

PEER-REVIEWED

Caring for rabbits: An overview and formulary

Rabbits have become popular companion animals and backyard pets and are showing up more often in examination rooms. But be careful not to treat a rabbit as if it were a small cat — rabbits have very different nutritional, medical, and management needs.

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THE DOMESTIC RABBIT, a descendent of the old world rabbit of western Europe and northwestern Africa,¹ has become a popular pet. Practitioners are increasingly asked to provide health care for this species. Although some domestic rabbits are used for commercial meat and fur, teaching and research, exhibition by rabbit fanciers, and as outdoor pets, probably most are now house pets. As pets, rabbits are small, relatively easy to care for, fastidious, and quiet. What's more, they can be litter box trained.

Practitioners often find the medical and surgical care of rabbits particularly exciting and challenging. But to be proficient in rabbit medicine, veterinarians also need to know the basics of rabbit anatomy and biology, housing, nutrition, and preventive medicine.

This article discusses anatomic and biologic characteristics of rabbits as well as their housing and nutritional needs. Additionally, we will provide an introduction to the medical and surgical management of pet rabbits. This knowledge is essential in providing high-quality veterinary care for your clients' pet rabbits.

Some anatomic and biologic characteristics of rabbits

Rabbit teeth are all open rooted, or continuously growing. As noted by their dental formula (2/1, 0/0, 3/2, 3/3), rabbits are distinguished from rodents by the presence of two pairs of upper incisors. The smaller second pair of upper incisors are located directly behind the first and lack a cutting edge. Malocclusion and overgrowth are most likely to occur with the incisors, which grow 10 to 12 cm a year throughout the rabbit's lifetime.²

Rabbits' ears are highly vascular and help regulate heat, as well as sensing sound.² The ears are fragile and sensitive and should not be used for restraint. The rabbit skeleton is also fragile, comprising only 8% of the animal's body weight, compared with 13% in the cat. The long bones and lumbar spine, which are surrounded by powerful muscle masses, are particularly susceptible to fracture.²

The rabbit's alimentary tract includes a glandular stomach and a large cecum. The simple stomach has thin walls and indistinctly separated glandular and nonglandular areas. The terminal ileum expands and forms a thin-walled sacculus ro-

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INDICATIONS

Dogs

Aerobic bacteria: ANTIROBE Capsules and ANTIROBE AQUADROPS Liquid are indicated for the treatment of soft tissue infections (wounds and abscesses), dental infections and osteomyelitis caused by susceptible strains of *Staphylococcus aureus*.

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CONTRAINDICATIONS

ANTIROBE Capsules and ANTIROBE AQUADROPS Liquid are contraindicated in animals with a history of hypersensitivity to preparations containing clindamycin or lincocmycin.

Because of potential adverse gastrointestinal effects, do not administer to rabbits, hamsters, guinea pigs and horses.

WARNINGS

Not for human use.

PRECAUTIONS

ANTIROBE Capsules and ANTIROBE AQUADROPS Liquid should be prescribed with caution in atopic animals.

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The use of ANTIROBE occasionally results in overgrowth of non-susceptible organisms such as clostridia and yeasts. Therefore, the administration of ANTIROBE should be avoided in those species sensitive to the gastrointestinal effects of clindamycin (see CONTRAINDICATIONS). Should superinfections occur, appropriate measures should be taken as indicated by the clinical situation.

Patients with very severe renal disease and/or very severe hepatic disease accompanied by severe metabolic aberrations should be dosed with caution, and serum clindamycin levels monitored during high-dose therapy.

Clindamycin hydrochloride has been shown to have neuromuscular blocking properties that may enhance the action of other neuromuscular blocking agents. Therefore, ANTIROBE should be used with caution in animals receiving such agents.

Safety in gestating bitches or breeding males has not been established.

SIDE EFFECTS

Side effects occasionally observed in either clinical trials or during clinical use were vomiting and diarrhea.

DOSE AND ADMINISTRATION

Canine Infected Wounds, Abscesses and Dental Infections

Oral: 2.5 mg/lb body weight every 12 hours. Duration: Treatment with ANTIROBE products may be continued up to a maximum of 28 days if clinical judgment indicates. Treatment of acute infections should not be continued for more than three or four days if no response to therapy is seen.

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SYMPOSIUM ON RABBIT MEDICINE

Caring for rabbits: An overview (cont'd)

TABLE 1

Selected Physiologic Values for Rabbits*

Adult body weight of male (buck)	2-5 kg
Adult body weight of female (doe)	2-6 kg
Birth weight	30-80 g
Rectal temperature	38.5-40 C (101.3-104 F)
Life span	5-7 years (up to 15 years)
Food consumption	5 g/100 g/day
Water consumption	≥5 ml/100 g/day
Gastrointestinal transit time	4-5 hours
Breeding onset of male	6-10 months
Breeding onset of female	4-9 months
Breeding life of female	4 ¹ / ₂ months to 4 years
Cycle length	Induced ovulation
Gestation period	29-35 days
Litter size	4-10
Weaning age	4-6 weeks
Respiratory rate	30-60 breaths/min.
Tidal volume	4-6 ml/kg
Heart rate	130-325 beats/min.

*Adapted from Harkness, J.E.; Wagner, J.E.: *The Biology and Medicine of Rabbits and Rodents*, 3rd Ed. Lea & Febiger, Philadelphia, Pa., 1989; pp 9-19.

tundus. Large amounts of lymphatic tissue are located in the wall of the sacculus, giving it a "honeycomb" external appearance. The cecum is large (about 10 times stomach capacity), thin walled, and occupies much of the abdominal cavity. The cecum is the primary site for cellulose digestion.

Rabbits produce two types of fecal pellets: mucus pellets and dry pellets (hard). The mucus pellet, or cecotrope, which comes from the cecum, is usually produced in the early morning (night feces), but may occur at any time of day. The cecotrope is generated four to eight hours after eating and is immediately ingested directly from the anus. This is rarely seen by the client. Upon redigestion, the ingested cecotrope serves as a source of nutrients, including B vitamins, amino acids, and volatile fatty acids. The dry pellets are generally pro-

duced during the first four hours after feeding and are not normally ingested.

As in cats, the rabbit penis points caudally; there is no os penis. The scrotum, however, is cranial to the penis. The inguinal canals lead to the inguinal pouches and remain open throughout the rabbit's lifetime, permitting the testes to move in and out of the abdominal cavity. In the female, the uterine horns are long and separate, and open into the vagina through two cervixes. The urethra opens into the vagina, forming the vestibule (urogenital sinus). There is one common urogenital opening in the female. This characteristic distinguishes the rabbit from the rodent, in which there are separate urinary and genital openings.

Young rabbits can be sexed by evertting the tissue in the perineal region. Males have a tubular penis with a round opening; females have

SYMPOSIUM ON RABBIT MEDICINE

Caring for rabbits: An overview (cont'd)

1. One technique for physically restraining a rabbit involves placing one hand under the rump to prevent kicking while holding the loose skin over the shoulders with the second hand. As a calming effect, place the rabbit's head in the crook of your elbow.

2. To administer fluids, a 25-ga. butterfly catheter can be placed in the rabbit's cephalic vein.



Figure 1



Figure 2

a slitlike vulval opening.³ The penis and vulva are located just cranio-ventral to the anus. For sexing mature rabbits, the male's penis can be protruded by manipulating the skin of the prepuce, and the testicles can generally be palpated.

Rabbits are induced ovulators. Although they do not have an estrous period, females do have a seven- to 10-day period of receptivity followed by a one- to two-day period of inactivity.² Receptivity is generally indicated by a swollen, reddened vulva and by a doe that stands and allows mounting.² Rabbits are receptive during pregnancy and lactation, with libido peaks at about 26 and 39 days postpartum.²

Rabbits have a breeding life from about 4½ months to four years of age. This usually provides seven to 11 litters per doe before the number of young per litter declines.² The onset of senescence probably results from a progressive endometrial fibrosis and a consequent failure of the ova to implant.² Other reproductive and biological data are presented in *Table 1*.

Nutritional needs

Nutritional problems are common in rabbits and include enteric diseases, fur chewing, and trichobezoars (hairballs). Commercial rabbit diets do not necessarily provide balanced nutrition. Some of the available commercial diets have been developed for rapid growth in the production rabbit. These diets are not good for the pet rabbit because of their high caloric content and inadequate fiber. The rabbit's inability to vomit and the small pyloric lumen predispose the animal to hair accumulation in the stomach. Hairballs in rabbits can generally be prevented by feeding high-fiber diets, minimizing stress and boredom, and brushing frequently.

The preferred diet for a pet rabbit is a high-quality, high-fiber (18 to 24%) pelleted diet containing 14 to 17% crude protein. The pellets should be fed at a rate of one-fourth cup per 2.3 kg (5 lb) body weight, divided into two meals a day.⁴ Loose hay (mixed-grass hay, timothy hay, or high-quality dried grass clippings) should be provided ad li-

bitum.⁴ Alfalfa hay can be offered throughout the growth stages, but should then be discontinued because of its high protein content. The diet should be supplemented with dark fibrous, leafy greens (kale, mustard greens), fresh vegetables (carrots, broccoli), and a small amount of fresh fruit (strawberries, apples). During gestation and lactation, the amount of protein and available energy should be increased by providing the rabbit with more pellets.^{5,6} Because the rabbit's intestinal microflora is sensitive to intestinal osmolarity, pH, and other factors, food changes (especially in four- to 12-week-old rabbits) should be introduced gradually over four to five days. During this time, combine the old and new feeds to allow for adjustments in the balance of normal flora.² Rabbits, particularly those recently weaned, are sensitive to foods high in sugar or starch. Feeding these foods has been associated with at least some cases of enterotoxemia. Nutritional counseling, therefore, is an important part of rabbit medi-

SYMPOSIUM ON RABBIT MEDICINE

Caring for rabbits: An overview (cont'd)

TABLE 2
Normal Values for the CBC and Serum
Chemistry Profile in Rabbits*

Parameter	Normal Values
CBC	
Hb (g/dl)	8-17.5
PCV (%)	30-50
RBC ($\times 10^6/\mu\text{l}$)	4-8
Platelets ($\times 10^3/\mu\text{l}$)	290-650
WBC ($\times 10^3/\mu\text{l}$)	5-12
Neutrophils (%)	35-55
Lymph (%)	25-50
Mono (%)	2-10
Eos (%)	0-5
Baso (%)	2-7
Serum Chemistry Profile	
ALP (IU/L)	4-16
ALT (IU/L)	14-80
AST (IU/L)	14-113
Bicarbonate (mEq/L)	16.2-31.8
Total bilirubin (mg/dl)	0-0.75
Calcium (mg/dl)	8-14
Chloride (mEq/L)	92-112
Cholesterol (mg/dl)	35-60
Creatinine (mg/dl)	0.8-2.5
Glucose (mg/dl)	75-150
LDH (IU/L)	34-129
Total lipids (mg/dl)	280-350
Phosphorus (mg/dl)	2.3-6.9
Potassium (mEq/L)	3.7-6.8
Total protein (g/dl)	5.4-7.5
Albumin (g/dl)	2.5-4.5
Globulin (g/dl)	1.9-3.5
Sodium (mEq/L)	138-155
Triglycerides (mg/dl)	124-156
Urea nitrogen (mg/dl)	15-30

*Adapted from Jenkins, J.R.; Brown, S.A.: *A Practitioner's Guide to Rabbits and Ferrets*. American Animal Hospital Association, Lakewood, Colo., 1993; pp 3-42; and Hillyer, E.V.: *Pet Rabbits*. *Vet. Clin. North Am. (Small Anim. Pract.)* 24(1):25-65; 1994.

cine, especially since many new rabbit owners think that lettuce and carrots are an appropriate diet for their animals.

Proper housing

Although rabbits are best housed in wire-bottomed cages (mesh size 1×2.5 cm) with access to a smooth sur-

face such as plexiglass or wood, prebuilt commercial cages are probably more practical for indoor rabbits. The cage should be well ventilated and easy to clean. Grass hay is a good bedding material because it is edible, although some owners prefer to use an absorbable inedible bedding such as wood chips or pelleted cellulose. Carpeting should generally not be used as bedding because of the difficulty in cleaning it and the potential for "carpet hairballs" if eaten by the rabbit. Cedar chips should be avoided because of the dust and potentially irritating oils that may be associated with them. If housed outdoors, rabbits should also be provided with shelter and shade. As with other species, a good husbandry and sanitation program is important to rabbit management.

Indoor rabbits should be caged when unattended. The most common behavioral problem in indoor rabbits is the chewing of rugs, furniture, and electrical wires.³ In addition to the destruction these pets cause to the house, rabbits can ingest foreign bodies, be electrocuted, or otherwise injure themselves if left unattended.

Rabbits should be protected from rapid temperature changes (e.g. moving between outdoors and indoors), excessive drafts, predators, insects, and rodents.² In particular, rabbits are sensitive to high temperatures. In high humidity and at temperatures greater than 29.5 C (85 F), heat stress may lead to death or infertility, especially in heavily furred or older rabbits. Additionally, under these conditions, does are more susceptible to embryonic mortality.²

SYMPOSIUM ON RABBIT MEDICINE

Caring for rabbits: An overview (cont'd)

TABLE 3
Selected Anesthetic and Related Drugs for Rabbits

Drug	Dose and Route	Comments
Acepromazine	1-2 mg/kg intramuscularly or subcutaneously	Tranquilizer, preanesthetic
Acetylsalicylic acid	100 mg/kg orally every four to eight hours	Anti-inflammatory, analgesic
Atropine	0.1-0.5 mg/kg intramuscularly or subcutaneously	Anticholinergic; many rabbits possess serum atropinase, higher doses may be required in rabbits with a high level of atropinase
Buprenorphine	0.02-0.1 mg/kg subcutaneously or intravenously every 12 hours	Analgesia
Butorphanol	0.1-0.5 mg/kg intravenously, intramuscularly, or subcutaneously every four hours	Analgesia
Chlorpromazine	1-10 mg/kg intramuscularly	Preanesthetic
Diazepam	1-5 mg/kg intramuscularly; 1-2 mg/kg may be adequate to permit intubation	Preanesthetic; may be used with ketamine
Doxapram	2-5 mg/kg intravenously	Respiratory stimulant
Flunixin meglumine	1.1 mg/kg intramuscularly or subcutaneously every 12 hours	Anti-inflammatory, analgesic
Halothane	To effect	Surgical anesthesia
Isoflurane	To effect	Surgical anesthesia; administer by mask for most short procedures
Ketamine-diazepam	Ketamine at 30-40 mg/kg + diazepam at 2-5 mg/kg intramuscularly Ketamine at 20-30 mg/kg + diazepam at 1-3 mg/kg intramuscularly	Surgical anesthesia Recommended for most surgical procedures when used with isoflurane; dental extractions may require a slightly higher dose
Ketamine-xylazine	Ketamine at 35 mg/kg + xylazine at 3 mg/kg intramuscularly	Surgical anesthesia; butorphanol (0.1 mg/kg intramuscularly) can be administered concurrently
Naloxone	0.01-0.1 mg/kg intramuscularly or intravenously	Opioid reversal
Yohimbine	0.2 mg/kg intravenously	Xylazine reversal

SYMPOSIUM ON RABBIT MEDICINE

Caring for rabbits: An overview (cont'd)

Figure 3

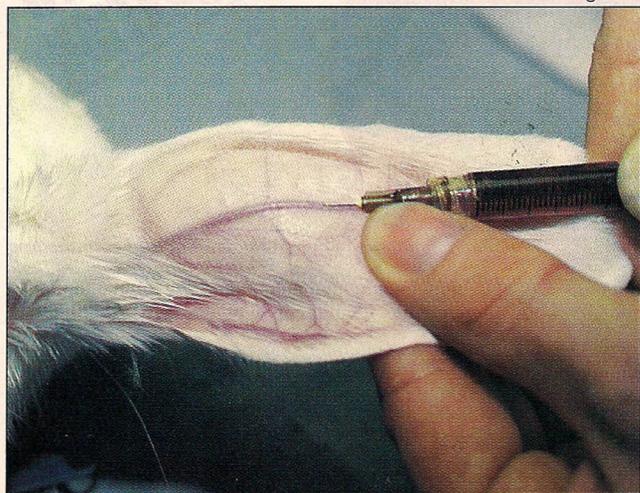


Figure 4



Figure 5

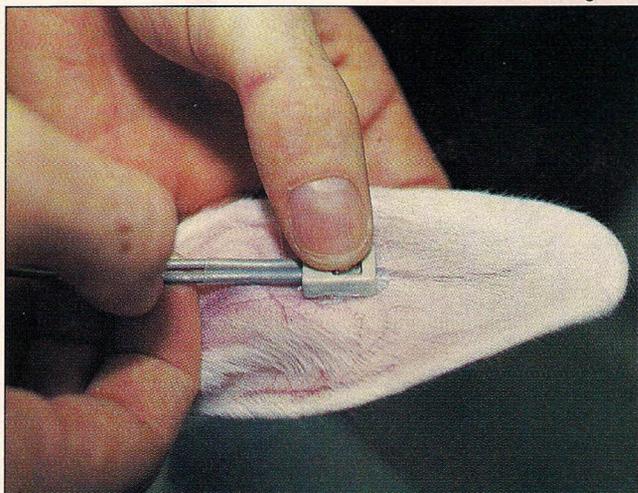


Figure 6



3. For diagnostic purposes, blood can be obtained from the central ear artery. The artery can be made more prominent by gently thumping it with your finger.

4. Masking a rabbit with isoflurane. A cat restraint bag can be useful when restraining a fractious animal. 5. A Doppler blood pressure monitor sensor placed on the central ear artery of a rabbit. 6. Passing an endotracheal tube over a flexible stylet and into a rabbit's trachea.

Physical examination

Restraint methods

To avoid struggling that can lead to fractures or luxations of the lumbar vertebrae, it is important to hold rabbits properly and securely. Rabbits can be carried by grasping the loose skin over the shoulders with one hand, tucking the head under your arm, and placing the other arm under the rump to support the weight (*Figure 1*). An al-

ternative is to pick up a scruffed rabbit by cupping the hindquarters with the other hand to prevent the rear legs from kicking back.³ Physical restraint of a rabbit can also be achieved by approaching the patient from behind and placing both hands around the chest. As the rabbit is lifted up, slide one hand up under the axillae extending the forelegs, and slide the flat of the other hand down the abdomen extending the hind legs completely.

SYMPOSIUM ON RABBIT MEDICINE

Caring for rabbits: An overview (cont'd)

TABLE 4
Selected Anti-infective Drugs for Rabbits*

Drug	Dose, Route, and Frequency
Amikacin sulfate	10 mg/kg subcutaneously or intramuscularly every 8-12 hours
Amprolium 9.6% solution	1 ml/7 kg orally once daily for 5 days or 5 ml/gallon drinking water for 3 weeks
Carbaryl 5% powder	Dust twice weekly
Chloramphenicol palmitate	30-50 mg/kg orally every 12 hours for 5-7 days
Chloramphenicol sodium succinate	30 mg/kg intramuscularly or intravenously every 8 hours for 5-7 days
Doxycycline	2.5 mg/kg orally every 12 hours
Enrofloxacin	5-10 mg/kg orally, intramuscularly, or subcutaneously** every 12 hours
Fenbendazole	10-20 mg/kg orally, repeat in 2 weeks
Gentamicin sulfate	2.5 mg/kg subcutaneously or intramuscularly every 8 hours for 5 days
Griseofulvin	12.5-25 mg/kg orally every 12 hours for 30 days
Ivermectin 1% solution	0.2-0.4 mg/kg subcutaneously, repeat in 10-14 days
Lime sulfur	Dip weekly for 4-6 weeks; use with caution
Metronidazole	20 mg/kg orally every 12 hours
Neomycin	30 mg/kg orally every 12 hours for 5 days
Oxytetracycline	15 mg/kg intramuscularly every 8 hours for 7 days
Penicillin, benzathene	42,000-60,000 IU/kg intramuscularly every 48 hours for 3-4 treatments
Piperazine salts	200 mg/kg orally, repeat in 2-3 weeks
Praziquantel	5-10 mg/kg orally, subcutaneously, or intramuscularly, repeat in 10 days
Sulfadimethoxine	12.5 mg/kg orally every 12 hours
Sulfamethazine	1 mg/ml drinking water
Sulfaquinoxaline	Prophylactic level 0.025% in water for 30 days; treatment level 0.1% in water for 2 weeks
Thiabendazole	50 mg/kg orally, repeat in 3 weeks
Thiabendazole/dexamethasone/neomycin drops	3 drops in each ear every 12 hours for 7 days
Trimethoprim-sulfa	15-30 mg/kg orally or subcutaneously every 12 hours
Tylosin	10 mg/kg orally, subcutaneously, or intramuscularly every 12 hours

*There is a potential for antibiotic-induced enterotoxemias following administration of antibiotics, especially penicillins. Appetite and fecal character must be monitored closely during and after therapy.

**Repeated intramuscular or subcutaneous injections can lead to muscle necrosis or sterile abscesses. Therefore, oral administration is recommended after a few initial injections.

SYMPOSIUM ON RABBIT MEDICINE

Caring for rabbits: An overview (cont'd)

TABLE 5
Selected Miscellaneous Drugs Used in Rabbits

Drug	Dose, Route, and Frequency	Indication
Cimetidine	5-10 mg/kg every 6-12 hours	Gastric ulceration
Dexamethasone	0.5-2 mg/kg parenterally	Shock, anti-inflammatory
Dipyrrone	6-12 mg/kg every 8-12 hours	Elevated temperature
Metoclopramide	0.2-0.5 mg/kg orally or subcutaneously every 6-8 hours	Delayed gastric emptying
Oxytocin	1-2 IU total dose intramuscularly	Delayed parturition, dystocia
Prednisone	0.5-2 mg/kg orally, intramuscularly, or subcutaneously	Anti-inflammatory

TABLE 6
Suggested Nonsurgical Treatments for Trichobezoars in Rabbits*

Treatment	Dose, Route, and Frequency	Comments
Analgesics	See Table 3	Used for abdominal discomfort, thereby stimulating the appetite
Antibiotics	See Table 4	Use when indicated; trimethopim-sulfa or enrofloxacin are generally the drugs of choice; use parenterally until stools are passed
Femalt Hairball Remedy® (Carter-Wallace)	3 ml orally every 24 hours for treatment; 2 ml orally each week for prevention	Increase exercise concurrently
Fluid therapy	Orally, subcutaneously, or intravenously	Rehydration is essential; given concurrently with other medical treatments
Force-feeding	Fruit or vegetable baby foods, fresh greens, powdered rabbit pellets in lactated Ringer's solution	Important in the anorectic rabbit; helps prevent hepatic lipidosis; also offer fresh greens and hay ad libitum
Laxatone® (Evsco)	Orally every 12-24 hours for 5 days	Use as a supplement to pineapple juice treatment
Metoclopramide	0.2-0.5 mg/kg orally or subcutaneously every 6-8 hours	Promotes gastric emptying
Pineapple juice, fresh**	10 ml orally every 24 hours for 5 days for treatment; 10 ml orally every 24 hours for 3-5 days every 2-3 months for prevention	

*Controlled studies are not available.

**Enzymes have no direct effect on the hair, but presumably have a role in digesting the trichobezoar's matrix.

SYMPOSIUM ON RABBIT MEDICINE

Caring for rabbits: An overview (cont'd)

TABLE 7
Drugs Reported to Be Toxic in Rabbits*

Drug	Comments
Ampicillin	Antibiotic-associated diarrhea
Amoxicillin	Enteric disease
Cephalosporins	Enteric disease
Clindamycin	Antibiotic-associated diarrhea
Erythromycin	Enteric disease
Lincomycin	Antibiotic-associated diarrhea
Penicillin	Enteric disease
Procaine	At doses of 0.4 mg/kg
Tiletamine	Nephrotoxic

*There have also been some reports of antibiotic-related colitis in rabbits given penicillin/streptomycin, trimethoprim/sulfamethoxazole, cephalosporins, amoxicillin, tetracycline, and gentamicin. In general, parenteral antibiotic therapies are preferred over oral.

The rabbit's spine is now protected by the holder's abdomen.⁷ A second person can then examine or medically treat the animal. Wrapping the rabbit in a towel or placing it in a cat restraint bag also works well for physical restraint.

General examination

Practitioners should encourage rabbit owners to have their pets physically examined at least once a year. This examination should include hematologic and parasitic evaluations (and a serum chemistry evaluation in older rabbits or in animals with clinical evidence of disease) because signs of disease in rabbits are generally not detected as early as in dogs or cats. Normal values for rabbits are presented in *Table 2*.

The basic principles of physical examination in rabbits are similar to those for other domestic species. Pay particular attention to inspecting the ears (ear mites, otitis externa), mouth (malocclusion), and abdomen (gastric trichobezoars and urinary calculi) for signs of disease.

Because obesity is a problem in pet rabbits, frequent weighing is also important. In the United States, no vaccines are approved for use in the rabbit.⁸

Oral examination

The oral cavity, especially the molars, can generally be examined using an otoscope with a large cone or a canine vaginal speculum with an attached light. The mouth can be opened with a mouth gag, and some practitioners use a canine vaginal speculum for holding the cheeks apart. Although sedation may be required, most oral examinations can be performed using physical restraint by wrapping the patient securely in a towel.

Injections and venipuncture

As with other animals, medications or fluids can be administered intramuscularly, intravenously, subcutaneously, intraperitoneally, orally, or intraosseously in the rabbit. For intramuscular injection, the preferred injection site is deep in the quadriceps or posterior muscle groups of

the hindlimb using a 23- to 25-ga. needle. For intravenous administration, the lateral saphenous or cephalic veins (*Figure 2*) are typically used, although access may be difficult if the patient is in shock. Some practitioners use the marginal ear veins for intravenous injections only in emergencies because of the potential for perivascular irritation, which can cause the lateral margin of a pinna to slough.³ Intraosseous access can be achieved using a spinal needle in the trochanteric fossa of the femur.

For diagnostic purposes, blood can be obtained from the central ear artery (thump the artery with your finger for better vasodilation) (*Figure 3*), lateral saphenous, jugular, or cephalic vein using a 22- to 25-ga. needle (27-ga. for exceptionally small veins). The marginal ear vein can also be used for collecting small samples. Although less preferable, a toenail can be clipped and a small blood sample obtained. Phlebotomy is best performed by placing the rabbit in a cat bag or wrapping it in a towel and covering the rabbit's eyes.

Formulary for rabbits

Tables 3 through 5 outline anesthetic and related drugs, anti-infective drugs, and miscellaneous drugs commonly used in rabbit medicine. Antibiotic choices in rabbits are limited because many antibiotics suppress the healthy flora and allow pathogens to proliferate, resulting in well-documented enteric disorders. Suggested nonsurgical treatments for trichobezoars and drugs that have been reported to be toxic to rabbits are presented in *Tables 6 and 7*.

Anesthesia and elective surgeries**Anesthesia and anesthetic monitoring**

Most anesthetic protocols for rabbits combine ketamine with diazepam, xylazine, or acepromazine at high doses for short periods of surgical anesthesia or at lower doses for induction of anesthesia and maintenance of anesthesia with inhalant agents (Table 3).⁹⁻¹³ Because of its wide margin of safety, a ketamine and diazepam combination is our preference when an injectable anesthetic is indicated. Although some practitioners use tiletamine and zolazepam to induce anesthesia in the rabbit, others suggest that it may be nephrotoxic^{14,15} and that it may have been associated with several anesthetic deaths. Because of the success with other parenteral anesthetic agents, the use of tiletamine and zolazepam in rabbits is probably not warranted.

Isoflurane is

the inhalant of choice in rabbits and is generally used for longer procedures, after an injectable anesthetic agent is given. Masking an animal with isoflurane without using an injectable anesthetic agent can be useful when performing minor proce-

dures (e.g. bandaging and splinting, radiography, phlebotomy) or when a patient is stressed (Figure 4). Although intubation is desirable to provide a patent airway, one study found that maintaining anesthesia by masking did not limit the length

of anesthesia or result in serious complications.¹⁴

Atropine has been used in rabbits to prevent bradycardia and to decrease tracheal secretions.¹² The dose and frequency of administration of atropine is higher in rabbits than in other species because some rabbits possess a natural atropinase that readily metabolizes atropine. Some investigators recommend that atropine not generally be used or be used with caution in rabbits because thickened secretions may accumulate in the pharynx and trachea, resulting in an obstructed airway.¹² However, some practitioners have found atropine useful and have not observed complications.

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SYMPOSIUM ON RABBIT MEDICINE

Caring for rabbits: An overview (cont'd)

Successful anesthesia and recovery require close monitoring in rabbits. Anesthetic monitoring usually includes an electrocardiogram monitor and a Doppler blood pressure monitor (Figure 5).¹⁴ Some practitioners also find the pulse oximeter useful when monitoring an anesthetized rabbit. It is important to monitor the rate and pattern of the respiration while monitoring heart rate and rhythm.^{10,12,16} An adequate surgical plane of anesthesia, a circulating warm-water heating pad to maintain body temperature, careful monitoring, and minimal anesthetic times are important to successful rabbit anesthesia.^{10,12,16} Warmed intravenous, subcutaneous, or intraperitoneal fluids may also be indicated to reduce recovery time, particularly if an injectable anesthetic is used or if the surgical procedure has been prolonged.

Although endotracheal intubation during anesthesia maintains a patent airway and reduces the possibility of tracheal aspiration of ingesta, this technique is difficult in rabbits because they have a large tongue, large molars, a small larynx, a soft palate that obscures the epiglottis, and they may develop laryngospasms.^{14,17,18} In addition, continued trauma to the larynx by attempting to pass an endotracheal tube may result in laryngeal edema and obstruction of the airway. Therefore, short procedures are often done with the rabbit masked with isoflurane, frequently in combination with an injectable anesthetic. When endotracheal intubation is indicated, the preferred technique involves visualizing the larynx by hyperextending the head and neck and using a small-bladed laryngoscope

or a canine otoscope in small rabbits.^{16,18} Use the otoscope to depress the tongue and elevate the soft palate so you can identify the vocal folds. Once you visualize the larynx, introduce a flexible stylet such as a 5-F. polypropylene urinary catheter into the larynx and trachea (Figure 6). Remove the laryngoscope or otoscope and pass the endotracheal tube (usually with an internal diameter of 2 to 4 mm) over the catheter and into the larynx. The catheter guide can then be removed.

Surgical procedures

Elective surgical procedures such as castration or ovariectomy can generally be performed safely in young, healthy rabbits with a minimum of complications. (These surgical procedures are detailed in the second article of this symposium.) However, patients with any historical or physical abnormalities warrant further presurgical evaluation.¹⁴ Castrating and spaying of rabbits have been recommended to prevent breeding and unwanted litters, burrowing, pyometra, neoplasia of reproductive organs, urine spraying, and aggression.^{11,19} Rabbits should be observed closely for postoperative complications and signs of systemic illness, and appropriate therapy should be given if warranted.¹⁴

Conclusion

Because there are many differences between rabbits and other domesticated companion animals, a knowledge of rabbit biology, husbandry, and nutrition becomes essential if we are to provide proper medical care to this species. A knowledge of physical and chemical restraint, en-

dotracheal intubation, fluid and medication administration, and blood sampling techniques will also help ensure proper medical care in rabbits. Practitioners also need to be aware of drugs commonly reported to be toxic in this species.

REFERENCES

1. Fox, R.R.: Taxonomy and Genetics. *The Biology of the Laboratory Rabbit*, 2nd Ed. (P.J. Manning et al, eds.). Academic Press, New York, N.Y., 1994; pp 1-26.
2. Harkness, J.E.; Wagner, J.E.: *The Biology and Medicine of Rabbits and Rodents*, 3rd Ed. Lea & Febiger, Philadelphia, Pa., 1989; pp 9-19.
3. Hillyer, E.V.: Pet Rabbits. *Vet. Clin. North Am. (Small Anim. Pract.)* 24(1):25-65; 1994.
4. Jenkins, J.R.: Nutrition and Nutrition-related Diseases of Rabbits. *J. Small Exotic Anim. Med.* 1:12-14; 1991.
5. Cheeke, P.R.: *Rabbit Feeding and Nutrition*. Academic Press, Orlando, Fla., 1987; pp 88, 147.
6. Cheeke, P.R. et al: *Rabbit Production*. Interstate Printers and Publishers, Danville, Ill., 1987; p 249.
7. Burgmann, P.M.: Restraint Techniques and Anesthetic Recommendations for Rabbits, Rodents, and Ferrets. *J. Small Exotic Anim. Med.* 1(2):73-78; 1991.
8. Brooks, D.L.: Rabbits, Hares, and Pikas (Lagomorpha). *Zoo and Wild Animal Medicine*, 2nd Ed. (M.E. Fowler, ed.). W.B. Saunders, Philadelphia, Pa., 1986; pp 711-725.
9. Mulder, J.B.: Anesthesia in the Rabbit Using a Combination of Ketamine and Promazine. *Lab. Anim. Sci.* 28:321-322; 1978.
10. Schuchman, S.M.: Individual Care and Treatment of Rabbits, Mice, Rats, Guinea Pigs, Hamsters, and Gerbils. *Current Veterinary Therapy X* (R.W. Kirk, ed.). W.B. Saunders, Philadelphia, Pa., 1989; pp 738-765.
11. Sedgwick, C.J.: Spaying the Rabbit. *Mod. Vet. Pract.* 63:401-403; 1982.
12. White, W.J.; Field, K.J.: Anesthesia and Surgery of Laboratory Animals. *Vet. Clin. North Am. (Small Anim. Pract.)* 17(5):989-1017; 1987.
13. White, G.L.; Holmes, D.D.: A Comparison of Ketamine and the Combination Ketamine-xylazine for Effective Surgical Anesthesia in the Rabbit. *Lab. Anim. Sci.* 26:804-806; 1976.
14. Millis, D.L.; Walshaw, R.: Elective Castrations and Ovariectomies in Pet Rabbits. *JAAHA* 28:491-498; 1992.
15. Jenkins, J.R.; Brown, S.A.: *A Practitioner's Guide to Rabbits and Ferrets*. AAHA, Lakewood, Colo., 1993; pp 3-42.
16. Sedgwick, C.; Jahn, S.: Techniques for Endotracheal Intubation and Inhalation Anesthesia for Laboratory Animals. *Calif. Vet.* 31:27-33; 1980.
17. Davis, N.L.; Malinin, T.I.: Rabbit Intubation and Halothane Anesthesia. *Lab. Anim. Sci.* 24:617-621; 1974.
18. Gilroy, B.A.: Endotracheal Intubation of Rabbits and Rodents. *JAVMA* 179(11):1295; 1981.
19. Dulisch, M.L.: A Castration Procedure for the Rabbit, Rat, Hamster, and Guinea Pig. *J. Zoo Anim. Med.* 7:8-11; 1976.