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THERAPEUTICS IN FERRETS

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Owing to its "exotic" nature, engaging personality, and adaptability to apartment life, the domestic ferret (*Mustela putorius furo*) has risen rapidly in popularity over the last decade. Now considered the third most popular mammalian pet in the United States, it also enjoys great popularity outside the United States. In the year 2000 and beyond, opportunities for veterinarians to treat ferrets will continue to increase. As the armamentarium of therapeutic drugs for ferrets is quite similar to those that are used to treat dogs and cats, more and more veterinarians will realize the potential value of supplementing their traditional clientele with ferret owners.

In the author's 15 years of treating ferrets, as well as working with ferret owners and ferret associations, he has discovered several guiding principles that he will gladly pass on to any practitioner who is currently treating or considering treating ferrets.

1. **A ferret is not a cat, nor is it a dog.** Ferrets are their own species, and many of their diseases are unique. One cannot extrapolate from one's knowledge of dog and cat diseases when treating ferrets, because even diseases that may be seen in all three species (e.g., insulinoma, adrenal neoplasia, mast cell tumors) have markedly different courses and prognoses in ferrets than in dogs or cats.
2. **Ferret owners are generally well informed about their pet's condition.** More than any other pet owner, the ferret community is well connected, and many ferret owners routinely research the Internet or contact other ferret owners or veterinary consultants before or during the course of treatment. Be honest with your

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EXOTIC ANIMAL PRACTICE

ferret owners—they will forgive an honest mistake far faster than they will being kept in the dark.

3. **Ferrets make excellent surgical patients.** There are several common conditions in ferrets that are better treated surgically with a medical follow-up than vice versa (e.g., adrenal disease and insulinoma). As a general rule, it is far better to operate early and forego empiric antibiotic/anti-inflammatory therapies. One has a better surgical candidate, as well as potential pathology untempered by the use of therapeutic drugs.

In the remainder of the article this author reviews the most commonly used therapeutics drugs in ferrets, as well as some commonly used nutritional supplements. Practitioners should realize that the use of therapeutic drugs (with the exception of two vaccines, Fervac-D [United Vaccines, Madison, WI] and Imrab [Merial Ltd., Athens, GA]) and nutritional supplements in ferrets represent extralabel use of these drugs, and informed consent rules of usage do apply. Additionally, because these drugs are used in an extralabel fashion, principles and levels of toxicity for these compounds have not been established for ferrets.

ADMINISTERING MEDICATIONS TO FERRETS

Medications are most commonly administered to ferrets in the form of oral liquids, powders masked by a variety of treats, or as injections. The small size of the ferret oral cavity precludes the use of tablets as a therapeutic option.

Oral medications can be instilled into the side of a ferret's mouth with a dropper or dose syringe; however, ferrets that strongly resist medication given in this way can incur aspiration pneumonia as a result of struggling. Several oral medications used in ferrets, such as bismuth subsalicylate or metronidazole, are extremely bitter and are met with tremendous resistance. To maximize owner compliance and minimize patient stress, the wily practitioner can request specially compounded formulations from a nearby pharmacy. Large numbers of compounding flavors are now available for pharmacists; trial and error can be used to identify the best preparation for a specific ferret. (In general, the cherry flavoring used to flavor many OTC children's drugs is acceptable to ferrets.)

Another tried-and-true method of medicating ferrets is adding the drug to a flavored treat. The author's preference is the use of Gerber's chicken baby food (Gerber, Inc., Fremont, MI) to mask a number of bitter drugs such as bismuth subsalicylate (Pepto-Bismol, Procter and Gamble, Cincinnati, OH), prednisone, and even metronidazole. Other compounds that can be used to mask the flavor of bitter compounds are Linatone (Lambert Kay, Inc., Cranbury, NJ) or Nutrical (EVSCO, Buena, NJ).

Subcutaneous injections such as vaccines or antibiotics are generally given to scruffed ferrets between the shoulder blades. Ferret skin is considerably tougher than dog or cat skin, and a new disposable needle (25-gauge) should always be used. Fluids can be administered subcutaneously along the ribs and on either side of the thoracic and cranio-lumbar spine. Intramuscular injections are generally given into the quadriceps muscle (with care given to protect the sciatic nerve), and the lumbar musculature can be used as necessary. Even healthy ferrets generally do not possess a tremendous amount of muscle mass, and this diminishes in several disease conditions and old age.

Although phlebotomy can occasionally be performed on unsedated ferrets distracted with Linatone or another coveted treat, intravenous injections are generally administered to anesthetized or sedated ferrets; this prevents extravasation of drugs in the event of movement. Injections or IV fluids can be administered to sedated ferrets in the cephalic or saphenous veins with 20- to 23-gauge butterfly catheter; indwelling catheters can be placed in either of these veins, as well as the jugular vein. Catheter placement (24-gauge over-the-needle) might require a modified cutdown technique, ranging from nicking the skin over the vein (with a sharp needle) to more invasive techniques in severely dehydrated animal. Intraosseous catheter placement can also be used in severely dehydrated patients for fluid administration; however, the use of other drugs is discouraged with intraosseous catheters to prevent bone marrow damage.

Stomach tubes of a diameter of 5 mm or less can be used for administration of nutritional supplements or contrast media, but sedation is often required.¹¹ Caution must be used in placement because ferrets may struggle and vomit. Because the ferret's cough reflex is poorly developed, intratracheal placement might go unnoticed by the practitioner, with devastating results.

ANTIBIOTICS

Antibiotics represent the largest class and most widely used of therapeutic agents used in ferrets. Ferrets are tolerant of a wide range of antibiotics; however, several general principles are important to remember when employing antibiotics in treating ferrets.

1. **Improper use of antibiotics can sorely hamper diagnostic testing.** Ideally, antibiotics should be chosen as a result of diagnostic testing, rather than employed in an empiric fashion. In cases of suspected bacterial disease, broad-spectrum antibiotics such as amoxicillin (20 to 40 mg/kg b.i.d.) or enrofloxacin (Baytril, Bayer Corp., Agricultural Division, Kansas City, MO) (10 mg/kg b.i.d.) can be administered immediately following diagnostic procedures until definitive results are available. The use of antibiotics prior to culture and sensitivity of suspected viral lesions could

skew results or totally negate efficacy. Additionally, premature use of antibiotics can reduce levels of bacteria below the threshold needed for visualization of bacteria in cytology preparations or in tissue section.

2. **Antibiotics can mask clinical signs.** It is not uncommon that the use of antibiotics, even those not specifically warranted for a particular clinical disease, results in a decrease in the severity of clinical signs, yielding a false impression that an individual animal is responding appropriately to therapy. The typical clinical picture is that a sick animal is treated empirically with a broad-spectrum antibiotic, resulting in an increase in appetite and activity and a return to normal body temperature. After several days, a recurrence in clinical signs is seen, and a different broad-spectrum antibiotic is employed. In some cases, four and five antibiotics may be tried without success in the span of 2 to 3 weeks before any diagnostic procedures are attempted.
3. **Antibiotics may result in clinical signs by themselves.** Although broad-spectrum antibiotics are generally well tolerated by ferrets and do not result in life-threatening alterations of intestinal flora (as can be seen in rodents and rabbits), occasionally antibiotic usage can result in development of clinical signs. For example, approximately 5% to 10% of animals receiving amoxicillin at higher dosages (20 mg/lb) become inappetent. In this case, reducing the dose of 20 mg/kg or substituting enrofloxacin at 10 mg/kg can result in appetite recovery. Other antibiotics, such as metronidazole, can result in clinical signs ranging from inappetence to nausea, ptyalism, or development of gastric ulcers owing to the stress of administration. The prudent practitioner ensures that antibiotics are warranted and specific for a disease or agent prior to their employment.
4. **Be specific in the use of antibiotics.** Over the years, the author has seen a number of antibiotics employed as broad-spectrum antibiotics, often as a result of impatience with clinical progress or a lack of proper diagnostic testing. One of the most commonly misused antibiotics is chloramphenicol, a drug that is efficacious in only one ferret disease, proliferative colitis (the result of *Leobacter* infection). A well-stocked pharmacy is no substitute for knowledge of ferret diseases or the judicious use of culture and sensitivity.

A special note is warranted about the use of aminoglycosides in ferrets. Nephrotoxicity and ototoxicity of the aminoglycosides in domestic animals has been well documented⁴; the same is true for the domestic ferret. Ferrets appear to be exquisitely sensitive to the nephrotoxic effects of gentamicin; the use of even published therapeutic dosages in this species can result in acute tubular necrosis and death. Some authors suggest that minimization of renal toxicity and neuromuscular blockade could be seen as a result of division of the total daily dose into three

smaller doses given over 8 hours and dilution of the antibiotic with saline (4 mL/kg) and slow infusion over 20 minutes, followed by serial evaluation of blood urea nitrogen (BUN) and creatinine values.²² The author recommends the use of this antibiotic only as a last resort following positive identification of an organism that is sensitive to this antibiotic and no other. Amikacin appears to be a better choice for gram-negative organisms that are sensitive to aminoglycosides.³ Additionally, use of other aminoglycosides or cephalosporins in concert with aminoglycoside antibiotics can potentiate the toxicity of this group of antibiotics, and concurrent use with loop diuretics such as furosemide can potentiate ototoxicity (Table 1).

ANESTHETICS AND ANALGESICS

A wide array of anesthetics and analgesics are available for use in the ferret, with many having recently become available (Table 2). Inhalant anesthetics are the anesthetics of choice for ferrets, even those with chronic illness or critical injury. Owing to their small size, ferrets can be masked down easily; fractious patients can be placed in an induction cage. Inhalant anesthesia by mask is excellent for short procedures, including phlebotomy, and can be used even in some instances for somewhat longer procedures, such as castration or removal of skin tumors. Ferrets undergoing intra-abdominal surgery or extended or multiple surgical procedures should be intubated and maintained using a nonbreathing system. Intubation should be performed only on ferrets that have been masked down; this can be facilitated by local application of 0.05% lidocaine to the larynx with a cotton swab. Premedication is generally not necessary in the ferret when inhalant anesthetic is used.

Of the inhalant anesthetics, isoflurane is by far the safest for use in the ferret, with side effects being uncommon. Reported side effects include dose-dependent cardiopulmonary depression in a small number of cases.⁶ Halothane and methoxyfluorane can also be used in ferrets, but a higher rate of compound-specific side effects (hepatotoxicity and nephrotoxicity, respectively, and dose-dependent cardiopulmonary depression with both) should be expected. Additionally, both isoflurane and halothane anesthesia result in a number of changes in the complete blood count in ferrets, decreasing hematocrit, hemoglobin concentration, red blood cell count, and plasma protein levels.¹⁰

Traditionally, injectable anesthetics have been associated with several problems in ferrets, such as prolonged induction and recovery, a need for premedications (e.g., atropine) and occasionally, unexpected death. Ketamine, often used in combination with other drugs, such as valium or acepromazine, to provide analgesia and muscle relaxation is probably the agent most commonly used but can result in prolonged recovery or seizure activity. Newer injectable anesthetics, such as metomidine (Dormitor, Pfizer Corp., New York, NY) and tiletamine/zolazepam (Telazol, Fort Dodge Animal Health, Fort Dodge, IA) are gaining

Table 1. COMMONLY USED ANTIBIOTICS AND RECOMMENDED DOSAGES

Antibiotic	Recommended Dosage	Comments
Amikacin	8–16 mg/kg total per day IM or IV	Potentially ototoxic and nephrotoxic
Amoxicillin	10–35 mg/kg b.i.d. PO, SC	Can result in decreased appetite
Ampicillin	5–10 mg/kg b.i.d. SC, IM, IV	
Cefadroxil	15–20 mg/kg b.i.d. PO	Can potentiate aminoglycoside toxicity
Cephalexin	15–25 mg/kg b.i.d.–t.i.d. PO	Can potentiate aminoglycoside toxicity
Cephaloridine	10–15 mg/kg s.i.d. IM, SC	Can potentiate aminoglycoside toxicity
Chloramphenicol	50 mg/kg b.i.d. PO (palmitate), SC, IM (succinate)	Potential human toxicity; palmitate form unavailable in US
Ciprofloxacin	5–15 mg/kg b.i.d. PO	
Clavulanic acid/ amoxicillin	10–20 mg/kg b.i.d.–t.i.d. PO	
Clindamycin hydrochloride	5–10 mg/kg b.i.d. PO	
Clarithromycin	50 mg/kg s.i.d. PO	
Enrofloxacin	10–20 mg/kg b.i.d. IM, SC, PO	
Erythromycin	10 mg/kg q.i.d. PO	
Gentamicin	4–8 mg/kg total divided b.i.d.–t.i.d. SC, IM, IV	Potentially ototoxic and nephrotoxic; use only when specifically indicated by culture and sensitivity
Lincocin	10–15 mg/kg t.i.d. PO 10 mg/kg b.i.d. IM	
Metronidazole	10–30 mg/kg s.i.d.–b.i.d. PO	Extremely bitter; flavor must be masked for client compliance
Neomycin	10–20 mg/kg b.i.d.–q.i.d. PO	
Netilmicin	6–8 mg/kg divided s.i.d.–t.i.d. SC, IM, IV	Potentially ototoxic and nephrotoxic
Oxytetracycline		Not for use in pregnant jills
Penicillin G, procaine	20,000–40,000 IU/kg s.i.d.–b.i.d. IM	
Penicillin G, sodium or potassium	20,000 IU/kg q4hr SC, IM, IV or 40,000 U/kg t.i.d. PO	
Sulfadimethoxine	25 mg/kg s.i.d. PO, SC, IM	
Tetracycline	25 mg/kg b.i.d.–t.i.d.	
Trimethoprim-sulfa	30 mg/kg b.i.d. PO	Concentrated in urine, therefore could be broad-spectrum of choice for urogenital infections prior to C&S; idiopathic blood dyscrasias have rarely been seen in ferrets
Tylosin	10 mg/kg s.i.d.–b.i.d. PO	

wider acceptance for short procedures and can be combined with additional injectable agents such as butorphanol, ketamine, or xylazine for a longer duration of action or deeper planes of anesthesia and muscle relaxation. The actions of metomidine, when this agent is used alone, can be fully reversed by administration of the alpha-agonist atipamezole (Antisedan, Pfizer Corp., New York, NY), providing a higher safety factor; however, addition of butorphanol or ketamine is often required for longer procedures or to attain a higher level of anesthesia.

It is hoped that the emergence of newer injectable anesthetics with a higher margin of safety will diminish the use of the older injectable anesthetics (e.g., xylazine and barbiturates) that characteristically produce dose-dependent effects such as prolonged recovery, cardiorespiratory depression, and marked difficulties in regulating the depth of anesthesia. When compared with newer injectables, xylazine, which in healthy patients can result in heart block, hypoxemia, and unexpected death, is a poor choice even when used with other anesthetics. Barbiturates, which have long been used in ferrets in research settings, have a known history of drug interactions and prolonged recoveries, and also should probably be avoided in this species.

A general note: Ferrets have a marked tendency to become hypothermic during and immediately after anesthesia. The proper use of heat lamps, circulating water baths, and heated IV fluids markedly decreases the incidence of prolonged recovery and unexpected death in ferret surgical patients.

The use of analgesia is becoming more commonplace in ferret surgery. Analgesia results in a smoother recovery, a decrease in systemic stress and resultant stress-related diseases (e.g., gastric ulcers), and a more rapid return to normal behavior and function. Preemptive analgesia, or the administration of analgesic drugs during premedication, is an excellent option available for practitioners working with ferrets. Caution should be exercised, however, in employing analgesia in ferrets with injuries requiring prolonged cage rest past the immediate postoperative period. Buprenorphine, which has a prolonged period of action (up to 12 hours) and butorphanol are both well tolerated in ferrets (Table 3).

PREMEDICATIONS AND SEDATIVES

Premedications are rarely needed for routine ferret procedures in which inhalant anesthesia is used. Actually, in most instances, surgical recovery is smoother and more rapid if premedications are not used. A possible exception to this rule is the use of atropine when inhalation anesthesia is administered by facemask rather than by endotracheal tube.

Premedications are commonly used with certain injectable anesthetics, however. Atropine is used to counter the excessive salivation which can be seen with tiletamine/zolazepam or ketamine. Atropine also should be administered as a premedication whenever xylazine is used to counteract heart block. Acepromazine can be used to smooth recovery

Table 2. ANESTHETICS AND RECOMMENDED DOSAGES

Anesthetic	Route	Dosage	Comments
Enflurane	Inh	Induce at 5%, MAC = 2%	O ₂ flow rate at 1–1.5 L min
Isoflurane	Inh	Induce at 5%, MAC = 1%	Inhalant anesthetic of choice O ₂ flow rate at 1–1.5 L min
Halothane	Inh	Induce at 5%, MAC = 1.5%	O ₂ flow rate at 1–1.5 L min
Ketamine	IM, SC	10–20 mg/kg (sedation) 10–35 mg/kg (surgical anesthesia)	Can require premedication with atropine for salivation; can result in seizures in some individual animals; muscle rigidity can be seen, incomplete analgesia likely
Ketamine-diazepam*	IM	K = 10–30 mg/kg D = 1–2 mg/kg	Muscle rigidity may be seen, incomplete analgesia likely.
Ketamine-medetomidine†	IM	K = 5 mg/kg M = 80 µ/kg	
Ketamine-xylazine	IM	K = 10–30 mg/kg X = 1–2 mg/kg	Xylazine reversible with yohimbine at 0.5 mg/kg IM
Ketamine-acepromazine	IM	K = 10–30 mg/kg A = 0.05–0.3 mg/kg	Hypotensive, hypothermic
Ketamine-medetomidine-butorphanol†	IM	K = 5 mg/kg M = 80 µ/kg B = 0.1 mg/kg	Medetomidine reversible with atimepazole (Antisedan) at 400 mg/kg
Medetomidine	IM	M = 80 µ/kg	Reverse with atimepazole (Antisedan) at 400 mg/kg
Medetomidine-butorphanol†	IM	M = 80 µ/kg B = 0.1 mg/kg	Medetomidine reversible with atimepazole (Antisedan) at 400 mg/kg
Telazol	IM	22 mg/kg	Paddling and sneezing may be seen during recovery ¹⁵
Telazol-xylazine*	IM	T = 1.5 mg/kg X = 1.5 mg/kg	Xylazine reversible with yohimbine at 0.5 mg/kg IM
Telazol-xylazine-butorphanol*	IM	T = 1.5 mg/kg X = 1.5 mg/kg B = 0.2 mg/kg	Xylazine reversible with yohimbine at 0.5 mg/kg IM
Xylazine-butorphanol	IM	X = 2.0 mg/kg B = 0.2 mg/kg	Xylazine reversible with yohimbine at 0.5 mg/kg IM

*Can be combined in same syringe.

†Draw up in separate syringes, can be combined in one syringe for administration.

Inh = inhalant; MAC = minimum alveolar concentration

Table 3. ANALGESICS AND RECOMMENDED DOSAGES

Analgesic	Route	Dosage	Comments
Aspirin	PO	10–20 mg/kg s.i.d.	Short-term duration
Buprenorphine	SC, IM,	0.01–0.05 mg/kg b.i.d.–t.i.d.	
Butorphanol tartrate	IM, SC	0.05–0.5 mg/kg q4hr	
Flunixin meglumine	IM, PO	0.5–2.0 mg/kg s.i.d.	Bitter tasting but injectable; can be given PO
Meperidine	SC, IM	5–10 mg/kg q2–3hr	
Nalbuphine	SC, IM	0.5–1.5 q2–6hr	
Oxymorphone	IM, IV	0.05–0.2 mg/kg b.i.d.–q.i.d.	
Pentazocine	SC, IM	5–10 mg/kg q4hr	

from injectable anesthesia, but practitioners should be cognizant of its hypotensive and hypothermic action in ferret patients. Diazepam can be used in conjunction with ketamine to prevent seizure activity (Table 4).

FLUID AND NUTRITIONAL THERAPY

One of the most important adjuncts to treating ill ferrets is providing for fluid and nutritional needs. Ill ferrets, like sick dogs and cats, rarely take in enough food and water to cover their needs. In the author's experience, dehydration is commonly underestimated in the ferret. The ferret's tough skin does not lend itself well to the skin turgor test; overall activity is a better clinical monitor for borderline dehydration. Empiric fluid therapy is often of benefit in ferrets with history of vague GI signs or a complaint of recent lethargy and can restore the ferret activity and attitude for a period. The normal daily intake of water for maintenance is approximately 75 to 100 mL/kg/day for adult ferrets; ferrets presenting in shock or those with profound losses from vomiting or diarrhea can require doses of up to 180 to 240 mL/kg over a 24-hour period.

Noncritical ferrets do well with subcutaneous fluids; total intake should be divided and given every 8 to 12 hours. Most ferrets can readily absorb 30 to 60 mL subcutaneously, depending on size and body weight. Ferret owners can often perform this task at home, not only ensuring proper fluid therapy of the ferret at night and on weekends, but also assisting the veterinarian in the control of infectious diseases at

Table 4. PREMEDICATIONS AND RECOMMENDED DOSAGES

Premedication	Route	Dosage	Comments
Acepromazine	IM, SC	0.1–0.25 mg/kg	Hypotensive, hypothermic
Diazepam	IM	3 mg/kg	For use with ketamine
Midazolam	IM, SC	1 mg/kg	
Atropine	IM, SC	0.05 mg/kg	For bradycardia or control of salivary secretions
Glycopyrrolate	IM, SC	0.01 mg/kg	

the hospital. Lactated Ringer's solution is the backbone of fluid therapy in the ferret and has a wide application in this species. Dextrose in saline 2.5 or 5% is the solution of choice for hypoglycemic patients.^{12, 19}

Another problem commonly facing practitioners is nutritional therapy of the ill ferret. Many patients arrive at the hospital with a history of eating only treats (if anything) for several days prior to presentation. Ferrets, which generally eat every 4 to 6 hours, quickly mobilize fat stores to supply short-term energy needs. Over time, the flooding of the liver with fat results in elevations of alanine aminotransferase and serum alkaline phosphorus levels and a diffusely yellow gross appearance to the liver.

Currently, nutritional supplements are extralabel uses of human foods or food supplements. The author's preference is Gerber Second Foods Chicken (Gerber, Inc., Fremont, MI)—a ferret-palatable supplement that is highly digestible and can also be used as a treat or to mask unpalatable medications. An additional benefit to this product is that unlike many other nutritional supplements, it need not be administered by dosing syringe and can easily be fed by hand. Many veterinarians use Hills' a/d (Hills Pet Products, Topeka, KS) for nutritional supplementation with excellent results. In the ferret community, there is a vast array of recipes for nutritional supplements, known as "duck soup." The balance of these supplements is based on high-caloric human supplements such as Ensure (Abbott Laboratories, Abbott Park, IL) or Deliver 2.0 (Bristol-Myers Squibb, Princeton, NJ) combined with any number of additives.

If giving nutritional supplements by syringe, administer at a rate of 2 mL to 5 mL every 2 to 3 hours. Ideally, ill ferrets can be trained to drink gruel from a saucer or bowl, at which time it can be fed ad libitum every 4 hours. In cases in which these products are used for over 30 days, it is wise to grind the ferret's normal ration and add it in powdered form to the mixture. This not only ensures that all trace mineral and vitamin requirements are met but also facilitates the animal's eventual return to normal rations. Ferrets on a high-quality feline or ferret maintenance diet generally do not need additional mineral or vitamin supplementation. Dosages for commonly administered vitamins and minerals are available here, however (Table 5).

A key to the proper fluid and nutritional support of the ferret patient is the delegation of this activity to the owner for the greatest extent possible. In the author's experience, ferret owners are generally capable of giving subcutaneous fluids and handfeeding ferrets on a round-the-clock basis, when such activity is required. Practitioners

Table 5. SUPPLEMENTS

Supplement	Route	Dosage	Comments
B-vitamin complex	SC, IM	1-2 mg/kg daily	
Iron dextran	IM	10 mg/kg q7 days	

should encourage owners to take an active role in nursing as early in the treatment cycle as possible.

PARASITICIDES

As compared with dogs and cats, ferrets generally do not have significant parasite problems. Owing to the nature of ferret farming in the United States, as well as their primarily indoor pet role, endoparasites are rarely seen in adult ferrets. Pet store kits are most likely to have endoparasites, which generally take the form of asymptomatic protozoal infections. Nematode infections of the gastrointestinal tract are quite rare in this country. For this reason, a fecal examination should be part of the annual or semiannual examination of all ferrets, but empiric endoparasite treatment is neither recommended nor necessary.

Ectoparasites, such as fleas and ear mites, are common in ferrets, however. Flea control treatments that are used in puppies and kittens are generally considered safe for ferrets. The new generation of flea treatments available, including lufenuron (Program, Novartis Animal Health, East Hanover, NJ) fipronil (Frontline Top Spot, Merial Ltd., Athens, GA), and imidacloprid (Advantage, Bayer Animal Health, Shawnee Mission, KS) appears safe in ferrets, although testing has not been performed in this species. Dosages for these products approximate those used in small cats. Pyrethrin-based shampoos and dips are generally acceptable for ferrets; organophosphate shampoos are best avoided. Ear mites can be treated by subcutaneous injection of 0.2 to 0.4 mg/kg ivermectin (Ivomec, Merial, Ltd., Athens, GA) every 2 weeks or topical instillation of a solution of 0.5 mg/kg divided between the ears. Practitioners should avoid using both the topical and subcutaneous routes concurrently to decrease the risk of toxicity.¹⁴

Rarely, practitioners may encounter skin mites such as *Demodex* and *Sarcoptes scabiei* in the ferret. These are most often seen in animals that are housed with infected dogs or cats, or in animals immunosuppressed from a concurrent disease such as distemper. Although dosages for older treatments such as lime sulfur or organophosphate dips are available, ivermectin injections, at 0.2 to 0.4 mg/kg subcutaneously every 7 to 14 days, are safer and more effective.¹⁴

Antiprotozoal drugs occasionally are required in ferrets. Coccidiosis is occasionally seen in facility outbreaks; whereas adult infections are usually asymptomatic, severe infections in kits can be lethal. Sulfadiazine (Albon, Pfizer, Inc., New York, NY) works well in cases of coccidiosis in ferrets at dosages and protocols commonly used in dogs and cats. Another commonly diagnosed protozoal infection of ferrets, especially those housed outdoors, is giardiasis. Although clinical signs are often not seen with this infection, its zoonotic potential warrants treatment whenever the diagnosis is made. Metronidazole is effective in the treatment of giardiasis in ferrets; however, its bitter taste requires a masking flavor.

Heartworm disease is a commonly overlooked problem in ferrets. As ferrets are natural hosts for *D. immitis*, all ferrets living in heartworm endemic areas receive heartworm preventive medication. Although treatment for heartworms in the ferret is feasible, the overall survival rate of infected ferrets is significantly less than that of dogs, because of several reasons: (1) because ferrets do not produce circulating microfilaria, infections are less readily identified, (2) because of the small size of the ferret's heart, a smaller worm burden can result in heart failure and death, (3) increased incidence of aberrant migration of adults in the ferret as compared with the dog, and (4) difficulty in enforcing cage rest following treatment. Treatment for heartworm disease in ferrets is similar to that in dogs, with thiacetarsamide at 2.2 mg/kg IV by cephalic catheter b.i.d. for 2 days. Immiticide (melarsomine dihydrochloride) can be used instead of thiacetarsamide but is associated with a lower survival rate. Additionally, antithrombotic therapy is recommended in all treated ferrets, starting with heparin at 100 U SC s.i.d. for 21 days, which is followed by 22 mg/kg aspirin s.i.d. PO for 3 months. Oral prednisone given at 1 mg daily may also be of benefit.⁸ Following a negative ELISA test (generally in about 4 months), heartworm prevention can begin. Heartworm prevention in ferrets can be accomplished either with a 0.1 mg/mL suspension of ivermectin in propylene glycol given at a dosage of 0.02 mg/kg, or a monthly dosage (55 µg) of a commonly available ivermectin tablet preparation for cats up to 5 lb (Heartgard for Cats, Merck Agvet Division, Rahway, NJ) (Table 6).⁸

ANTIFUNGALS

Dermatophytosis occasionally is seen in ferrets housed outdoors or with other household pets who are infected. Infections are more severe in kits or ferrets who are immunosuppressed from concurrent disease. For infections that do not heal spontaneously, griseofulvin and topical keratolytic shampoos should effect a cure.

Systemic fungal infections such as blastomycosis, coccidiomycosis, and histoplasmosis have been reported but fortunately are rare. Dosages for systemic antifungals are provided in Table 6; however, a poor prognosis should be offered to the owner before initiating any type of therapy. The nephrotoxicity of amphotericin B is well known, and careful monitoring of BUN values and hydration status is warranted. Although ketoconazole is not as nephrotoxic, and the drug can be given orally rather than intravenously, results of therapy with this drug as the mainstay of treatment have not been promising (Table 7).

ADRENAL-RELATED THERAPIES

Over the last few years, there has been a tremendous amount of interest in finding medical options for the treatment of adrenal-associ-

Table 6. PARASITICIDES

Parasiticide	Route	Dosage	Comments
Amitraz	Dip		Apply 3–6 times at 2-week intervals
Caparsolate	IV	2.2 mg/kg q12hr for 2 days	
Diethylcarbamazine	PO	5–11 mg/kg s.i.d.	
Fiperonil	Topical	0.2–0.4 mL once monthly	Supplied in premeasured 0.4-mL tubes of 1.9% solution
Imidiclopride	Topical	0.1 mL once monthly	Supplied in premeasured 1.0-mL tubes
Immiticide	IM	2.5 mg/kg once, then 2 injections 1 month later 24 hr apart	Associated with a lower survival rate than traditional caparsolate therapy for heartworm disease, only advantage is IM route
Ivermectin	SC	0.2–0.4 mg/kg	Given SC every 7–14 days for <i>S. scabiei</i> and <i>Demodex</i> sp, given every 14 days for ear mites
	Topical	0.2–0.5 mg/kg	Instilled into ear and massaged for ear mites
	PO	0.6 mg/kg once monthly	For heartworm prevention
Lime sulfur	Dip	1:40 dilution	Once weekly for 6 wk; can discolor fur
Lufenuron	PO	30 mg/kg monthly	Available as flavored tablets for cats weighing less than 6 lb
Metronidazole	PO	15–25 mg/kg b.i.d. for 14 days	Bitter taste, ferret may salivate or vomit
Milbemycin oxime	PO	1.15–2.33 mg/kg once monthly	For heartworm prevention
Praziquantel	PO	5–10 mg/kg, repeat in 2 wk	For cestode infections
Pyrantel pamoate	PO	4.4 mg/kg, repeat in 2 wk	For nematode infections
Sulfadimethoxine	PO	50 mg/kg once, then 25 mg/kg s.i.d. for 9 days	For coccidial infections

Table 7. ANTIFUNGAL AGENTS AND RECOMMENDED DOSAGES

Antifungal	Route	Dosage	Comments
Amphotericin B	IV	0.4–0.8 mg/kg once per week to total dose of 7–25 mg	Nephrotoxic; must monitor BUN values and hydration status carefully
Griseofulvin	PO	25 mg/kg s.i.d. for 3–4 wk	
Ketoconazole	PO	10–30 mg/kg s.i.d.–b.i.d.	

BUN = blood urea nitrogen

ated endocrinopathy (AAE) in the ferret. AAE, a syndrome resulting from excessive liberation of estrogens and estrogenic precursors from proliferative lesions in the adrenal cortex, is a common condition in American ferret bloodlines. The syndrome results in a constellation of cutaneous, behavioral, and reproductive signs in affected ferrets. Bilaterally symmetrical alopecia, vulvar swelling in spayed females, and a return to intact reproductive behavior are common signs of AAE; less commonly, prostatic disease, dysuria, and even pancytopenia are seen. Although unilateral and bilateral adrenalectomy still remains the most effective treatment method,^{21, 24} several new drugs are being evaluated for use in geriatric ferrets who are not good surgical candidates.

For several years, mitotane (o,p'-DDD, Lysodren, Bristol Myers Squibb, Princeton, NJ), an adrenocorticolytic agent, has been used in ferrets with AAE; however, results have been largely unsatisfactory. Drawbacks of mitotane use in affected ferrets include (1) nonselectiveness for the estrogen-secreting cells of the adrenal cortex, (2) high required dose to elicit a clinical response, and (3) a wide variability in individual response to the drug. The outcome of mitotane use in ferrets is at best unpredictable and ranges from no effect to widespread necrosis of the adrenal cortex with resultant adrenocortical insufficiency. Clinical results are generally palliative and tend to recur when the drug is discontinued.²¹ Ketoconazole, which has been used in the dog to inhibit adrenocortical hormone production, appears to have no significant therapeutic effect in the ferret.

Recently, new classes of drugs are being explored to treat adrenal disease in the ferret.* It should be noted, however, that these drugs affect only the debilitating clinical signs of the disease but not the growth of the adrenocortical lesion. Adrenocortical malignancies, although a minority of overall cases, continue to grow unchecked, resulting in life-threatening complications.

Leuprolide acetate (Lupron, TAP Pharmaceuticals, Deerfield, IL) is a gonadotropin-releasing hormone (GnRH) agonist, which through negative feedback inhibits the release of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) from the pituitary gland. In humans,

*The following information was graciously provided by Dr. Charles A. Weiss, Potomac Animal Hospital, Potomac, Maryland, 1999.

rats, and dogs it has been shown to significantly decrease serum levels of androgens and estrogens.^{5, 13} Clinical trials in ferrets are ongoing, and initial results are promising. The drug can be used as a daily injection, or a 1- or 4-month depot injection. Each bottle must be reconstituted with diluent, which is provided by the manufacturer. Although expensive, a single vial can treat 10 ferrets. Stability once reconstituted is unknown but is also under investigation. Clinical signs generally begin to resolve within 1 to 4 weeks of treatment. Reversal of clinical signs is often complete.

Bicalutamide (Casodex, Zeneca Pharmaceuticals, Wilmington, DE) is a nonsteroidal, androgen antagonist drug that blocks the androgen receptor at the level of the target organ and at the level of the hypothalamus. Bicalutamide is available in 50-mg tablets, which can be used at a dosage of 5 mg/kg once a day.²⁶ Results do not appear as encouraging as with leuprolide acetate, but it can be effective in certain individual animals. It works particularly well to alleviate the stranguria associated with an enlarged prostate.

Anastrozole (Arimidex, Zeneca Pharmaceuticals, Wilmington, DE) is a nonsteroidal aromatase inhibitor that inhibits the production of estrone and estradiol from their precursors. This is available as a 1-mg tablet and can be compounded into a liquid. Because it primarily interferes with estrogen production, it is less useful in animals in which large amounts of androgens are secreted by the adrenal gland. This drug should not be administered concurrently with Casodex, because clinical signs can worsen as a result of a buildup of the precursors (Table 8).

HORMONES

Several hormones or their human analogs are used to induce ovulation in the ferret. Prolonged estrus is a potentially life-threatening condi-

Table 8. HORMONAL AND OTHER AGENTS

Drug	Route	Dosage	Comments
Anastrozole	PO	0.1 mg/kg s.i.d.	Anti-estrogen
Bicalutamide	PO	5 mg/kg s.i.d.	Androgen blocker; can be effective in male animals with adrenal-related prostatic disease
Leuprolide acetate	IM	3 mg/kg q4mo (dosage for 1-month and daily injections not available)	Decreases levels of estrogens and androgens at level of the pituitary gland
Mitotane	PO	50 mg/kg daily for 7 days, then 50 mg every third day	Unpredictable results; recommend ACTH stimulation test to evaluate corticolytic effects

ACTH = adrenocorticotropic hormone

tion in the ferret, which is an induced ovulator. High levels of estrogens in jills that are not brought out of heat either by coitus or by use of therapeutic drugs can result in fatal bone marrow depression.

In most cases, ovariectomy is the logical and efficient method of bringing the jill out of heat, especially when prolonged estrus is the result of owner ignorance or neglect; however, ovulation can be induced in breeding jills or by animals that are not surgical candidates by injection of exogenous hormones. Human chorionic gonadotropin (Cystorelin, Merial Ltd., Athens, GA) can be used IM at a dose of 100 IU, or gonadotropin releasing hormone can be used at a dose of 20 µg either IM or subcutaneously. The dose can be repeated in 1 week if signs of estrus have not significantly regressed.

Epoetin alfa (Epoegen, Amgen, Inc., Thousand Oaks, CA), a recombinant human erythropoietin, has been used in the ferret to stimulate the production of red blood cells in the bone marrow, but overall the results of this therapy are not encouraging.

Diabetes mellitus occasionally is seen in the ferret. Although diabetes is treatable in the ferret, blood glucose levels are notoriously difficult to regulate. Most animals are best regulated with NPH insulin, beginning at an empirical dosage of 0.1 U insulin per ferret twice daily.¹⁹ Ultralente insulin, which may only require injection once daily, can be considered in ferrets when the blood glucose remains consistently lower than 200 mg/dL (Table 9).¹⁹

CARDIOACTIVE DRUGS

Cardiomyopathy is a common malady of American bloodlines of ferrets. A genetic problem of incomplete penetrance, all degrees of heart failure can be seen in ferrets of all ages. Older ferrets with less severe

Table 9. HORMONES

Hormone	Route	Dosage	Comments
Epoetin	IM	50–150 IU/kg 3 × weekly	Dosage can be decreased to once weekly if significant RBC index increases are seen
GnRH	IM	20 µg, repeat in 1 wk as necessary	Most effective 14 days after onset of estrus
Human chorionic gonadotropin	IM	100 IU, repeat in 1 wk as necessary	Most effective 14 days after onset of estrus
Insulin, NPH	SC, IM	0.1–0.5 U/kg b.i.d. to start, adjust to optimal dose	Can require additional dilution; monitor urine for glucose and ketones
Stanozolol	PO, SC	0.5 mg/kg b.i.d.	Use with caution in hepatic disease

GnRH = gonadotropin-releasing hormone; RBC = red blood cell

signs generally tend to respond to treatment more readily than do younger ferrets with more fulminant signs. It is prudent to caution the owner that cardiomyopathy is a progressive condition and that treatment only slows the progression of the disease, rather than effecting a cure or even stabilization.

When using cardioactive drugs in the ferret, it is advisable to begin treatment at the lowest doses and frequency if possible and adjust upward as needed. Cardioactive drugs should not be administered in the absence of good follow-up and periodic evaluation. Electrocardiography, ultrasonography, radiography, and monitoring of blood levels of digitalis, as well as periodic evaluation of clinical chemistry values, helps to find and maintain the optimal levels and combinations of these drugs and adjunctive therapies.

Although many cardioactive drugs have become popular in veterinary medicine over the past 10 years, furosemide and digitalis are still the mainstays of therapy in this condition. In many cases, because the onset of clinical signs is slow, one or both of these drugs needs to be instituted at presentation.

Because both hypertrophic and dilated cardiomyopathies are seen in the ferret (with dilated being the more common), practitioners should choose additional drugs with care and make sure that they are appropriate for the type of heart disease present. Angiotensin-converting enzyme (ACE) inhibitors (e.g., enalapril), which decrease vascular tension and thereby reduce edema can be used in cases of dilative cardiomyopathy. Enalapril maleate is supplied in tablet form; if compounded into a solution, the solution is good for 24 hours only. Venodilators also can help in dilative cardiomyopathy by decreasing preload and can be applied directly to the skin. Hypotension can be seen when a combination of these drugs is used.

A different armamentarium of adjunctive therapies is recommended for hypertrophic cardiomyopathy. Because the desired result is to increase diastolic function and relax a thickened myocardium, calcium channel blockers and beta-adrenergic blockers are recommended. Owing to the predilection of these drugs to induce heart block, close clinical follow-up to include electrocardiography is recommended (Table 10).

ANTINEOPLASTIC AGENTS

Lymphosarcoma, or malignant lymphoma, is the commonest malignancy in the ferret and the malignancy in which chemotherapy is most often attempted. Ferrets generally tolerate the use of common chemotherapeutic agents in lymphoma protocols well; however, only a small minority go into remission. Hence, it is best to give lymphoma patients a poor prognosis at the outset of chemotherapy, in hopes that one eventually will be proven wrong.

Several protocols for lymphoma chemotherapy have been published,^{1, 7, 20} and the reader is directed to these articles and texts for a

Table 10. CARDIOACTIVE AGENTS AND RECOMMENDED DOSAGES

Cardioactive Drug	Route	Dosage	Comments
Atenolol	PO	6.25 mg s.i.d. PO	For hypertrophic cardiomyopathy, supplied as 25-mg tablet; beta-adrenergic blocker
Digoxin elixir	PO	0.005–0.01 mg/kg s.i.d.–b.i.d. for maintenance	Monitor blood levels if possible
Diltiazem	PO	2.0–7.5 mg/kg b.i.d., adjust as necessary	For hypertrophic cardiomyopathy, calcium channel blocker; can result in heart block
Enalapril	PO	0.25–0.5 mg/kg s.i.d.–q48hr	For dilative cardiomyopathy, ACE inhibitor
Furosemide	PO, SC, IM, IV	1–4 mg/kg b.i.d.–t.i.d.	Loop diuretic
Nitroglycerin 2% Ointment	Apply to shaved skin	1/8 in s.i.d.–b.i.d.	For dilative cardiomyopathy; apply to ear pinna or skin of thigh; may result in hypotension; venodilator
Propranolol	PO, SC	0.5–2 mg/kg s.i.d.–b.i.d.	For hypertrophic cardiomyopathy Beta-adrenergic blocker

detailed description of the protocols. Drugs that have been used in combination protocols in the treatment of lymphosarcoma include prednisone, vincristine, cyclophosphamide, doxorubicin, asparaginase, and methotrexate. The dosages of these agents are published in Table 11; however, these are only guideline values, and definitive dosages can be tailored to the size and weight of the patient, level of response to previous chemotherapy, and several other factors. Isotretinoin, a drug used in the prevention of skin cancer and cystic acne in humans, has been used as palliative therapy in ferrets with cutaneous lymphoma.¹⁸ In addition, homeopathic, herbal, and vitamin treatments have been described for lymphoma in the ferret.¹ Owing to the many factors that must be considered when planning treatment for lymphoma patients, including the variant of lymphoma, tumor burden and distribution, age and general health, owner resources and desires, drug availability, and practitioner experience, there is probably no one “best” combination of drugs, radiation, and surgical intervention for ferrets with lymphoma.

In geriatric patients, or in patients whose owners are unwilling

Table 11. ANTINEOPLASTIC AGENTS AND RECOMMENDED DOSAGES

Agent	Dosage	Comments
Asparaginase	400 IU/kg IP	
Bleomycin	10 μ /m ² q7 days	Used for SCC in ferret
Cyclophosphamide	10 mg/kg PO or SC	
Doxorubicin	1 mg/kg IV q21 days for 5 treatments	May be used in conjunction with other agents or as a single agent in rescue protocols
Prednisone	1 mg/kg s.i.d.–b.i.d. in conjunction with other drugs, up to 5 mg/lb as palliative therapy by itself	Single agent in use for palliative therapy
Vincristine	0.07–0.12 mg/kg IV	

SCC = squamous cell carcinoma

to use more stringent chemotherapy protocols, palliative therapy of lymphosarcoma can be accomplished with high-dose oral prednisone beginning at a dose of 2 mg/kg PO s.i.d., which can be increased as needed. In several cases, especially in younger animals with lymphoblastic lymphoma, neoplastic cells initially have a good response to high dose prednisone for several weeks to months, with overall decrease in tumor burden and an increase in activity and appetite. Eventually, however, tumor resurgence occurs, and the neoplasm will continue to spread unchecked.

With the exception of lymphoma, evaluation of antineoplastic agents in ferrets is sketchy at best and largely limited to case reports, often with questionable results. The use of chemotherapy in the treatment of other common neoplasms of the ferret, namely adrenocortical neoplasms and insulin-secreting tumors of the pancreas, are described in other sections and are considered to be inferior treatment modalities when compared with surgical removal. The author has also had the opportunity of reviewing several cases in which streptozotocin was used in the treatment of insulinoma in the ferret without noticeable antineoplastic results.²⁶ Bleomycin was used in a ferret for metastatic squamous cell carcinoma, with initial decrease in the tumor size; however, remission was not seen.⁹

Several generalizations and cautionary statements can be made in the use of chemotherapeutic agents in ferrets.

1. Great care should be exercised in the use of chemotherapeutic agents in ferrets. All intravenous chemotherapeutic agents should be given through an IV catheter to an anesthetized ferret, to minimize hazards to both veterinarian and patient. A subcutaneous vascular access port for administration of these drugs has been reported in the literature.¹⁷ Great care should be exercised in handling many of these chemotherapeutic agents to minimize risks to veterinarians and technicians.

2. Consultation with a veterinary oncologist and referral should be considered in practices at which experience with the use of these agents is limited.
3. Careful and frequent monitoring of the clinical status, as well as blood parameters, to include weekly CBCs and platelet counts, should be part of every chemotherapy protocol.

MISCELLANEOUS DRUGS

Several other drugs have wide application in ferret medicine. Although this list should by no means be considered complete, it does include several commonly used therapeutics not previously covered.

One of the most commonly used classes of therapeutic agents is that of gastrointestinal protectants and antacids. Protectants have wide use owing to the prevalence of gastrointestinal problems in the ferret. This, as well as their relatively high margin of safety, makes them a reasonable choice in many nonspecific gastrointestinal problems in the ferret. Bismuth subsalicylate (Pepto-Bismol, Procter and Gamble, Cincinnati, OH) is a commonly used compound in the treatment of *Helicobacter mustelae* in the ferret. Although it is efficacious, the ferret's resistance to administration of this compound is the stuff of legend. Rather than the typical dosage of 1 mL/kg every 8 hours, the author has found that 1/15 of a tablet ground up and added to a babyfood treat is generally much more palatable. Sucralfate (Carafate, Hoechst Marion Russel Pharmaceuticals, Kansas City, MO) is an excellent treatment for ulcers in the ferret and should be instituted whenever ulcers of any cause are suspected. Dosage is 75 mg/kg 10 minutes before each meal, or four to six times daily. This medication is well tolerated by ferrets. Kaolin-pectin solutions can be of some benefit in chronic diarrhea.

Cimetidine (Tagamet, SmithKline Beecham, Philadelphia, PA) or famotidine (Pepcid, Merck, West Point, PA) can also be used in ferrets with stress ulcers but should be used with caution in ferrets with concurrent inflammatory bowel disease. Elevated gastric pH can worsen digestive function in ferrets with altered digestion from concomitant diseases (e.g., chronic atrophic gastritis or enteric coronavirus infection). Metoclopramide (Reglan, AH Robins, Richmond, VA) is effective in vomiting ferrets; however, practitioners should carefully examine vomiting ferrets for the presence of gastrointestinal foreign bodies or other types of blockage before considering its use.

Anti-inflammatory medication is also widely used in the ferret. The ferret is considered to be a steroid-resistant species and tolerates the use of prednisone or other corticosteroid medications very well. Prednisone is most commonly used either as a palliative chemotherapy agent (see earlier discussion), as a glucogenic agent in the treatment of insulinoma, or as an anti-inflammatory agent in the treatment of chronic inflammatory bowel disease. In the treatment of chronic inflammatory bowel disease, oral dosage of prednisone at 2.2 mg/kg is often enough to

decrease the levels of inflammation in the gut to a level that facilitates normal regeneration; injectable prednisone yields less satisfactory results for this purpose. Dexamethasone is appropriate treatment in cases of shock or trauma for stabilization but generally has little effect against chronic inflammation in the ferret. In the author's experience, ferrets do not show significant clinical effects of steroid administration at levels of 2.2 mg/kg or less, such as elevations in the WBC counts, adrenocortical suppression, or peptic ulcers. Guidance would be to use corticosteroids in this species when indicated without reservation, but within reason.

Table 12. MISCELLANEOUS DRUGS AND RECOMMENDED DOSAGES

Drug	Route	Dosage	Comments
Bismuth subsalicylate	PO	0.25 mg/kg t.i.d.-q.i.d.	(0.5-1 mL/kg Pepto-Bismol suspension) or 1/15 tablet. Ferrets resist this drug strongly!
Chlorpheniramine maleate	PO	1-2 mg/kg b.i.d.-t.i.d.	
Cimetidine	PO, SC, IM, IV	5-10 mg/kg t.i.d.	For use in stress-related gastric ulcers
Diazoxide	PO	5 mg b.i.d. to start; increase as needed up to 30 mg b.i.d.	For use with prednisone for insulinoma therapy; expensive
Diphenhydramine	PO, IM, IV	2 mg/kg 10 min prior to vaccination	Prevaccination dose Therapy for URI, allergy
Famotidine	PO, IV	0.5-2.0 mg/kg 0.25-0.5 mg/kg s.i.d.	For use in stress-related gastric ulcers
Hydroxyzine hydrochloride	PO	2 mg/kg t.i.d.	
Kaolin-pectin	PO	1-2 mL/kg t.i.d.-q.i.d.	
Oxytocin	SC, IM	0.2-3 IU/kg	Parturition induction (with prostaglandin F2-alpha)
Phenobarbital	PO	1-2 mg/kg b.i.d.-t.i.d.	
Prednisone/prednisolone	PO, IM	0.5-2.0 mg/kg	Insulin therapy, anti-inflammatory
Prostaglandin F2-alpha			Parturition induction (with oxytocin)
Sucralfate	PO	75 mg/kg q4-6hr	Administer 10 min before feeding
Sulfasalazine	PO	10-20 mg/kg b.i.d.-t.i.d.	
Theophylline	PO	4.25 mg/kg b.i.d.-t.i.d.	Bronchodilator, occasionally useful in asthma

URI = upper respiratory infections

Sulfasalazine (Azulfidine, Pharmacia & Upjohn, Kalamazoo, MI) can be used in cases of chronic inflammatory bowel disease, but results are usually disappointing. Flunixin meglumine (Banamine, Schering Plough, Kenilworth, NJ) can be used preoperatively and postoperatively to decrease pain and inflammation associated with certain surgical procedures.

The use of prednisone in the treatment of insulinoma deserves special mention. Prednisone's glucogenic actions are widely used for short-term elevation of blood glucose levels in hypoglycemic ferrets; however, the actions of prednisone become progressively less effective over time at higher and higher doses. Practitioners are strongly urged to consider pancreatic nodulectomy or partial pancreatectomy and reserve prednisone therapy for postsurgical or nonsurgical candidates.²⁵ Diazoxide (Proglycem, Baker Norton Pharmaceuticals, Miami FL) is occasionally used as an adjunct to prednisone in the control of hypoglycemia. Diazoxide is a benzothiadiazine derivative that works by inhibiting insulin release from the pancreas. In most cases, the effects of diazoxide are slight, and because of the expense of this medication, it might not be cost effective. Occasionally, severely hypoglycemic ferrets can suffer seizure activity at presentation. Intravenous or intramuscular injection of diazepam should control seizure activity long enough for administration of dextrose-containing fluids to restore blood glucose levels to normal levels.

Antihistamines are occasionally used in the treatment of severe diseases in the ferret. Most commonly, they are given prior to routine vaccination for rabies or canine distemper. Systemic anaphylaxis has been associated with a commonly used distemper product in the ferret, and many practitioners feel that administration of diphenhydramine prior to vaccination decreases the incidence or severity of reaction. Antihistamines are also occasionally used in the treatment of viral upper respiratory infections in ferrets to decrease the amount of nasal secretion and to facilitate eating. The author has used theophylline elixir successfully in the treatment of asthma in the ferret in some cases that did not respond well to antihistamine treatment (although the duration of action of theophylline, even in timed-release form, is considerably shorter) (Table 12).

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