Ketoprofen	1 mg/kg IM	*Mirounga angustirostris*	Greene et al. 2015				1
	1 mg/kg IM Q24h	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	1 mg/kg PO BID	*Phoca vitulina*	Zabka et al. 2006				1
Leuprolide acetate	0.09–0.12 mg/kg IM Q28d	*Zalophus californianus*	Calle et al. 1997	Suppression of testosterone	Controlled undesirable male-associated behaviors	☠	3

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Levamisole	8 mg/kg PO	*Zalophus californianus*	Dalton and Robeck 1998				Unspecified
	15 mg/kg SC	*Zalophus californianus*, *Mirounga angustirostris*	Gage et al. 1985				Unspecified
Levofloxacin	4.8 mg/kg PO Q24h	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		1
Lidocaine	4 mg/kg SQ (retrobulbar)	*Zalophus californianus*	Gutierrez et al. 2016	For use in retrobulbar local block	Do not exceed 6 mg/kg total dose		26
Lorazepam	0.2 mg/kg IM once, followed by 0.1–0.2 mg/kg PRN	Pinnipeds	TMMC Pharmacopeia		Longer lasting anticonvulsant effects, and more consistent IM absorption than diazepam		Multiple
	0.05 mg/kg IM	*Phoca vitulina*	Zabka et al. 2006	Anticonvulsant			1
Mannitol	250–1500 mg/kg IV (SLOWLY)	Pinnipeds	TMMC Pharmacopeia	Osmotic diuretic for tx of cranial trauma or cerebral edema			Multiple
Marbofloxacin	4 mg/kg PO Q24h	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		1
	5 mg/kg PO once	*Phoca vitulina*	KuKanich et al. 2007		Plasma concentrations likely to be effective for bacteria with MIC <0.2 mcg/mL	✪	55
Maropitant	1 mg/kg SQ Q24h or 2 mg/kg PO	Pinnipeds	TMMC Pharmacopeia		May also have anti-inflammatory effects due to action against Substance P		Multiple
Medroxyprogesterone acetate	3.4 mg/kg IM Q28d	*Phoca vitulina*	Flower et al. 2014	Contraceptive			1
Meloxicam	0.2 mg/kg IM, PO loading dose, then 0.1 mg/kg IM, PO Q24h	Pinnipeds	TMMC Pharmacopeia			☠	

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	0.1 mg/kg IM	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		2
Metoclopramide	0.15 mg/kg PO BID	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		2
	0.2 mg/kg PO TID	*Phoca vitulina*	Biancani et al. 2012		Animal died (anesthesia)		1
	0.2 mg/kg IM TID	*Mirounga angustirostris*	Greene et al. 2015		Mild clinical improvement (final diagnosis of hernia)		1
	0.3–0.4 mg/kg IM TID × 3d	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Metronidazole	5 mg/kg PO BID × 10d	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		1
	10 mg/kg PO TID	*Phoca groenlandica*	Chinnadurai et al. 2009		Animal died (final diagnosis of *Staphylococcus* sepsis)		1
	10–20 mg/kg PO BID-TID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Mirazapine	0.6 mg/kg PO Q24h (do not exceed 30 mg total dose)	Pinnipeds	TMMC Pharmacopeia				Multiple
Neomycin	20 mg/kg TID	*Zalophus californianus*	McBain, unpubl. data				Unspecified
Neomycin-polymyxin B-gramicidin	Ophthalmic topical solution TID	*Phoca vitulina*	Flower et al. 2014	For pinniped keratitis			1
Nystatin	600,000 IU TOTAL DOSE PO TID		Dunn et al. 1982				Unspecified
Omeprazole	0.1 mg/kg PO Q24h	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		1
Ondansetron	0.2–0.4 mg/kg PO, SQ, IM, IV Q24h-BID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Oxytetracycline	20 mg/kg IM Q3-4d	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
	20–40 mg/kg IM Q48h	*Zalophus californianus*	Prager et al. 2015	For tx of leptospirosis	Clinical resolution	☠	14

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Oxytocin*	5 IU TOTAL DOSE SQ, IM, IV	*Zalophus californianus*	TMMC Pharmacopeia	Induction of parturition		☠	Multiple
	20 USP units TOTAL DOSE IM once	Pinnipeds	See **Chapter 10** Reproduction	For milk letdown			Multiple
	20–40 USP units TOTAL DOSE IM		Schroeder 1993				Unspecified
Penicillin G (potassium)	30,000 IU/kg IM Q48h	*Zalophus californianus*	Prager et al. 2015	For tx of leptospirosis	Clinical resolution	☠	14
Penicillin G (benzathine/procaine)	30,000 IU/kg IM Q24h Q48h	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Pentobarbital	78–156 mg/kg IV, IC (2–4 mL/10 kg of 390 mg/mL)	Pinnipeds	TMMC Pharmacopeia	For euthanasia			Multiple
Phenobarbital	1 mg/kg PO	*Zalophus californianus*	Field et al. 2012				1
	1–1.5 mg/kg PO Q24h-BID	*Zalophus californianus*	Gage 1999	Anticonvulsant			Unspecified
	4 mg/kg PO BID	*Phoca vitulina*	Zabka et al. 2006				1
	4 mg/kg PO, IM BID × 2d, then 2 mg/kg PO, IM BID × 5d	*Zalophus californianus*	TMMC Pharmacopeia				Multiple
Piperazine	110 mg/kg PO		Sweeney 1974b				Unspecified
Ponazuril	5 mg/kg PO Q24h	*Phoca vitulina*	Zabka et al. 2006		Animal died (final dx of lead toxicosis)		1
	10 mg/kg PO Q24h × 28d	Pinnipeds	TMMC Pharmacopeia	For tx of protozoal infections (*Toxoplasma, Sarcocystis, Neospora*)			Multiple
Potassium chloride/potassium gluconate	2 meq/5 kg PO BID	Pinnipeds	TMMC Pharmacopeia	For tx of hypokalemia			Multiple
Praziquantel	5 mg/kg IM	*Neomonachus schauinslandi*	Gobush et al. 2011		Did not eliminate cestode infection	☠	21
	5 mg/kg PO Q24h × 2d, or 10 mg/kg PO once	*Neomonachus schauinslandi*	Norris et al. 2011	For tx of cestodes	Clinical resolution		3

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	5 mg/kg IM, PO × 2d, or 10 mg/kg IM, PO once	Pinnipeds	TMMC Pharmacopeia	For tx of cestodes and trematodes			Multiple
	10 mg/kg PO Q24h	*Zalophus californianus*, *Phoca vitulina*, *Mirounga angustirostris*	Gage et al. 1985				Unspecified
Prednisone	0.05–0.3 mg/kg PO Q24h	*Zalophus californianus*	Field et al. 2012		No clinical improvement (final diagnosis of fungal)		1
	0.2 mg/kg PO BID	*Zalophus californianus*	Carlson-Bremer et al. 2012		Clinical resolution		1
	0.25–0.5 mg/kg PO BID, tapering dose	Pinnipeds	TMMC Pharmacopeia	Anti-inflammatory dose		☠	Multiple
	0.5 mg/kg PO Q24h	*Zalophus californianus*	Field et al. 2012	For appetite stimulation	Mild improvement in appetite		1
Prednisone-G	Ophthalmic topical solution QID	*Phoca vitulina*	Esson et al. 2015	Post lensectomy			1
Prednisolone	0.4 mg/kg PO BID	*Phoca vitulina*	Flower et al. 2014	Anti-inflammatory dose	No clinical improvement (final diagnosis of neoplasia)		1
Prednisolone sodium succinate	0.25–0.5 mg/kg IM, IV BID	Pinnipeds	TMMC Pharmacopeia	Anti-inflammatory dose		☠	Multiple
Primidone	2.5 mg/kg PO TID loading dose; 1–2.5 mg/kg PO Q24h maintenance		Needham 1978	Anticonvulsant (has largely been replaced by newer anticonvulsants)			Unspecified
Proligestone	5 mg/kg SQ	*Phoca largha*	Katsumata et al. 2003	For contraception	Effective in 94% of cases		10
Prostaglandin F2a (cloprostenol)	0.5 mg (500 μg) TOTAL DOSE IM	*Zalophus californianus*	Brodie et al. 2006	Abortifacient in animals with domoic acid toxicity		☠	13
Prostaglandin F2a (dinoprost)	10 mg TOTAL DOSE IM Q24h × 3d	*Zalophus californianus*	TMMC Pharmacopeia	Abortifacient dose for pregnant animals with domoic acid intoxication, if dexamethasone was not successful in inducing abortion		☠	Multiple

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Ranitidine	150 mg total PO BID × 7d	*Zalophus californianus*	Chinnadurai et al. 2008		Animal died (final diagnosis of amyloidosis)		1
	1.25 mg/kg PO BID	*Phoca vitulina*	Flower et al. 2014	Prophylactic gastroprotectant			1
	1.5 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal)		1
Rifampin	5 mg/kg PO Q24h		Stoskopf et al. 1987				Unspecified
S-adenosyl-methionine	5 mg/kg PO BID	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		1
Simethicone	0.45 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal)		1
	31.25–62.5 mg TOTAL DOSE per feed	Pinnipeds	TMMC Pharmacopeia	For signs of bloat or enteritis			Multiple
Sucralfate	<25 kg: 0.5 g PO TID TOTAL DOSE, >25 kg: 1 g PO TID TOTAL DOSE	Pinnipeds	TMMC Pharmacopeia	Gastroprotectant		☠	Multiple
	10 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal)		1
	15–35 mg/kg PO	*Phoca vitulina*	Flower et al. 2014		Animal died (final diagnosis of neoplasia)		4
	25 mg/kg PO TID × 3d	*Zalophus californianus*	Kelly et al. 2005		Animal died of *Otostrongylus*		1
Sulfadimethoxine-ormetoprim	5.5 mg/kg PO BID	*Phoca vitulina*	Biancani et al. 2012		Animal died (final diagnosis of neoplasia)		1
	10–13 mg/kg PO Q24h	*Zalophus californianus*	McBain, unpubl. data				Unspecified
Suprofen	Ophthalmic topical solution BID	*Neomonachus schauinslandi*	Braun et al. 1996	For tx of corneal opacities			Unspecified
Terbinafine	2.4–2.6 mg/kg PO Q24h	*Zalophus californianus*	Sos et al. 2013		Clinical resolution of dermatomycosis		2
Terbutaline	0.1 mg/kg PO BID (IM, SQ for acute bronchospasm)	Pinnipeds	TMMC Pharmacopeia				Multiple

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Tetracycline	4.5 mg/kg PO TID	*Zalophus californianus*	Gage et al. 1985				Unspecified
	12.5 mg/kg PO Q24h		Farnsworth et al. 1975				Unspecified
	22 mg/kg PO Q24h		Vandenbroek et al. 1985				Unspecified
	22 mg/kg PO TID	*Zalophus californianus*	Dierauf et al. 1985	For tx of leptospirosis	Clinical resolution	☠	66
	44 mg/kg PO BID	*Odobenus rosmarus*	McBain, unpubl. data				Unspecified
Theophylline	0.44 mg/kg IV SLOWLY, twice	*Zalophus californianus*, *Mirounga angustirostris*	Gage et al. 1985				Unspecified
Thiacetarsamide*	1 mg/kg IM Q24h		Sweeney 1986			☠ SEE TEXT—POTENTIAL LETHAL REACTIONS	
Thyroxine (L-thyroxin)	0.01–0.03 mg/kg PO BID, increase to 0.02–0.04 mg/kg PO BID during molt	*Cystophora cristata*	Barnett et al. 2011	For tx of alopecia and decreased serum thyroxine			1
Ticarcillin + clavulanate potassium	20–40 mg/kg IM, IV TID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Tramadol	0.5–1 mg/kg PO BID	*Phoca vitulina*	Flower et al. 2014		No apparent improvement (final diagnosis of neoplasia)		2
	2 mg/kg PO BID	*Phoca vitulina*	Rubio-Garcia et al. 2015				4
	2–4 mg/kg PO BID-QID	*Zalophus californianus*	Boonstra et al. 2015	For analgesia	Active M1 metabolite undetectable in majority of samples	✪	15

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	4.0–5.0 mg/kg PO BID-TID	Pinnipeds	TMMC Pharmacopeia	For analgesia	Questionable efficacy (Boonstra et al. 2015). May work better in conjunction with NSAID		Multiple
Trimethoprim-sulfadiazine	3.6 mg/kg PO BID	*Phoca vitulina*	Koski and Vandenbroek 1986				Unspecified
	22–30 mg/kg PO Q24h	*Zalophus californianus*	Vandenbroek et al. 1985				Unspecified
	33 mg/kg PO Q24h	*Zalophus californianus*	Dierauf et al. 1985	For tx of leptospirosis	Clinical resolution		66
	12 mg/kg PO BID × 7d	*Mirounga angustirostris* pups	TMMC Pharmacopeia	For tx of intestinal coccidia			Multiple
Trimethoprim-sulfamethoxazole	12 mg/kg PO Q24h	*Mirounga angustirostris*	Fauquier et al. 2003		No apparent improvement (final diagnosis of neoplasia)		1
	12–20 mg/kg PO BID	Pinnipeds	TMMC Pharmacopeia			☠	Multiple
Ursodiol	6.6 mg/kg PO Q24h	*Phoca vitulina*	Flower et al. 2014		No apparent improvement (final diagnosis of neoplasia)		1
	10–15 mg/kg PO Q24h	Pinnipeds	TMMC Pharmacopeia	For tx of cholestasis			Multiple
Voriconazole*	1.8 mg/kg PO Q24h, followed by serum voriconazole monitoring	*Odobenus rosmarus*	Schmitt and Proctor 2014		Apparent resolution		1

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	4 mg/kg PO BID	*Zalophus californianus*	Field et al. 2012		Animal died (final diagnosis of fungal)	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	1
Vitamins/Minerals/Supplements							Unspecified
Alpha Lipoic Acid	2–3 mg/kg PO Q24h	*Zalophus californianus*	Mejia-Fava et al. 2011				
	10 mg/kg SQ Q24h	*Zalophus californianus*	TMMC Pharmacopeia	For antioxidant effects to treat acute domoic acid toxicosis			
Lutein	0.89–3.6 mg/kg	Pinnipeds	Koutsos et al. 2013		Supplementation of 3.6 mg/kg Q24h does not affect absorption of vitamin A or E and thus is not a concern for competition		Multiple
Vitamin A	100 IU/kg PO in fish	*Callorhinus ursinus*	Mazzaro et al. 1995a	For maintenance	High levels (50,000 IU/D) may increase vit E requirements		Unspecified
	300–600 IU/day PO	*Callorhinus ursinus*	Mazzaro et al. 1995b	For maintenance		✪	2
Vitamin B1 (thiamine)	2–4 mg/Kcal feed PO Q24h. Follow with oral dosing.		Geraci 1986	For tx of thiamine deficiency			Unspecified
	25–35 mg/kg fish PO Q24h. Give 2 h before feeding.		Geraci 1986	For supplementation when supplements are administered prior to feeding	Empirically effective with reasonably handled food fish		Unspecified
	4.5 mg/kg PO BID. Give at main feeding.		Geraci 1986	For supplementation when supplements are administered at time of feeding	Empirically effective with reasonably handled food fish		Unspecified
	30 mg/kg fish/day		Wohlsein et al. 2003	To prevent thiamine deficiency	Supplement in fish immediately prior to feeding, as thiaminase degrades thiamine		7

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Table 27.3 (Continued) Drug Dosages Reported for Pinnipeds (See Text for Precautions)

Drug	Dosage	Species	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Vitamin B6 (pyridoxine)	0.25 mg/kg PO Q24h		Stoskopf et al. 1987				Unspecified
Vitamin B12	0.25 mg (250 μg) TOTAL DOSE PO Q24h	*Zalophus californianus*, *Phoca vitulina*	Bernard and Ullrey 1989	For maintenance			Multiple
Vitamin B complex	3 mg/kg SQ	*Phoca vitulina*	Flower et al. 2014		Clinical efficacy was not evaluated		1
	7.5 mg/kg IM	*Zalophus californianus*	Kelly et al. 2005		Animal died of *Otostrongylus*		1
Vitamin C	500 mg PO Q24h	*Zalophus californianus*, *Odobenus rosmarus*	Bernard and Ullrey 1989	For maintenance			Multiple
Vitamin E	100 mg/day TOTAL DOSE PO		Geraci 1986		Administer in fish		Unspecified
	5–7 IU/kg IM	*Phoca vitulina*	Flower et al. 2014				2
	600–1000 IU PO Q24h	*Zalophus californianus*, *Phoca vitulina*	Bernard and Ullrey 1989	For maintenance			Multiple
	2200–3000 IU PO Q24h	*Odobenus rosmarus*	Bernard and Ullrey 1989	For maintenance			Multiple
Sodium chloride	3 g/kg of fish PO Q24h		Geraci 1986	For maintenance			Unspecified
	100–200 mg/kg PO, IP		Geraci 1972				Unspecified

Note: tx = treatment; ☠ = read text for important cautions; ✪ = pharmacokinetic study performed.
*Adverse effects observed.

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Table 27.4 Drug Dosages Reported for Sirenians (See Text for Precautions)

Drug	Dosage	Species*	References	Indication	Clinical Notes	Precautions	Number of animals Treated
Amikacin	7 mg/kg IM BID		Walsh and Bossart 1999				Unspecified
Ampicillin	5.5 mg/kg PO Q24h		Stoskopf 1990				Unspecified
Atropine	0.02 mg/kg TOTAL DOSE, 1/4 given IV, 3/4 given SC		Ball et al. 2014	For tx of brevitoxicosis			Unspecified
Bismuth subsalicylate	12 mg/kg PO once, then 6 mg/kg PO Q24h × 5d		Hall et al. 2012		Clinical resolution		1
Ceftiofur	4–10 mg/kg SQ once		Gerlach et al. 2013		Clinical resolution		1
	6.5 mg/kg SQ once		Hall et al. 2012		Clinical resolution		1
Ceftriaxone	22 mg/kg IM Q24h		Walsh and Bossart 1999				Unspecified
Cephalexin	40 mg/kg PO Q24h		Stoskopf 1990				Unspecified
Danofloxacin	6 mg/kg IM Q48h		SeaWorld Orlando Pharmacopeia				Multiple
Dexamethasone	2.2 mg/kg IM		Stoskopf 1990				Unspecified
Fenbendazole	10 mg/kg PO once		Walsh and Bossart 1999				Unspecified
	10–15 mg/kg PO once		Walsh and de Wit 2015				Unspecified
Flunixin meglumine	0.3 mg/kg IV once		Hall et al. 2012				1
	0.07 mg/kg IM once		Hall et al. 2012				1
Gentamicin	4.4 mg/kg IM Q24h		Stoskopf 1990				Unspecified
	2.5 mg/kg PO TID		Walsh et al. 1999	For tx of hemorrhagic colitis, adjunct to metronidazole			Unspecified
Itraconazole	2.5 mg/kg PO BID		See **Chapter 43**, Sirenian Medicine				Unspecified
Ivermectin	0.2 mg/kg (200 mcg/kg) PO		Walsh and Bossart 1999				Unspecified
Ketoprofen	1–2 mg/kg IM		Walsh and de Wit 2015			☠	Unspecified
	2 mg/kg IM		Gerlach et al. 2013		Clinical resolution		1

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Table 27.4 (Continued) Drug Dosages Reported for Sirenians (See Text for Precautions)

Drug	Dosage	Species*	References	Indication	Clinical Notes	Precautions	Number of animals Treated
Metronidazole	7 mg/kg PO BID		Walsh et al. 1999	For tx of hemorrhagic colitis, adjunct to gentamicin			Unspecified
Mineral oil	2–3 mL/kg up to 1.5 L		Walsh and Bossart 1999	For tx of constipation			Unspecified
Oxytetracycline	4.5 mg/kg IM BID	Dugong (*Dugong dugon*)	Elliot et al. 1981				Unspecified
	15 mg/kg IM BID		Stoskopf 1990				Unspecified
Penicillin G (benzathine/ procaine)	25,000 IU/kg IM Q24h	Dugong (*Dugong dugon*)	Cohen 1993				Unspecified
	22,000 IU/kg		Walsh and Bossart 1999				Unspecified
	25,000 IU/kg SC	Dugong (*Dugong dugon*)	Elliot et al. 1981				Unspecified
Praziquantel	8–16 mg/kg PO		Walsh and Bossart 1999	For tx of trematodes			Unspecified
	10–20 mg/kg PO once		Walsh and de Wit 2015				Unspecified
Simethicone	80 mg TOTAL DOSE PO BID-TID		SeaWorld Orlando Pharmacopeia	For gas relief in calves			Multiple
Sulfasalazine	10 mg/kg IM BID		See **Chapter 43**				Unspecified
Tetracycline	55 mg/kg IM BID		See **Chapter 43**				Unspecified

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Table 27.4 (Continued) Drug Dosages Reported for Sirenians (See Text for Precautions)

Drug	Dosage	Species*	References	Indication	Clinical Notes	Precautions	Number of animals Treated
Tramadol	1 mg/kg PO Q24h		Komarnicki et al. 2012				1
Trimethoprim-sulfamethoxazole	21.5 mg/kg PO Q24h × 8d		Hall et al. 2012	Empirical therapy	Clinical resolution		Unspecified
Tulathromycin	2.5 mg/kg SQ Q7d		Ball et al. 2014				Unspecified
Vitamins/Minerals/Supplements							
Vitamin B1 (thiamine)	1 mg/kg IM Q24h. Follow with oral dosing.		Geraci 1986	For tx of thiamine deficiency			Unspecified
	2–4 mg/Kcal feed PO Q24h. Give 2 h before feeding.		Geraci 1986	For supplementation when supplements are administered prior to feeding	Empirically effective with reasonably handled food fish		Unspecified
	25–35 mg/kg fish PO Q24h. Give at main feeding.		Geraci 1986	For supplementation when supplements are administered at time of feeding	Empirically effective with reasonably handled food fish		Unspecified
Vitamin C (ascorbic acid)	1 mg/kg PO Q24h		Stoskopf 1990				Unspecified
Vitamin E	100 IU/kg fish PO Q24h		Geraci 1986				Unspecified

Note: tx = treatment; ☠ = read text for important cautions; ✪ = pharmacokinetic study performed.
*All species are Florida manatee (*Trichechus manatus latirostris*) unless otherwise specified.

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Table 27.5 Drug Dosages Reported for Sea Otters (*Enhydra lutris*) (See Text for Precautions)

Drug	Dosage	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Acetylsalicylic acid	10 mg/kg PO Q36h	Stoskopf 1990		Has largely been replaced by newer NSAIDs	☠	Unspecified
ACTH gel	40 IU TOTAL DOSE	Monterey Bay Aquarium Pharmacopeia	For ACTH-challenge testing			Multiple
Albendazole	100 mg/kg PO BID × 3d, then repeat Q14d × 4 tx cycles	Monterey Bay Aquarium Pharmacopeia	For tx of acanthocephalans	Varied clinical success		Multiple
Amikacin*	5 mg/kg IM BID	Stoskopf 1990			☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified
	10 mg/kg IM Q24h	Stoskopf 1990			☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified
Aminopentamide sulfate	0.1–0.4 mg/kg IM BID	Williams et al. 1995a	Anticholinergic			Unspecified
Aminophylline	5 mg/kg PO, IM	Monterey Bay Aquarium Pharmacopeia				Multiple
	10 mg/kg PO BID	Williams et al. 1995a				Unspecified
Amoxicillin	10–20 mg/kg PO QID	Williams et al. 1995b				Unspecified
Amprolium	19 mg/kg PO Q24h	Kollias and Fernandez-Moran 2015	For tx of coccidia			Unspecified
Atropine	0.02–0.04 mg/kg IM, IV	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE			Multiple
Buprenorphine	0.01–0.03 mg/kg IM BID-QID	Monterey Bay Aquarium Pharmacopeia	For analgesia		☠	Multiple
Butorphanol	0.05–0.5 mg/kg IM BID-QID	Monterey Bay Aquarium Pharmacopeia	For analgesia		☠	Multiple
Calcium gluconate	50–150 mg/kg IV, IP SLOWLY to effect	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE			Multiple
Carprofen	1.5–2 mg/kg PO BID × 5–10d	Calle et al. 1999	For analgesia		☠	Unspecified
Cefazolin	10–30 mg/kg IM QID	Monterey Bay Aquarium Pharmacopeia				Unspecified
Cefovecin	8 mg/kg SC Q5-7d	Lee et al. 2016			✪	7
Ceftiofur	6.6 mg/kg SQ once	McDermott et al. 2013	Prophylactic during castration			2
Cephalexin	20 mg/kg PO BID	Williams 1993				Unspecified

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Table 27.5 (Continued) Drug Dosages Reported for Sea Otters (*Enhydra lutris*) (See Text for Precautions)

Drug	Dosage	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Charcoal, activated	10 mL slurry/kg PO (slurry = 1 g/5 mL water)	Monterey Bay Aquarium Pharmacopeia	For tx of toxin ingestion			Multiple
	100 mL TOTAL DOSE	Williams 1993		Give via orogastric tube		Unspecified
Cholestyramine	2 g/20 mL water Q24h-BID	Monterey Bay Aquarium Pharmacopeia	For tx of microcystin intoxication	Some evidence of protective benefit if given early in case		Multiple
Cimetidine	5–10 mg/kg IV, IM, SC, PO BID	Monterey Bay Aquarium Pharmacopeia				Unspecified
	5 mg/kg IM TID	Williams 1993	For hemorrhagic diarrhea in pups			Unspecified
Cyproterone	1.5–2.3 mg/kg PO Q24h	Calle et al. 1999	Testosterone blocking agent	Controlled undesirable male-associated behaviors		Unspecified
Dawn liquid detergent	1:16 dilution, 4–8 L topically	Williams 1993	To remove external oil			Unspecified
Deslorelin	0.18–0.23 mg/kg SC once	Calle et al. 1999	GnRH agonist to suppress testosterone	Controlled undesirable male-associated behaviors		Unspecified
Dexamethasone	2 mg/kg IV, IM	Williams et al. 1995b				Unspecified
Dexamethasone SP	5 mg/kg IM, IV	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE (shock)			Multiple
Dextrose 2.5% in normal saline	20 mL/kg SQ	Monterey Bay Aquarium Pharmacopeia	For tx of hypoglycemia, hypothermia, dehydration			Multiple
Dextrose 5% in LRS	To effect IP	Williams 1993	For hypoglycemic seizure			Unspecified
Dextrose 10%	To effect IV	Williams 1993	For hypoglycemic seizure			Unspecified
Dextrose 50%	0.5–2 mL/kg IV, IP SLOWLY	Monterey Bay Aquarium Pharmacopeia	For profound hypoglycemia	Follow with a high protein/fat meal ASAP to prevent rebound hypoglycemia		Multiple
Diazepam	0.5–1 mg/kg IV, IM	Monterey Bay Aquarium Pharmacopeia	For status epilepticus			Multiple
	0.5–2 mg/kg per rectum or intranasal	Monterey Bay Aquarium Pharmacopeia	For status epilepticus	Maximum of 20 mg bolus		Multiple

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Table 27.5 (Continued) Drug Dosages Reported for Sea Otters (*Enhydra lutris*) (See Text for Precautions)

Drug	Dosage	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Diphenhydramine	0.5–2 mg/kg PO BID	Stoskopf 1990				Unspecified
	2 mg/kg IM PRN	Monterey Bay Aquarium Pharmacopeia	For allergic reaction, anaphylaxis, vaccine reaction			Multiple
Diphenoxylate	0.1–0.2 mg/kg PO BID	Williams et al. 1995a				Unspecified
Diphenylhydantoin	20–30 mg/kg PO BID	Stoskopf 1990	Anticonvulsant	Has largely been replaced by phenobarbital		Unspecified
Doxapram HCl	5–10 mg/kg IV, IM, sublingual (pups)	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE			Multiple
Enrofloxacin	5–20 mg/kg IM, PO Q24h	Monterey Bay Aquarium Pharmacopeia			☠	Unspecified
Epinephrine	0.0025–0.005 mg/kg (2.5–5 μg/kg) IV, 0.05 mg/kg (50 μg/kg) IT	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE—anaphylaxis			Multiple
	0.01–0.02 mg/kg (10–20 μg/kg) IV, 0.2 mg/kg (200 μg/kg) IT	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE—cardiac arrest			Multiple
Famotidine	0.5 mg/kg IM, SQ	Monterey Bay Aquarium Pharmacopeia	For gastritis, gastric ulcers			Multiple
Furosemide	2 mg/kg IM	Williams et al. 1995a				Unspecified
	2–4 mg/kg IM, IV, SC	Monterey Bay Aquarium Pharmacopeia	For pulmonary edema, hypertension			Multiple
Gentamicin*	2 mg/kg IM BID × 5d	Williams 1993	Pups		☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified
	2 mg/kg IM TID	Williams 1993	Adults		☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified
	4.4 mg/kg IM BID	Stoskopf 1990			☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified
Glycopyrrolate	0.011 mg/kg IV, IM	Monterey Bay Aquarium Pharmacopeia	For bradycardia			Multiple
Griseofulvin	30 mg/kg PO BID × 45d	Stoskopf 1990				Unspecified
Hetacillin	20 mg/kg PO BID	Stoskopf 1990			☠	Unspecified

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Table 27.5 (Continued) Drug Dosages Reported for Sea Otters (*Enhydra lutris*) (See Text for Precautions)

Drug	Dosage	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Hydrocortisone	50 mg/kg IV, 5–150 mg/kg	Stoskopf 1990	EMERGENCY DOSE: for shock			Unspecified
Insulin (NPH)	2 IU/kg SC	Stoskopf 1990		To effect, monitoring required		Unspecified
Isoproterenol	0.1–0.2 mg TOTAL DOSE IM, SC Q24h	Stoskopf 1990				Unspecified
Ivermectin	0.2–0.5 mg/kg (200-500 mcg/kg) SC, PO, repeat q2wk as needed	Kollias and Fernandez-Moran 2015			☠	Unspecified
	0.3 mg/kg (300 mcg/kg) intranasal	McDermott et al. 2013; Monterey Bay Aquarium Pharmacopeia	For tx of nasal mites	Nasal mites controlled with twice yearly administration		Multiple
Ketoconazole	10 mg/kg PO TID	Stoskopf 1990				Unspecified
Lactated Ringer's Solution (LRS)	40–50 mL/kg/d IV, SC, IP	Stoskopf 1990	Maintenance fluids			Unspecified
	66 mL/kg SC	Williams 1993	Pups			Unspecified
Leuprolide acetate	0.11–0.19 mg/kg IM Q28d	Calle et al. 1997	Suppression of testosterone	Controlled undesirable male-associated behaviors	☠	Unspecified
	0.9-1.1 mg/kg IM, SC Q4 months	Calle et al. 1999	4-month depot formulation		☠	Unspecified
Levamisole*	CONTRAINDICATED	Kollias and Fernandez-Moran 2015	CONTRAINDICATED	CONTRAINDICATED	☠ **SEE TEXT—POTENTIAL LETHAL REACTIONS**	Unspecified
Lidocaine	2 mg/kg IV bolus; repeat in 20 min	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE—ventricular arrhythmia			Multiple
Lincomycin	20 mg/kg IM BID	Stoskopf 1990				Unspecified
Lorazepam	0.03–0.04 mg/kg IM, intranasal BID	Monterey Bay Aquarium Pharmacopeia	For status epilepticus			Several
Mannitol	1500 mg/kg IV once	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE—to reduce intracerebral pressure			Multiple
Mebendazole	50 mg/kg BID × 2d	Kollias and Fernandez-Moran 2015			☠	Unspecified

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Table 27.5 (Continued) Drug Dosages Reported for Sea Otters (*Enhydra lutris*) (See Text for Precautions)

Drug	Dosage	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Medroxyprogesterone acetate	75 mg/kg IM Q21d × 3 doses	Stoskopf 1990	To decrease sex drive in males			Unspecified
Meloxicam	0.1–0.2 mg/kg SC	McDermott et al. 2013				2
	0.3 mg/kg PO, IM BID × 3d; then Q24h	Monterey Bay Aquarium Pharmacopeia				Unspecified
Methylprednisolone	0.06 mg/kg/day IM, IV	Williams et al. 1995a				Unspecified
Metoclopramide HCl	0.2 mg/kg IM BID	Stoskopf 1990	Pups			Unspecified
Metronidazole	15–20 mg/kg BID × 2d	Kollias and Fernandez-Moran 2015				Unspecified
	25–30 mg/kg PO × 5d	Stoskopf 1990				Unspecified
Neomycin	10–14 mg/kg PO Q24h	Williams et al. 1995a	As presurgical GI prep			Unspecified
Oxacillin	20 mg/kg IM TID	Stoskopf 1990				Unspecified
Oxytocin	10–20 USP units IV, IM	Stoskopf 1990	For milk letdown			Unspecified
Penicillin G	20,000 IU/kg IM BID	Williams 1993				Unspecified
	22,000 IU/kg IM BID	Williams and Siniff 1983				Unspecified
Phenobarbital	1 mg/kg IV PRN	Stoskopf 1990	Anticonvulsant			Unspecified
	1–5 mg/kg PO BID	Monterey Bay Aquarium Pharmacopeia	For chronic seizure management	Periodic evaluation of blood levels indicated for long-term maintenance		Multiple
	2–4 mg/kg IM, IV Q30 min	Monterey Bay Aquarium Pharmacopeia	Anticonvulsant	Do not exceed 20 mg/kg total dose		Multiple
Ponazuril	5–10 mg/kg PO Q24h × 30–60d	Monterey Bay Aquarium Pharmacopeia	For *Sarcocystis* infection	Recrudescence of clinical signs not uncommon		Multiple
Praziquantel	5–25 mg/kg PO, SC, repeat in 2 weeks	Kollias and Fernandez-Moran 2015				Unspecified
	6 mg/kg IM once	Williams et al. 1995a				Unspecified
Prednisolone sodium succinate (Solu-Delta-Cortef)	15–30 mg/kg IV Q4-6h	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE—shock			Multiple
Ranitidine	1–4 mg/kg PO TID	Williams et al. 1995b				Unspecified
Simethicone	0.5–1.5 mL TOTAL DOSE PO BID-QID	Monterey Bay Aquarium Pharmacopeia	For pups with hyper borborygmus, tenesmus, colic	Well tolerated		Multiple

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Table 27.5 (Continued) Drug Dosages Reported for Sea Otters (*Enhydra lutris*) (See Text for Precautions)

Drug	Dosage	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Sodium bicarbonate	0.5–1 mEq/kg IV SLOWLY	Monterey Bay Aquarium Pharmacopeia	EMERGENCY DOSE—metabolic acidosis			Multiple
Sodium iodide	4 mg/kg IV, PO BID	Stoskopf 1990				Unspecified
Stanozolol*	10–25 mg TOTAL DOSE IM Q7d	Stoskopf 1990		Contraindicated in gravid females	☠ SEE TEXT—POTENTIAL LETHAL REACTIONS	
Sucralfate	500–1000 mg TOTAL DOSE PO before feeding	Monterey Bay Aquarium Pharmacopeia	For GI protection			Multiple
Tetracycline	20 mg/kg IM Q24h	Stoskopf 1990			☠	Unspecified
Trimethoprim-sulfadiazine	20 mg/kg IM BID	Williams 1993	For hemorrhagic diarrhea in pups			Unspecified
	33.6 mg/kg PO BID	Calle et al. 1999				Unspecified
Vasopressin	2.5–5 IU TOTAL DOSE IV, IM Q48h	Stoskopf 1990				Unspecified
Zinc chlorhexidate gel	0.5 mL TOTAL DOSE Q24h	Young et al. 1999	For dental prophylaxis	Give in an ice cube		Unspecified
Vitamins/Minerals/Supplements						
Selenium	0.1 mg/kg IV, IM	Williams et al. 1995b				Unspecified
Vitamin B1 (thiamine)	1 mg/kg IM Q24h	Geraci 1986		Follow by oral		Unspecified
	2–4 mg/kcal feed PO Q24h	Geraci 1986		2h before feeding		Unspecified
	25–35 mg/kg fish PO Q24h	Geraci 1986		At main feeding		Unspecified
Vitamin B9 (folic acid)	2.5 mg TOTAL DOSE PO	Stoskopf 1990				Unspecified
Vitamin B complex	2 mL/L fluids SC	Williams 1993	Pups			Unspecified
	1 mL/10 kg SC	Williams 1993	Adults			Unspecified
Vitamin C (ascorbic acid)	50–100 mg TOTAL DOSE PO, IM, SC Q24h	Stoskopf 1990				Unspecified
Vitamin E	100 IU/kg fish Q24h	Geraci 1986				Unspecified
	400 IU/day	Williams et al. 1995b				Unspecified

Note: tx = treatment; ☠ = read text for important cautions; ✪ = pharmacokinetic study performed.
*Adverse effects observed.

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Table 27.6 Drug Dosages Reported for Polar Bears (*Ursus maritimus*) (See Text for Precautions)

Drug	Dosage	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Aluminum hydroxide	21.1 mg/kg PO BID	LaDoucer et al. 2014	For management of end-stage renal failure			1
Amoxicillin	22 mg/kg PO BID × 7d	Morris et al. 1989		Animal died (final diagnosis of blastomycosis)		1
Amoxicillin-clavulanic acid	12 mg/kg PO BID × 7d	Velguth et al. 2009	Postsurgical prophylaxis			1
Ampicillin	10 mg/kg IV, IM BID	Mendez-Angulo et al. 2014		Clinical resolution		1
Buprenorphine	0.01 mg/kg IM Q24h	Velguth et al. 2009	For analgesia			1
Butorphanol	0.2–0.4 mg/kg IM BID	Velguth et al. 2009	For analgesia			1
Carprofen	0.75 mg/kg IM	Velguth et al. 2009		Clinical improvement noted		1
	0.85 mg/kg PO Q24h × 2d	Velguth et al. 2009		Clinical improvement noted		1
	1.5–2 mg/kg PO Q24h-BID	LaDoucer et al. 2014				5
Ceftiofur	2.3 mg/kg IM once	Velguth et al. 2009	Post-surgical prophylaxis			1
Cephalexin	11 mg/kg PO BID	Velguth et al. 2009		Clinical resolution		1
Chloramphenicol	30 mg/kg PO IV Q8h	Association of Zoos and Aquariums (AZA) 2009	For tx of *Neorickettsia*			Multiple
Cimetidine	3.5 mg/kg IM Q24h	Velguth et al. 2009		Clinical resolution		1
Diphenhydramine	0.3 mg/kg PO BID × 5d	Monson et al. 2014		Did not improve stool (final dx of food allergy)		1
Enrofloxacin	5 mg/kg IM Q24h	Mendez-Angulo et al. 2014		Did not improve (required surgery for omental torsion)		1
	5–6 mg/kg IM Q24h	Velguth et al. 2009		Clinical resolution		1
Famotidine	0.5 mg/kg IM Q24h	Velguth et al. 2009		Clinical resolution		1
	0.5 mg/kg PO BID	Velguth et al. 2009		Clinical resolution		1

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Table 27.6 (Continued) Drug Dosages Reported for Polar Bears (*Ursus maritimus*) (See Text for Precautions)

Drug	Dosage	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
	0.53 mg/kg PO Q24h	LaDoucer et al. 2014	For management of end-stage renal failure			1
Fenbendazole	10 mg/kg PO Q24h × 3d	AZA 2009	For tx of cestodes			Multiple
	25 mg/kg PO Q24h × 3d, repeat 2 weeks	Monson et al. 2014		Did not improve stool (final dx of food allergy)		1
	50 mg/kg PO Q24h × 10–14d	AZA 2009	For tx of trematodes			Multiple
Hydromorphone	0.05 mg/kg IV	Mendez-Angulo et al. 2014	For analgesia	Intraoperative		1
Itraconazole	4.3 mg/kg PO Q24h × 90d	Morris et al. 1989	For tx of blastomycosis	Clinical resolution		1
Ivermectin	0.2 mg/kg (200 μg/kg) PO once	AZA 2009	For tx of mites and lice, or monthly heartworm preventative in endemic areas			Multiple
Ketoprofen	3 mg/kg IV	Mendez-Angulo et al. 2014	For analgesia	Intraoperative		1
Mebendazole	20 mg/kg PO Q24h × 3d	AZA 2009	For tx of nematodes			Multiple
Meloxicam	0.1 mg/kg Q24h	AZA 2009				Multiple
Metoclopramide	0.5 mg/kg IM Q24h	Mendez-Angulo et al. 2014		Clinical resolution		1
Metronidazole	25 mg/kg PO BID × 7d	Monson et al. 2014		Did not improve stool (final dx of food allergy)		1
Milbemycin oxime	1 mg/kg PO once	AZA 2009	For tx of *Baylisascaris* and other nematodes			Multiple
Omeprazole	0.82 mg/kg PO Q24h	LaDoucer et al. 2014	For management of end-stage renal failure			1
Oxytetracycline	7 mg/kg IV BID	AZA 2009	For tx of *Neorickettsia*			Multiple

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Table 27.6 (Continued) Drug Dosages Reported for Polar Bears (*Ursus maritimus*) (See Text for Precautions)

Drug	Dosage	References	Indication	Clinical Notes	Precautions	Number of Animals Treated
Penicillin G (benzathine/ procaine)	44,000 IU/kg IM Q48h	Velguth et al. 2009		Clinical resolution		1
Pyrantel pamoate	12 mg/kg PO Q24h × 3d	AZA 2009				Multiple
Tetracycline	20 mg/kg PO TID × 21d	AZA 2009	For tx of *Neorickettsia*			Multiple
Trimethoprim-sulfadiazine	15 mg/kg PO, SC BID	AZA 2009	For tx of *Neorickettsia*			Multiple
	30 mg/kg PO Q24h × 7d	Velguth et al. 2009	Post-surgical prophylaxis			1
Trimethoprim-sulfamethoxazole	16 mg/kg PO BID × 7d	Velguth et al. 2009		Clinical resolution		1

Note: tx = treatment; ☠ = read text for important cautions; ✪ = pharmacokinetic study performed.

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