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**CHAPTER 12**

**MICE AND RATS**

This chapter, on mice and rats, contains information on the companion species that is useful for veterinarians treating the animals or providing information to the owners. Although similarities exist for mice and rats—in care, husbandry, diagnostic testing, and treatment—emphasis will be on the differences between the species.

**MICE**

Mice may be maintained as pets because of their size and playful nature. Although playful, mice can be aggressive to cagemates and owners. The aggressive nature often manifests as barbering and/or fighting with cagemates and biting their owners. Any potential owner should be educated on the aggressive nature of these small dynamos. Domestic mice (*Mus musculus*) and the African pygmy mouse (*Baiomys* spp.) are commonly sold for pets and are available in several varieties. The mice varieties sold in pet stores include white, black, or tan colored, satin hair coat (shiny), pied or spotted, and long-haired1,2 (Figure 12-1). The size and ability of mice to escape quickly from the grasp of a human handler make these animals, as pets, better suited for older individuals. The timid nature of mice predispose these animals to biting if handled roughly, which commonly occurs with a young owner. Mice are nocturnal animals and may be a disturbance at night if maintained in a bedroom. Female mice produce less odor than males and therefore may be more desirable as pets. As mentioned earlier, male mice are territorial, and if placed with other male mice, may fight. Advantages of having mice as pets include their size, ability to be a good companion animal for the educated (regarding mouse behavior) owner, and adorable appearance.

Mice also rarely become infected with bacterial diseases, and their life span is approximately 2 years (Box 12-1).

**BIOLOGY**

The integument of mice is commonly associated with a number of disease presentations. A hair coat that has not been adequately maintained is often the first clinical sign associated with disease. Mice are fastidious with their grooming and, when healthy, maintain a very tidy hair coat. Common problems associated with a hair coat that is not maintained include general illness, parasitism (internal and external), aggression by cagemates as a result of psychological trauma, and infectious dermatitis.

Neoplasia is a disease condition that affects mice. There are some mouse strains in which mouse mammary tumor viruses have been identified that have a neoplasia incidence as high as 70%.

Tumor viruses, as well as a very short life span (up to 2 years), predispose these animals to cancer. Mammary adenocarcinomas and fibrosarcomas are the most common tumors that affect mouse mammary tissue. Unfortunately, by the time many of these tumors are diagnosed, the malignant masses are large and ulcerated.

Fibrosarcomas may be hormonally induced, and the incidence of this disease process can be reduced through an ovarioectomy at an early age. The small size of the female mouse often makes the ovarioectomy surgery challenging for the veterinary surgeon.

Although relatively uncommon, urethral obstruction can occur in male mice as a result of preputial and/or bulbourethral gland infections. Male mice suffering from an urethral obstruction may have a mutilated penis, a sign often associated with the disease process.
Mice are continuous, polyestrous rodents that should be bred in polygamous or monogamous setups because of the males’ aggressive territoriality behavior. When breeding mice that have been housed in a polygamous ratio, there may be one male with two to six females. Females are removed from a polygamous cage before parturition, whereas the monogamous pair is maintained together with the young until weaning.

### HUSBANDRY

#### Environmental Considerations

Mice can chew out of enclosures; therefore, it is important that the housing be “mouse proof.” If an animal escapes, the best way to capture the pet is to place food in the center of the room. Once it has been determined in which room the animal is staying, then it should be sealed and measures taken to look for the pet. Because mice are nocturnal animals, capture at night in a dark room with a flashlight may work best. This technique will work for capture of other small rodents and pocket pets too.

Mice are maintained in environments that are similar to other small rodents but require a thorough cleaning of their cage more often because of their malodorous urine. Ventilation is essential for small rodent housing to prevent irritation of the respiratory tract from ammonia vapors generated by urine. The recommended housing unit for mice is 12-15″ × 12-15″ × 6″ (length × width × height) for each adult mouse; females and young require 2 to 3 times the space listed. The major considerations for selecting an enclosure for mice is that it be resistant to their escape and easy to clean. An open screen top of the enclosure is recommended for proper ventilation. Available rodent cages that fit this criterion are wire or metal mesh, plastic, and Plexiglas. If the plastic tube housing systems are used, there should be routine cleaning of the sections using hot water and a mild detergent. Owners should be informed of the small distance required for a mouse to escape and their ability to chew through plastic. An owner must always monitor the cage for possible escape avenues, especially if the animal has a predilection for modifying the cage opening through chewing. It is very important to provide cage toys and exercise opportunities for mice. The enclosure should be large enough to house not only food and water containers but also cage toys and an exercise wheel (Figure 12-2). Although not a cage toy, a hide box, in some form, should also be included for the psychological well-being of the animal. This hide box can be manufactured or a small cardboard container that has one end cut out. Mice like to hide and also sleep during the day. This piece of cage furniture will enable the mouse to sleep undisturbed during the daylight hours.

Mice, especially males, have odiferous urine. To prevent the buildup of urine and fecal material in the cage, commercially available paper rodent bedding or hardwood shavings should be used as a cage substrate. Although softwood (pine) and cedar shavings are available, the volatile oils that radiate from these substrates are irritating to small animals. These irritating
compounds can cause dermal and respiratory inflammation, often leading to secondary bacterial infections.

Cardboard tissue tubes can be placed in a mouse enclosure; mice like to chew and run through these items. Because many fabrics have strong thread and elastic, it is not recommended to put clothes items in enclosures with animals that chew. Often mice will shred the clothing items, exposing thread and elastic that can become entangled around an extremity; this can lead to necrosis distal to the stricture. It is recommended to change the substrate within the enclosure at least twice a week—more often if there is a problem with odor or excessive excreta.

Temperature, humidity, and lighting within the enclosure should follow what is commonly maintained with the ambient conditions within the house. If the animals are housed outside or in an outbuilding, the temperature range should be 65°F to 85°F and humidity 30% to 70%, although the recommended humidity is on the higher end of the range provided.2 Mice, especially males, are extremely territorial animals. If mice are housed alone, it is better to keep them separate, as introduction of new animals will often lead to aggression and fighting. To prevent aggression, fighting, and psychologically induced adverse behavior (e.g., barbering), a single mouse is recommended as a companion animal. For those who intend to breed the animals, enclosures with a single pair is necessary for reproductive success.

Nutrition

Because mice are commonly used as laboratory animals in investigations of human disease processes, much research literature is available on the recommended nutritional requirements of these animals. The benefit of these dietary studies is the availability of commercially produced diets that provide the recommended daily nutritional requirements of the mouse. The problem that most owners face is the multitude of dietary products available for mice and the lack of knowledge regarding which food to buy. Most new mouse owners think that rodents eat seed-based diets. Although mice will happily eat seed, seed-based diets are lacking in a number of the nutritional requirements needed to maintain long-term health. Commercial rodent biscuits or pellets with more than 14% protein are the recommended diets for mice.2 The commercial rodent biscuits or pellets are the only food mice need to obtain their required nutrients (Figure 12-3). Again, seed-based diets are not recommended, nor is a significant supplementation of fruits, nuts, vegetables, cheese, or other human foods (e.g., peanut butter). If a treat is to be given, yogurt or dried fruit treats manufactured specifically for rodents and/or mice should be provided 2 to 3 times a week. For younger mice, less than 3 weeks old, softer pellets are needed because babies start eating pellets and drinking water at 2 to 3 weeks of age.2 A sipper bottle, placed on the outside of the cage, is easy to maintain and does not take any space within the enclosure. If the cage is plastic or Plexiglas, modifications will be needed to attach the sipper bottle on the outside of the cage. Most sipper bottles come with attachment hardware to attach to wire cages (Figure 12-4). Fresh bottled water is recommended for mice, although chlorinated tap water is acceptable. The water should be checked on a daily basis and clean water supplied at least every 2 days, if not every day.

PREVENTIVE MEDICINE

Quarantine

Quarantining an animal is important when a new animal is being introduced into a setting in which there is an established group. As with other animals, a 30-day quarantine period is recommended, along with a physical examination and fecal parasite check. Unfortunately, there is no time period that will screen 100% against potential infectious agents, and with mice, time is critical because their life span and reproductive time frame are so short. The animals should be quarantined in conditions similar to those in which they will be permanently maintained. Providing adequate food and water will
make for a smooth transition. It is imperative that the owner screen the new animal for diseases and watch for any signs of illness. The most common sign of clinical illness is a rough hair coat. The lack of grooming is most often related to the animal feeling depressed or sick, thereby not having the energy to perform routine behaviors. If a number of animals are being quarantined, sacrificing an apparently diseased animal is the most efficient way to determine a rapid definitive diagnosis. If it is a single or an expensive animal, routine diagnostic testing will be required.

To maintain oversight of breeding animals’ health and reduce the exposure of young animals to infectious disease and parasites, routine screening of representative animals within the colony is recommended. In very large colonies, special caging (e.g., filter), food, and water may be necessary to prevent exposure to disease organisms.²

**Routine Exams**

Before a veterinarian examines a mouse, the examination table should be disinfected with either a dilute sodium hypochlorite or chlorhexidine solution. The examiner should always wash his or her hands and, if necessary, wear examination gloves to capture and restrain the patient. The difficulty with using latex gloves when examining a mouse is the small size of the patient and its ability to twist and turn. The only way to restrain some mouse patients is without gloves. If gloves are not worn, the examiner’s hands must be washed thoroughly after the examination is completed.

**RESTRAINT**

To catch a mouse, the tail should be grabbed with the thumb and forefinger, allowing the mouse to hold on to an object with their front feet (Figure 12-5). When the mouse securely attaches itself to an object, the opposite hand then grabs the dorsal skin in the cervical region while keeping the tail in a firm grasp.

If one is unable to adequately restrain a mouse while the animal is conscious, inhalant anesthesia may be used for sedation purposes. The animal should be placed in a small induction chamber and isoflurane gas permeated into the closed space. Once the animal has stopped moving, the enclosure top is removed and a nose cone placed on the anesthesia tube and placed on the patient’s face. A syringe case can be modified as a nose cone for small rodents, including mice. Once the physical examination is complete, the nose cone is removed, allowing the patient to breathe oxygen from the anesthesia unit.

**HISTORY**

Obtaining a detailed history of the mouse patient is very important, as it is with other animal patients that are brought to a veterinarian’s office. It is important to get as much information from the owner as possible, even if it is a routine health examination.

Typical background information required includes how long the mouse been owned, where it was acquired, how often it is handled, and what the character of the feces and urine is. Husbandry questions should focus on the animal’s housing and whether it is allowed to roam unobserved; cage location; type, size, and material of the cage; cage substrate, furniture, and toys; and the frequency with which the cage is cleaned and
what disinfectant is used. When investigating the diet, the veterinarian should ask not only if pellets are fed and in what quantity, but also what the animal is eating and what the primary diet is. Supplemental offerings and frequency of feeding are important data for the case work-up. The veterinarian should find out about the water supply, how often the water is changed, and how much the animal drinks on a daily basis.

Because there are transmissible diseases among animals, the final questions should center on the other pets in the household, if new animals have been added to the family, and if the animals are housed together. A description of any previous problems and a complete chronological description of the presenting problem are needed to complete the history form.

**PHYSICAL EXAMINATION**

Before the animal is restrained, an observation should be made on the attitude, activity, and posture of the animal. The next step is to weigh the mouse in a basket on a digital gram scale. If possible, temperature, respiration, and pulse should be measured and any abnormalities in rate and/or character noted. The veterinarian should start the physical examination at the head, looking for any abnormalities. Eyes, ears, and naris are observed, looking for discharge or inflammation. The oral cavity is difficult to examine in mice because of the small opening and tendency for the buccal mucosa to encroach toward the middle of the mouth. A small speculum (e.g., modified paper clip) or an otoscope may be used to examine the oral cavity and cheek teeth. Mucous membranes help determine hydration status using capillary refill time and moisture. Body condition and abdominal palpation are important information that should be obtained. Lymph nodes and limbs are palpated before checking the nails and plantar surface of each foot. The patient should have a normal posture, be aware of its surroundings, and move properly. Any problems should be noted in the record. Finally, a dermatologic exam considers hair coat quality, alopecia, external parasites, and any skin abnormalities. All abnormal findings are written in the record for case review, differential diagnoses determination, diagnostic testing, and treatment considerations.

**COMMON ABNORMALITIES FOUND ON PHYSICAL EXAMINATION**

Most of the common problems noted during the physical examination of mice involve the skin and hair coat. As mentioned previously, an unkempt hair coat may point toward generalized illness or external parasitism. Abrasive lesions or pustules on the skin can be signs of external parasites or infectious dermatitis. If external parasites are a problem, the mouse may be uncontrollably scratching. Hair loss may be associated with barbering, either cagemate or self-induced, or with infection (e.g., ringworm). Although not common, *Trichophyton mentagrophytes* will cause hair loss in mice, from the face, head, and neck.¹

Mice will commonly present with tumors and abscesses. The entire body of the mouse should be palpated for any evidence of masses. If a mass is identified, a fine needle aspirate is recommended for basic diagnostic evaluation. With most fine needle aspirate samples, the clinical pathology results are not very rewarding. If a diagnosis cannot be obtained through cytologic examination, a biopsy of the lesion is required, and if possible, an excisional biopsy is the procedure of choice.

As with many rodents, respiratory disease is commonly identified in mice. Mice may have presenting symptoms of dyspnea, sneezing, coughing, chattering, and sniffing if they have a respiratory infection. In cases where respiratory signs are observed, anesthetizing the animal to perform the physical examination is not recommended, and handling should be kept to a minimum. The two most common respiratory disease conditions in mice are Sendai virus and *Mycoplasma pulmonis*.² These two organisms are very difficult to identify through routine diagnostic measures, and obtaining samples significantly stresses the patient. If the animal is being examined for placement into a colony or breeding environment, sacrifice to identify the disease condition is recommended. If the animal is an individual companion animal, doxycycline treatment should be initiated. Although treatment with doxycycline will not clear the organism from the animal, it will reduce clinical disease and improve the quality of life. The treated animal should always be considered a carrier of these respiratory diseases if a definitive diagnosis cannot be obtained.

Male mice that are licking and/or mutilating their penis may be suffering from a urethral obstruction. Infection of accessory sex glands, young males with aggressive breeding activity, urolithiasis, and trauma may initiate this self-induced trauma to the penis.⁴ *Pasteurella pneumotropica* is often isolated from accessory sex gland infections as well as subdermal abscesses.⁵ Treatment for this organism may aid in the recovery of a mouse affected by urethral obstruction.

Diarrhea in mice is rare, but endoparasite examinations should be performed if the animal has diarrhea. Although pinworms are considered nonpathogenic in mice, *Syphacia obvelata* and *Aspiculuris tetraptera* may cause rectal prolapse due to straining in immunosuppressed individuals.⁶ As with other animals, a tape test is the best way to identify these parasites. A tape test follows a procedure of pressing the sticky side of the tape against the rectum and perianal area and then examining the tape under a microscope for eggs and parasites.⁷

**DIAGNOSTIC TESTING**

**Hematology**

As with other pocket pets, blood collection from mice can be quite difficult. Approximately 0.5 to 0.7 ml/100 g body weight can be safely removed from a nonanemic healthy mouse.³ The mouse patient should always be anesthetized for blood collection procedures. Usually inducing the animals in a closed chamber and maintaining the patients in a mask will allow the technician plenty of time to collect the blood sample. A small, 25-, 26-, or 30-gauge needle, usually placed on a 1-ml syringe, is recommended for collecting the blood. Recommended blood collection sites in a mouse are a warmed ventral tail vein
or the tip of the tail. Box 12-2 describes the technique used for retroorbital bleeding in mice. The retroorbital bleeding technique is commonly used in laboratory animal settings and is easily performed by an experienced veterinarian or veterinary technician.

On smaller rodents, the saphenous vein or lateral vein of the tarsus may be used for multiple blood collections without the use of anesthesia. The patient must be properly immobilized in a restraint tube (35-ml syringe) with the leg extended and the skin held tight on the medial aspect of the thigh using the thumb and forefinger. The taut skin on the lateral aspect of the thigh allows exposure of the saphenous vein. A 23-gauge needle is used to puncture the vein, and blood is collected in a microhematocrit tube as it flows from the vessel.

Blood samples obtained from nail and ear clips are not considered appropriate diagnostic samples. Cardiac puncture is recommended only in terminal cases and when the animal is maintained under general anesthesia because of possible complications involving the lungs and heart vessels. Reference ranges for complete blood counts and serum biochemistry panels for mice are listed in Boxes 12-3 and 12-4.

Bone Marrow Aspiration

Marrow samples may be obtained from the ilium, tibia, sternum, femur, or the bones of the proximal one third of the tail. Preparation of the samples is consistent with that of other mammalian patients.

Urine Collection

Standard rodent cages can be used without substrate to collect urine and feces when the patient is hospitalized. After placing the rodent in a zip-lock bag, urination frequently occurs and the sample can be collected. In a similar manner, urine can be collected over a disinfected stainless steel examination table.

The urine is voided while the animal is restrained and can be collected in a capillary tube for evaluation on urine reagent strips. Urinalysis reference values for mice are listed in Box 12-5.

Diagnostic Imaging

Under most practice settings, the size of a mouse patient limits imaging capabilities to radiographs. Restraint is essential for quality diagnostic images and is even more important when patients weigh as little as 40 g. To obtain adequate restraint and prevent movement of the mouse patient during radiographic evaluation, sedation is required. As with all diagnostic
procedures involving avian and exotic animals, an evaluation of the patient is required to determine its ability to withstand the stress associated with the assessment. If it is determined that the patient cannot withstand sedation, then it should be stabilized until it is deemed healthy enough for diagnostic imaging evaluation.

Sedating the mouse using an induction chamber and isoflurane anesthetic, as described for restraint, is necessary to obtain diagnostic films. High-speed, 300-mA machines with fine or detail-intensifying screens should be adequate for most small exotic mammal images. With mice, dental x-ray units that can focus at short distances may be advantageous for both isolation of focal anatomy and full body radiographs in extremely small patients. For extreme detail in small exotic mammal medicine, using a traditional radiography unit, the Min R mammography system (Eastman Kodak) with Min R single-intensifying screen cassettes, in conjunction with Min R single-emulsion film, has been recommended. Digital radiography is bringing a new dimension to radiograph evaluations and detail. The secret to success in either traditional or digital radiographic imaging is to restrict patient movement during exposure. Two views, ventrodorsal and lateral, are recommended for mice patients. Again, because of a mouse patient’s size, whole body radiographs are commonly obtained during the radiographic evaluation, even using dental radiographic equipment.

Microbiology

For the mouse patient in which microbiological testing is recommended, standard collection techniques used for other animals is appropriate. The difficulty when culturing mice is acquiring a representative sample of the suspect area that will provide diagnostic information. Sick mice often are extremely stressed when being examined or when diagnostic samples are being collected. It is also important to know what the common disease conditions are and the common etiologies associated with those clinical signs. With the most common respiratory conditions in mice, one is Sendai virus and the other a Mycoplasma sp. Both Sendai virus and Mycoplasma spp. will not be isolated using standard aerobic or anaerobic culture techniques. If in doubt on collecting, preserving, and/or shipping a microbiological sample, the diagnostic laboratory must be contacted for full instructions as they relate to mouse submissions.

Parasitology

Routine fecal parasite evaluations should be performed on small rodents when they are brought to the veterinary clinic for a health examination or an abnormal stool. Common protozoal organisms can be detected using a direct fecal examination, and mouse pinworms are commonly diagnosed using the sticky side of clear cellophane tape to make an impression of the perianal area. The anal tape test will aid in diagnosing Syphacia spp. The sticky surface will pick up any of the banana-shaped pinworm eggs that can be observed under a microscope.

Diagnosis of ectoparasites in small rodents is similar to that in other species listed in this text. The pelage tape test is performed by pressing clear cellophane tape against the pel of a mouse, dorsally and ventrally, from the nose to the base of the tail. Myobia spp. and Myocoptes spp. can be diagnosed using the pelage tape test. A skin scraping of the affected area may also help in identifying ectoparasites. Diagnosis of intestinal parasites can be made by finding individual eggs during fecal examination or whole worms within the lumen of the small intestine during necropsy.

Miscellaneous Diagnostics

Even though most of the diagnostic testing is performed through pathologic examination for mice, there are serologic tests available that can be run on a minimum of 50 µL of undiluted serum. Sound Diagnostics, Inc. (Woodinville, Washington) provides serologic testing on a number of common mouse diseases, including ectromelia virus, mouse hepatitis virus, mouse parovirus, mouse minute virus, rotavirus, Theiler’s murine encephalomyelitis virus, pneumonia virus of mice, reovirus 3, Sendai virus, Mycoplasma pulmonis, lymphotoytic chorioneningsitis virus, and mouse adenovirus. The serologic tests are done using enzyme-linked immunosorbent assay (ELISA) and, when indicated, are confirmed by indirect fluorescent antibody testing. Many of the diseases for which there are available serologic tests are beneficial in maintaining disease-free animals in laboratory settings or large breeding facilities. In cases of unknown disease conditions for the individual pet mouse, there are panels available that test for multiple diseases from a single serum sample. It is very important for the veterinary clinician to understand both the significance of any test that is being promoted for mice and how the results are interpreted.

COMMON DISEASE PRESENTATIONS

Infectious

Bacterial infections associated with dermatitis lesions and subcutaneous abscesses in mice are commonly caused by Staphylococcus aureus, Pasteurella pneumotropica, and Streptococcus pyogenes. Acute and chronic respiratory infections may be caused by Sendai virus or Mycoplasma pulmonis. Acute respiratory infections usually are associated with Sendai virus; adults live while neonates often die. Chronic respiratory infection, with clinical signs being pneumonia, suppressive rhinitis, and occasionally otitis media, may be the result of a Mycoplasma pulmonis infection. Both infections should be treated using supportive care, whereas mycoplasmosis can be treated with enrofloxacin in combination with doxycycline hyclate for 7 days.

P. pneumotropica has been associated with urethral obstruction caused by inflammation and swelling related to infection of accessory sex glands. Although uncommon, Trichophyton mentagrophytes (ringworm) can cause alopecia of the face, head,
and neck of mice. In addition to the disease organisms mentioned in this chapter (which are the most common disease organisms identified in pet mice), there are other bacterial, fungal, and viral organisms that can cause disease in mice. Proper diagnostic protocol should always be followed to identify the causal agent. Once the cause is identified, the proper treatment can be initiated and control measures implemented to prevent other animals’ exposure to the disease.

Parasites

ENDOPARASITES

Numerous parasites have been identified in mice. *Hymenolepis nana* (dwarf tapeworm) and *Cysticercus fasciolaris* (the larval stage of the cat tapeworm) can be isolated from these small rodents. The dwarf tapeworm is often found in young mice that are dead or have severe gastroenteritis resulting in diarrhea. Diagnosis of the dwarf tapeworm can be made following either a fecal flotation exam or necropsy, when the adults may be found in the small intestine. Treatment for the dwarf tapeworm is piraziquantel.

The mouse pinworm (*Syphacia obvelata*) is a commensal oxyurid nematode that feeds on bacteria that can inhabit the intestinal tract of mice. Although these nematodes are nonpathogenic in most cases, an overwhelming number of them can cause severe irritation of the terminal gastrointestinal tract. These nematode parasites can be diagnosed using transparent tape and applying it to the rectal area. After removing the tape from the affected rectal area, it is placed on a slide and the ova may be viewed under a microscope. Ivermectin and fenbendazole have been used effectively in treating this parasite in mice.

*Giardia muris* is a common protozoal parasite affecting mice. This organism can be seen using a direct fecal examination of an affected patient’s fecal material. Metronidazole is the treatment of choice for *Giardia* spp. infections in small rodents.

ECTOPARASITES

*Myobia musculi*, *Myocoptes musculinis*, *Rafordia affinis*, and *Pсорergates simplex* are fur mites that can cause severe self-mutilation and hair loss in mice. *Polyplax serrata* (house mouse louse) can cause anemia, pruritus, dermatitis, and death in severely infested mice. Diagnosis of ectoparasites in mice is similar to that in other companion animal species (e.g., skin scraping, examining hair samples for nits). Treatment of ectoparasites can be accomplished with ivermectin and a topical miticide. As with other rodent species, there has been an increasing ectoparasite resistance to ivermectin treatment.

Nutritional Disease Problems

Because most rodent diets are manufactured in the form of pellets or small biscuits that provide all recommended nutrients, there are few nutritional disease problems diagnosed in pet mice. If mice are fed an all-seed diet, there could be nutritionally related consequences. A lack of vitamin A could result in roughened hair coat or skin lesions. A breakdown of the protective epithelial lining of the gastrointestinal and/or respiratory tract could predispose the mouse to secondary bacterial infections affecting those body systems. Nutritional deficiencies may also result in poor reproductive activity. It is important to provide an adequate supply of fresh water and appropriate rodent food on a daily basis. Following these basic nutritional instructions should provide a nutritional basis for mice to live healthy lives.

Neoplasia

The average life span of a mouse is 2 years old. This short life span and aging process increase the prevalence of tumors in these small rodents. If an animal is over 18 months of age, neoplastic disease should be considered as a differential diagnosis, especially if an asymmetrical mass is present. The most common tumors diagnosed in mice are mammary adenocarcinomas and fibroadenomas. Other tumor types are identified in mice, and if possible, the suspect tissue should be completely excised. Representative tissue sections should be submitted for histopathological evaluation. Although there are treatment options available for mice that have been diagnosed with neoplasia (e.g., radiation, chemotherapy), its small size does not allow it to withstand the stress and negative side effects of these healing modalities. In mice, the recommended treatment for neoplasia is removal of the affected tissue, if possible, to increase its quality of life.

Miscellaneous

The most common disease in mice colonies is barbering. Barbering is defined as the dominant mouse nibbling off the whiskers and hair around the face of the subservient cage-mates. The hair clipping is very close to the skin without causing skin lesions. This behavior is noted often among female mice, whereas male mice are more likely to fight.

Mice may injure themselves on cage furniture or poorly designed cages and sustain abrasions on the face or nose. Individual animals may show stereotypic behavior that results in abrasions and/or alopecia. Enrichment furniture and toys may help alleviate this initial cause of dermatologic abnormality.

THERAPEUTICS

The size of mice contributes to the difficulty in properly administering therapeutic medications. The scruff of the neck or caudal flank are the subcutaneous sites that may be utilized to administer medication, fluids, or both. The semitendinosus, triceps, and epaxial muscles are commonly used for intramuscular injections, whereas intraperitoneal injections are used in extremely small animal species, including mice. Intramuscular catheters are much easier to place in mice than are intravenous catheters. The tibial plateau and the greater trochanter are the sites of choice for intraosseous catheter placement in mice.
Although there are many methods that may be used to administer medication in small mammals, oral treatment using a dropper or tuberculin syringe is the easiest to administer and the least stressful for the patient. Medication can be added to the food or water, but often the patient is anorexic or the medicated food or water is not palatable, in which case, the patient does not receive the treatment. Although a relatively difficult procedure in mice, gastric gavage can be performed using a bulb-ended stainless steel feeding needle or flexible red rubber feeding tube. The length of the tube is premeasured, externally from the nares to the last rib, and marked. A water-based lubricant is applied to the feeding tube before it is inserted through the intradermal space toward the back of the oral cavity. The tube should advance without difficulty until the premeasured mark is reached. Restraint of mice for this procedure is accomplished by pinching the dorsal neck skin fold and holding the body with the remaining free fingers. Both oral medication and nutritional supplementation can be administered through an oral gastric feeding tube.

Medication dosages for mice can be found in a number of formularies. Before administration of any therapeutic agent, the dosage should be checked twice and calculations thoroughly evaluated to make sure they are correct. Because mice are very small patients, any overdose of medication can have adverse consequences on the patient’s recovery.

### SURGICAL AND ANESTHETIC ASSISTANCE

Inducing and maintaining mouse patients under anesthesia can be very challenging. With the widespread use of isoflurane anesthesia in small animal practices, the previous problems associated with methoxyflurane and halothane anesthetic agents has been overcome. There are still concerns and differences in anesthetic protocol because of these animals’ small size, but in general, isoflurane is a safe agent when used on a relatively healthy surgical candidate. Although there are doses of injectable agents for sedation, the small size of the mouse makes it difficult to respond to anesthetic crises that may appear during a diagnostic or surgical procedure. Therefore, inhalant anesthetic agents (e.g., isoflurane, sevoflurane) are recommended for anesthetizing mouse patients.

An induction chamber is used to induce the patients, and then they are maintained under gas anesthesia using a face mask. It may be possible to intubate a larger rodent, but it is very difficult in mice; under most conditions, a modified syringe case face mask is used. To guard against aspiration of stomach contents in a patient that is not intubated, the veterinary surgeon should place the head and neck in a position slightly higher than the body.

Box 12-6 provides basic guidelines for proper techniques used in surgical preparation and surgical assistance in small mammals, including mice.

Premedication and sedation doses for mice and rats are listed in Table 12-1. Although general anesthesia is not recommended under most circumstances, injectable doses are listed in Table 12-2. Analgesia is important for patient recovery and should be administered before, during, and after surgery, depending on the patient’s presenting symptoms and the procedure being performed. Table 12-3 lists analgesic drug dosages for mice and rats. Surgical procedures that are performed on mouse patients require similar techniques to those used with larger animals. Veterinarians should follow the same protocol but remember that the surgical field is smaller and patient manipulation more delicate with patients that weigh less than 50 g.
ZOONOSES

Zoonotic diseases associated with mice maintained as pets are rare. Possibly the most commonly reported zoonotic condition associated with mice is an allergic reaction to their dander and urine. As with all animals, it is important that a handler wash his or her hands after interacting with a mouse. *Salmonella* spp. may colonize the intestinal tract of small mammals, including mice. Contact with the feces or anus of a mouse may expose the handler to this enteric pathogen. Washing hands after handling a mouse will help prevent exposure to possible pathogenic organisms a mouse may carry. One can monitor the individual mouse and mice colonies for subclinical carriers of zoonotic organisms by culturing the terminal intestinal tract.

Mice are carriers of two potentially deadly viruses: the Hantaan disease virus and an arenavirus that causes lymphocytic choriomeningitis (LCM) in humans. Mice that are propagated for sale in the pet trade are rarely if ever exposed to the Hantaan disease virus. Lymphocytic choriomeningitis–infected mice generally show no clinical signs, although weight loss, photophobia, tremors, and convulsions may occur. Humans are exposed to LCM through contaminated feces, urine, or a bite wound. Disease signs in humans infected with LCM are flu-like (e.g., malaise, headaches, fever, myalgia, arthritis). Fatal aseptic meningitis or meningoencephalitis in humans infected with LCM is rare.

*Hymenolepis* spp. are cestodes found in mice that can infect humans if contaminated feces are ingested. Rarely identified in pet mice, *Giardia* spp. are protozoan parasites that can cause severe gastroenteritis in humans. Because feces have to be ingested for someone to be exposed, it is more common for children to become infected with zoonotic intestinal parasites than for adults. Using proper sanitary practices after handling mice helps reduce exposure to zoonotic intestinal parasites and other potentially transmissible diseases. Although there are diseases listed in this zoonotic section that can be transmitted from mice to humans, the occurrence of this happening is extremely rare when commercially bred mice are purchased at reputable pet stores.

TABLE 12-3 Analgesic Dosages* for Mice and Rats

| Analgesic Dosages* for Mice and Rats |
|--------------------------------------|
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From Tully TN, Mitchell MA: A Technician’s Guide to Exotic Animal Care, Lakewood, CO, 2001, American Animal Hospital Association Press.

RATS

Rats, like mice, are common laboratory animals and are propagated for commercial sale in the pet trade and for use as reptile food. The life expectancy of a rat is 2 to 3 years. Unlike mice, rats have excellent pet characteristics that include a charming personable disposition and extreme intelligence (Figure 12-6). The common rat species maintained as a companion animal is *Rattus norvegicus*, with the white rat and hooded rat being the most common variations. Although rats have an excellent temperament for companionship, they can inflict a serious bite if provoked. Also, as with other animal species, humans can be allergic to their hair, skin dander, and urine and salivary proteins. Rats are not as territorial as other rodent species and are very social.

BIOLOGY

The integument of rats is commonly associated with a number of presenting symptoms of disease. As with mice, a rat’s hair coat that has not been adequately maintained is often the first clinical sign associated with disease. Rats are fastidious with their grooming and, when healthy, maintain a very tidy hair coat. Common problems associated with a hair coat that is not maintained include general illness, parasitism (internal and external), aggression by cagemates as a result of psychological trauma, and infectious dermatitis. *Staphylococcus aureus* infections initiated by self-trauma due to a fur mite infestation will manifest as ulcerative dermatitis. The most common tumor in rats is a mammary-associated
fibroadenoma. Fibroadenomas rarely metastasize but are locally invasive and can grow to a large size.

A coronavirus is the etiologic agent behind sialodacryoadenitis which results in inflammation and swelling of the cervical salivary glands. The most common disease presentations in rats involve the respiratory system. The three major pathogens that infect rat respiratory systems are *Mycoplasma pulmonis, Streptococcus pneumoniae, and Corynebacterium kutscheri.* Respiratory disease in rats often produces "red tears" and a red nasal discharge. This red staining around the eyes and nose is not blood but porphyrins produced by an irritated hardnerian gland located behind each eye. The red staining at the nasal opening is due to the drainage of the porphyrins via the nasolacrimal duct.

Renal disease may present in older males in the form of chronic progressive nephrosis. On necropsy, kidneys in affected animals are enlarged, appear pale, and have a pitted mottled surface.

Rats are continuous, polyestrous rodents that should be bred in polygamous or monogamous systems. When breeding rats that are housed in a polygamous ratio, it is recommended to have one male with two to six females. Females are removed from a polygamous cage on day 16 of gestation, whereas the monogamous pair is maintained together with the young until weaning.

Baseline rat physical information is listed in Box 12-7.

### HUSBANDRY

#### Environmental Considerations

Rats, like mice, can chew out of enclosures; therefore, it is important that the housing be "rat proof" regarding the animal’s ability to chew through the substance and escape into the house.

Rats are maintained in environments that are similar to those of other small rodents, but rats do not produce the quantities of odiferous urine associated with other rodents. For rats, large wire cages with easy-to-remove plastic bottoms are the optimal enclosure (Figure 12-7). The recommended housing unit size for rats is $15-20" \times 15-20" \times 7-10"$ (length $\times$ width $\times$ height) for each adult rat, with females and young requiring 2 to 3 times the space listed. Rats like to climb ramps and rope for exercise, so a cage that is taller than the listed requirements would be better suited for most singly housed animals. The major considerations for selecting an enclosure for rats, as with mice, are that it is resistant to their escape and easy to clean. An open screen top on the enclosure is recommended for proper ventilation. Available rodent cages that fit this criterion are wire or metal mesh, plastic, and Plexiglas. If the plastic tube housing systems are used, there should be routine cleaning of the sections using hot water and a mild detergent. An owner must always monitor the cage for possible escape avenues, especially if the animal...
has a predilection for modifying the cage opening through chewing. It is very important to provide cage toys and exercise opportunities for rats; therefore, the enclosure should be large enough to house not only food and water containers but also cage toys and an exercise wheel. Although not a cage toy, a hide box, in some form, should also be included, for the psychological well-being of the animal. This hide box can be a manufactured one or a small cardboard container that has one end cut out. Rats like to hide and also sleep during the day. By providing this piece of cage furniture or deep enough substrate for the rat to burrow, it will be able to sleep undisturbed during the daylight hours.

To prevent the buildup of urine and fecal material in the cage, commercially available paper rodent bedding or hardwood shavings should be used as a cage substrate (Figure 12-8). Although softwood (pine) and cedar shavings are available, the volatile oils that radiate from these substrates are irritating to small animals, especially because they are in very close contact with the material. These irritating compounds can cause dermal and respiratory inflammation, often leading to secondary bacterial infections.

Cardboard tissue tubes can be placed in a rat enclosure for chewing and play. Clothes items are not recommended in cages with animals that chew. Rats will shred the clothing items, exposing thread and elastic material that can become entangled around a rat’s extremity, leading to necrosis distal to the stricture. It is recommended to change the substrate within the enclosure at least twice a week and more often if there is a problem with odor or excessive excreta.

Temperature, humidity, and lighting within the enclosure should follow what is commonly maintained with the ambient conditions within the house. For animals housed outside or in an outbuilding, the temperature range should be 65° F to 85° F. The preferred light cycle for rats is 12 hours of light alternating with 12 hours of darkness.

**Nutrition**

There have been a number of studies investigating the recommended nutritional requirements of rats. These studies have taken place because of the fact that rats are one of the most commonly used laboratory animals when investigating human disease processes. The benefit of these dietary studies is the availability of commercially produced diets that provide the recommended daily nutritional requirements of the rat. The problem that most owners face is the multitude of dietary products available for rats, and owners often buy seed-based diets. Like mice, rats will happily eat seed although seed-based diets are lacking in a number of the nutritional requirements needed to maintain long-term health. Commercial rodent biscuits or pellets with 20% to 27% protein are the recommended diets for rats. The commercial rodent biscuits or pellets are the only food rats need to obtain their required nutrients. Again, seed-based diets are not recommended, nor is a significant supplementation of fruits, nuts, vegetables, cheese, or other human foods (e.g., peanut butter). If a treat is to be given, yogurt or dried fruit treats manufactured specifically for rodents and/or rats should be provided 2 to 3 times a week (Figure 12-9). For younger rats, less than 3 weeks old, softer pellets are needed because babies start eating pellets and drinking water at 2 to 3 weeks of age. A sipper bottle, placed on the outside of the cage is easy to maintain and does not take up space within the enclosure. If the cage is plastic or Plexiglas, modifications will be needed to attach the sipper bottle on the outside of the cage. Most sipper bottles come with attachment hardware to attach to wire cages. Fresh bottled water is recommended for rats, although chlorinated tap water can also be used. The water should be checked on a daily basis and clean water supplied at least every 2 days, if not every day.
**PREVENTIVE MEDICINE**

**Quarantine**

Quarantining an animal is important for the pet owner who is introducing a new animal into a setting in which there is an established group. As with other animals a 30-day quarantine period is recommended, along with a physical examination and fecal parasite check. Unfortunately, there is no time period that will screen 100% against potential infectious agents, and with rats, time is critical because their life span and reproductive time frame is so short. Quarantining the introduced animals in conditions similar to those in which they will be maintained permanently, reduction of handling, and providing adequate food and water will make for a smooth transition. It is imperative that the owner screen the new animal for diseases and watch for any signs of illness. All rats that are captive, either as pets or in a breeding setup, should have no access to insects, wild rodents, or other animals. The most common sign of clinical illness is an unkempt hair coat. The lack of grooming is most often related to the animal feeling depressed or sick and thereby not having the energy to perform routine behaviors. If a number of animals are being quarantined, sacrificing an apparently diseased animal is the most efficient way to determine a rapid definitive diagnosis. If it is a single or an expensive animal, routine diagnostic testing will be required.

To maintain oversight of a breeding animal’s health and reduce the exposure of young animals to infectious disease and parasites, routine screening of representative animals within the colony is recommended. In very large colonies, special caging (e.g., filter), food, and water may be necessary to maintain disease control.1

**Routine Exams**

**DISINFECTION AND SANITATION**

Before examining a rat, the examination table should be disinfected with either a dilute sodium hypochlorite or chlorhexidine solution. The examiner should always wash his or her hands and, if necessary, put on gloves before the capture and restraint of the patient. The difficulty with using latex gloves when examining a rat is the small size of the patient and its ability to twist and turn. Some rat patients can be restrained only if the examiner is not wearing gloves. If gloves are not worn, the examiner must thoroughly wash his or her hands, as with all cases, after the examination is completed.

To restrain a rat, the animal should be picked up with one hand being placed over the back and rib cage, restraining the head with the thumb and forefinger directly behind the jaws. The other hand is grasping the tail, stabilizing the animal (Figure 12-10). The skin on the dorsal cervical region may also be used, as with other rodents, to pick up the rat. A plastic sandwich bag can be modified as a restraint device for rats and small rodents. The rat’s head is placed toward a bottom corner and the sides folded over the animal’s back to limit movement.

If one is unable to adequately restrain a rat while the animal is conscious, an inhalant anesthetic may be used for sedation purposes. The animal should be placed in a small induction chamber and isoflurane gas permeated into the closed space (Figure 12-11). Once the animal has stopped moving, the enclosure top is removed and a nose cone placed on the anesthesia tube and placed on the patient’s face. A syringe case can be modified as a nose cone for small rodents. After the physical examination is completed, the nose cone is removed and the patient is allowed to recover, breathing oxygen from the anesthesia unit.

Injectable agents are another form of sedation used with rats for examination and diagnostic sample collection purposes (see Table 12-2). A thorough assessment of the patient is necessary before using injectable drugs for sedation and anesthesia because of the inability of veterinarians or technicians to rapidly manipulate the effects of these treatments.
HISTORY

Obtaining a detailed history for the rat patient is very important. It is imperative to get as much information from the owner as possible as it relates to the patient’s presenting problem, even if it is routine health examination.

Typical background information required for the rat patient includes how long the owner has had the animal, where it was acquired, how often it is handled, and the appearance of the feces and urine. Husbandry questions should focus on where the animal is housed, whether it is allowed to roam unobserved, where its cage is located; type, size, and material of the cage; cage substrate, furniture, and toys; how often the cage is cleaned and what disinfectant is used. When investigating the diet it is important to ask not only if pellets are fed and in what quantity, but also what the animal is eating and what its primary diet is. Supplemental offerings and frequency of feeding are very important data for the case work-up. The technician should find out about the water supply, how often the water is changed, and how much the animal drinks on a daily basis.

Because there are transmissible diseases among animals, the final questions should center on other pets in the household, if new animals have been added to the family, or if the animals are housed together. A description of any previous problems and a complete chronological description of the presenting problem are needed to complete the history form.

PHYSICAL EXAMINATION

Before restraining the animal, an observation should be made on its attitude, activity, and posture. The next step is to weigh the rat in a basket on a digital gram scale. If possible, temperature, respiration, and pulse should be measured and any abnormalities in rate and/or character noted. The physical examination starts at the head where the veterinarian should look for any abnormalities. Eyes, ears, and nares are observed for signs of discharge or inflammation. The oral cavity is difficult to examine in rats because of the small opening and tendency for the buccal mucosa to encroach toward the middle of the mouth. Rat incisors have a tendency to overgrow, so examination of the front teeth for normal occlusion and length is essential. A small speculum (e.g., modified paper clip) or an otoscope may be used to examine the oral cavity and cheek teeth. Mucous membranes help determine hydration status using capillary refill time and moisture. Body condition should be examined and abdominal palpation performed. Lymph nodes and limbs are palpated before checking the nails and plantar surface of each foot. The patient should have a normal posture, be aware of its surroundings, and move properly. Any problems should be noted in the record. Finally, a dermatologic exam considers hair coat quality, alopecia, external parasites, or any skin abnormalities. All abnormal findings are written in the record for case review, differential diagnoses determination, diagnostic testing, and treatment considerations.

ABNORMALITIES COMMONLY FOUND ON PHYSICAL EXAMINATION

Respiratory disease is often the primary complaint offered by owners when presenting a sick rat to the veterinary hospital. Bacterial and viral pathogens can infect rats and are easily spread within breeding colonies because most of the organisms are transmitted by subclinical carriers. Ocular and nasal discharge is often observed in combination with dark red pigment. This pigment may be mistaken for blood by owners but actually is porphyrins produced by the harderian glands located behind the eyes. The irritation of the harderian glands causes the excessive production of porphyrins, which are secreted around the eye and down the nasolacrimal duct to the nose.

Rats have incisors that grow continuously. The continuous growth is not a problem for animals with normal occlusion. If the incisors do not line up, then there is a condition that leads to overgrowth of these teeth. The upper incisors will curve around, and if they are not cut, they will lodge in the dorsal aspect of the oral cavity. The ventral incisors will flare out from the oral cavity.

A common tumor found in older intact female rats is the mammary tumor. Mammary tumors can be large and extensive. Rat mammary tissue extends, on their ventrum, from the inguinal area to the thoracic inlet and up to their dorsal lateral body wall. The most common subcutaneous mammary tumor in the rat is a fibroadenoma (Figure 12-12). Removing the ovaries at an early age reduces the incidence of the hormonally influenced tumor later in a female rat’s life.

Swelling of the cervical salivary gland is caused by a virus. The etiologic agent of this condition is a coronavirus, sialodacryoadenitis virus, resulting in upper respiratory inflammation and the previously mentioned swelling of the cervical salivary and lacrimal gland. There is no treatment for this highly contagious viral disease.

External and internal parasites may affect rats in the form of a rough hair coat or dermal lesions. Rats that are pruritic
may cause abrasions or scratches that become infected with Staphylococcus aureus bacteria, leading to secondary ulcerative dermatitis. Routine parasite examinations are necessary so that the veterinarian can identify parasitic infestations and administer treatment.

Rats can also present with neurologic, gastrointestinal, and urinary disease signs. A detailed history and examination will help direct the clinician toward a differential diagnosis list in which the appropriate diagnostic tests can be submitted to obtain a definitive diagnosis.

## DIAGNOSTIC TESTING

### Hematology

As with other pocket pets, blood collection from rats can be quite difficult. Approximately 0.5 to 0.7 ml/100 g body weight can be safely removed from a nonanemic healthy rat. A rat patient should always be anesthetized for blood collection procedures, to reduce patient stress and movement. Usually inducing the animals in a closed chamber and maintaining the patients in a mask will allow the technician plenty of time to collect the blood sample.

Using a warmed ventral tail vein, 0.5 ml can be collected through a 23-gauge butterfly needle. To collect from the tail vein, warm the distal two-thirds of the ventral aspect of the tail in a container of warm water for approximately 15 minutes. The tail vein can be observed more clearly in the distal aspect of the tail. A 22- to 25-gauge butterfly needle is used, and free flowing blood can be collected directly into the microtainer tubes. A tape bandage should be placed on the injection site to aid in hemostasis.

The easiest way to collect blood from many small mammals, including rats, is from the anterior vena cava. With the rat under general anesthesia, a 25-gauge, 1-inch needle attached to a 3-ml syringe is directed toward the umbilicus from the right side of the manubrium.

Box 12-8 describes the technique used for retroorbital bleeding in rats and is not recommended for companion animals. The retroorbital bleeding technique is commonly used in laboratory animal settings and is easily performed by an experienced veterinarian or veterinary technician.

As with smaller rodents, the saphenous vein or lateral vein of the tarsus may be used for multiple blood collections without the use of an anesthetic. The patient must be properly immobilized in a restraint tube (35-ml syringe) with the leg extended and the skin on the medial aspect of the thigh held tightly between the handler’s thumb and forefinger. The taut skin on the lateral aspect of the thigh allows exposure of the saphenous vein. A 23-gauge needle is used to puncture the vein, and blood is collected in a microhematocrit tube as it flows from the vessel.

Blood samples obtained from nail and ear clips are not considered appropriate diagnostic samples. Cardiac puncture is recommended only in terminal cases and when the animal is maintained under general anesthesia because of possible complications involving the lungs and heart vessels.

### BOX 12-8 Retroorbital Blood Collection for Rats

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From Tully TN, Mitchell MA: A Technician’s Guide to Exotic Animal Care, Lakewood, CO, 2001, American Animal Hospital Association Press.

### BOX 12-9 Complete Blood Count Reference Ranges for Rats

| Erythrocytes | 5.4-8.5 × 10⁸ μL³ |
| Hematocrit | 37%-49% |
| Hemoglobin | 11.5-16 mg/dl |
| Leukocytes | 6.6-12.6 × 10³ μL |
| Neutrophils | 1.77-3.38 × 10³ μL |
| Lymphocytes | 4.78-9.12 × 10³ μL |
| Eosinophils | 0.03-0.08 × 10³ μL |
| Monocytes | 0.01-0.04 × 10³ μL |
| Basophils | 0.00-0.03 × 10³ μL |
| Platelets | 150-460 × 10³ μL |
| Serum protein | 5.6-7.6 g/dl |
| Albumin | 3.8-4.8 g/dl |
| Globulin | 1.8-3.0 g/dl |

From Bihune C, Bauck L: Basic anatomy, physiology, husbandry, and clinical techniques. In Quesenberry KE, Carpenter JW, editors: Ferrets, Rabbits and Rodents: Clinical Medicine and Surgery, ed 2, St Louis, 2004, WB Saunders; Johnson-Delaney CA, Harrison LR: Small Rodents: Exotic Companion Medicine Handbook for Veterinarians, Lake Worth, Fla, 1996, Wingers.

The collection of samples for diagnostic testing in rats is similar to that in other rodents. The reference ranges for complete blood counts and serum biochemistry panels are listed in Boxes 12-9 and 12-10.

### Bone Marrow Aspiration

Marrow samples may be obtained from the ilium, tibia, sternum, femur, or the bones of the proximal one third of the tail. Preparation of the samples is consistent with that of other mammalian patients.
Urine Collection

Standard rodent cages can be used without substrate to collect urine and feces when the patient is hospitalized. By placing a rodent in a ziplock bag, urination frequently occurs and the sample can be collected. In a similar manner the urine in a rat can be collected over a disinfected stainless steel examination table.1 The urine is voided while the animal is restrained and can be collected in a capillary tube for evaluation on urine reagent strips.1 Urinalysis reference values for rats are listed in Box 12-11.

Diagnostic Imaging

Under most practice settings, the size of a rat patient limits imaging capabilities to radiographs. Restraint is essential for quality diagnostic images. To obtain adequate restraint and prevent movement of the patient during radiographic evaluation, sedation is required. As with all diagnostic procedures involving avian and exotic animals, an evaluation of the patient is required to determine its ability to withstand the stress associated with the assessment. If it is determined that the patient cannot withstand sedation, then it should be stabilized until it is deemed healthy enough for diagnostic imaging evaluation.

Microbiology

For the rat patient in which microbiological testing is recommended, standard collection techniques used for other animals are appropriate. With the most common respiratory conditions in rats being viral and bacterial organisms, it is important to try and aid the diagnostic laboratory in organism isolation through listing the potential pathogens. As always, if in doubt on collecting, preserving, and/or shipping a microbiological sample, the diagnostic laboratory should be contacted for full instructions regarding rat submissions.

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Box 12-10: Serum Biochemistry Reference Ranges for Rats

| Test                  | Reference Range |
|-----------------------|-----------------|
| Serum glucose         | 50-135 mg/dl    |
| Blood urea nitrogen   | 15-21 mg/dl     |
| Creatinine            | 0.2-0.8 mg/dl   |
| Total bilirubin       | 0.20-0.55 mg/dl |
| Cholesterol           | 40-130 mg/dl    |
| Serum calcium         | 7.2-13.9 mg/dl  |
| Serum phosphorus      | 3.11-11.0 mg/dl |
| Alkaline phosphatase  | 56.8-128 IU/L   |
| Alanine aminotransferase (ALT) | 17.5-30.2 IU/L |
| Aspartate aminotransferase (AST) | 45.7-80.8 IU/L |

Box 12-11: Urinalysis Reference Values for Rats

| Test                  | Reference Range |
|-----------------------|-----------------|
| Urine volume (ml/24 h)| 13-23 ml        |
| Specific gravity      | 1.022-1.050     |
| Average pH            | 5-7             |
| Protein               | <30 (mg/dl)     |

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From Bihune C, Bauck L: Basic anatomy, physiology, husbandry, and clinical techniques. In Quesenberry KE, Carpenter JW, editors: Ferrets, Rabbits and Rodents: Clinical Medicine and Surgery, ed 2, St Louis, 2004, WB Saunders; Johnson-Delaney CA, Harrison LR: Small Rodents: Exotic Companion Medicine Handbook for Veterinarians, Lake Worth, Fl, 1996, Wingers.
Parasitology

Routine fecal parasite evaluations should be performed on small rodents when they are brought to the veterinary clinic for a health examination or an abnormal stool. Common protozoal organisms can be detected using a direct fecal examination. An anal tape test is useful for identifying Syphacia spp. in rats.

Diagnosis of ectoparasites in small rodents is similar to that in other species listed in this text. A skin scraping of the affected area or a pelage tape test (to identify Radfordia spp.) will usually yield the parasite. Diagnosis of intestinal parasites can be made by finding individual eggs in a fecal flotation of a macerated fecal pellet and in the lumen of the small intestine during necropsy.

Miscellaneous Diagnostics

There are serologic diagnostic tests available for rats through Sound Diagnostics, Inc. (Woodinville, Washington). Fifty μL of undiluted serum is needed to run one test or a rat infectious panel. Rat infectious diseases for which serologic tests are available include Kilham’s rat virus, pneumonia virus of mice, rat parvovirus, rat coronavirus, Mycoplasma pulmonis, Toolan’s H-1 virus, Sendai virus, Theiler’s murine encephalomyelitis virus, cilia-associated respiratory bacillus, mouse adenovirus, and reovirus 3.

COMMON DISEASE PRESENTATIONS

Infectious

Staphylococcus aureus is the most common cause of ulcerative dermatitis in rats. This organism is ubiquitous in most rat colonies and survives on the animals’ skin. Unless there is a break in the skin, there is no infection or disease caused by the organism. In cases where there is a fur mite (Radfordia ensifera) infestation, rats become pruritic, developing lesions that seed the S. aureus organism. The ulcerative dermatitis can be treated with an appropriate antibiotic through both systemic and topical application, cleaning the affected areas, and clipping the toe nails of the rear feet.

Mycoplasma pulmonis, Streptococcus pneumoniae, Corynebacterium kutscheri, Sendai virus, and cilia-associated respiratory bacillus have been isolated and identified as infectious agents causing rat respiratory disease. With the respiratory pathogens, clinical signs can vary from mild dyspnea to severe pneumonia and death. Rats with mycoplasmosis are treated in much the same way as infected mice.

Sialodacryoadenitis virus is a highly contagious disease that causes rhinitis and inflammation of the cervical salivary and lacrimal glands. There is no treatment for this viral disease, and supportive care is recommended for the affected patient.

There are other infectious diseases that can infect rats, as evidenced by the available serologic tests (e.g., Kilham’s rat virus, pneumonia virus of mice, rat parvovirus, rat coronavirus, Toolan’s H-1 virus, Theiler’s murine encephalomyelitis virus, mouse adenovirus, reovirus 3). These infectious diseases are diagnosed less commonly than those previously identified. Even so, veterinarians should be aware of the infectious disease organisms to which rat patients may be exposed and aware that tests are available for antemortem diagnosis.

Parasites

ENDOPARASITES

Specific intestinal parasites identified in rats include the dwarf tapeworm (Hymenolepis nana), pinworms (Syphacia muris), nematodes (specifically Trichomonoides cristicauda), and Giardia muris. Diagnosis of intestinal parasites is important for the implementation of the appropriate treatment plan. Pinworms are diagnosed through the anal tape test, protozoan parasites (e.g., Giardia muris) through a direct fecal exam, and cestodes and nematodes from fecal flotation on macerated fecal pellets. Once the parasite has been identified, proper treatment can be initiated and environmental recommendations applied to prevent exposure of other animals and reexposure of the patient being treated.

ECTOPARASITES

Rats do not appear as susceptible to ectoparasites as mice, but the following have been identified: Ornithonyssus bacoti (tropical rat mite), Radfordia ensifera (rat fur mite), Demodex nanus (demodex), Polyplax spinulosa (the spined rat louse), and fleas. Diagnosis and treatments are similar to those recommended for mice although the dosages and duration differ.

Treatment of ectoparasites can be accomplished with ivermectin and a topical miticide. As with other rodent species, there has been an increasing ectoparasite resistance to ivermectin treatment.

Nutritional Disease Problems

Because most rodent diets are manufactured in the form of pellets or small biscuits that provide all recommended nutrients, there are few nutritional disease problems diagnosed in pet rats. It is also important to provide an adequate supply of fresh water and appropriate rodent food on a daily basis. If rats are fed an all-seed diet, there could be nutrition-related consequences. A lack of vitamin A could result in roughened hair coat or skin lesions. A breakdown of the protective epithelial lining of the gastrointestinal and/or respiratory tract could predispose the rat to secondary bacterial infections affecting those body systems. Nutritional deficiencies may also result in poor reproductive activity. Vitamins B complex, C, and E plus selenium are recommended for treatment of female rats diagnosed with pregnancy toxemia.2

Rats, if fed a high quantity of human food, will develop dental plaque on the cheek teeth. Proper diet, primarily rodent biscuits or pellets, will reduce the formation and buildup of dental plaque. If left unattended, the excess plaque may lead to gum disease and dental caries. If caries develop within cheek
teeth, the recommended treatment is removal of the affected teeth.

Neoplasia

Rats are susceptible to tumors, most likely because of their short life span and physiologic predisposition. The most common subcutaneous tumor in rats is the fibroadenoma of the mammary tissue. The mammary tumors can reach very large sizes and affect both males and females. To reduce the incidence of fibroadenomas, ovariohysterectomies are advocated at an early age in female animals. Whereas mammary tumors in mice are almost always malignant, rat mammary tumors are usually localized and respond to surgical resection.

Miscellaneous

Rats have continuously growing incisors. Under normal anatomic conditions, the incisors maintain their length by grinding on their occlusive surface. If the position of the incisors is compromised, malocclusion will occur, causing overgrowth of their front teeth. The teeth, if left untrimmed, can cause trauma to the dorsal surface of the oral cavity (upper incisors) and the lower teeth extending outside of the mouth. In severe cases the teeth may adversely affect the animal’s ability to eat. The teeth can be trimmed with a high-speed motor tool (e.g., Dremel®) with a cutting disk attachment.

A common disease in older male rats is chronic progressive nephrosis; the disease can also affect females. The protein level in the urine commonly exceeds 10 mg/day and progressively increases as the animal ages. The pathophysiology of chronic progressive nephrosis involves glomerulosclerosis with tubulointerstitial disease primarily affecting the convoluted proximal tubule. The progression of the disease process may be slowed through a low-protein diet and anabolic steroid therapy.

Therapeutics

Fluid therapy can be given to rats through intramuscular, subcutaneous, intraperitoneal, and intravenous routes. Using a 25-gauge needle, a volume of up to 0.2 ml of fluid can be injected into the quadriceps muscle. Up to 5 ml of fluid can be injected under the loose skin covering the neck or lateral body wall. Intraperitoneal fluids should be administered while the rat is properly restrained to restrict movement. With one of the rat’s hindlimbs extended, a 25-gauge needle is inserted into the center of the caudal quadrant of the abdomen, following the line of the extended leg. Up to 5 ml of fluids can be given via the intraperitoneal route. The most common method of providing fluids is intravenously to the lateral tail vein. To access the tail vein, warming the tail to dilate the vessel in warm water for approximately 15 minutes is required to aid in visualization. The older the animal is, the more difficult it is to see the vessel through the tail skin.

Although there are many methods that may be used to administer medication in small mammals, oral treatment with a dropper or tuberculin syringe is the easiest for the veterinarian and least stressful to the patient. Medication can be added to the food or water, but often the patient is anorexic or the medicated food/water is not palatable, in which case, the patient does not receive treatment.

Both oral medication and nutritional supplementation can be administered through an oral gastric feeding tube to rat patients. The techniques described earlier for mice can also be applied to rats.

Dosing can be found in a number of formularies. Before administration of any therapeutic agent, the dosage should be checked twice and calculations thoroughly evaluated to make sure they are correct.

Surgical and Anesthetic Assistance

The same surgical and anesthetic techniques described for mice can be used for rats (see Box 12-6). Dosages for rat injectable anesthetic and sedative agents and analgesic treatment can be found in Tables 12-1 and 12-2.

Rats are larger than mice and can be intubated using a modified otoscope head (Figure 12-13). When using inhalant anesthesia, an intubated animal can be ventilated and there is less risk of aspiration from fluid that enters the oral cavity.

Surgical procedures that are performed on rat patients use similar techniques utilized on larger animals. Veterinary surgeons should follow the same protocols but remember that the surgical field is small and patient manipulation is delicate. The most common surgical procedures performed on rats are castration, ovariohysterectomy, and tumor (especially mammary tumor) removal.

Zoonoses

Occurrences of humans becoming infected with zoonotic diseases associated with pet rats are uncommon. As with mice, an
allergic reaction to rat dander and urine may be the most commonly reported zoonotic condition. As with all animals it is important that a handler always wash his or her hands after interacting with a rat. *Salmonella* spp. may colonize the intestinal tract of rats.  

There has been a human case of chorioamnionitis in which *Corynebacterium kutscheri* has been isolated. This Gram-positive bacillus is routinely isolated from the nasopharynx of rats and therefore can be considered a zoonotic agent.  

*Streptobacillus moniliformis* and *Spirillum minus* are organisms that initiate the disease called rat-bite fever. A rat bite is required to seed the bacteria in a human, and after a 6- to 10-day incubation cycle, the human begins to show clinical signs associated with the disease (e.g., relapsing fever, chills, vomiting, myalgia, regional lymphadenopathy).  

Rats appear to be one of the primary rodent carriers of *Streptococcus pneumoniae*. The rodent develops respiratory disease through which the organism is shed and humans are exposed. Infected humans have respiratory and meningeal disease signs associated with *S. pneumoniae* illness.  

It should be mentioned that the rodent flea (*Xenopsylla cheopis*) transmits the plague organism *Yersinia pestis*. It is wild rodents in which the plague organism is of most concern, but the disease is found worldwide, especially in the American Southwest. This is a very good reason why rats under the care of humans should have no access to wild animals.  

*Leptospira interrogans* is transmitted from the infected urine of rats. Again, restricting contact with wild rodents will reduce the risk of pet exposure. Humans infected with *L. interrogans* have chills and fever and often develop septicemic conditions that can lead to organ dysfunction.  

*Hymenolepis* sp. is a cestode found in rats, which can infect humans if contaminated feces are ingested. *Giardia* sp. is a protozoan parasite, rarely identified in pet rats, that can cause severe gastroenteritis in humans. Because feces have to be ingested for exposure, it is more common for children to become infected with zoonotic intestinal parasites than for adults. Proper sanitary practices after handling rats will help reduce humans’ exposure to zoonotic intestinal parasites and other potentially transmissible diseases. All potential rat owners and current rat owners should know that the occurrence of zoonotic disease transmission is extremely rare when commercially bred rats are purchased from reputable pet stores.

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