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PET RABBITS

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Rabbits are popular as pets for both adults and children. They have lively and responsive personalities and do well as indoor pets in urban and suburban settings. In many households, rabbits receive (and return) the level of attention and affection that is traditionally associated with canine and feline pets. In turn, rabbit owners are demanding expert and individualized veterinary care for their pets.

The bulk of knowledge about rabbits concerns those animals used for laboratory research or meat, wool, or fur production. Practitioners who work with rabbits are challenged to take this information and apply it to pet rabbits. Many diseases of middle-age to older animals are not well researched in the rabbit literature. Additionally, the focus of most rabbit research is on production herds and research colonies rather than on the individual animal.

The emphasis of this article is on the common diseases and conditions of pet rabbits. Much of this information is based on the author's experience and that of other clinicans. The reader is referred to the references for information on laboratory and meat rabbit husbandry and medicine. Other sources of information on pet rabbits are listed in the Appendix.

BIOLOGICAL CHARACTERISTICS

Taxonomy

Domestic rabbits (*Oryctolagus cuniculus*) belong to the order Lagomorpha, family Leporidae. The lagomorphs, including pikas, hares, and cottontail rabbits, differ from rodents in the presence of a second set of

From Oldwick, New Jersey

upper incisors (the "peg teeth" or "wolf teeth") found caudal to the larger, principal pair.

Pet rabbits have been domesticated since the Middle Ages; they are descended from wild rabbits of western Europe and northern Africa. There are over fifty breeds of domestic rabbit, ranging in size from the dwarf breeds (0.9 to 1.8 kg, or 2 to 4 lbs) to the giant breeds, which may weigh 6.4 to over 9 kg, or 14 to over 20 lbs. The breed standards are published by the American Rabbit Breeders Association (see the Appendix.)

Physiology and Reproduction

The average lifespan of domestic rabbits is 5 to 6 years or longer, with reports of some rabbits living up to 15 years.[19] Medium-size and larger rabbits usually live longer than the dwarf breeds.

Sexual maturity occurs earlier in females than in males and occurs earlier in the smaller breeds than in the large ones. The small breeds, such as the Dutch and Polish, can be bred at 4 to 5 months of age; the medium breeds, like the New Zealand White, are bred at 5 to 7 months; and the giant breeds are bred at 9 to 12 months.[27]

Does should be brought to the buck's cage for breeding. Receptive does will assume a mating position with elevated hindquarters. Less reliable signs of receptivity include a restless behavior, chin rubbing, and a red to purple, congested vulva. The estrous cycle is irregular, with 4- to 17-day-long periods of receptivity interspersed with 1- to 2-day periods of inactivity. Does are induced or "reflex" ovulators; ovulation occurs 10 to 13 hours postcoitus. If breeding is successful, the fetuses can be palpated by day 14 or 15 after conception. Gestation is short, usually lasting between 30 and 33 days. Pseudopregnancy can occur after sterile matings, mounting by other does, or from stimulation by the presence of nearby bucks and generally lasts 15 to 17 days.

In the final 3 to 4 days of gestation or pseudopregnancy, the doe builds a nest from available materials and hair pulled from her dewlap, belly, and thighs. The birthing process (kindling) typically occurs in the early morning and is quite rapid, although it can last for 1 to 2 days.[10] Both breech and anterior presentations are normal, and dystocias are uncommon.[27] Litter size ranges from one to 22 and averages seven to eight young (kits) for the medium-sized breeds. The doe eats the placenta and any stillbirths. The young are born hairless, blind, and deaf. Their eyes open at about 10 days of age. Rabbits do not retrieve young that have fallen out of the nest; the caretaker should do this for them.

Primiparous and agitated does may neglect or, in rare instances, cannibalize their young. Normally, the doe nurses the kits only once daily in the early morning or evening. Because nursing is rarely observed, the inexperienced owner may assume the doe is neglecting her young. Assessing the vitality and appearance of the kits will give an indication as to whether they are nursing. Kits that are not nursing have

sunken abdomens, whereas those that are nursing have distended stomachs that are visible through the skin. Rabbit milk is high in fat and protein, containing approximately 13% fat, 12.5% protein, 2% lactose, and 2.5% minerals.[26] Weaning occurs naturally at 5 to 6 weeks of age.

Rabbits have open-rooted teeth that grow continuously at a rate of 10 to 12 cm per year.[18] The dental formula is I 2/1, C 0/0, P 3/2, M 2-3/3. Malocclusion of the incisors or the cheek teeth is very common in pet rabbits.

Rabbits have a large orbital venous sinus, which must be avoided during surgery in that area. The nostrils of rabbits normally move up and down 20 to 120 times per minute.[27] Nostril twitching is absent in rabbits that are very relaxed or very ill. Mature females often have a prominent dewlap, which is a common site for moist dermatitis to develop. There are four right lung lobes and two left lung lobes. Rabbits have a relatively small thoracic cavity and a large abdominal cavity.

Rabbits are hindgut fermenters. They have a simple, glandular stomach which, in health, is never empty. Like horses and rats, they cannot vomit. They have a large cecum with a capacity 10 times that of the stomach. Two areas of prominent gut-associated lymphoid tissue are the cecal appendix and the sacculus rotundus (ileocecal tonsil). The length of the intestines is approximately 11 times the length of the body.[27]

The bones of rabbits are delicate and brittle; the skeleton comprises 8% of body weight (compare with cats, in which skeleton is 13% of body weight).[19] Rabbits have powerful hindquarters, adapted for jumping. If not restrained properly, a rabbit can kick with its rear legs and fracture its spine, usually in the lumbar area.

The inguinal canals remain open for the life of the rabbit. In males, the testes descend at 12 weeks and are carried in a hairless scrotum. Young rabbits can be sexed by everting the tissue in the perineal region: males have a tubular penis with a round opening; females have a slit-like vulvar opening. The penis and vulva are located just cranioventral to the anus, and the perineal scent glands are located bilaterally just off the midline and lateral to the external genitalia. Females have a bicornuate uterus, a double cervix, and four to five pairs of mammary glands. Male rabbits do not have nipples.

MANAGEMENT

Pet Quality

Rabbits make lively, personable, and affectionate pets. Some will interact with the owner on a level usually associated with dogs: i.e., following the owner around and coming when called. Many rabbits have strong personalities and are able to clearly communicate their needs. Like other species, they are more relaxed with humans if handled when young; rabbits that have had minimal human contact tend to be more skittish around humans.

A rabbit does well as an "only pet"; however, human interaction is important. There should be at least one daily period of exercise and socializing out of the cage. Multiple rabbits can be housed together if they are compatible and if birth control issues have been addressed. Rabbits will interact better if they have been raised together. A solitary, older animal will often be very aggressive towards a younger newcomer.

Most rabbits are not aggressive towards humans, although some individuals will bite when provoked. Thumping with the rear feet is a territorial behavior and often indicates displeasure or alarm. Urine spraying to mark territory is an undesirable trait of some males and the occasional female; this behavior usually resolves with neutering.

Housing

Rabbits can be kept indoors or outdoors. Suggestions on hutch construction can be found in the references.[9, 19] Pre-built, commercial caging is often advertised in laboratory animal science journals and in periodicals such as *Domestic Rabbits* (see Appendix 1). Cage size requirements depend on the size of the rabbit(s) and the amount of time in confinement; a larger cage is necessary for rabbits that are mostly kept confined.

Caging should be well-ventilated and easy to clean. Glass aquaria are not suitable because of the lack of ventilation. Use of wire flooring and a drop pan facilitates sanitation; however, some rabbits on wire flooring will develop "sore hocks" (see later discussion). Ideally, the floor wire mesh size should be small (1 x 2.5 cm), and there should be a smooth surface, such as plexiglass or wood, in part of the cage so the rabbit can spend time off the wire. Grass hay is a good bedding material because it is edible.

Outdoor hutches should be constructed to provide shelter from wind and direct sunlight. Rabbits tolerate cold weather if they are properly acclimatized and sheltered, but they do not tolerate high temperatures (>29.5°C or >85°F). Heat prostration and reduced fertility can be problems in summer months. Screening should be used during the warmer months to protect against insects.

Rabbits kept as indoor pets can be trained to use a litter box. Indoor rabbits should be caged when unattended. The most common behavioral problem in indoor pets is the propensity of some individuals to chew on furniture, rugs, and electrical wires. These animals can be very destructive. Provision of a varied, high-fiber diet and "safe" chewing toys may alleviate the problem. "Rabbit proofing" involves protection of electrical wires and exposed wooden furniture.

Nutrition

Rabbits are monogastric herbivores that use hindgut fermentation and have a very complex digestive physiology. Adequate dietary fiber is

necessary for normal gastrointestinal (GI) motility. Normal intestinal motility, balance of microflora, and cecal pH are all important for the maintenance of GI homeostasis.

Normal rabbit feces are of two types: the firm, round feces, which comprise about two-thirds of the output, and the cecotrophs, which comprise one-third. Cecotrophs, or night feces, are soft feces that originate from the cecum and are an important source of B-vitamins, protein, and water. Rabbits ingest them directly from the anus in a process known as cecotrophy. Cecotrophy occurs on a circadian rhythm, typically once a day during the night or early morning. In wild rabbits, cecotrophy occurs during the day when they are in their burrows.

The nutritional needs of rabbits vary with age and reproductive status. In general, higher calories, protein, and calcium are necessary for growth, pregnancy, and lactation as compared with maintenance. Most commercial pelleted diets do not provide enough fiber for the needs of middle-aged, nonbreeding, sedentary house rabbits. Inadequate dietary fiber is an important underlying factor in many disease processes, including diarrhea, obesity, and trichobezoars.

The basic diet for a mature, nonreproducing pet rabbit should include a good pelleted feed, grass hay, leafy green vegetables, and a limited amount (1 to 2 Tbsp) of treat foods such as rolled oats, stale bread, and fruit. A high-fiber pellet (≥18% fiber) is optimal; pellets are offered at 1/4 cup/2 kg (5 lbs) of body weight. Grass hay, such as timothy, is offered free-choice. Alfalfa hay is too high in protein and calcium for a maintenance diet but is preferred for breeding females, growing rabbits, and those that receive no pellets. Lactating females and young rabbits up to 8 months of age can receive pellets free-choice. Leafy green vegetables are enjoyed in abundance by most rabbits. Any diet changes should be made gradually.

Clean, fresh water should always be available. Inverted sipper bottles are more sanitary than water bowls; however, they should be checked routinely because the ball tips sometimes stick and obstruct the flow of water.

CLINICAL APPROACH TO PET RABBITS

Preventive Medicine

Rabbits should be examined once a year. All rabbits should be screened for ear mites, GI parasites, and dental malocclusion. The owner's husbandry should be reviewed to ensure that proper caging with adequate ventilation is provided and that the diet contains ample fiber. Vaccinations are not necessary for pet rabbits.

Routine neutering of pet rabbits is often desirable and can be done as early as 3 to 4 months of age. Many intact male rabbits, and some female rabbits may spray urine or display territorial aggression by thumping and biting. Spaying females prevents the development of uter-

ine adenocarcinoma, a common neoplasm of rabbits. Finally, neutering may be necessary for birth control.

Restraint

Proper restraint facilitates the physical examination and clinical procedures. Although most rabbits are relatively docile, they are easily spooked and can transform very suddenly and unexpectedly from a motionless posture into a violent escape attempt. Restraint should be quiet, firm, and gentle. The rabbit should be grasped by the scruff of the neck; which often quiets it. The rabbit should then be picked up by cupping the hindquarters with the other hand to prevent the rear legs from kicking back (Fig. 1). The rabbit can be carried a short distance, in a vertical position, with this hold. Alternatively, while still holding the scruff, the rabbit's head can be placed under the opposite arm, using that arm and hand to support the hindquarters.

Physical Examination

The basic principles of physical examination in rabbits are the same as for other species. A few peculiarities of rabbits and practice tips are covered herein.

Figure 1. One method of picking up a rabbit using a neck scruff hold. The hindquarters are fully restrained in the holder's opposite hand.

Solid footing, such as a clean towel or mat, should always be provided when working with these animals, because rabbits often become frightened and excited on the slippery surface of a metal table. Minimal restraint is usually preferable for the physical examination; a neck scruff hold may be necessary for some individuals. Some animals remain calm if their eyes are covered by a hand during the physical examination.

A temperature determination is often not necessary for a routine health check; this is at the clinician's discretion. The author prefers to take a rectal temperature, when necessary, prior to the examination (normal is 38.5°C to 40°C or 101.3°F to 104°F). Although this can be stressful, it may be the only way to get an accurate reading, because body temperature in rabbits may rise rapidly as a result of excitement. Indeed, many rabbits will have an elevated temperature—over 40.5°C (105°F)—on a hot day due to the wait in the reception area, particularly if they have been sitting on their owners' lap.

Checking the teeth for malocclusion is an important part of the physical examination. The incisors are checked by gently parting the lips. The cheek teeth are examined using a medium-size otoscopic cone (Fig. 2). This technique gives a "tunnel-like" view of the oral cavity and will detect most, but not all, dental abnormalities. Abnormal points on the premolars and molars are typically on the lateral aspect of the top teeth and on the medial aspect of the bottom teeth. Other physical clues to dental problems include drooling, moist dermatitis under the chin, and pus, blood, or excessive saliva in the oral cavity.

The nares and eyes should be checked for discharge, and the ears should be examined for the crusty exudate that is seen with ear mites. The contours of the skull and jaws should be felt to rule out bony abscesses. The nose should be twitching. Auscultation of the heart is routine. Referred upper airway sounds are common because rabbits

Figure 2. Otoscopic examination of the cheek teeth.

breathe through the nose. The abdomen feels very full on palpation; stomach and cecal contents should be relatively sôft. The contours of the kidneys are readily palpable. Abnormalities that may be detectable on palpation include cystic calculi, enlargement of the uterus in females, and dense, firm gastric trichobezoars or cecal impactions. The extremities should be palpated for masses.

An assistant should hold the rabbit in a vertical position with its ventrum facing outward, while the bottom of the feet are checked for hairloss, abrasions, or infection (Fig. 3). The perineal region can be examined at this time, including the genitalia and the perineal scent glands.

Clinical Techniques

Blood Collection

Blood volume in rabbits is roughly 5.5% to 6.5% of body weight.[19] Rabbit veins are easily visualized through the skin and tend to stand up nicely when occluded for venipuncture. Visualization is facilitated by shaving or plucking the fur or by the liberal use of alcohol to wet down the area. Rabbit veins are fragile and prone to hematoma formation.

Figure 3. An assistant restrains the rabbit for suture removal. This hold is also used for examination of the ventrum, perineal region, and feet.

A small volume of blood (e.g., 0.1 to 0.3 mL) can be collected by venipuncture of the cephalic or lateral saphenous vein using a low-dose insulin syringe with 27-g needle or a tuberculin syringe with 25-g needle. In medium-size to larger rabbits, these veins are large enough to collect 1 to 3 mL with a 22- to 25-g needle or butterfly catheter. Restraint may be easier for cephalic than for lateral saphenous venipuncture if a rabbit tries to kick with the rear legs.

The author uses the jugular vein for collection of most blood samples (Fig. 4). An assistant is needed to hold the patient in sternal recumbency at the edge of a table with the head extended up and the forelegs pulled down. The jugular vein is large, superficial, and relatively laterally placed. If the vein cannot be visualized, it is often palpable as a soft area with associated fremitus. A 22-ga or larger needle can be used for blood collection in most rabbits. Some clinicians collect blood from the marginal ear vein or central ear artery using a butterfly catheter and vacuum blood collection equipment. Cardiac puncture is not appropriate in pet rabbits.

After collection, blood is placed in the appropriate specimen container. Some laboratories supply small blood collection tubes (with a capacity of 0.7 mL) for use in exotic pet species. Clinicians should contact their local laboratories to determine the desired submission technique

Figure 4. Venipuncture of the jugular vein.

and to confirm that the laboratory technicians are trained to evaluate rabbit hematology.

Normal-complete blood count (CBC) and biochemistry values are listed in Table 1. The hematocrit of healthy rabbits is 33% to 48%. The normal white blood cell count (WBC) ranges from 6 to 12 x 10^3/mm. The neutrophils of rabbits are called heterophils, amphophils, or pseudoeosinophils because they contain small eosinophilic granules. Lymphocytes are usually the predominant white blood cells in the peripheral blood of healthy rabbits.[26] One study found that rabbits developed a neutrophilia and lymphopenia, rather than leukocytosis, in response to bacterial infection.[40] Basophils are relatively common in rabbits (2% to 7%). Serum biochemistry values are similar to those for other mammals with the exception of serum calcium, which can fluctuate with diet and may be as high as 15 mg/dL in an otherwise normal rabbit.

Urinalysis

The urine is a major route of calcium excretion in rabbits. Normal values for urinalysis are in Table 1. Normal rabbit urine is often turbid and ranges in color from white to yellow to brown or orange. An orange-brown color is due to porphyrin pigments and is alarming to new owners who assume it is due to blood. A urine dipstick can be used in the home setting to test for blood. Albuminuria is common in young rabbits.[27]

Urine is collected as a clean catch sample or by cystocentesis using a small-gauge needle.

Treatment Techniques

Rabbits are very difficult to "pill". Oral medications can be given in liquid form; alternatively, tablets can be crushed and mixed with Nutri-Cal (Evsco Pharmaceuticals, Buena, NJ), smashed banana, strawberry jam, or any palatable liquid. Intramuscular (IM) and subcutaneous (SQ) injections are given as in dogs and cats. Small intravenous (IV) injections can be given into a cephalic or lateral saphenous vein using a low-dose insulin syringe. Use of the marginal ear veins for IV injections is reserved for emergencies by the author because of the potential for perivascular irritation causing a slough of the lateral margin of a pinna.

Fluid Therapy

Fluid therapy is important in inappetant and anorexic rabbits. Subcutaneous fluids often are most practical. Peripheral catheters are not well tolerated by most rabbits. In very sick animals, or during surgery, short 20- to 24-g intravenous catheters can be placed in the cephalic or lateral saphenous veins. Jugular catheters are often difficult to place; a cut-down or modified cut-down procedure may be necessary. Isotonic, sterile fluids are administered for SQ and IV use. Rabbit water consump-

Table 1. NORMAL LABORATORY VALUES FOR RABBITS*

Hematology

Erythrocytes (RBC)	$5.5-7.5 \times 10^6/mm^3$
Hematocrit (PCV)	33%–48%
Hemoglobin (Hb)	10–16 g/dL
Mean corpuscular volume (MCV)	$60-65 \ \mu m^3$
Mean corpuscular hemoglobin (MCH)	18–22 pg
Mean corpuscular Hb concentration (MCHC)	30%–36%
Platelets	$300-600 \times 10^3/mm^3$
Leukocytes (WBC)	$6-12 \times 10^3/mm^3$
Neutrophils (heterophils)	20%–52%
Lymphocytes	30%–85%
Basophils	2%–7%
Eosinophils	0–5%
Monocytes	1%–12%

Serum Biochemistry

Total protein	5.5–7.5 g/dL
Albumin	2.5–4 g/dL
Globulin	1.9–3.5 g/dL
Glucose	75–150 mg/dL
Blood urea nitrogen	13–30 mg/dL
Creatinine	0.5–2.0 mg/dL
Total bilirubin	0–0.75 mg/dL
Total lipids	280–350 mg/dL
Cholesterol	10–80 mg/dL
Calcium	5.5–12.5 mg/dL
Phosphorus	4.0–6.9 mg/dL
Sodium	130–155 mEq/L
Potassium	3.7–6.9 mEq/L
Chloride	92–120 mEq/L
Bicarbonate	16–32 mEq/L
Alanine aminotransferase (ALT)	14–80 IU/L
Aspartate aminotransferase (AST)	14–113 IU/L
Alkaline phosphatase	4–16 IU/L
Lactic dehydrogenase	34–129 IU/L

Urinalysis

Urine volume/24 hr	20–350 mL/kg (average 130 mL/kg)
Specific gravity	1.003–1.036
Average pH	8–9[17]
Color	White to yellow to red-brown
Appearance	Turbid
Protein	Negative to trace
Ketones	Negative
Glucose	Negative to trace
Sediment	
Casts	None
WBC	Rare
RBC	Rare
Epithelial cells	None to rare
Bacteria	None to rare
Crystals	Common: triple phosphate, calcium carbonate monohydrate, and anhydrous calcium carbonate

*These figures are approximate ranges.[19, 26, 27] Values vary depending on the laboratory and on the age, breed, and sex of the rabbit.

tion is 50 to 100 mL/kg/day.[19] In most patients, maintenance fluids of about 80 mL/kg/day seem to be adequate.

Drug Therapy

Very few drugs are approved by the FDA for use in rabbits, and those that are approved tend to be older preparations and less effective than newer drugs. Therefore, most drug therapy in pet rabbits constitutes extralabel use. Table 2 lists recommended dosages for commonly used drugs. These dosages are rarely based on pharmacokinetic studies, but rather are derived from established dosages for other species and from clinical experience.

Some antibiotics are toxic in rabbits by causing alteration of normal intestinal flora and subsequent enterotoxemia. Antibiotics that have been associated with fatal enterotoxemia include penicillin, ampicillin, lincomycin, clindamycin, and erythromycin (see following section on enterotoxemia, under diarrhea).[5] Fatalities also can occur from the use of amoxicillin, amoxicillin-clavulinic acid (Clavamox), and the cephalosporins. In the author's opinion, use of any of the aforementioned antibiotics is contraindicated in pet rabbits.

Trimethoprim-sulfa combination suspensions (Bactrim; Septra) are good first-line antibiotics. Chloramphenicol is an excellent antibiotic in rabbits but can be hazardous to humans and may be impractical to

Table 2. SELECTED DRUG DOSAGES FOR PET RABBITS

Antibiotics

Chloramphenicol	50 mg/kg PO, IM, SQ, IV q8h
Ciprofloxacin	10–20 mg/kg PO q12h
Enrofloxacin	5–10 mg/kg PO, IM, SQ q12h
Gentamicin	2.5 mg/kg IM, SQ, IV q8–12h
Metronidazole	20 mg/kg q12h
Penicillin	40,000 U/kg IM q24h × 5–7 days
Benzathine penicillin G	42,000–84,000 U/kg SQ q2–7 days
Trimethoprim-sulfa combinations	30 mg/kg (of combined dose), PO, SQ q12h

Parasiticides

Amprolium (9.6% solution)	0.5 cc per pint of drinking water × 10 days
Fenbendazole	10 mg/kg PO once, repeat q2 wk PRN
Ivermectin	0.4 mg/kg PO, SQ q1–2 wk
Piperazine	200 mg/kg, repeat in 2–3 wk
	or 2–5 mg/mL in drinking water × 1 wk
	or 500–750 mg/kg × 2 d[27]
Sulfadimethoxine	50 mg/kg PO once, then 25 mg/kg PO q24h × 10–20d

Miscellaneous

Calcium versenate (CaEDTA)	27.5 mg/kg SQ q6h × 2–5d[37]
	Make at 10 mg/ml In 5% dextrose in water or saline
Griseofulvin	25 mg/kg ÷ q12h × 4–6 wk
Metoclopramide	0.2–0.5 mg/kg PO, SQ q6–8h
Pineapple juice (fresh)	10 mL daily × 5 days for medium-size rabbit

administer because of the expense and dilute formulation of the oral suspension. The fluorinated quinolones, such as enrofloxacin or ciprofloxacin, are useful in treating or controlling chronic infections. Injectable aminoglycosides and penicillin appear to be safe in rabbits. However, if a rabbit develops diarrhea, even on the "safe" antibiotics, the medication should be discontinued.

Corticosteroids should be used with great caution in rabbits because of the potential for immunosuppression and activation of subclinical pasteurellosis. Treatment of endophthalmitis and traumatic vertebral fracture and use of a single dose of a rapidly-acting corticosteroid such as dexamethasone sodium phosphate or prednisolone sodium succinate (feline dose) for the treatment of shock are exceptions to this rule.

Force-Feeding

Maintaining caloric intake is important because anorexic rabbits are prone to hepatic lipidosis, which often develops in 2 to 3 days. Postoperative patients should be encouraged to start eating as soon as they are sufficiently recovered. Fresh, leafy greens may stimulate an inappetant rabbit to start eating on its own.

If a rabbit refuses all food, syringe feeding and placement of a nasoesophageal (NE) (Premature Infant Feeding Tube, 5 Fr, 30"-long, CR Bard, Cranston, RI) tube are two options while diagnostic tests are pending.[20] Syringe feeding is performed two to four times a day; the rabbit is given as much as it will take at each session. Possible foods include various combinations of blenderized pellets, pureed vegetables, V-8 juice, and human baby cereals. Human enteral formulas such as Isocal (Mead Johnson Nutritionals, Evansville, IN) are practical for short-term feeding (up to a few days).

A NE tube can be placed without chemical restraint (Fig. 5). The NE tube placement technique is the same as for cats and is facilitated by a drop or two of ophthalmic topical anesthetic placed at the nostril. The tube is sutured in place using a tape butterfly on the bridge of the nose. An Elizabethan collar (of the smallest possible diameter) may be necessary to prevent the rabbit from pawing at the tube. Rabbits do not tolerate Elizabethan collars very well, so the NE tube is generally a temporary measure.

General Practice Tips

The successful practice of medicine and surgery in pet rabbits requires a knowledge of the peculiarities and general personality traits of these animals. In particular, minimizing stress and alleviating pain are important for a successful outcome. Rabbits that are ill and in pain tend to be quitters; this can be very discouraging for owners and practitioners alike.

Rabbits are very catecholamine-oriented. They are prey animals and,

Figure 5. Nasoesophageal tube in a rabbit with oral injuries from biting an electric cord.

as such, have evolved for flight rather than fight. Stress adversely affects the balance of intestinal flora and interferes with anesthesia. Stress reduction is accomplished by minimizing handling and hospitalization. Handling is minimized by advance planning and preparation of equipment for procedures. Hospital stays are avoided by teaching owners to perform home nursing care, including force-feeding and giving injections such as metoclopramide. These rabbits can be brought daily or every other day to the hospital for SQ fluids.

Rabbits that are experiencing pain are anorexic, dull, depressed and may adopt a hunched posture and grind their teeth. Prudent use of analgesics is often beneficial.

Rabbits react very poorly to Elizabethan collars, peripheral catheters, belly wraps, and any kind of restraining device. Excitement or, conversely, depression and anorexia often result from use of these devices.

Hospital receptionists and veterinary technicians should be trained to respond to the common concerns of rabbit owners. Important facts include the following: normal rabbit urine can be dark orange, rabbits typically nurse their young only once a day, and orphan rabbits are difficult to hand-raise. Owners may complain of "worms" on the stool. These are usually either fly larvae (maggots) or rabbit pinworms *Passalurus ambiguus*.

Zoonotic Diseases

Disease transmission from rabbits to humans is rarely a problem. The most clinically important zoonoses (in terms of incidence relative to potential for transmission) are *Cheyletiella* and ringworm (*Trichophyton*). Rarely, *Pasteurella* can cause a dermatitis in humans (the author has never

seen this); other common diseases (ear mites, coccidiosis, enteric diseases, encephalitozoonosis, myxomatosis, and rabbit syphilis) are not contagious to humans.[18] Diseases that are uncommon but potentially zoonotic include salmonellosis, tularemia, tuberculosis, and rabies.

ANESTHESIA AND SURGERY

Sedation and Anesthesia

Sedation is often necessary to obtain radiographs, place splints and to perform short procedures such as dentistries. The basic principles of anesthesia are covered in the article by Heard in the first half of this symposium*; however, a few points warrant mentioning here.

Isoflurane administration by facemask is convenient and safe for most short procedures. Injectable agents are preferred for work in the oral cavity because rabbits are difficult to intubate. For dentistries, the author uses ketamine IM at 20 to 30 mg/kg and then, 5 to 10 minutes later, diazepam 0.5 mg/kg IV. Alternatively, diazepam 1 to 3 mg/kg can be given IM at the same time as ketamine. Results are variable among different individuals. For rabbits that need periodic dental work, it is helpful to keep a record of the dose given each time and results. Doses should be lowered slightly for debilitated individuals.

Ideally, rabbits should be intubated under gas anesthesia for any procedure longer than 20 minutes. Premedication with a low dose of acepromazine may facilitate intubation. There are many different techniques for intubating rabbits, however, all take practice.[33, 36, 43] Large rabbits are easier to intubate than small ones. For the inexperienced clinician, it is advisable to make one or two attempts at intubation. If unsuccessful, it may be better to rapidly proceed with surgery rather than further lengthening anesthetic time. Rabbits should always be closely monitored under anesthesia. The risk of anesthesia is greater without an endotracheal tube in place.

Surgery

Preoperative antibiotics are beneficial in debilitated rabbits or if subclinical pneumonia is a possibility. The benefit of therapy must be weighed against the importance of obtaining a useful culture at surgery, because antibiotic therapy may affect culture results.

Rabbit skin is very delicate and susceptible to clipper burns. This, in conjunction with the fine fur undercoat on many animals, can make clipping slow and difficult. Clipping should be performed carefully, and the skin should be stretched taut and flat under the clipper blade.

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*Veterinary Clinics of North America: Small Animal Practice, Symposium on Exotic Pet Medicine Part I, November 1993, Volume 23, Number 6.

Absorbable monofilament sutures are preferred by some surgeons for use in any intra-abdominal surgery.[21] Chromic gut generally should be avoided; it is reactive, and some rabbits produce a suppurative response around it.

Many rabbits chew out their skin sutures. Because most rabbits do poorly with an Elizabethan collar, the surgeon must use an alternative means of skin closure, such as subcuticular closure, skin staples, or tissue glue. Even with the latter two techniques, some rabbits will find a way to open an incision, so a postoperative period of observation may be helpful. Tension on the skin closure site will cause irritation and should be avoided.

Basic surgical procedures in rabbits are the same as in dogs and cats. A few peculiarities are covered here; and more complete description of surgical techniques is found in the references.[3, 21, 36]

Castration

Rabbits have an open inguinal canal. Three alternatives for castration are possible: closed castration, open castration with closure of the inguinal rings, or open castration with preservation of the epidydymal fat pad. The approach can be scrotal or prescrotal. The simplest technique is to make a scrotal incision and to perform an open castration, taking care to leave the large fat pad that is associated with the epidydymis. This fat pad appears to prevent herniation of viscera through the inguinal ring.[21] The vas deferens is then tied to the rest of the spermatic cord. Alternatively, the entire cord is ligated with chromic gut or absorbable monofilament.

Ovariohysterectomy

Once the rabbit is anesthetized, and prior to surgery, the bladder should be *gently* expressed. Rabbits' bladders can be very large, and the potential for bladder rupture with manual expression is greater than with dogs and cats.[36] The incision for an ovariohysterectomy (OHE) is centered halfway between the umbilicus and the cranial edge of the pubis. Great caution should be exercised on entering the abdomen not to incise the thin-walled cecum or bladder, which are often pressed against the peritoneum. The uterus is usually located just dorsal to the cranial pole of the bladder. Mature does have large fat deposits in the mesometrium. The uterus can be ligated just cranial or caudal to the double cervices. Does have a vaginal diverticulum where the urethra enters the vagina. This can be a site of urine pooling when the bladder is expressed with the doe in dorsal recumbency, and therefore should be avoided during surgery if ligation is caudal to the cervices.[36]

Enucleation

Enucleation in rabbits is performed using a transconjunctival approach, taking great care to stay very close to the globe while dissecting it out. This is because of the large orbital venous sinus, which bleeds profusely if unintentionally incised. Alternatively, the transpalpebral (en bloc) method can be used so long as care is taken to follow the wall of the bony orbit to avoid incising the venous sinus (Susan Kirschner, personal communication, May 1993).

If there is a retrobulbar abscess or infection in the periocular tissues, surgical debridement and flushing is performed after the eye has been removed. Again, great care must be taken to avoid the sinus.

COMMON DISEASES OF PET RABBITS

The reader is referred to Table 3 for a list of the most common differential diagnoses based on clinical signs in pet rabbits.

Bacterial Infections

Bacteria are the most important infectious agents in rabbits. Parasitic infections are second in incidence, mycotic diseases are uncommon, and viral diseases are rare. *Pasteurella multocida* is the most important bacterial pathogen. Other common bacterial pathogens include *Staphylococcus aureus, Bordetella bronchiseptica; Clostridium piliformis* (formerly *Bacillus piliformis*), the cause of Tyzzer's Disease; and *Treponema cuniculi,* the cause of rabbit syphilis. The clinical approach to diagnosis and treatment of the most important manifestations of bacterial infection is covered in the following sections under the appropriate body system.

Rabbits typically respond to bacterial infection with a suppurative response, producing a thick and white purulent exudate.

Pasteurella Multocida

Pasteurellosis is one of the most common and important diseases of rabbits. *P. multocida* is a small, gram-negative rod. Several serotypes, with varying pathogenicity, are found in rabbits.

P. multocida is endemic in most rabbitries and many conventional rabbit colonies. In several studies of New Zealand White rabbit colonies, the rate of positive *Pasteurella* nasal cultures in asymptomatic animals ranged from 31% to 94%.[12] One study conducted in nine institutional colonies found that 34% to 100% of rabbits were positive for pasteurellosis when screened for antibodies by ELISA.[46]

Transmission of *Pasteurella* is by direct contact, fomites, and airborne spread. The incidence of infection increases with age, with a low rate usually in preweanlings and a high rate in adults. Transmission from the

Table 3. MOST IMPORTANT DIFFERENTIAL DIAGNOSES FOR COMMON
PRESENTING PROBLEMS

Anorexia	Dental disease
	Trichobezoar (hairball)
	Bacterial infection
	Metabolic disease
	Toxicity (e.g., lead poisoning)
Diarrhea	Inadequate dietary fiber
	Hairball
	GI parasites
	Enterotoxemia
Hairloss	*Cheyletiella* (usually dorsal)
	Dermatophytosis
	Barbering (usually dewlap area)
	Urine scald (inguinal area, in obese or aged rabbits)
	Generalized *Psoroptes* infection (may be on feet)
"Hematuria"	Normal red-brown pigments in urine (negative for blood on testing)
	Uterine hyperplasia or neoplasia
	Urolithiasis
	Bleeding from rectal papillomas
Hypersalivation	Dental disease
	Oral foreign body
Nasal crusting	*Treponema cuniculi* (syphilis)
	Bacterial rhinitis
Posterior paresis/paralysis	Traumatic vertebral fracture (acute onset)
	Encephalitozoonosis
	CNS bacterial infection
Subcutaneous mass	Abscess
	Lipoma
	Lymphosarcoma
	Cuterebriasis (check for larval breathing pore)
"Worms" on stool	Pinworms: *Passalurus ambiguus*
	Fly larvae

doe to the young occurs after birth and appears to be greater if the doe has an active infection with rhinitis or vaginitis. Higher rates of infection in young rabbits seem to be related to late weaning, vaginal infection in the dams, and a high rate of infection in the colony.[12]

The portal of entry of *Pasteurella* is usually the respiratory tract, especially the nasopharynx. Spread of infection is hematogenous, lymphatic, through the trachea, or along the Eustachian tube. The dorsal soft palate, tympanic bulla, nasal turbinates, and paranasal sinuses may be sites of lifelong infection.[27] Asymptomatic carriers are common, and the infection is difficult, if not impossible, to eradicate in known infected animals.

Multiple attempts to produce an effective *Pasteurella* vaccine have been unsuccessful. Good sanitation, adequate ventilation, and a stress-free environment are important for prevention. The susceptibility to in-

fection increases with high concentrations of ammonia in the air. High levels of ammonia result from a high dietary protein level and inadequate ventilation.[8] Stress is another predisposing factor.[18]

Clinical signs of pasteurellosis are highly variable. Almost all body systems can be infected, including the respiratory tract, central nervous system (CNS), reproductive tract, musculoskeletal system, and skin. Possible manifestations include: septicemia, rhinitis ("snuffles"), pneumonia, conjunctivitis, tooth root abscesses, middle/inner ear infection, CNS and ophthalmic infection, orchitis, metritis, infertility, septic arthritis, osteomyelitis, and subcutaneous abscesses.

Testing for pasteurellosis is best accomplished by culturing for the organism in conjunction with the ELISA antibody test. False-negative results are possible for either test. Asymptomatic animals are cultured under sedation by passing a no. 4 Calgi swab deep into the nose to harvest a sample from the dorsal soft palate (Nephi M. Patton, personal communication, May, 1993). Samples should be submitted to a laboratory for *Pasteurella* culture. The ELISA test requires a drop of blood on filter paper. Antibodies to *Pasteurella* develop after 2 weeks of infection. Contact the Oregon State University Rabbit Research Center for further information on the ELISA test (Corvallis, OR 97331; 503-737-2263).

Treatment of pasteurellosis is with antibiotics and supportive care (see the following on specific syndromes). In vitro, *Pasteurella* is often sensitive to a wide range of antibiotics; in the clinical setting, a trimethoprim-sulfa combination, enrofloxacin, ciprofloxacin or injectable penicillin are often efficacious and safe. Injectable aminoglycosides can be used in combination with the aforementioned antibiotics. Antibiotic therapy should be continued for a minimum of 10 to 14 days; 1 month or longer of therapy is often necessary.

Staphylococcus Aureus

Staphylococcus aureus is a common cause of suppurative inflammation in rabbits and can often be isolated from abscesses, nasal discharge, and pneumonia. It is the most common cause of conjunctivitis in rabbits (Nephi M. Patton, personal communication, May, 1993). Staphylococcal mastitis with subsequent septicemia in nursing does may result in mortality of both dam and young.[19] An outbreak of cutaneous staphylococcosis with high mortality has been described at one rabbitry. Disease manifestations included exudative dermatitis in young animals, purulent rhinitis and conjunctivitis, mastitis in lactating does, subcutaneous abscesses in all age groups, and generalized infection in some rabbits.[30]

Tyzzer's Disease

The cause of Tyzzer's Disease in rabbits has recently been reclassified as *Clostridium piliforme*.[6] This is a disease that is diagnosed at necropsy and is rarely seen in pet rabbits.

Tyzzer's Disease is most common in farmed and laboratory rabbits. Weanling rabbits are typically affected, but older animals are susceptible also.[27] Clinical signs are profuse diarrhea, dehydration, and death in 12 to 48 hours. The diagnosis is based on finding the intracytoplasmic organisms in periodic acid-Schiff (PAS) or silver-stained sections of the liver, heart, or cecum. There is no known treatment. Prevention is through good management practices, including sanitation, minimizing the stress of weaning, and avoiding overcrowding and temperature extremes.

Treponematosis

Rabbit syphilis, or vent disease, is caused by *Treponema cuniculi*, a spirochete. Typical lesions include ulcers and dry crusts of the genitalia, perineum, ears, nose, eyelids, and lips. The disease can cause infertility and high mortality of neonates. Transmission is venereal or from the dam to the young.

The organism can be visualized in dark field preparations of exudate from active lesions. In practice, the diagnosis is often based on clinical signs and response to treatment with penicillin. Two possible treatment regimens are (1) benzathine penicillin G-procaine penicillin G 42,000 to 84,000 U/kg SQ once weekly for 3 weeks;[11] or (2) penicillin 40,000 U/kg IM q24h for 3 to 5 days.[19] All exposed rabbits should be treated.

Viral Diseases

Viral disease is rarely diagnosed in pet rabbits in the US.

Myxomatosis

Myxomatosis virus is endemic in European wild rabbits (*Oryctolagus cuniculus*) and is found in some areas of the West Coast of the United States. The virus is transmitted by arthropod vectors, especially mosquitoes and fleas. The principal clinical sign in infected rabbits is subcutaneous edema around the face and body orifices. Mortality approaches 100%. Prevention is by screening outdoor hutches and insect control.

Rotavirus

Rotaviruses have been associated with diarrhea in rabbits; however, they are thought not to be a primary cause of clinical signs (see section on diarrhea).[8, 19, 27] In one study, a mild diarrheal disease resulted from inoculation of specific-pathogen-free rabbits with a rotavirus isolate from a natural outbreak of severe diarrheal disease, suggesting that cofactors are involved.[38]

Viral Hemorrhagic Disease

This viral disease is also known as rabbit hemorrhagic disease or necrotic hepatitis of rabbits. It first appeared in 1984, causing heavy

losses on rabbit breeding farms in China. Since then, the disease has been reported in other Asian countries, Europe, and, most recently, Mexico. No cases have been reported in the United States. Mortality in infected rabbits approaches 100%. Clinical signs include acute death, squealing when dying, and blood around the face and nose. The virus has tentatively been identified by different scientists as a calicivirus, a picornavirus, or a parvovirus. The use of a formalin-inactivated vaccine has greatly reduced losses in China;[45] in Europe, several vaccines are available.[32]

Rabbit Coronavirus

Rabbit coronavirus infection produces myocarditis and congestive heart failure (CHF) from dilatative cardiomyopathy. The infection has been studied as an experimental model for virus-induced myocarditis and CHF in man.[14] The importance of this virus in the pet population is not known.

Fungal Diseases

Dermatophytoses in pet rabbits are relatively uncommon in the author's experience; however, fungal infection (ringworm) should always be part of the differential diagnosis for dermatologic problems. *Trichophyton mentagrophytes* is the most common dermatophyte isolated from rabbits. Clinical signs are most common in younger animals and include hair loss, pruritus, and crusting. The lesions occur typically on the head, ears, and feet. Rabbits can be asymptomatic carriers.

The diagnosis is by positive fungal culture or demonstration of the organism from skin scrapings mounted in 10% KOH. *T. mentagrophytes* does not fluoresce under ultraviolet light from a Wood's lamp. Treatment includes good sanitation in conjunction with topical therapy and, for multiple or widespread lesions, oral griseofulvin. The hair surrounding the lesions should be clipped and the lesions cleaned twice daily with a 10:1 mixture of water and chlorhexidine (Nolvasan, Fort Dodge Laboratories, Ft. Dodge, IA) or povidone-iodine. For small lesions, it may be more practical to apply a chlorhexidine or povidone-iodine ointment twice daily. Treatment should be continued for 2 weeks beyond resolution of clinical signs. Ringworm is potentially contagious to humans, particularly children and the elderly.

Deep fungal infections are rare in pet rabbits. *Aspergillus* pneumonia may result from exposure to moldy bedding material.

Parasitic Diseases

Ear Mites

The rabbit ear mite, *Psoroptes cuniculi*, causes inflammation and crusting in the external ear canal (Fig. 6). Affected rabbits scratch their

Figure 6. A severe case of ear mites *(Psoroptes cuniculi)*. This infection responded to two injections of ivermectin 2 weeks apart. Treatment did not include topical medications or cleaning.

ears and shake their heads. The crusts, consisting of mites, mite feces, desquamated epithelial cells, serum, and inflammatory cells, can adhere to the internal aspect of the pinna and may be so thick as to cause upright ears to droop. The mite infection can become generalized in debilitated animals and involve the perineum, legs, and feet.

Diagnosis is based on clinical signs and observation of the mite with either the naked eye, an otoscope, or a microscope. *Psoroptes* infection responds dramatically to treatment with ivermectin (400 μg/kg SQ), and topical medications are usually not necessary. Ear cleaning should be avoided because it is often difficult and painful and leaves a moist, red surface on the inner aspect of the pinna. The ivermectin should be repeated twice more at 2 week intervals; the life cycle of the mite is 3 weeks under optimal conditions.[27] Other treatments include mineral oil, topical liquid acaricides, or flea powder applied in the ears.

Cheyletiella

Cheyletiella parasitivorax is a fur mite that can also infect humans, dogs, and cats. The incidence is as high as 15% to 20% of pet rabbits in southern California.[22] Affected rabbits show hair thinning and scaliness,

especially on the rump, dorsum, and dorsal cervical region. Pruritus, when present, is usually mild to moderate. Some rabbits are asymptomatic. The diagnosis is by skin scraping, acetate tape preparations (the "scotch tape test"), or examination under magnification of hair and skin debris collected with a flea comb.

Injectable ivermectin is an effective treatment when given every 2 weeks for three doses. Alternatively, a feline flea powder is used one to two times a week for 6 weeks. Mite eggs are attached to the hair shaft; therefore, treatment of the environment with flea products may be necessary to avoid reinfection or contagion to humans or other pets in the household.

Fleas

Flea infestations occassionally occur in pet rabbits, especially in multi-pet households. The treatment is as for cats, making sure also to treat the environment.

Myiasis

In the warmer months, two forms of myiasis are encountered in pet rabbits: cuterebriasis and infestation with the smaller maggots of other dipterid flies. Rabbits that are housed outdoors or spend time in the yard without protective screening are susceptible. Prevention is with fly control and use of screening.

Cuterebra fly larvae pupate in the subcutis, typically in the ventral cervical or perineal regions, although they can be found anywhere on the trunk. The resulting subcutaneous swelling has a prominent airhole through which the larva can be seen. Treatment consists of enlarging the air hole and removing the larva. Occasionally, the swelling may persist, requiring surgical excision.

The author has seen several rabbits with severe maggot infestations. Most were housed outdoors; one rabbit was an indoor, urban pet. Affected rabbits were all sedentary, overweight, mature animals. They presented with hair loss, dermatitis, and fecal matting in the perineal region and extending over the rump. It was not possible to identify an inciting wound, but the maggots had caused extensive skin trauma at the time of presentation. The lesions went unnoticed by owners until they became evident on the rump.

Treatment of maggot infestation is done under sedation and involves clipping the fur, cleaning the wounds, and physical removal of any visible maggots. Ivermectin for two doses 2 weeks apart is a useful adjunct to therapy. Antibiotics are indicated in most cases for secondary bacterial infection. The wounds are kept clean and allowed to granulate, with follow-up visits scheduled as necessary.

Encephalitozoonosis

Encephalitozoon cuniculi is an intracellular protozoan parasite that is common in rabbits world-wide, usually as a latent infection. *Encephalito-*

zoon causes lesions in the brain and kidney, and the organism is shed in the urine. Transmission occurs from the doe to the kits. The role of vertical transmission is uncertain. When present, clinical signs result from CNS infection and can include ataxia, posterior paresis, head tilt, and depression. Renal lesions do not cause clinical disease. Definitive diagnosis is by histopathologic identification of the organism. Clinically, a tentative diagnosis can be made with positive serology in conjunction with typical neurologic signs. One laboratory that performs encephalitozoonosis testing is the University of Missouri Research Animal Diagnostic Laboratory (800-669-0825).

The author has worked with a large herd of pet rabbits with endemic encephalitozoonosis (diagnosed serologically and confirmed histopathologically in rabbits with neurologic signs). Most rabbits remained asymptomatic. Clinical signs of disease were sporadic with an unpredictable course, and included stiff rear gait, posterior paresis, urine scald resulting from incontinence, and intermittent inappetance and depression. There is no treatment other than supportive care. Control is by good sanitation and serologic monitoring with isolation of infected individuals.

Pin Worms (Oxyurids)

Several nematodes occur in wild rabbits. *Passalurus ambiguus*, the rabbit pinworm, is the only one found with any frequency in pet rabbits. It inhabits the cecum and colon. Clinical signs, even in heavy infections, are usually absent, although in one rabbit colony, *Passalurus* infection has been reported to cause death, poor condition, and unsatisfactory breeding performance.[13]

Diagnosis is made by finding the characteristic eggs in the feces: 43 x 103 μm and flattened on one side. The anal-adhesive tape test is not a reliable test for this species of oxyurid.[13] Sometimes rabbits pass the live worms in the feces, and the worms may be visible in the cecum during a spay or other intra-abdominal surgery. Treatment is with piperazine or fenbendazole. Ivermectin is not effective against *Passalurus* (Nephi M. Patton, personal communication, January, 1992).

Coccidia

Coccidiosis is common in rabbits. There are several species of *Eimeria* that inhabit the intestine; *Eimeria stiedae* is found in the liver. An individual rabbit may be infected with several species of coccidia concurrently. Rabbits can be asymptomatic carriers, and immunity is long-lasting in those rabbits that are exposed and survive infection.

Coccidiosis is primarily a disease of younger animals. The severity of disease depends on the rabbit's age at time of exposure, the parasite load, the species of *Eimeria*, and environmental stress factors, including physical stresses and other infectious agents. Infective oocysts are passed in the feces; therefore, good sanitation is important for disease control. All young animals should be screened by fecal flotation or direct smear.

Four species of intestinal coccidia are most common in the United States: *E. irresidua, E. magna, E. media,* and *E. perforans.* The prepatent period for these species is 5 to 8 days. Possible clinical signs include diarrhea, inappetance, and sudden death. Treatment is with a sulfonamide, such as sulfadimethoxine, and supportive care. Concurrent conditions also should be treated.

Eimeria stiedae inhabits the bile duct epithelium. Clinical signs of heavy infection are referable to hepatic dysfunction and blockage of the bile ducts and include weakness, anorexia, diarrhea, and hepatomegaly. Treatment with coccidiostats and supportive care is often unsuccessful. Death may occur prior to the end of the prepatent period, which is 15 to 18 days following exposure. At necropsy, the liver is enlarged with multiple pale yellow foci. Weanling rabbits exposed to high levels of infective oocysts under unsanitary conditions are most susceptible to clinical infection.

Gastrointestinal Diseases

Dental Malocclusion

Dental malocclusion is a common, and underdiagnosed, problem of pet rabbits. Incisors, premolars, and molars can be affected. The teeth in rabbits grow 10 to 12 cm per year. Normally, mastication keeps the teeth at the proper height. If the teeth do not occlude properly, they can overgrow or develop sharp points that ulcerate the lip, tongue, and buccal gingiva. Causes of malocclusion include genetic factors, trauma, and tooth root infection. Affected rabbits should not be used for breeding.

Rabbits with malocclusion present for anorexia or problems prehending and masticating food. They may appear hungry and then drop or turn away from offered food, or select softer foods in place of pellets. Some rabbits grind their teeth. A moist dermatitis may develop under the chin secondary to hypersalivation, which is common in rabbits with malocclusion.

On physical examination, the incisors are easily observed by pulling up the lips, whereas the cheek teeth are examined with the aid of an otoscope. The incisors should be straight with a horizontal surface at the tips. Malocclusion of the cheek teeth is suggested if the top and bottom incisors do not line up in a vertical plane. In normal rabbits, the occlusal surfaces of the cheek teeth are flat and relatively smooth. In rabbits with malocclusion, teeth may be long or obvious points may be present, typically on the lateral surface of upper teeth and the medial surface of lower teeth. Food, pus, blood, or excessive saliva in the mouth is abnormal. Oral ulcers, with a typical white fibrinous coating, are a clue to dental points.

If the history suggests an oral problem but the physical examination is inconclusive, a complete oral examination should be performed under sedation. Ketamine and valium in combination work well for this pur-

pose (see the section on anesthesia). Dental equipment should be prepared prior to sedating the rabbit so that a dentistry can be performed if necessary.

Skull or dental radiographs are a useful diagnostic tool to check for tooth root infection. If osteomyelitis is present, the longterm prognosis is poor. A CBC and biochemistry panel are indicated in older rabbits as part of an overall health assessment prior to sedation.

Simple incisor malocclusion can be treated by periodic trimming. A dental or Dremel drill is ideal for this purpose, although a wire saw is an alternative. Some rabbits require sedation. The use of a Resco nail clipper is contraindicated for tooth clipping because it can cause tooth fractures.

For owners who prefer not to return for monthly tooth trimming, extraction of their pet's incisors is an alternative. The procedure for incisor extraction has been described in detail.[3] Rabbits adjust well to the loss of the incisors, learning to prehend food with their lips.

Positioning for oral examination and dentistry of the premolars and molars requires the help of an assistant, who holds the rabbit in sternal recumbency with its head pulled forward and up by a gauze strip around each set of incisors (Fig. 7). The rabbit's neck should be straight to facilitate respiration, and the nares should not be occluded. A vaginal speculum is used to part the oral commissures. Cotton swabs can be used to manipulate the tongue and cheeks to visualize every surface of every tooth. The gingiva is examined for ulceration in association with dental points. Dental points are removed with rongeurs. Any sharp edges can be smoothed with a dental drill. Oral ulcers heal rapidly once the inciting cause has been removed. Many rabbits will start to eat soft foods the same day; others will resume their regular eating habits within 2 to 3 days. Owners should be taught the signs of malocclusion so that

Figure 7. Oral examination of a sedated rabbit.

repeat dentistries for their pets can be scheduled expeditiously. Affected rabbits require repeat dentistries from every one to 12 months, with every 4 months most typical.

If a tooth root abscess is present, the rabbit should be placed on antibiotics. Osteomyelitis in rabbits is difficult, if not impossible, to cure, but long-term antibiotic therapy may control the condition (see later section on abscesses and osteomyelitis). If a premolar or molar is loose, it should be extracted, and a culture should be taken of the tooth root. Ideally, the opposing tooth also should be extracted so it does not overgrow. Because the mouth of rabbits does not open very wide, extraction of a healthy tooth usually requires an extraoral approach through a bucotomy.[15] Otherwise, the opposing tooth may need periodic trimming.

The prognosis for rabbits with malocclusion varies according to examination findings, radiographic results, and response to therapy and must be determined on an individual basis. Most rabbits can be managed successfully, although routine dentistries and follow-up visits are usually necessary. Owner education is essential.

Trichobezoars

Hairballs (wool block) are a common problem in rabbits. Clinical signs associated with the presence of a hairball include anorexia, lethargy, diarrhea, or, conversely, small, dry feces. There often is a history of recent shedding. Boredom, long fur, and inadequate dietary roughage are thought to be predisposing factors.[41] Inadequate roughage causes decreased intestinal motility in addition to possibly predisposing rabbits to barbering or biting off their fur.

A definitive diagnosis may not be possible without surgery; however, the diagnosis is suggested by the combination of history, clinical signs, and presence of a firm mass effect in the region of the stomach. On radiographs, the stomach will be distended with ingesta with a ''halo'' effect of gas around it (Fig. 8).

In the author's experience, medical management is almost always preferable to surgical management, which is accompanied by a high mortality rate. Medical treatment includes parenteral fluid therapy, fresh pineapple juice, force feeding, and stimulation of appetite by offering fresh greens. Fresh pineapple juice is given at 10 mL once daily or divided every 12 hours for 5 days. Pineapple juice contains bromelain, an enzyme that helps to digest the hair so it can pass. Papaya enzymes (papain) are clinically ineffective once the rabbit is anorexic, at least in this author's experience. Metoclopromide may be beneficial in treating hairballs.

Hairballs are prevented by feeding adequate dietary roughage and minimizing environmental stress factors and boredom. Daily administration of a bromelain-papain tablet (purchased at health food stores) may be beneficial. During shedding season, rabbits should be brushed frequently to remove loose hair.

Trichobezoars are usually situated in the stomach; however, they can dislodge and cause intestinal blockage.[35] Rabbits with intestinal

Figure 8. Ventrodorsal radiograph of a rabbit with a gastric trichobezoar and calciuria. Note distension of stomach with ingesta and halo of gas around ingesta.

blockage will present for acute onset of anorexia and depression. There may be diarrhea or absence of feces. On physical examination, these animals are hypothermic, and some are bloated. There may be an obstructive gas pattern on abdominal radiographs, but definitive diagnosis is difficult. This syndrome carries a very guarded prognosis, and, although surgery is usually indicated, most of these rabbits are poor surgical candidates.

Diarrhea

Enteric diseases are an important economic problem for commercial rabbit breeders. They are the subject of ongoing, intensive research in many countries. Enteritis is usually associated with decreased GI motility, which, in turn, results in diarrhea. Therefore, diarrhea in rabbits is often the result of constipation, a seeming contradiction.[8]

In pet rabbits, three diarrhea syndromes are most common: acute diarrhea in young, newly acquired animals; a chronic diarrhea in older animals; and antibiotic-induced diarrhea. For further information, the reader is referred to more detailed references.[5, 6, 8]

Under commercial conditions, enteric diseases are most common in weanling rabbits. Onset is related to the stress and change in diet that

occur at weaning time. *Clostridium spiroforme* and *Escherichia coli* are the most important enteric pathogens. Rotaviruses and coccidiosis may contribute or predispose to enteritis; however, they are not considered to be primary pathogens.[8] Lack of dietary fiber, soluble carbohydrate overload, and high protein level are important factors also insofar as they, respectively, decrease GI motility, alter cecal pH, and increase cecal ammonia level. The susceptibility to enteritis also appears to have a genetic component. In addition, stress plays a role because it causes a decrease in intestinal motility. The "enteritis complex" usually refers to enterotoxemia and mucoid enteritis.[8]

Enterotoxemia is the result of secretion of toxins by pathogenic bacteria in the GI tract. Two factors are necessary for this to occur: an alteration of normal GI flora in conjunction with the presence of pathogenic bacteria. Therefore, this condition is truly an infection.[6] *C. spiroforme* a semi-circular gram-positive rod, is the best documented cause. It produces an extracellular enterotoxin, iota toxin, when in the presence of glucose.[8] Colonization occurs in weanling rabbits and adult animals that are under environmental stress or treatment with certain antibiotics, including clindamycin, lincomycin, penicillin, ampicillin, and erythromycin. Signs of enterotoxemia include diarrhea, depression, and sudden death. Definitive diagnosis is with isolation of the organism and demonstration of the toxin. A presumptive diagnosis is made by demonstrating the spiral, C-, U-, and S-shaped microcolonies of *C. spiroforme,* beaded gram-positive, in gram-stained feces.[5, 7] The condition is usually rapidly fatal. However, if there is time to institute treatment, a good therapeutic choice might be one of the drugs used for clostridial colitis in humans, namely metronidazole, vancomycin, or bacitracin.[5, 6]

The term "mucoid enteritis" has been used to describe different enteric conditions in rabbits. Currently, it is used to describe a condition in which cecal motility is impaired and a hard mass of particulate matter impacts in the cecum.[8] The condition is promoted by inadequate dietary fiber, which decreases cecal motility, and high environmental temperatures, which increase fluid requirements and cause water to be drawn out of the cecum. Diarrhea and excretion of mucus are the results. Affected rabbits have a hunched posture and tend to stay over the water bowl. When handled, these rabbits sound like a hollow water bottle. The condition has a high mortality rate.

The diagnostic approach to diarrhea in pet rabbits should include a complete history, physical examination, fecal flotation, and direct smear. A fecal gram stain is indicated if clostridial enterotoxemia is a possibility. The history should establish level of dietary fiber, and whether there has been dietary changes, environmental stress, or antibiotic therapy. The abdomen is palpated for the presence of gas or firm masses in the stomach or cecum. Radiographs may be helpful. Treatment includes fluid therapy, nutritional support, and general supportive care. Coccidiosis is treated with an appropriate sulfonamide, and metronidazole is used for possible clostridial enteritis. Fresh pineapple juice and metoclopramide are indicated for suspected hairball. The diet should be gradually altered as necessary to provide adequate dietary fiber. Commercial lactobacillus

preparations may be helpful in some cases. Intermittent diarrhea at the same time each day may indicate failure of coprophagy, particularly in obese rabbits. There is no specific treatment for this condition, although correction of diet may help.

The prevention of diarrhea in pet rabbits is by provision of adequate dietary fiber, gradual institution of diet changes, and prophylactic treatment of young rabbits for coccidia.

Respiratory Tract Diseases

Rhinitis

Contrary to rhinitis in dogs and cats, rhinitis in rabbits is typically bacterial, rather than viral, in origin. Rhinitis, or "snuffles," is usually caused by *Pasteurella* infection. The condition is seen in all ages of pet rabbits, although it is most common in younger animals (Fig. 9). Nasal discharge and sneezing are the most common clinical signs; discharge can range from watery to thick and purulent. There may be no other clinical signs, although some rabbits show lethargy and inappetance, particularly if the lower respiratory tract is involved.

Diagnostics may include *Pasteurella* culture and serology and a CBC. Treatment is with antibiotics. A trimethoprim-sulfa combination is usually efficacious in mild cases, and enrofloxacin is a good choice for more severely affected rabbits. Antibiotics should be continued for a minimum of 10 to 14 days. Adjunct therapy, when necessary, includes vaporizer therapy, pediatric neosynephrine drops, nasal flushes, and nebulization with antibiotics. The prognosis is generally good. However, rabbits with very thick, purulent nasal discharge (sometimes not sick otherwise) may not respond well to therapy.

Figure 9. Snuffles in a rabbit. Note nasal debris on paws secondary to the rabbit cleaning its face.

Pneumonia and Dyspnea

Similar to rhinitis, pneumonia in rabbits is typically bacterial. *Pasteurella multocida* is the most common cause, while other possible pathogens include *Pseudomonas aeruginosa, Staphylococcus aureus,* and *Bordetella bronchiseptica.* Pneumonia may be subclinical in rabbits, or it may be accompanied by inappetance, lethargy, pyrexia, nasal discharge, and dyspnea. Diagnostics include thoracic radiographs and a CBC. Treatment is with long-term antibiotics, nebulization, and supportive care.

Dyspnea carries a poor prognosis; dyspneic rabbits rarely survive.

Cutaneous and Musculoskeletal Diseases

Abscesses

Abscesses can occur anywhere in rabbits, and all age groups are affected (Fig. 10). Possible sites include: the subcutis, joints, long bones, bones of the skull, lungs, tooth roots, and retrobulbar. Abscesses may occur spontaneously or secondary to trauma; they can be single or multiple. Etiologic agents include *Pasteurella multocida, Staphylococcus aureus, Pseudomonas, Proteus,* and *Bacteroides.* Clinical signs, other than those referrable to the abscess site, are usually absent, although some affected rabbits are chronic poor doers. The differential diagnosis for subcutaneous swellings includes lipoma, lymphoma, and cuterebriasis. The diagnosis is easily made by needle aspiration (with a 20-ga or larger needle) of purulent material. Radiographs should always be included in the diagnostics if bony involvement is a possibility.

Surgical excision is the treatment of choice for abscesses in rabbits. Even with excision, an abscess may recur. If excision is not possible, the abscess can be lanced and drained; however, recurrence is common with

Figure 10. Large submandibular abscess.

this technique, even if the abscess site is regularly flushed and cleaned postoperatively. Exudate is usually thick and does not drain well, and Penrose drains are indicated only to keep a skin incision from closing prematurely.

If possible, culture and sensitivity testing of the abscess wall should be done at the time of surgery. Postoperative antibiotic therapy should be continued for 10 to 14 days or longer if necessary.

Retrobulbar abscesses have a high rate of recurrence and can be very difficult to manage. If osteomyelitis is present, the potential for a cure is remote. Owners should be made aware of the poor prognosis, and treatment should be undertaken only if they are very dedicated to their pet. Depending on the location, osteomyelitis often can be controlled with surgical debridement and long-term antibiotic therapy. Enrofloxacin is a good drug for long-term therapy; the dose can gradually be decreased to as low as 2.5 to 5 mg/kg once daily for maintenance. If the infection is on an extremity, amputation is often the best treatment approach. Rabbits will usually tolerate the loss of either a forelimb or a rearlimb. Treatment of tooth root abscesses is covered under the section on dental problems.

Abscess treatment is often long-term, and recurrence is not uncommon at the same or another site. Clinically, this is one of the most frustrating conditions for practitioners and rabbit owners alike. Prior to initiating treatment, owners must be made aware of the prognosis and need for long-term management.

Traumatic Vertebral Fracture (Broken Back)

Rabbits are prone to vertebral fracture if they are dropped or inadequately supported in the rear and kick out during restraint. The caudal lumbar spine is the most common site of fracture.[27] Clinical signs depend on the site and severity of injury and may include posterior paresis or paralysis, fecal incontinence, and loss of control over micturition. The prognosis depends on neurologic examination findings but usually is poor. Diagnostic, prognostic, and therapeutic criteria are as for dogs and cats.

Ulcerative Pododermatitis (Sore Hocks)

Sore hocks describes a condition of hair loss, ulceration, cellulitis, and, occasionally, abscessation on the plantar surface of the metatarsal region. The palmar metacarpal area is less frequently affected. The condition is multifactorial, and *Staphylococcus* may cause secondary infection. Rabbits with thin fur pads on a moist or abrasive substrate or wire flooring are most susceptible (Fig. 11). Obesity and frequent thumping with the rear feet will predispose rabbits to sore hocks. Rabbits with wide, heavily furred feet are less commonly affected.

The treatment of pododermatitis can be difficult and is usually lengthy. The rabbit should be moved to a soft, dry substrate. Foot ban-

Figure 11. Poorly furred plantar metatarsals of a rabbit with sore hocks.

dages are not tolerated by most rabbits, although they can be tried for a few days. Application of a light, protective dressing such as Tegaderm (3M Medical-Surgical Division, St. Paul, MN) or BioDres (DVM Pharmaceuticals, Miami, FL) may be better tolerated if there is no active infection. Antibiotic ointments or creams may be beneficial in some cases, and systemic antibiotic therapy is often clinically useful. Some rabbits will improve if encouraged to stand for part of each day on a board to which bag balm has been applied.

Urinary Tract Diseases

Urolithiasis

Urolithiasis is seen with some frequency in pet rabbits. The etiology of urolithiasis in rabbits is unknown. As for other species, different factors are probably involved, such as diet, infection, and anatomy. Clinical signs may be nonspecific, and can include lethargy, inappetance, abdominal distension, and perineal debris or urine scald. In a study of 14 rabbits with hematuria, 29% had urolithiasis.[17] A retrospective study of seven pet rabbits with urolithiasis reported that signs suggestive of the condition in dogs and cats, such as hematuria and strainguria, often were not present.[34] Only one out of seven rabbits in this study had hematuria ("rectal bleeding" was also reported in one animal), and two rabbits showed strainguria. On physical examination, an abdominal mass or a small, thickened bladder was palpable in six rabbits, and four rabbits had urine scald or perineal debris. Abdominal radiographs were diagnostic for urolithiasis in all seven rabbits. Rabbit uroliths typically contain primarily calcium and are therefore radiodense. Most calculi are in the bladder, although renal and urethral calculi also are seen.

The treatment for rabbit urolithiasis is currently based on standard therapy for urolithiasis in dogs. Preoperative CBC, biochemical analysis, and urinalysis are indicated. Surgical removal is the treatment of choice for cystic and urethral calculi. Calculus analysis and bladder wall culture should be performed. Postoperative therapy includes a 1- to 2-day in-hospital diuresis (SQ fluids are adequate if the rabbit is stable) and antibiotic therapy for 7 to 10 days, or longer if culture results are positive. Rabbits should be monitored periodically with radiographs for evidence of recurrence.

The role of diet in the incidence of urolithiasis is unknown; however, it is possible that high dietary protein or calcium levels may predispose to the development of uroliths. One study of calcium metabolism[2] found that rabbits placed on a diet with excessive calcium did not reduce intestinal calcium absorption. Instead, calcium excretion in the urine greatly increased; from 1 to 18 g Ca/L urine. The author suggests that the predisposition of rabbits to develop calcium-containing uroliths is related to the peculiarities of their calcium metabolism.[24] Rabbits on an all-pellet diet should be gradually converted to a more varied diet (see section on nutrition).

Renal Failure

Renal failure is an uncommon condition that usually is seen in older rabbits. Both acute and chronic renal failure are seen. Common clinical signs include lethargy, depression, and anorexia. Careful questioning may be necessary to elicit a history of polyuria/polydipsia (PU/PD). (For example: "Is the litter pan wetter than normal?") Some affected rabbits have urine scald in the perineal area.

The approach to diagnosis and treatment of renal failure in rabbits is based on that for dogs and cats. Elevated creatinine and blood urea nitrogen (BUN), in conjunction with isosthenuria, are diagnostic. A urine culture and sensitivity should be submitted to screen for infection, particularly with an active urine sediment. Treatment includes diuresis with SQ or IV fluids, supportive care, and antibiotics if indicated. The prognosis depends on the severity of laboratory findings and the response to therapy.

Diseases of the Reproductive Tract

Uterine Hyperplasia and Adenocarcinoma

Endometrial adenocarcinoma is the most common tumor of rabbits.[27] The clinical signs of endometrial hyperplasia and early adenocarcinoma are similar; therefore, these two conditions are discussed together here.

Uterine adenocarcinoma is very common in older rabbits, reaching an incidence of 50% to 80% in rabbits of certain breeds over the age of 3. The tumor is rare in rabbits of some breeds, including the Polish, Rex,

and Belgian, which suggests that a genetic factor may be involved. Uterine adenocarcinoma is a slow-growing tumor. The clinical course averages 12 to 24 months.[39] Local metastasis occurs prior to hematogenous spread to other organs, including lung, liver, and bone.

The relationship between uterine hyperplasia and neoplasia is not clear.[17] Some studies have found that cystic endometrial hyperplasia precedes the development of adenocarcinoma.[42] One study found that there was little ultrastructural resemblance between carcinoma lesions and glandular or cystic hyperplasia. Moreover, carcinoma was associated with senile atrophy of the endometrium; estrogen administration appeared to reduce the incidence of tumors.[1]

Clinically, both uterine hyperplasia and adenocarcinoma are common in pet rabbits. Clinical signs are similar and include increased aggressiveness, cystic mammary glands, and bleeding. These are the primary differentials for intact female pet rabbits reported to have "hematuria." Bleeding may be severe enough to cause anemia and even death. Breeding animals will show decreased reproductive performance.

On physical examination, a firm, irregular uterus may be palpable. Useful diagnostic tools include abdominal radiography and ultrasonography. Pulmonary metastasis is rare, but thoracic radiographs are indicated in animals suspected of having advanced disease. The treatment is ovariohysterectomy. At surgery, the uterus will be enlarged and discolored, and nodules of varying size may be present in one or both horns. Cystic ovaries are usually seen with uterine hyperplasia. A complete abdominal exploratory should be done to rule-out local metastasis.

The prognosis following OHE is good with uterine hyperplasia or adenocarcinoma that has not yet metastasized. If local or hematogenous metastasis has already occurred, the prognosis is poor. Prevention is with routine neutering of young females. Intact females older than 3 years of age should be examined twice yearly, as early detection and treatment carries a very good prognosis.

Mastitis and Cystic Mammary Glands

Mastitis in rabbits is usually caused by *Staphylococcus, Pasteurella,* or *Streptococcus.* It can be diffuse or characterized by localized abscesses. Mastitis is more common in heavily lactating does; trauma to the teats and poor sanitation are predisposing factors. Clinical signs may be referable to accompanying septicemia and can include anorexia, depression, fever, and death of both the doe and young.[16] Treatment includes aggressive systemic antibiotic therapy in conjunction with supportive care and local treatment for the mammary glands (hot packs and abscess drainage).

A nonseptic, cystic mastitis is seen occasionally in nonbreeding does. Affected gland(s) are swollen and firm, and nipples are discolored and distended. A clear to serosanguinous discharge may dribble from the nipple spontaneously or be readily expressible on physical examination. One or more glands may be affected: the glands are not painful and the

doe is not sick. This condition is usually associated with uterine hyperplasia or adenocarcinoma. The treatment of choice is an OHE.

Hand-raising Rabbits

Newborn rabbits are very altricial. If the doe rejects her young, hand-rearing is the only option unless another lactating doe is available for cross-fostering. Clients should be warned that hand-raising rabbits is difficult and can have a disappointing outcome.

Orphan rabbits can be fed a canine milk replacement product or a home-made formula of one egg blenderized into 8 oz whole cow's milk.[18] They should be fed from an eye dropper or doll's nursing bottle three to four times daily with an amount sufficient to make the abdomen rounded in appearance. Gently massaging the perineal area with warm, wet cotton or cloth is necessary to stimule urination and defecation during the first week or two of life. Orphans can start to take milk and solid foods from a bowl by about 15 days of age.[10]

Neurologic Diseases

Head Tilt (Wry Neck)

Head tilt (torticollis) in rabbits is usually the result of infection with *Pasteurella* or *Encephalitozoon* (Fig. 12).[28] A head tilt may be the only sign of infection with either organism. In one study of rabbits with torticollis, *Pasteurella* was found to cause otitis and empyema of the inner ear, whereas *Encephalitozoon* was found only in the CNS.[28] Clinically, head tilt is most common in younger animals, although all age groups can be affected. Associated clinical signs include ataxia, rolling, and inappetance.

Diagnostic tests include serology for pasteurellosis and encephalito-

Figure 12. Torticollis or wry neck.

zoonosis. A positive response to antibiotic therapy also is a diagnostic tool; rabbits with *Encephalitozoon* infection do not respond to therapy. Enrofloxacin and chloramphenicol are good choices for treatment. Supportive care includes padding the cage and force-feeding. The prognosis is good if the rabbit shows a response within the first week of therapy. Therapy should be continued beyond the resolution of clinical signs. If therapy is successful, there is rarely a residual head tilt.

Lead Poisoning

Lead poisoning is uncommon; however, it should be included in the differential diagnosis for anorexic rabbits. Presenting signs of lead poisoning in rabbits tend to be vague and include inappetence, lethargy, and subtle neurologic changes. The history is rarely helpful in identifying a source of lead, although, with prompting, owners may remember the rabbit biting on a painted surface. Other than lead paint, which was outlawed in the early 1970s, possible sources of lead include drinking water, foil tops from wine bottles, lead sodder, some galvanized cages, and soil contaminated with car exhaust fumes or old leaded paint.

A full medical work-up is often necessary in these rabbits to identify the cause of anorexia. Basophilic stippling of red blood cells or nucleated red blood cells may be present on the CBC. Abdominal radiographs are taken to screen for metallic densities in the GI tract. Although a blood lead level of over 25 µg/dL is reported as abnormal,[37] therapy should be instituted in rabbits with a level of >10 µg/dL in conjunction with typical clinical signs.

Chelation with calcium versenate (CaEDTA) is the recommended therapy for lead poisoning. Most rabbits need to be hospitalized for treatment; however, some owners can administer the injections at home. One to two courses of treatment a week apart may be necessary. Other chelating agents including dimercaprol (BAL) and oral penicillamine are used in humans and may be useful in rabbits.

Ophthalmic Diseases

Conjunctivitis

Conjunctivitis is a common problem in all age groups of pet rabbits. The condition can be acute or chronic, with discharge ranging from clear and serous to thick and purulent. Affected rabbits often are clinically normal otherwise, although they may have associated rhinitis or, rarely, pneumonia. *S. aureus* is reported to be the most common cause, and pasteurellosis is second in incidence (Nephi M. Patton, personal communication, May, 1993).

Chloramphenicol, aminoglycoside, and triple-antibiotic ophthalmic solutions or ointments are good choices for topical therapy; treatment should be for 10 to 14 days. With chronic or nonresponsive conjunctivitis, systemic antibiotics, such as oral trimethoprim-sulfa or enrofloxacin, are

useful adjuncts to topical therapy. Systemic antibiotics may be more efficacious when infection is harbored in periorbital tissues, such as the nasolacrimal duct.

The nasolacrimal ducts are often inflamed and obstructed in rabbits with conjunctivitis. In rabbits with moderate to severe conjunctivitis, the ducts should be flushed prior to topical therapy. In most rabbits, this procedure can be done without sedation. After placing an ophthalmic topical anesthetic in the eye, the duct is cannulated using the appropriate size nasolacrimal cannula or a 18- to 22-g short IV catheter. There is a single ostium located deep in the craniomedial portion of the lower conjunctival sac. Once the cannula is in place, the nasolacrimal duct is gently flushed with warm sterile saline or a dilute antibiotic preparation. There may be initial resistance until a plug of mucus or pus is dislodged. Flushing should be repeated as necessary every 1 to 7 days.

Purulent discharge may inactivate topical antibiotics, and the eyes should be kept clean by flushing with ophthalmic saline. Lid scrubs, a technique that is the mainstay of treatment of human staphylococcal blepharitis, can be done once daily if the rabbit will tolerate them.[25] Gauze sponges are used to gently scrub the closed lids with a dilute baby shampoo solution until the discharge is removed. More wet sponges are used to rinse the lids.

Hypopyon and Endophthalmitis

Occasionally, rabbits will present with fluffy, white intraocular masses. In the author's experience, young to middle-aged rabbits are usually affected. Most of these animals are clinically normal otherwise, although blepharospasm and signs of systemic infection may be present.

A full ophthalmic examination should be done in conjunction with a complete physical exam. Iridal synechiae and corneal vascularization are often present. Intraocular pressure may be elevated or decreased, depending on the stage of disease. A CBC is indicated for baseline data, and, if possible, an aspirate of the anterior chamber should be submitted for cytology and culture. The condition is thought to be part of the *Pasteurella* complex,[2] but other bacteria may also cause this condition. The author has seen one rabbit with intraocular encephalitozoonosis.

The goal of therapy is to control inflammation and keep the eye comfortable. Short of enucleation, a "cure" is unlikely. The best results are achieved with an initial course of aggressive therapy with topical and systemic antibiotics and topical corticosteroids, followed by a gradual taper, based on the rabbit's response. Constant maintenance therapy may be necessary. A low-level (0.25% to 1%) topical prednisone (Poly-Pred, Allergan) may be beneficial. As a guideline, it could be applied twice daily for 7 days and then once daily for 7 days. Alternatively, a topical nonsteroidal anti-inflammatory preparation could be used, such as flurbiprofen (Ocufen). If the rabbit appears to be otherwise healthy, enucleation is an option (see section on surgery).

Rabbit "Cherry Eye"

Occasionally, rabbits present with a condition that looks like "cherry eye" in dogs: namely, a large, round mass protruding from the medial canthus. The author has not had the opportunity to dissect one of these eyes; therefore, it is difficult to identify the structure that is prolapsed. However, there are some possible etiologies.

Rabbits have a prominent Harderian gland, a large lacrimal gland, and a large venous sinus located in the medial part of the orbit. It is possible that an infected lacrimal or Harderian gland could become enlarged and protrude from the medial canthus. Alternatively, periocular infection and swelling could cause the venous sinus to prolapse out. Conjunctivitis usually is part of the clinical picture.

Treatment includes ophthalmic and systemic antibiotics and removal of any potential environmental ocular irritants, such as dusty hay. Any attempt to surgically reduce the prolapse carries a high risk of hemorrhage from the venous sinus.

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SOURCES OF INFORMATION ON PET RABBITS

The following list of sources contains information on pet rabbit medicine. The serious reader is referred also to the laboratory and meat rabbit literature, which often contains information applicable to pet rabbits.

1. Seminars in Avian and Exotic Pet Medicine (published quarterly) WB Saunders Co, The Curtis Center, Independence Square West, Philadelphia, PA 19106-3399; (800)654-2452

2. Journal of Small Exotic Animal Medicine (published quarterly) PO Box 618686, Orlando, FL 32861-8686; (407)521-6111

3. Proceedings, The North American Veterinary Conference (annual) Eastern States Veterinary Association, 2614 SW 34th Street, Suite 4, Gainesville, FL 32608; (904)375-5672

4. House Rabbit Journal (written for the layperson) House Rabbit Society, 1615 Encinal Avenue, Alameda, CA 94501

5. Domestic Rabbits (written for rabbit breeders) American Rabbit Breeders Association, Inc, PO Box 426, Bloomington, IL 61702; (309)827-6623 (book of breed standards available also)