

Ferret Medicine

Introduction:

In exotic animal practice, the ferret is the closest of the commonly seen species to the traditional canine and feline pets. Principles of diagnosis and treatment used for these species can be used for ferrets with good success. Ferrets make ideal patients as they are docile, hardy, and quiet pets. They require little space in the hospital, adapt readily, and tolerate medical procedures well. There are some differences in behavior, techniques and disease susceptibility that the clinician should know, however, so that a diagnosis and treatment can be achieved more easily and efficiently. These differences will be emphasized here.

Ferret Husbandry

Ferret requirements are not difficult to meet. Like any other animal, however, serious problems can result from failure to meet these requirements.

Housing

Most households are not suitable for ferrets to be allowed to range freely. These mischievous creatures can get into the smallest crevices and will often get themselves into dangerous situations. Foreign object ingestion is common and ferret environments should be policed for ingestion hazards. Large wire cages are usually considered best for ferrets. Aquaria tend to have poor ventilation, thereby causing stress to the animal. Multilevel cages with ramps and terraces allow more exercise within the cage confines. Toys should be chosen for safety. Many ferrets have a taste for rubber so toys made of this material should be avoided. Ferrets often choose a corner of the cage for eliminating wastes. If a litter box is placed in this area it will facilitate cleaning. Cellulose litters are preferred over clay cat litter as clay litters are usually dusty and can contribute to respiratory problems.

Nutrition

Ferret nutrition research is not as extensive as canine and feline nutrition research. As carnivore, the natural diet of ferrets is small creatures, usually rodents. In captivity, however, they are usually fed feline diets or specifically made formulated ferret diets. Only very high quality feline diets are acceptable and the highest protein and fat should be chosen. Young ferrets probably require about 38% protein and 20% fat. Slightly lower amounts may be acceptable for mature ferrets. During winter months, fatty acid supplements may be required to keep a healthy coat. All ferret diets should be meat based. Attempts at using plant based diets always result in health problems in ferrets. Carbohydrates and fiber are not handled well by ferrets so diets low in these should be selected. Treats should be limited.

Handling

Most ferrets are docile, friendly, curious creatures that are easily handled without restraint. The stories accounting their foul nature and tendencies to bite are mostly propaganda generated by those who wish ferrets to be banned. Young ferrets can be "mouthy" and caution should be taken, but severe bites are uncommon. Docile ferrets can be lifted under the chest and held on the forearm. It is somewhat difficult for them to hold still, however, so further restraint may be necessary during the veterinary exam. When ferrets are dangled by the scruff of the neck with the feet off of the table, they relax, often yawn, and stop struggling. (Figure 1)

Figure 1



Reproduction

This is not an issue with the majority of ferrets seen in practices in the United States. Marshal Farms produces most of the ferrets sold in pet stores and their policy is to spay or neuter the babies prior to sale. Therefore it is extremely uncommon to find reproductively intact ferrets. While early neutering has made ferrets more saleable and perhaps has made regulatory agencies see ferrets as less risky, some health problems may be associated with this practice.

Female ferrets are known as jills and are seasonal induced ovulators. They will remain in heat for extended periods of time if not bred. This can lead to severe problems as will be discussed later. Litters of 5-10 kits are produced after a gestation of 42 days. Kits open their eyes at 25-35 days and are weaned at 6-8 weeks.¹

Male ferrets are called hobs. Intact males possess a strong musky odor and have a tendency to spray their anal sac contents for marking or defense. Their prepuce terminates on the ventral abdomen much like in a dog, making even very young ferrets easy to sex. Neutering male ferrets will reduce their musk and the tendencies to spray. Descending makes little or no difference in the odor.

Preventative Health Care

Preventative health care is very similar to that in dogs and cats. Early detection and treatment of disease, vaccinations, parasite control, neutering, and dental prophylaxis are all used to maintain their health. For this reason, ferrets are easily incorporated into small

¹Bell JA "Periparturient and Neonatal Diseases" in Hillyer EV, Quesenberry KE eds, *Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery*. Saunders 1997.

animal practices. The veterinarian should become familiar with ferret behavior, anatomy, and diseases but little special equipment is required.

Ferrets should be vaccinated against canine distemper virus. This is a serious disease and the virus is still prevalent in wild carnivores and in dogs. Modified live canine distemper vaccine produced in chicken embryo cell culture should be used (Fervac-United Vaccine). Vaccines produced in ferret cell cultures may cause distemper in ferrets and killed vaccines have poor efficacy. Canine distemper vaccines should be given at 6, 10, and 14 weeks, and then annually. Ferrets are not susceptible to feline distemper and should not be vaccinated for this. Canine combination vaccines (provided that the distemper portion meets the criteria above) can be used without problems in some ferrets but vaccinating with the unnecessary viruses increases the chance of vaccine reactions. Ferrets are somewhat susceptible to Bordatella so it may be advisable to vaccinate them for this disease in high risk situations (shows etc.).

Rabies vaccination is more for legal protection than for protection from the rabies virus. Most pet ferrets have literally no potential exposure to rabies. However, if a ferret bites someone, even accidentally, the legal position of many regulatory agencies is to euthanize the ferret and test for rabies. Since the approval of Imrab-3 (Meriel) for ferrets, some agencies will allow vaccinated ferrets to be quarantined like dogs or cats. Vaccinating with unapproved products is probably not justified. Although this product can be given every three years in dogs or cats, it is only approved for one year in ferrets.

Neutering ferrets can prevent all of the problems associated with the reproductive tract. In jills, it is essential unless they can be bred at each heat. In the United States, most young ferrets are purchase already neutered. Ideally, ferrets should be neutered later at 4 to 6 months of age. While most ferrets have also been descented at the time of adoption, this provides no health benefit and is of very questionable value.

Heartworm prevention is important in endemic areas. Like cats, ferrets have a lower susceptibility to heartworm but a single worm can cause severe disease. Diagnosis and treatment are difficult and prevention is easy. Ivermectin can be used for prevention. Ferrets are very tolerant of this drug. Small canine or feline heartworm preventatives can be given or Ivomec can be diluted and given monthly.

Geriatric monitoring is an extremely important part of ferret health care. Several conditions are extremely common in ferrets over 3 years of age and early detection is important if successful therapy is to occur. The frequency of examination should increase to every 6 months after 3 years of age and at least one of these should be accompanied by laboratory and other diagnostics. Minimally, a complete blood count and a fasting blood glucose should be performed. Preferably a full chemistry profile, radiography, or ultrasound evaluation should be done.

Dental prophylaxis is important in ferrets. As a ferret ages periodontal disease can progress to serious stages with pain, tooth loss, and gingivitis. Unfortunately many ferrets do not live long enough for this to become a problem due to other problems but dental care must be included if good long term health is to be achieved.

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Diagnostic Approach

Ferrets make ideal patients. They are hardy, resilient, easily handled, and most clinical procedures can be easily mastered. They are carnivores like dogs and cats, with similar anatomy and physiology.

A thorough history should be taken on ferrets. Information regarding the age, previous medical problems, if and when they were neutered, husbandry, vaccinations, and of course, the problem at hand. The history can often give a strong indication of what the problem may be but it is important that the clinician does not develop tunnel vision toward that problem. Concurrent diseases are quite common, a systematic approach is critical.

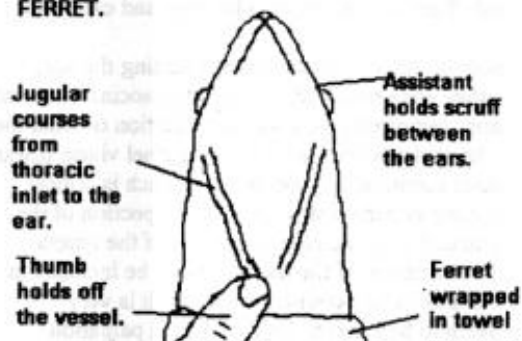
Examination of ferrets should be done systematically. A visual inspection of the eyes, nose, ears, skin, coat, and the genital and anal openings, palpation of the lymph nodes, thorax, abdomen, and limbs, and auscultation of the thorax should be included in the examination. The oral cavity and teeth should be examined carefully. It is very common for one or more of the canine teeth to be broken. The abdominal palpation should take place with the ferret held vertically by the scruff. This allows the viscera to "fall" caudally so they are more easily palpated. Splenomegaly is very common in ferrets and may or may not be significant. Normal ferrets are very relaxed during palpation. A tense abdomen may indicate pain. Very little gas is generally present in the intestinal tract of ferrets. Extensive gurgling or borborygmus should be considered significant. The weight, preferably in grams, the temperature, pulse, and respiration should be recorded. Normal body temperature of ferrets is 101 to 103°F. Heart rate is 180-250 beats per minute. Respirations vary from 10 to 40 per minute. Once the examination is complete, a problem list, differentials, and diagnostic and therapeutic plans should be made.

Radiography is often part of the workup in ferrets. It is especially valuable for detection and evaluation of gastrointestinal, respiratory, and cardiac diseases. There is a large amount of intraperitoneal fat in most ferrets, giving substantial contrast. It is beyond the scope of this paper to detail the anatomy and radiographic interpretation of the ferret but a few comparisons with canine and feline radiography will be noted. Splenomegaly is a common but fairly non-specific finding. Very little gas is normally present in the gastrointestinal tract. The intestinal loops should be no larger than 2-3 times the diameter of the ribs. Larger loops may suggest an obstruction. The heart of ferrets is conical shaped, more like that of a cat than a dog. The hook shaped os penis is easily visible radiographically. Imaging using other techniques such as ultrasound is receiving more attention recently. Ultrasound imaging can evaluate the heart, liver, spleen, bladder, and most significantly, the adrenals and pancreas.

Blood testing in ferrets follows the same principles as in dogs and cats. Although ferrets are somewhat smaller than dogs or cats, an adequate sample can be drawn for most tests needed. Blood can be drawn from the jugular vein, the cranial vena cava, the cephalic vein, the lateral saphenous vein, or the ventral caudal artery/vein. Because of the small size, the larger vessels yield a good sample more readily than do the peripheral vessels. This author prefers the jugular vein. (Figure 2).

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Figure 2
JUGULAR VENIPUNCTURE IN A
FERRET.



Hematology should be part of the workup for any sick ferret and part of the geriatric workup of ferrets over 3 years. Normal ferrets have a relatively high hematocrit. This leads to low plasma/serum yields. This should be taken into account when the blood volume required for a panel is determined. The normal white blood cell count of ferrets is quite low compared to canine and feline patients and elevations in the white blood cell count are uncommon. This is likely to be due to the infrequency of bacterial infections. The complete blood count should be interpreted in the same way as for dogs and cats. Lymphocytosis is sometimes seen in ferrets with lymphoma. Eosinophilia will be seen in ferrets with eosinophilic gastroenteritis. Table 1 lists reference ranges.²

² Quesenberry KE, "Basic Approach to Veterinary Care" in Hillyer EV, Quesenberry KE eds, *Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery*. Saunders 1997.

| Parameter | Range | Units |
|-----------|-----------|-----------------|
| Hct | 46-57 | Percent |
| Hg | 15.2-17.7 | g/dl |
| RBC | 7.3-12.18 | million/uL |
| Retics | 1-12 | Percent |
| WBC | 3-8 | thousnd/uL |
| Neut | 11-84 | Percent |
| Lymph | 12-54 | Percent |
| Mono | 0-9 | Percent |
| Eo | 0-7% | Percent |
| Baso | 0-2 | Percent |
| Platelets | 297-910 | thousnd/uL |
| MCV | 54-81 | um ³ |
| MCH | 17.6-19.9 | pg |
| MCHC | 32.2-32.8 | Percent |

| Parameter | Range | Units |
|-----------------|----------|--------|
| Protein | 5.1-7.4 | g/dl |
| Albumin | 2.6-4.1 | g/dl |
| Glucose | 90-125 | mg/dl |
| BUN | 10-45 | mg/dl |
| Alk Phos | 34-66 | IU/L |
| SAST | 28-120 | IU/L |
| SALT | 119 avg | IU/L |
| GGT | 5 avg | IU/L |
| Total Billi | <1.0 | mg/dl |
| Creat | 0.4-0.9 | mg/dl |
| Na | 128-158 | mmol/L |
| K | 3.9-5.5 | mmol/L |
| Cl | 99-127 | mmol/L |
| Phos | 3.2-9.5 | mg/dl |
| CO ₂ | 16-28 | |
| Chol | 82-298 | mg/dl |
| Ca | 8.0-11.8 | mg/dl |

Chemistries are also valuable in the evaluation of ferrets. The interpretation of abnormal values follows the same principles as in more familiar pets. One exception is that creatinine may not be reliable for indicating renal failure.³ Some reference values for biochemical parameters in ferrets is listed in Table 2.⁴

Endocrinology is a valuable diagnostic aid in ferrets due to the high incidence of endocrine disorders. The common endocrine tests used in dogs and cats, however, are of little value in ferrets. Testing thyroid function in ferrets is not generally indicated as neither hypothyroidism, nor hyperthyroidism are clinical problems in ferrets. While adrenal disease is quite common in ferrets, standard adrenal function testing is not applicable, since the diseased adrenal of ferrets secretes estrogen and other sex steroids rather than cortisol or corticosterone. For ferrets, the most common endocrine disorders are insulinoma and adrenal-associated endocrinopathy. Measuring insulin levels, especially when used with glucose levels is useful for diagnosis of insulinomas. For detection of adrenal endocrine diseases, estradiol, androstenadione, dehydroepiandrosterone, and 17-hydroxyprogesterone should be measured. Values should be compared to reference ranges for the particular laboratory used.

Exploratory surgery is a commonly used diagnostic tool in ferrets. Because of the high incidence of abdominal disease, it frequently yields a definitive diagnosis for many of the common conditions of the pet ferret. In addition, some of these diseases are treated surgically and the exploratory diagnostic aid puts the clinician in the position to resolve or treat the condition as well. Regardless of the suspected condition, a complete exploration of the abdomen is indicated. Biopsies should be taken if any suspicious lesions exist. When intestinal obstruction is even vaguely suspected, an exploratory should always be

³Kawasaki TA, "Normal Parameters and Laboratory Interpretation of Disease States in the Domestic Ferret" *Semin Avian Exotic Pet Med* 1994 3:40-47.

⁴Brown SA, Unpublished data.

performed as soon as possible. The result of failure to cut is much worse than the result of cutting when there is no obstruction.

Soft Tissue Surgery

Ferrets make ideal surgical patients. They are easily anesthetized using isoflurane, they are easily intubated, intravenous catheters are easily placed, they have shallow body cavities, allowing for excellent visualization, and they are exceptionally resilient to surgical manipulation.

Ovariohysterectomy and castration were once the most common surgical procedures performed on ferrets. Currently for most practitioners, these surgeries are very rare since most ferrets are purchased already neutered. In the event that this needs to be done, the procedure is identical to that of a dog.

Excision of diseased adrenal glands is the most common surgical procedure performed on ferrets in the author's practice. The left adrenal lies just cranial to the left kidney, in the retroperitoneal fat. When normal, the adrenal is barely visible as a yellowish pink, 2-3mm nodule. The left adrenal is crossed by a small blood vessel, the adrenolumbar vein and is about 5-10 mm from the aorta. When removing this adrenal, the small vessel must be ligated with suture or vascular clip or electrocoagulated. The adrenal is then dissected carefully out of the fat pad. The right adrenal is slightly more cranial and lies dorsal to the caudate lobe of the liver and is adherent to the caudal vena cava. This anatomical arrangement makes the surgery more difficult and higher risk than tumors in the left gland. Hemostatic clips can be applied at the junction of the gland and the vena cava, parallel to the cava. the gland can then be removed. Care must be taken that the clips do not slip off. The author has seen two ferrets in which the diseased right adrenal gland shifted location to a site dorsal to the vena cava. After some difficulty, these adrenals were removed without hemorrhage. However both of these ferrets unexpectedly and unexplainably died in the following 24 hours. Occasionally both adrenals are affected. In these cases the entire left gland is removed and a portion of the right is resected. These ferrets will usually improve for some time but clinical signs may return after some time. Gastrotomy and enterotomy procedures are common in ferrets due to the frequency of foreign body ingestion and obstructive hairballs. The procedure is the same as in dogs and cats although smaller sutures will be required. Although not common, urinary obstruction will occasionally occur in male ferrets. If medical therapies fail, if the problem reoccurs, or if the obstruction cannot be relieved, a urethrostomy may be required. A catheter should be placed if possible, but if not, a suture can be passed to aid in the identification of the urethra. An incision is made in the perineal skin and the urethra is located and incised. The open urethra is then sutured to the skin.

Diseases of Ferrets

Ferrets are host to a wide variety of conditions. Some of these are not particular to ferrets and they can be treated in the same way as in dogs and cats. There are a number of conditions, however that are more common, that differ in nature, or are treated differently than in dogs and cats.

Insulinoma

Insulinoma is a disease that is extremely uncommon in dogs but very common in ferrets. In one study, insulinomas accounted for 114 of 301 neoplasms found in ferrets.⁵ These tumors are beta cell tumors in pancreas that secrete excessive levels of insulin. The result is that the affected ferret may have hypoglycemic episodes. Weakness, lethargy, salivation, pawing at mouth, or seizures may be noted. In addition to the hypoglycemia, these tumors are generally malignant and can metastasize to the liver, spleen, or other tissues. Presumptive diagnosis is based on low fasting blood glucose (<70 mg/dl). Ferrets suspected of having this disease should be fasted for 4-6 hours prior to measurement of the glucose level. Longer fasts could precipitate a dangerous drop in blood glucose. Insulin levels may be measured to distinguish insulinoma from other causes of hypoglycemia. Definitive diagnosis is based on histopathology of biopsy samples taken at exploratory laparotomy. Treatment of this disease can include medical or surgical approaches. Animals presenting during a seizure or comatose episode should have an IV catheter placed and 50% dextrose should be administered slowly to effect. Hypoglycemic ferrets generally will respond in a matter of minutes to this therapy. Once conscious, oral feedings of the regular food or a canned formulation such as A/D (Hills Prescription Diet) should be started in addition to medical therapies listed below. Rarely, anticonvulsants such as diazepam may be required. Once the ferret is stabilized, long term maintenance can be started. Surgical debulking of the tumors will help reduce the secretory mass and can slow progression of the disease. Unfortunately, there are often multiple small nodules and surgical resection is rarely curative. Ferrets should have an intravenous drip of dextrose should be started prior to surgery and maintained throughout and after the procedure. During a laparotomy, the pancreas is examined and palpated and any suspicious nodules are "shelled out". If several nodules are present in one limb of the pancreas, the limb can be excised by ligating the base and removing the entire limb. Unlike in dogs, pancreatitis following this type of manipulation is rare. Dietary management is usually required in ferrets with insulinomas. Frequent feedings using a high protein and high fat diet are required to maintain the glucose levels. Owners should have a high sugar material to give during a hypoglycemic episode but should be instructed to use it only when absolutely necessary. Nutrical (Evsco Pharmaceutical) is useful as it has both sugar and fats, providing short and intermediate term glucose sources. Chromium picolinate may be useful in helping regulate glucose levels and can be used as a supplement. Brewers yeast is rich in chromium and therefore makes a useful supplement provided that the taste does not inhibit eating. Dosing has not been critically determined but brewers yeast has been used at 1/8 to 1/4 tsp per ferret per day. Prednisolone can be used to help maintain glucose levels in ferrets that have not had surgery or that do not remain euglycemic following surgery. Prednisolone works by promoting gluconeogenesis and by inhibiting glucose uptake by the tissues. Doses of prednisolone ranging from 0.1 mg/kg to 4 mg/kg SID to BID have been used for this purpose. Initially a low dose is used and then raised as needed to maintain glucose levels adequately. Diazoxide may be used alone or in combination with

⁵Brown SA "Neoplasia" in Hillyer EV, Quesenberry KE eds, Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery. Saunders 1997.

prednisolone. This drug works by inhibiting insulin release and reducing cellular uptake of glucose. A dose of 5-10 mg/kg BID should be used. While this disease is rarely cured, most affected ferrets can be reasonably controlled and will often live months to years following the diagnosis. Since these ferrets are usually older ferrets, this often brings them to a normal life expectancy.

Adrenal Endocrinopathy

Adrenal endocrinopathy is another condition that is uncommon in canine and feline patients but is extremely common in ferrets. The disease is represented by a continuum of adrenal hyperplasia, adenomas, and adenocarcinomas. Adrenal disease usually occurs in ferrets over 3 years of age. Left adrenals are more commonly affected than right adrenals and rarely, both are affected. Estrogen and its precursors are secreted by these masses rather than cortisol or corticosterone. Therefore these ferrets should not be referred to as Cushingoid. Bilaterally symmetrical alopecia is the hallmark of this condition. Virtually all ferrets exhibiting alopecia in the author's practice have proven to have an adrenal mass. Vulvar enlargement may be seen in female ferrets, giving further evidence of the presence of estrogen. Male ferrets may exhibit aggression or sexual behavior in some cases and prostatic cysts have occurred in some ferrets with adrenal endocrinopathies. Affected ferrets may exhibit some reduction in muscle tone, and overall vigor but are generally not severely ill. In rare cases, estrogen induced bone marrow suppression can occur. Carcinomas of the adrenals are slow to metastasize but could potentially pose a true cancer threat to the patient. Diagnosis is not easy to confirm. Endocrinology can be useful provided that the correct tests are performed. Estrogen, and its precursors should be measured, not cortisol. For detection of adrenal endocrine diseases, estradiol, androstenedione, dehydroepiandrosterone, and 17-hydroxyprogesterone should be measured. These are specialized and expensive assays. ACTH tests and dexamethasone suppression tests have no place in the diagnosis of adrenal disease in ferrets. Ultrasound has proven useful for both detection of the disease, determination of the affected side, and the presence of metastases or concurrent disease. These additional factors may be useful in determining whether surgery is indicated and the prognosis. Exploratory laparotomy and visual inspection of the adrenals is an excellent means of diagnosis, especially since removal of the affected gland is the treatment of choice. Following removal, histopathology can confirm the gross findings and determine if the gland is hyperplastic or neoplastic. Treatment of this disease is the surgical excision of the affected gland. Following surgery, prednisolone appears to reduce post-operative depression. A dose of 0.5 mg/kg daily for three days followed by tapering over the next several days. Surgery should not be pushed onto the owners, however, since life threatening complications of the disease are uncommon. Untreated ferrets often live for several years without severe problems. In ferrets that have had incomplete removal of the gland, Lysodren (50 mg/ferret daily for one week then twice weekly) can be used to selectively destroy adrenal tissue. It has poor success in most ferrets.

Estrogen Toxicosis

Once common, this disease is rarely encountered in most practices today. As induced ovulators, jills seasonally remain in heat until bred. These extended periods of estrus lead to bone marrow suppression and eventually to pancytopenia. Affected jills will be weak, pale, and sometimes shocky. The vulva will be swollen and turgid. Diagnosis can be made based on the history and the results of a complete blood count. Anemia, leukopenia, and thrombocytopenia may all be present. Treatment is not difficult in ferrets with mild clinical signs. An ovariohysterectomy can be performed and the signs will generally resolve. In cases where the ferret is intended for breeding, or is not in suitable condition for surgery, human chorionic gonadotropin (HCG) (100 IU once and repeat in 2 weeks if needed) may be given to stimulate ovulation and bring the jill out of heat. Transfusions should be given if needed. All ferrets tested have been the same blood type so transfusions can be given easily and safely. Whole blood transfusions are usually used.

Lymphosarcoma

Lymphoma or lymphosarcoma is the third most common neoplastic disease of ferrets. This disease can affect ferrets of any age. The etiology is not known although an unidentified retrovirus has been suggested.⁶ The clinical features of lymphoma are similar to those in dogs. Lymphadenopathy is the hallmark of lymphoma. The peripheral, mediastinal, sublumbar, or mesenteric lymph nodes may be involved. Peripheral lymphocytosis may be seen if a CBC is performed. This is a useful screening tool for this disease. Splenomegaly often occurs with lymphoma (and in many other diseases of ferrets). Weight loss will occur as the disease progresses and gastrointestinal or respiratory signs may occur as lymph nodes enlarge. Diagnosis is made at the microscopic level. Cytology or histopathology of lymph node aspirates or biopsy samples, biopsies or aspirates of the spleen or other lymphatic tissues will demonstrate neoplastic characteristics. Lymphoma is more responsive to chemotherapeutic treatment than most other neoplastic diseases. Various protocols have been used which include the use of vincristine, cyclophosphamide, prednisolone, and/or doxorubicin.⁷ Table 3 lists these protocols. Prognosis is guarded although remissions of 3 months to 5 years are reported.⁸ Ferrets in which the disease is localized to the peripheral or mediastinal nodes, the spleen, or the skin, and in which 50% or more of the bone marrow leukocytes are normal, and that have no concurrent systemic disease states are the best candidates for chemotherapy.⁹

⁶Brown SA "Neoplasia" in Hillyer EV, Quesenberry KE eds, *Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery*. Saunders 1997.

⁷Brown SA "Neoplasia" in Hillyer EV, Quesenberry KE eds, *Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery*. Saunders 1997.

⁸Brown SA "Neoplasia" in Hillyer EV, Quesenberry KE eds, *Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery*. Saunders 1997.

⁹Brown SA "Neoplasia" in Hillyer EV, Quesenberry KE eds, *Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery*. Saunders 1997.

Table 3 Chemotherapy Protocols for Lymphoma

| Day | Drug | Dose |
|-----------|------------------|---------------------------------|
| 1 | Prednisolone | 1 mg/kg PO q12h through therapy |
| 1 | Vincristine | 0.12 mg/kg IV |
| 3 | Cyclophosphamide | 10 mg/kg PO or SQ |
| 8 | Vincristine | 0.12 mg/kg IV |
| 15 | Vincristine | 0.12 mg/kg IV |
| 22 | Vincristine | 0.12 mg/kg IV |
| 24 | Cyclophosphamide | 10 mg/kg PO or SQ |
| 46 | Cyclophosphamide | 10 mg/kg PO or SQ |
| | Prednisolone | Taper over 4 weeks |
| II | | |
| 7 | Vincristine | 0.07 mg/kg IV |
| | Asparaginase | 400 IU/kg IP |
| | Prednisone | 1 mg/kg PO q24h through therapy |
| 14 | Cyclophosphamide | 10 mg/kg SQ |
| 21 | Doxorubicin | 1 mg/kg IV |
| 28 | Vincristine | 0.07 mg/kg IV |
| | Asparaginase | 400 IU/kg IP |
| 35 | Cyclophosphamide | 10 mg/kg SQ |
| 42 | Doxorubicin | 1 mg/kg IV |
| 56 | Vincristine | 0.07 mg/kg IV |
| 70 | Cyclophosphamide | 10 mg/kg SQ |
| 84 | Vincristine | 0.07 mg/kg IV |
| 98 | Methotrexate | 0.5 mg/kg IV |

Aleutian Disease

Aleutian disease is a disease of mink that ferrets are also susceptible to. Although it is not common, this can be a serious disease and should be considered when a ferret with consistent clinical signs is presented. Aleutian disease is caused by a parvovirus but unlike most parvoviruses which cause disease related to the damage to rapidly dividing cells, this is an immune complex disease. Clinical signs of Aleutian disease in ferrets include weight loss, hepatomegaly, and neurologic signs. Hypergammaglobulinemia and glomerulonephritis (proteinuria, casts in urine, azotemia), and plasmacytosis may be found in the course of the workup. Diagnosis is based on the presence hypergammaglobulinemia and a positive titer. No treatment has been successful as yet.

Canine Distemper

Although ferrets are very susceptible to canine distemper, vaccination has made this a relatively rare disease. In ferrets, this disease behaves much as it does in dogs. High fever, mucopurulent oculonasal discharge, pedal hyperkeratosis, inguinal dermatitis, and a variety of neurologic signs are all hallmarks of distemper. While some will survive distemper, in ferrets, it is 100% fatal. Prevention is relatively effective with vaccination. A modified live vaccine derived from chick embryo cell culture should be used. (Fervac-United Vaccine) Ferrets should be vaccinated at 2-3 week intervals until they are 14 weeks old.

Gastric/Intestinal Obstruction

Hairballs or foreign bodies that cause partial or complete obstruction of the stomach or small intestine are very common in pet ferrets. The small intestinal lumen will not allow the passage of even very small foreign objects. The author has seen ferrets die from the ingestion of a cherry pit. Ferrets are mischievous creatures and will often ingest items that can be harmful. They particularly have a taste for rubber and foam rubber products. In addition, the hairballs that ferrets develop tend to be very firm and can lead to chronic gastric or occasionally acute intestinal obstruction. Typically, foreign body ingestion occurs in younger ferrets while hairballs occur more in middle to older aged ferrets. The presenting complaint for gastric obstruction may be a chronic weight loss and lack of appetite with or without vomiting. Although ferrets are physically capable of vomiting, it is an uncommon finding. Intestinal obstructions present as severe acute processes involving anorexia, dehydration, abdominal pain, and severe depression. Diagnosis is based on palpation or radiography. Contrast studies may be performed but should not be considered conclusive. Many of the items ingested by ferrets can absorb barium, making it difficult to visualize on contrast films. Confirmation of the disease is made at exploratory laparotomy. When doubt exists, it is better to err on the side of caution: perform the exploratory. **The consequences of a negative exploratory are much better than the consequences of leaving an obstruction unresolved.** The treatment for gastrointestinal obstruction is a gastrotomy or enterotomy, depending on the site affected. In the case of intestinal obstruction, the surgery should be performed as soon as possible (within hours). The procedure is the same as in dogs or cats. Intravenous fluids, antibiotics, and other supportive care is administered as deemed necessary as well.

Proliferative Bowel Disease

Proliferative bowel disease in ferrets is the same disease that swine and hamsters develop with this organism. Originally the organism was referred to as a campylobacter-like bacteria. Later it was renamed *Desulfovibrio*. Currently the organism is called *Lawsonia intracellularis*. Chronic diarrhea is the primary clinical sign seen with this disease. Partial rectal prolapse is sometimes seen. Weight loss can be dramatic as a result of the chronic malabsorption. Young ferrets are most commonly affected but not exclusively. *Lawsonia intracellularis* is difficult to culture, making diagnosis challenging. A presumptive diagnosis can be made based on the signalment and clinical signs. Fecal cytology may reveal the typical spiral to curved bacteria but this does not constitute a definitive diagnosis, especially since *Helicobacter*, another common gastrointestinal pathogen is shaped the same. Chloramphenicol (50 mg/kg BID) is the treatment of choice for this disease. Fluid and nutritional support should be provided as well. Because this disease can be difficult to distinguish from *Helicobacter* gastritis, it may be advisable to treat both conditions in ferrets with severe gastrointestinal disease.

Helicobacter Gastritis

Helicobacter mustelae is a spiral shaped bacterium that can cause gastritis and gastric ulceration in ferrets. This organism and disease is being studied as a model for gastric ulceration in humans caused by *Helicobacter pylori*. As in humans, the onset of

clinical signs is often stress associated. Clinical signs may include vomiting, anorexia, weight loss, diarrhea, and melena. Although this disease is reported to be more common in young ferrets, the author has encountered it more in mature ferrets, especially those with concurrent diseases.¹⁰ Presumptive diagnosis can be made based on the clinical signs. Hematology may show anemia or occasionally toxic changes in leukocytes. Definitive diagnosis is made by surgical or endoscopic examination of the gastric lining. This is often done to rule out a radiolucent foreign body or trichobezoar in the stomach. Biopsies taken from the stomach can confirm the etiology of erosions and ulcers. Treatment for this disease consists of amoxicillin (20mg/kg BID), with or without clavulenic acid, metronidazole (20 mg/kg BID) and gastrointestinal protectants. Bismuth subsalicylate (1 cc/kg BID), H2 blockers such as cimetidine (10 mg/kg TID), or sucralfate (25 mg/kg BID) may be used to prevent or treat ulcers. Nutritional support, fluid therapy, and occasionally, blood transfusions may be necessary as well. Because this disease is difficult to distinguish from proliferative bowel disease, it may be advisable to treat for both in ferrets with severe gastrointestinal signs.

Eosinophilic Gastroenteritis

Although not common in ferrets, this disease appears to be more common than it is in cats and certainly more than in dogs. Unlike most of the other gastrointestinal disorders of ferrets, this one is most common in mature to older ferrets. Etiology unknown but is suspected to be a hypersensitivity reaction. The author had one ferret develop this disease about a week after having a vaccine reaction to rabies and distemper vaccination. Clinical signs include diarrhea, anorexia, vomiting, and weight loss. Peripheral eosinophilia is seen in the blood count in most cases. Treatment consists of the use of prednisolone at 2 mg/kg SID for a week and then every other day until resolved. At this time the dose is tapered. Ivermectin was successful in resolving the disease in one case.¹¹ Supportive care should be given as needed.

Epizootic Catarrhal Enteritis

This is the last of the major gastrointestinal diseases of ferrets. It is of an unknown viral etiology and has appeared over the past five years. It affects ferrets of any age but most will have a history of recent exposure to other ferrets. It is often seen following shows, fairs, etc. or in ferret shelters. The primary clinical sign of this disease is a green, mucoid, diarrhea, leading to the term "Green Slime Disease". Diagnosis is based on history and clinical signs since no etiologic agent has yet been identified. Treatment is supportive care and treating for the other differentials that have not been ruled out. This disease has a high morbidity, but a low mortality. Most ferrets recover in a matter of two to four weeks.

¹⁰Bell JA, "Helicobacter mustelae Gastritis, Proliferative Bowel Disease, and Eosinophilic Gastroenteritis" in Hillyer EV, Quesenberry KE eds, *Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery*. Saunders 1997.

¹¹Palley LS, Fox JG, "Eosinophilic gastroenteritis in the ferret" in Kirk RW, Bongura JD, eds., *Current Veterinary Therapy 11, Small Animal Practice*. Saunders 1992.

Megaesophagus

As in dogs, megaesophagus is a rare but serious condition. The etiology is unknown. Affected ferrets will exhibit regurgitation and weight loss. Secondary aspiration pneumonia is not uncommon. Diagnosis is based on plain or contrast radiographs. Treatment involves nutritional support. A semi-soft gruel is fed and the ferret must be held vertically for 20 to 30 minutes after each meal to allow gravity to aid in passage of food to the stomach. Prognosis for long term survival is poor.

Cardiomyopathy

Ferrets are subject to a number of cardiac disorders. Both dilated and hypertrophic cardiomyopathy can occur as well as valvular disorders such as mitral insufficiency. Dilated cardiomyopathy is the most common of these. Taurine deficiency has been speculated but not supported as a cause for this disease. This and other cardiac disorders may eventually lead to congestive heart failure. Diagnosis of congestive heart failure (CHF) and cardiomyopathy relies on physical exam findings, radiographs, electrocardiogram (ECG), and echocardiogram. Findings include lethargy, weight loss, anorexia, and respiratory distress, hypothermia, tachycardia, systolic murmur, moist rales, muffled heart and lung sounds, ascites, and rear leg weakness.¹² Muffling of heart sounds is much more common than murmurs. Like cats, ferrets compensate by reducing their level of activity, making the onset very insidious. Treatment of CHF consists of a combination of furosemide at 2-4 mg/kg BID, digoxin at 0.01-0.02 mg/kg SID, and enalapril at 0.5 mg/kg every 24 to 48 hours. Most ferrets are in advanced stages of disease when diagnosed and live less than one year.

Heartworm Disease

Although heartworm is uncommon in ferrets in the midwest, a single worm can cause severe disease in ferrets. Heartworm in ferrets is much more like the disease in dogs than in cats. Pulmonary congestion is the primary clinical effect. Diagnosis depends on radiographs and antigen testing. Some false negatives will occur when the worm numbers are very low. Ferrets rarely have circulating microfilaria. Treatment of heartworm is somewhat more difficult and dangerous for the ferret than it is in dogs. Arsenical drugs are used to kill the adult worms. Thiacetarsamide at 2.2 mg/kg q12 hours for two days is used first. Antithrombotic therapy using heparin at 100 U SQ daily for three weeks, followed by aspirin, at 22 mg/kg PO daily for three months. Prevention of heartworm is easy in ferrets using ivermectin once monthly.¹³ The liquid bovine preparation can be diluted and used orally once monthly at 0.02 to 0.2 mg/kg.

¹²Stamoulis ME, Miller MS "Cardiovascular Disease" in Hillyer EV, Quesenberry KE eds, *Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery*. Saunders 1997.

¹³Stamoulis ME, Miller MS "Cardiovascular Disease" in Hillyer EV, Quesenberry KE eds, *Ferrets, Rabbits, and Rodents; Clinical Medicine and Surgery*. Saunders 1997.

Splenomegaly

Splenomegaly is a very common finding in ferrets. It is a fairly non-specific finding and occurs with many conditions that are common in ferrets. It is important to look at splenomegaly in the context of all other clinical findings. The clinician should not look at the spleen as the primary problem until all other problems are ruled out. The diseases in which splenomegaly is of concern include lymphoma and metastatic neoplasia. A needle aspirate can be used to define the problem at the cellular level. If the spleen is irregularly shaped or physically is interfering with anything else, it should be removed.

Influenza

Ferrets are susceptible to human influenza viruses. Mild to moderate upper respiratory signs are seen. Occasionally a biphasic fever spike can be documented, but most often this is missed. Generally this disease is self limiting and should be treated symptomatically. Diphenhydramine can be given at 1-2 mg/kg BID. Fluids and nutritional support should be used as necessary.