Standards of Care in the 21st Century: The Rabbit

Peter G. Fisher, DVM

Abstract

State-of-the-art improvements in how we feed and provide medical and surgical care for the rabbit (*Oryctolagus cuniculus*) have resulted in a greater lifespan for this common pet animal. The rabbit consultation should begin with a discussion on husbandry, behavior, and nutrition, and then should be followed by a thorough patient history and physical examination. Having a support staff that can help with client education, patient restraint, and diagnostic sample collection, along with appropriate use of diagnostic equipment and knowledge of common rabbit health issues, demonstrates a hospital's proficiency in rabbit medicine. Proper use of sedation and analgesia, and knowledge of the basic critical care needs and methods for fluid therapy in rabbits, will improve patient treatment and case success. A review of the diagnostic workups and therapeutic plans associated with common rabbit illnesses will help the veterinary practitioner develop a comfort level and expertise with this unique species. Copyright 2010 Elsevier Inc. All rights reserved.

Key words: critical care; fluid therapy; medical therapy; *Oryctolagus cuniculus*; physical examination; rabbit

State-of-the-art improvements in how we feed and provide medical and surgical care for the pet rabbit (*Oryctolagus cuniculus*) has resulted in a healthier and longer lifespan for this common pet animal. The rabbit is the most popular exotic animal patient seen in the author’s small animal and exotics practice, and many rabbit owners are dedicated to excellent health care for their pets. All hospital team members need to be aware of a rabbit’s anatomical and physiological parameters so that when a patient is presented for an illness or to have a surgical procedure performed, they will be aware and can meet the special needs of these animals. Hind-gut fermentation, unusual calcium metabolism, teeth that continue to grow for most of the rabbit’s life, a very small thoracic size in comparison with body mass, high metabolic rates, and being a catecholamine-driven prey animal that stresses easily are all special factors that need to be taken into consideration when practicing rabbit medicine.

The Office Visit and Physical Examination

Client communication begins with the receptionist, who not only needs to know the required routine husbandry recommendations of raising a healthy rabbit, but must also recognize the signs of common illness. The receptionist should be the staff member who decides when to schedule the rabbit patient and understands the critical nature of certain disease problems (e.g., gastrointestinal [GI] or neurologic disease) that affect these animals.

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When a rabbit is presented to the veterinary hospital, all first-time clients should be offered a general lesson on husbandry, behavior, and nutrition as part of the initial examination. The author’s employees use prepared folders filled with rabbit-dedicated client education handouts to address various topics that help engage the client on proper rabbit care. These handouts are also required reading for all staff members, so that they are able to initiate these invaluable husbandry discussions. Having a support staff that can help with client education, patient restraint, and diagnostic sample collection demonstrates a hospital’s proficiency in rabbit medicine.

A routine physical examination should include inspection of the ears, nares, and eyes; abdominal palpation; auscultation of the heart, lungs, and abdomen (e.g., gut sounds); and visual examination of the fur and dermis including the perineum and foot pads. For pharmacological dosing and monitoring body condition scores, a digital scale that can measure precise weights in grams and kilograms is essential. Each examination room should be stocked with towels in a variety of sizes to aid in patient restraint, help ensure the animal’s footing on an examination table, and prevent heat loss on stainless-steel or laminate examination tables. Some practitioners prefer to use a rubber bath mat with suction cups on the examination table. The rubber provides traction and increased security for anxious rabbits and is easily cleaned and disinfected. For restraint, a small bath towel may be gently wrapped around the rabbit’s body so that it feels secure and can be examined without struggling (e.g., “bunny burrito”). When transporting a rabbit, its body should be supported and the back feet controlled with one arm while the opposite hand supports the chest between the front legs. The goal is to do this in a calm, soothing manner so that the rabbit will not be stressed. Feline/rabbit nail trimmers are recommended for all staff members to encourage nail trims. For initial dental examinations, a small animal otoscope or an illuminated Welch Allyn (Welch Allyn, Inc., Skaneateles Falls, NY USA) bivalve speculum can be used (Fig 1). The author has a separate set of otoscope cones set aside for this purpose, because the gnawing action during an oral examination will damage the plastic, leaving rough edges. Magnification head loupes will significantly enhance viewing of the skin and other lesions.

**Nutrition**

As a general rule, rabbit owners are likely to seek additional information regarding their pet; therefore, a discussion on rabbit GI physiology and how diet affects the overall well-being of the rabbit is often helpful in enhancing a veterinarian’s credibility. An understanding of the rabbit’s unusual digestion as a hind-gut fermenter, and the role of fiber in maintaining the physiologic balance of the digestive process, will help explain the potential complexities involved when considering recommendations on nutrition.

Ultimately, a diet with 20% to 25% fiber, low starch, and appropriate protein levels will reduce the incidence of many GI problems. As a general rule, a maintenance diet of 1 ounce of high-fiber (>20%), low-protein (<16%) pellets per kilogram of body weight and ad libitum grass hay (e.g., timothy, oat, orchard grass, meadow) is recommended. Showing clients a bag of food that meets the nutritional requirements of their pet rabbit provides a more memorable impression of the recommended product(s) than a general dietary discussion without visual aids. Oxbow Animal Health (Murdock, NE USA; www.oxbowanimalhealth.com) supplies the veterinary market with a variety of legume and grass hays and pelleted diets for the rabbit that are within the recommended nutritional requirements mentioned above. The availability of fresh, leafy greens at a veterinary hospital gives one the opportunity to show clients appropriate produce that can enhance a rabbit’s diet and also serve as an aid in evaluating the anorexic patient in suspect ileus cases. For nutritional support of anorexic rabbits, Oxbow Critical Care for Herbivores (Oxbow Animal Health) can be syringe fed and is an excellent source of fiber and nutrition.
Diagnostic Testing

Clinical Pathology
On completion of the history and physical examination, a veterinarian may choose to initiate a diagnostic workup; it is recommended to select diagnostic testing equipment that is best suited to the exotic mammal patient. Clinical pathology remains an important diagnostic tool with rabbits, because it enables the clinician to evaluate many different systems within their patient. The maximum amount of blood that can be safely collected from a “healthy” stable rabbit for diagnostic purposes is 1 mL/100 g body weight; the blood volume of the adult rabbit is 55 to 65 mL/kg. Venipuncture options include the jugular, lateral saphenous, cephalic, and marginal ear veins. The lateral saphenous vein is the author’s preferred site for sample collection. For sample collection, a 1-mL tuberculin syringe with a 25-gauge × 5/8-inch (0.50 × 16-mm) needle can be used. Alternatively, Monoject (Tyco Health care Group, Mansfield, MA USA) offers a 0.5-mL tuberculin syringe with an attached 28-gauge (0.36-mm) needle that may simplify blood collection from the cephalic or lateral saphenous veins in the smaller dwarf breeds. The size of many exotic mammal patients will limit the total volume of blood that may be obtained at any one time; therefore, working with diagnostic equipment that is calibrated for companion exotic mammals and yields the greatest amount of information from small volumes of blood is ideal. Our hospital performs virtually all routine rabbit plasma chemistry panels, complete blood counts, and urine analyses in-house, which offers the advantage of having same-day results and a more rapid response with initiating a treatment plan (Fig 2, A and B). Alternatively, many commercial laboratories offer next-day service for the same blood analyses that can be obtained with in-house equipment. For in-house chemistry analyzers requiring serum, the StatSpin MP Centrifuge (Iris International, Inc., Chatsworth, CA USA) is recommended because it is designed to efficiently centrifuge small volumes of blood (up to 2 mL) and maximize serum yields. It can also be used on small volumes of urine to obtain sediment samples for cytological review. For blood cultures, Septi-check BBL 20 mL (pediatric) collection vials (Becton Dickinson, Franklin Lakes, NJ USA) can be used.

Serodiagnosis
Most commercial veterinary diagnostic laboratories use enzyme-linked immunosorbent assays (ELISA) for serologic testing of rabbit diseases. Several veterinary diagnostic laboratories that primarily serve the laboratory animal research community offer DNA-based assays (e.g., DNA amplification polymerase chain reaction) and multiplex fluorometric immunoassays in ad-
addition to ELISA testing to screen for disease in research and biotechnical facilities. The sensitivity and specificity of the different serologic tests can vary with the disease in question and the modality used. For the pet rabbit practitioner, single rabbit samples are accepted by several laboratories (e.g., University of Miami Comparative Pathology Laboratory, Miami, FL USA; Sound Diagnostics, Woodinville, WA USA) for serological testing (Table 1). Paired titers to demonstrate active disease are ideal to help confirm a diagnosis with this diagnostic testing modality.

**Imaging**

Digital radiography has revolutionized the diagnostic value of radiographic images; however, even with the enhanced technological improvements associated with this modality, there are many determinants that can affect image quality and one’s ability to properly assess those images. The hardware and software used to generate images will have a dramatic effect on image quality. Image quality is also dependent on the veterinary personnel’s knowledge of the system (e.g., software) and ability to properly use it. Some digital radiography systems are very easy to use, whereas others are not. It is important that the equipment is capable of producing images that have excellent anatomic detail. High-quality images are especially important when evaluating the skull. Diagnostic imaging can be especially valuable for assessing the GI, urogenital, respiratory, cardiac, and skeletal systems, and as part of an overall oral health assessment.

Sonographic examinations record echoes of ultrasonic wave pulses directed into tissues and reflected by tissue planes where there is a change in density. Ultrasonography is a dynamic modality, and the Doppler unit is especially useful in assessing cardiac contractility and blood flow. A fluid:gas interface creates a highly reflective surface, which causes an artifact called reverberation. Reverberation makes imaging through gas/air difficult because it is impossible to distinguish these artifacts from real echoes. Abdominal ultrasonography is more challenging in rabbits because of fluid:gas artifacts, along with the large size of the herbivore cecum. It is vital that the ultrasonographer be familiar with both the practice of ultrasonography as well as the normal anatomy of rabbits. For most rabbits, a high-frequency transducer with a footprint of less than 2 cm is required. Ultrasonography is used most often by the author for assessment and diagnostic sampling of skull, abdominal, and thoracic masses/abscesses, and for cardiac disease evaluation (Fig 3, A and B).

**Critical Care**

**Fluid Therapy**

As the level of rabbit medicine and surgery has matured and become more sophisticated, so has the need for appropriate intravenous fluid therapy and patient monitoring. Physiological stabilization of a patient should be the goal of every case, whether associated with illness or surgery. Catheterization with a 24- to 26-gauge (0.56-0.46 mm) indwelling intravenous (IV) catheter in the cephalic vein is routinely performed in rabbit patients (Fig 4). Alternatively, for short-term IV access, a 26-gauge (0.46 mm × 19 mm) winged IV catheter can be placed in the caudal auricular vein. The catheter can be secured to the pinna by applying a small amount of tissue adhesive on the catheter wings and then pressing them against the skin. If one is unsuccessful at passing an IV catheter or if the peripheral veins have collapsed as a result of the patient’s condition (e.g., severe dehydration, shock), then intraosseous catheterization should be considered. A 22-gauge (0.72 mm × 3.81 cm) spinal needle inserted into the humerus via the greater tubercle will provide a direct route for fluid administration. The type of fluid selected for a patient will vary depending on serum chemistry and electrolyte results, underlying metabolic disease, and duration of therapy. The rate of fluid administration will vary based on the daily requirements of the patient, its current hydration status, presence of underlying metabolic disease (e.g., renal disease, cardiac disease), and daily fluid loss. The goal of fluid therapy is to provide necessary fluid and electrolytes, meet metabolic demands, and restore intracellular water balance until the patient is eating and drinking on its own or recovered from surgery. The duration of treatment will vary from case to case depending on the patient’s health, treatment response, and/or recovery from a surgical procedure. An infusion pump is a necessity in the accurate administration of maintenance fluids at rates of 4 to 10 mL/kg/h.

<table>
<thead>
<tr>
<th>Agent</th>
<th>Disease</th>
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<tr>
<td>Clostridium piliforme</td>
<td>Tyzzer’s disease</td>
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<tr>
<td>Encephalitozoon cuniculi</td>
<td>Encephalitozoonosis</td>
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<tr>
<td>Pasteurella multocida</td>
<td>Pasteurellosis</td>
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<tr>
<td>Treponema cuniculi</td>
<td>Syphilis</td>
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Table 1. Sound Diagnostics, Inc. offers ELISA serologic screening for detection of antibodies to the following infectious diseases of rabbits
Recognition and Treatment of Shock

In severely ill rabbits, fluid losses need to be treated aggressively, or early decompensatory shock may develop. Clinical signs of early decompensatory shock in rabbits include hypothermia, prolonged capillary refill time, pale mucous membranes, cool limbs and skin, bradycardia, and hypotension. Both crystalloid and colloid fluid products may be required during treatment; the determination for this will depend on patient condition, blood pressure and serum chemistry results.

A fluid resuscitation plan, to restore tissue perfusion and oxygenation, needs to be developed while considering the type, quantity, and rate of fluid to be administered. The primary goal of a fluid resuscitation plan should be to administer the smallest volume of fluid required to eliminate or prevent clinical signs associated with decompensatory shock. Resuscitation of hypovolemic shock is best accomplished with a combination of crystalloid and colloid fluid products. Crystalloid fluids are primarily comprised of water and have a sodium or glucose base, along with a smaller concentration of other electrolytes or buffers. Crystalloid fluid products are capable of distributing to all body compartments, and thus replace both interstitial and intravascular fluids losses. Colloid fluid products contain large molecular weight substances that, in general, are not able to pass through capillary membranes and aid in the expansion of intravascular volume. Examples of colloid fluid products include whole blood or plasma, Hetastarch (Braun Medical, Irvine, CA USA), Dextran 70 (Pharmacosmos A/S, Holbaek, Denmark), and Oxyglobin (Dechra Veterinary Products, Overland Park, KS USA). When a colloid product is used in combination with a crystalloid product, there can be

Figure 3. (A) Newer, portable ultrasonography units, such as the GE LOGIQ Book XP (GE Health Care, Buckinghamshire, United Kingdom), are allowing for more affordable sonograms in private practice; this cardiac image (B) was obtained from a rabbit with chronic low-grade respiratory distress.

Figure 4. Most calm rabbits tolerate intravenous catheterization with sedation and local subcutaneous infiltration of lidocaine. For replacement fluids, the author uses an isotonic crystalloid solution such as Plasmalyte-A (Baxter Healthcare, Deerfield, IL USA) or 0.9% saline solution (Baxter Health care) with or without added dextrose to form a 2.5% or 5% solution. An intravenous fluid warmer, such as this TempCare unit (Elitec Co. Ltd. Nagoya, Japan), will aid in maintaining patient thermoregulation and maximize patient recovery from surgery or illness.
as much as a 40% to 60% reduction in the total fluid volume required for resuscitation than if a crystalloid was used alone.2

A summary of the therapeutic approach for rabbits in decompensatory shock is as follows:2

- Administer a bolus infusion of isotonic crystalloid fluid product at 10 to 15 mL/kg.
- Administer Hetastarch at 5 mL/kg over 5 to 10 minutes.
- Monitor systolic blood pressure; once greater than 40 mm Hg, administer maintenance crystalloids (Fig 5).
- Aggressively warm patient with a forced-air heating system such as the Bair Hugger (Arizant Health Care, Eden Prairie, MN USA).
- Monitor rectal temperature until it approaches 98.0°F (37°C); recheck blood pressure and administer a crystalloid product (10 mL/kg) with Oxyglobin at 2-mL/kg increments (repeated over 15 minutes) until the systolic pressure increases to greater than 90 mm Hg.
- Begin rehydration phase of fluid resuscitation once systolic pressure is consistently greater than 90 mm Hg.
- Continue a constant-rate infusion of Oxyglobin at 0.2 to 0.4 mL/kg/h during the rehydration phase.

### Analgesia, Sedation, and Anesthesia

Patient sedation and pain control are a necessary part of daily rabbit practice. Whether treating painful conditions such as GI stasis, dental disease, or trauma, or premedicating for an oral examination or general anesthesia, the rabbit patient benefits from knowledgeable and judicious use of analgesic agents and sedatives.

Confirming the presence of pain in animals is difficult because of differences between and within species in the behavioral response to noxious stimuli.4 Many behaviors are consistent with, but not invariably indicative of, pain, and confirming the presence of pain in an animal may be complicated by the fact that normal behavior is not always indicative of a pain-free state.4 Like humans, rabbits show individual variability in both their pain threshold and tolerance, and recognition of pain in rabbits relies on skill, experience, and professional judgment of the patient. The following are behavioral changes that have been used in the assessment of pain in rabbits:4

- Searching/exploring behavior; frequency and duration
- Movement frequency and duration
- Food consumption, duration
- Grooming behavior, duration
- Conspecific interaction, duration
- Changed posture, tucking of abdomen, tensing of muscles
- Guarded or aggressive behavior
- Attempting to hide
- Squinting of the eyes
- Grinding of teeth

Nociception is the neural response to the application of a noxious stimulus. The process of nociception and pain involves multiple steps and pathways. An effective pain management plan includes drugs of different classes that act at different pathway locales, a process known as multimodal analgesia. This approach allows for smaller doses of each drug to be used because the effects are additive or synergistic, and thus reduce the undesirable side effects of individual drugs.

![Figure 5. Indirect blood pressure monitoring by the Doppler method is preferred by most veterinarians. Doppler flow detection (Parks Medical Electronics, Inc., Aloha, OR USA) uses ultrasonic waves for audible monitoring of arterial blood flow, and in the rabbit the front limb is more reliable and most commonly used. The transducer probe crystal is placed in a bed of ultrasound gel on the shaved medial midshaft of the radius-ulnar area to assess blood pressure of the radial artery. Ideally, a cuff size approximately 40% of the circumference of the humerus is used to measure indirect blood pressure in rabbits.](image_url)
affects expected when larger doses of individual drugs are used alone. Multimodal preemptive analgesia with opioids, nonsteroidal antiinflammatory drugs, alpha-2 agonists, dissociatives, or local anesthetics (Table 2) will prevent the “wind up” effect of surgical pain that occurs when neurons that mediate nociception in the dorsal horn of the spinal cord are repeatedly stimulated.

To alleviate the apprehension and stress associated with the hospital environment, rabbits should be given a sedative 20 to 30 minutes before any procedure requiring restraint or anesthesia. The author routinely uses midazolam (Baxter Healthcare Corp., Deerfield, IL USA) (Table 2) for a variety of diagnostic procedures and outpatient treatments that include imaging, blood or cytological specimen collection, and grooming procedures. Used before surgery, sedatives contribute to fewer complications associated with anesthetic induction, anesthesia itself, and recovery. For surgery patients, analgesic agents should also be given preemptively, because inhalant anesthetics produce unconsciousness but are not recognized for their analgesic effect. Well-recognized benefits of preanesthetic agents include: 1) reduced stress associated with restraint and induction, and 2) lowering of the mean alveolar concentration of inhalant agents required to achieve a surgical plane of anesthesia.

### Medical Therapy

Various diseases and health problems are unique to the rabbit. The following is a summary of several common medical problems and the standards of care in developing a diagnostic and treatment plan for these presentations.

### Respiratory Disease

Respiratory disease is a common finding in captive rabbits. Rabbit patients that present with recurrent upper respiratory disease and nasal discharge
should have a rigid endoscopic examination of the nasal passages to obtain biopsies and other diagnostic samples for histopathology and microbial (e.g., fungal, bacteria) culture and antimicrobial sensitivity testing. Ultrasonic nebulization is a worthwhile adjunct therapy if pneumonia is suspected (Fig 6). Although there are a number of different diagnostic tests that can be used to assess the respiratory system of a rabbit, one that is only recently being advocated is capnography. A recent report demonstrated that rabbits with respiratory disease can have elevated end-tidal CO₂ levels compared with nondiseased rabbits, and that this test may prove useful in the future for veterinarians looking to assess the physiologic status of a rabbit with respiratory disease. 7

Gastrointestinal Stasis

GI stasis is a syndrome where the normal muscular contractions of the stomach and intestines are greatly diminished and, as a result, the normal intestinal/cecal bacterial flora is adversely affected (dysbiosis).8 Several factors are usually involved with GI stasis, including environmental stressors, pain from other underlying conditions (e.g., dental/tooth points or spurs), and inappropriate diet. Feeding simple carbohydrates (e.g., breadstuffs or cereals) along with a lack of crude fiber can predispose rabbits to GI stasis. In the absence of adequate fiber, the GI tract has a reduced motility, which may result in subsequent changes in cecal pH, fermentation processes, and bacterial populations. Rabbits with GI stasis are frequently anorexic or have a reduced appetite. Affected animals tend to produce small stools or no stools; they display outward signs of discomfort by holding a “hunched-up” posture and/or grinding their teeth (bruxism). Diarrhea with or without mucus may develop. Abdominal auscultation may reveal normal or hyperactive gut sounds early in the course of the disease, with decreased to no gut sounds as the stasis continues. Prompt diagnosis and management improve the chances for full recovery. Rabbits presented in obvious distress with a palpably enlarged, noncompressible stomach warrant close monitoring and critical care. (Fig 7, A and B)

Depending on the severity of the GI condition and clinician discretion, a variety of treatment measures may include:

- Abdominal massage: Gentle, deep massage of the abdomen to stimulate intestinal contractions and to break down impacted stomach contents. If diagnosed early in the course of the disease, encourage movement and exercise as a way to stimulate gut motility.

- Fluid therapy with an appropriate type and volume of fluids, and route for administration.

- Analgesics as needed, especially if showing signs of pain or evidence of increased GI gas.

- Syringe feeding an enteral product (e.g., Oxbow Critical Care) to provide nutrition and fiber to stimulate GI motility. A nasogastric tube can be used to deliver the enteral. A 5- to 8-Fr Argyle tube (Kendall, Mansfield, MA USA) passed ventrally and medially into the ventral nasal meatus and advanced to the stomach has been found to be helpful.9

- Appetite stimulants: Vitamin B complex injections or cyproheptadine (Periactin; Merck, West Point, PA USA) 1 to 4 mg/rabbit by mouth every 12 to 24 hours.

- GI motility stimulants: Prokinetics such as cisapride (available through a compounding pharmacy) dosed at 0.5 mg/kg by mouth every 8 to 12 hours or metoclopramide (Reglan; Schwarz Pharm., Mequon, WI USA) at 0.5 mg/kg by mouth or subcutaneously every 8 to 24 hours.

- Simethicone: To help break down gas bubbles associated with bloating.

- If an endotoxin-induced gut mucosal injury is suspected, consider epidural analgesia to prevent functional and structural mucosal alterations.10
Dental Disease

Numerous writings on rabbit dental disease have been published in the past decade, with entire texts (Rabbit and Rodent Dentistry, Zoological Education Network, 2005) and journals (Journal of Exotic Pet Medicine 17(2):2008) being devoted to the subject. It is important to remember the direct association between diet and rabbit dental disease. Feeding the rabbit free-choice grass hay stimulates constant chewing action, which helps wear down the continuously growing incisors, premolars, and molars, and helps prevent acquired dental disease, primarily painful molar spurs or points. Metabolic bone disease associated with a poor diet and inadequate calcium, vitamin D, and natural sunlight has also been incriminated as a cause of malocclusion, overgrown dental roots, and mandibular abscesses.\(^{11}\)

The rabbit oral anatomy, including the fleshy tongue, buccal skin folds, long and narrow oral cavity, and caudally placed cheek teeth, make oral examination of the nonanesthetized patient difficult to impossible. Fortunately, a variety of special instruments have been designed to enhance visualization of the oral cavity and aid in treatment of dental disease in rabbits and smaller herbivorous species. When history and physical examination findings suggest dental disease, general anesthesia should be used to thoroughly evaluate the patient’s oral cavity. An overall loss of body condition, decreased appetite, digestive disturbances, and ocular discharge may all be associated with dental disease in this species. The author finds the following invaluable in assessing and treating rabbit dental disease:

- Skull radiographs, preferably 6 views that evaluate lateral, ventrodorsal, dorsoventral, rostrocaudal, and right and left lateral oblique projections, are an invaluable aid in assessing rabbit dental health.
- Use specialized dental tools to aid visualization (Fig 8).
- A stainless-steel spatula (Sontec, Englewood, CO USA), used to move oral soft tissues, allows for visual assessment of the premolars and molars and protects the oral mucosa and tongue during filing or burring of teeth.

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A diamond-coated rasp (Sontec) may be used to manually smooth small dental points and spurs.

Many veterinarians prefer to use a specially designed dental platform, the rodent table retractor restrainer (Jorgensen Laboratories, Loveland, CO USA), to allow hands-free elevation of the head and opening of the mouth.

Use of a high-speed dental drill is the preferred method of trimming overgrown incisors (Fig 9).

In those rabbit oral surgery cases in which endotracheal intubation will interfere with visualization and access to the teeth, injectable maintenance anesthesia with dexmedetomidine alone (80-120 µg/kg) or in combination with ketamine (25-30 mg/kg) can be used.12,13

Use of local anesthetic dental blocks. Approaches can be extrapolated from the dog and cat literature; however, it is important to have a strong grasp of rabbit skull anatomy. The author uses faster-onset 2% lidocaine (Vedco, Inc., St. Joseph, MO USA) mixed with slow-onset 0.5% bupivicaine (Hospira, Inc., Lake Forest, IL USA) at a rate of 1 mg/kg body weight for each drug and dilutes with saline solution to a final volume of 1 mL.

Extraction of the incisor teeth is recommended for resolution of persistent malocclusion in rabbits (Fig 10, A and B).

Periapical infection with abscessation and osteomyelitis requires aggressive and prolonged therapy (Fig 11, A, B, and C).14,17

Facial dermatitis as a result of chronic epiphora secondary to dacyrocystitis is not uncommon in the rabbit. Many times this is in association with elongated incisor tooth roots and blockage of the nasolacrimal system. A 23-gauge (0.64-mm) lacrimal cannula can be used to cannulate the punctum lacrimalis in the medial canthus to flush the duct. Infusing saline solution through the cannula will help to remove purulent debris and possibly relieve any blockage. This same cannulation technique can be used to infuse iodine-based contrast media to confirm the presence and severity of the blockage and aid in prognosis and long-term management recommendations.

**Head Tilt**

Head tilt or torticollis, which is usually an indication of vestibular dysfunction, can be associated with a central (e.g., cerebellum, brain stem) or peripheral
(e.g., inner ear) neurologic disease process and was the most common clinical sign noted in a retrospective study of rabbits with neurologic disease. Other vestibular signs include nystagmus and loss of balance and rolling. Causes include bacterial otitis interna and infection with *Encephalitozoon cuniculi*. A diagnostic and therapeutic plan for head tilt should include:

- **Diagnosis of otitis media/interna** is based on clinical signs, aural examination, and imaging, including skull radiography and computed tomography or magnetic resonance imaging, when available.

- **Bacterial culture and sensitivity** of deep aural or nasal swabs taken with the rabbit under anesthesia are indicated when physical examination supports infection.

- **Endoscopic examination** performed with the rabbit under general anesthesia aids in visualization of the distal ear canal and tympanic membrane.

- **Antimicrobial treatment of otitis interna** should be long term, 4 to 6 weeks or longer, because antibiotics do not penetrate well into pus-filled tympanic bullae. Systemic antibiotics, preferably based on the results of a bacterial culture and their ability to penetrate the central nervous system, are recommended.

- In addition to antibiotic therapy, affected rabbits often benefit from nutritional supplementation, environmental support to minimize the rolling and severe ataxia associated with this disease, and medical therapy with meclizine hydrochloride (Meclizine HCl; Rugby Labs, Duluth, GA USA) 12.5 to 25 mg/kg by mouth every 12 hours, an antihistamine that aids in the control of associated dizziness.

- *Encephalitozoon cuniculi* is a microsporidium, obligate intracellular protozoan parasite. The most commonly recognized neurological sign in rabbits infected with *E. cuniculi* is vestibular disease.

- **Clinical means of diagnosing definitive antemortem encephalitozoonosis** are limited. However, because *E. cuniculi* infection is persistent, antibodies continue to be produced, and as a gen-

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**Figure 11.** When treating periapical infections and subsequent facial abscessation and osteomyelitis, the author has found the following to be the key to long-term resolution: extract all diseased teeth associated with the abscess, thoroughly debride necrotic and infected jaw or skull bone (A), marsupialize the abscess capsule to facial skin, and treat as an open wound (B). It is recommended to pack the marsupialized site with gauze strips impregnated with antibiotics, preferably based on bacterial culture, antibiotic sensitivity, and the proclivity of anaerobic bacteria. The packing should be changed daily and the wound flushed daily or every other day until healing, wound granulation, and contracture occur. If the marsupial site healing is delayed, medicinal-grade honey can be used to pack the area and discourage local infection. One month into the outlined therapeutic program the abscess is healed (C).
eral rule the validity of antibody assays for the detection of *E. cuniculi* compares favorably with histology in rabbits.\(^{19-21}\)

- In the absence of controlled studies, it is difficult to assess the efficacy of therapeutic agents against *E. cuniculi* because latent infections occur and some clinical cases may improve spontaneously without treatment, presumably as a result of the host’s immune response.\(^{22}\)

- Several benzimidazole derivatives, including albendazole (30 mg/kg by mouth every 24 hours for 30 days),\(^{23}\) oxibendazole (30 mg/kg by mouth every 24 hours for 7-14 days, then 15 mg/kg by mouth every 24 hours for 30-60 days),\(^{23}\) and fen-bendazole (20 mg/kg by mouth every 24 hours for 30 days),\(^{24}\) have been used to treat presumptive *E. cuniculi* infections in rabbits (Fig 12, A and B) based on their antiinflammatory actions and their in vitro antiprotozoal activity (e.g., bioenergetic disruptions of membranes and microtubular [tubulin] inhibition of *E. cuniculi*).\(^{25-28}\)

### Perineal Soiling and Dermatitis

Rabbits often present with matted and soiled perineal fur with secondary dermatitis. Causes include

**Figure 12.** This 8-year-old female spayed rabbit was presented with signs of vestibular disease, including a head tilt and nystagmus (A). There was no evidence of tympanic bulla disease on skull radiography. The rabbit’s *E. cuniculi* ELISA test was positive and she was treated with fenbendazole at 20 mg/kg for 30 days. The vestibular signs resolved with time (B). With encephalitozoonosis, clinical signs may not be associated with the presence of the protozoa itself, but rather with the inflammatory response that persists after the organism has been eliminated.

**Figure 13.** A 6-year-old female spayed rabbit presented with a history of progressive rear limb weakness and a recent onset of perineal soiling. Spinal radiographs (A, B) showed severe thoracic lordosis at T9 to 11 with a distinct concavity in this region on gross palpation. Spondylosis can contribute to gait abnormalities and the inability to flex the spine to groom the caudal body, resulting in an unkempt fur coat and perineal soiling.
inappropriate diet and subsequent soft stools, diarrhea, and/or urine leakage as a result of infection or excessive crystalluria (bladder sludge syndrome), environmental factors resulting in behavioral urine retention, and decreased ability to groom because of obesity or pain. A workup should include using case history, physical examination findings, and imaging to determine an underlying cause.

- Rule out inappropriate diet and subsequent soft stools or diarrhea as a cause.
- Assess patient history: dietary and environmental. Is the rabbit on grass-based hay and pellets? Does the patient get plenty of exercise and opportunities to urinate? Is the patient obese and unable to groom the perineum?
- Assess for underlying pain by history, physical examination, and spinal and joint radiographs; use analgesics when indicated (Fig 13, A and B).
- If you suspect bladder sludge syndrome, inform the client that it is often a disease that can be managed but not cured; many rabbits become subclinical (Fig 14).
- Bladder sludge syndrome can be ruled out from infectious cystitis with bacterial culture; a non-contaminated urine sample collected via cystocentesis is required.

**Conclusion**

The 21st century is an exciting time to practice rabbit medicine. As one can see, rabbit medicine continues to mature and evolve. Nutritional management, ultrasound imaging, fluid therapy and use of colloid fluid products, blood pressure monitoring, preprocedural sedation, and multimodal analgesia are all considered standards of care for the pet rabbit. What will the future hold for rabbit medicine? Perhaps more definitive ways to diagnose and treat *E. cuniculi* infections, more routine use of advanced imaging techniques such as magnetic resonance imaging, better rabbit-specific pharmacokinetics on many of the drugs we are presently using, and lastly, new rabbit friendly antibiotics to treat anaerobes and Gram-positive bacterial infections. At the rate we are going, these advances in rabbit medicine may all be part of routine standards of care as we approach the year 2020.

**References**

1. Heatley JJ: Small exotic mammal comparative hematology. Proceedings of the American Board of Veterinary Practitioners, Austin, TX, 2009

**Figure 14.** Excessive crystalluria that results in stranguria and pollakiuria with or without perineal soiling requires administration of subcutaneous fluids with manual bladder massage/expression as part of the therapeutic plan. Repeat as necessary until signs are managed and bladder function and health (based on clinical signs, physical examination, and imaging) return to normal. Encourage more water intake by improving access to fresh, clean water and feeding moistened greens. If nonresponsive to treatment, catheterize the bladder and flush with warmed 0.9% saline solution with the rabbit under general anesthesia as shown in this image.