WHITE-NOSE SYNDROME: HOLY FUNGUS BATMAN!

David S. Blehert, PhD

U.S. Geological Survey, National Wildlife Health Center, Madison, WI 53711 USA

Abstract

White-nose syndrome (WNS) is a disease associated with unprecedented bat mortalities in the northeastern and mid-Atlantic United States. Since the winter of 2006-2007, bat population declines ranging from 80-97% have been documented at surveyed hibernacula. Estimated losses have exceeded one million bats over the past three years. Affected hibernating bats often present with visually striking white fungal growth on their muzzles, ears, and/or wing membranes. Histopathologic analyses confirmed that 90% (105 of 117) of necropsied bats submitted from WNS-positive sites exhibited an associated cutaneous fungal infection. Direct microscopy, culture, and PCR analyses demonstrated that the skin of WNS-affected bats is colonized by a new species of psychrophilic (cold-loving) fungus, *Geomyces destructans*. The fungal isolates were initially cultured at 3°C and grew optimally between 5°C and 14°C, temperatures consistent with the body temperatures of hibernating cave bat species within the WNS-affected region. Laboratory infection trials indicated that *G. destructans* is transmissible bat-to-bat, and the fungus has been identified in environmental samples collected from several bat hibernation caves within WNS-infested states. There is a growing body of evidence supporting an association between WNS and cutaneous fungal infection by *G. destructans*. Given the hundreds of thousands of hibernating bats found throughout the WNS-affected region, this disease represents an unprecedented threat to bats of the eastern United States and beyond.
USING THE ‘ONE HEALTH’ APPROACH TO SOLVE COMPLEX PROBLEMS AT THE LIVESTOCK-WILDLIFE INTERFACE

Jonna A. K. Mazet, DVM, MPVM, PhD,1* Deana L. Clifford, DVM, MPVM, PhD,1 Peter B. Coppolillo, PhD,2 Jon D. Erickson, PhD,3 Tom R. Stephenson, PhD,4 Vern C. Bleich, PhD,4,5 Walter M. Boyce, DVM, PhD,1 and Rudovick R. Kazwala, DVM, PhD6

1Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, CA; 2Yellowstone Rockies Program (Formerly Ruaha Landscape Program), Wildlife Conservation Society, Bozeman MT; 3Rubenstein School of Environment and Natural Resource, University of Vermont, Burlington, VT; 4Sierra Nevada Bighorn Sheep Recovery Program, California Department of Fish and Game, Bishop, CA; 5Department of Biological Sciences, Idaho State University, Pocatello, ID; 6Department of Medicine and Public Health, Faculty of Veterinary Medicine, Sokoine University of Agriculture, Chuo Kikuu, Morogoro, Tanzania

Abstract

When livestock and wildlife are in close proximity, diseases can have severe impacts on livelihoods, biodiversity, and even human health. Mitigating these complex ‘One Health’ problems requires identification of implementable and sustainable solutions. Because disease transmission between livestock and wildlife tends to place livestock keepers and conservationists at odds, approaches to solving these problems need to be framed in a neutral context to encourage participation. Using a transdisciplinary, ecosystem approach, we addressed disease transmission between livestock and wildlife—bovine tuberculosis in Tanzania and bighorn sheep pneumonia in the United States. In both countries, existing information was evaluated, and critical gaps were targeted for data collection, via disease testing, health and socioeconomic surveys, and evaluation of wildlife and livestock demography and land usage. The data were then used to assess risk of disease transmission and identify interventions. Science-based interventions likely to mitigate the problems and be implementable in the economic and cultural contexts were identified through stakeholder participation and the involvement of health scientists, ecologists, socioeconomists, cultural anthropologists, and public educators. Economics and work stress had been used as justifications for ecologically unhealthy practices in both countries, but cultural traditions were often at the root of behaviors rather than finances. In both contexts, some stakeholders were open to behavioral change based on scientific and financial justifications, while others were unwilling to participate in such solutions. In the developed country context, government agencies implemented interventions given financial and scientific evidence. In both developing and developed countries, the main obstacle to implementing change is tradition. While strong science is an excellent foundation on which to base recommendations, interventions can succeed only if stakeholders are involved in the characterization of the problem and are willing to make the tradeoffs necessary to balance the needs of people and wildlife.
TUBERCULOSIS IN NEPAL: ELEPHANTS, HUMANS, LIVESTOCK, AND WILDLIFE

Susan K. Mikota, DVM, 1* Gretchen Kaufman, DVM, 2 I.P. Dhakal, MVSc PhD, 3 and Basu Dev Pandey, MD, PhD 4

1Elephant Care International, Hohenwald, TN; 2Department of Environmental and Population Health, Cummings School of Veterinary Medicine at Tufts University, North Grafton, MA; 3Institute of Agriculture and Animal Science, Tribhuvan University, Rampur, Nepal; 4Sukra Raj Infectious and Tropical Disease Hospital and Everest International Clinic and Research Center, Kathmandu, Nepal

Abstract

Tuberculosis (TB) is endemic among humans in Nepal. Almost 50% of the > 28 million population are infected and up to 90,000 are active cases (http://www.who-int/inf-new/tuber4.htm). Direct observed therapy short-course (DOTS) was instituted in 1996 and now reaches 75% of the population. Implementation of DOTS nation-wide is hampered by the logistics of reaching and servicing remote hill areas. Between 5,000 and 7,000 people die every year despite DOTS therapy; some of these deaths may be due to multidrug-resistant (MDR) or extensively drug-resistant (XDR) TB. Four drug resistance surveys have been carried out since 2005. MDR-TB rates of 2.9% (1.8%-3.2%) among new cases and 11.7% (7.1%-18.3%) among re-treatment cases were reported at the end of the fourth survey (http://www.searo.who.int/en/Section10/Section2097/Section2100_14801.htm).

Nepal has a mixed farming system, including over four million buffaloes and almost seven million cattle. Sporadic studies have identified a TB prevalence of 0-24% among cattle and 4.5 to 41% among buffalo. In a recent study Mycobacterium bovis (M. bovis) was isolated from 17% of buffalo and 16% of cattle positive on the single intradermal cervical test. 1 There is no formal TB surveillance or control program for cattle or buffalo in Nepal. Although the World Health Organization recommends test and slaughter to eliminate bovine TB, Nepal is predominantly Hindu and the slaughter of cattle is forbidden.

The prevalence of M. bovis (BTB) infection in humans is unknown as TB diagnostic laboratories in Nepal (as in many countries) report positive culture results as “M. tuberculosis complex” but do not speciate. Risks of TB / BTB transmission from livestock to people exist through direct contact by farmers and slaughterhouse workers and consumption of contaminated meat and unpasteurized milk. Buffalo meat comprises over 64% of the total meat consumed in Nepal. In one study, tuberculosis was diagnosed in 14% of slaughtered buffaloes. 2 Intensive livestock production is rare, and human beings live in close association with their farm animals providing increased opportunities for exposure.

Captive elephants in Nepal are cared for by humans, bred by wild elephant bulls, and graze with domestic livestock. Government-owned elephants patrol the Chitwan National Park (and other protected areas) and are essential for rhino counts and other conservation programs. Privately-
owned elephants used for safaris in the parks generate tourist dollars that support conservation and local businesses.

TB has not yet been diagnosed in wild elephants, rhinos, or other wild mammals in Nepal but poses a significant threat. Controlling TB at the captive elephant interface may decrease transmission to the wild where it would be difficult if not impossible to control.

An elephant TB surveillance program was initiated in Nepal in 2006 following the postmortem diagnosis of TB in several captive elephants. To date, 164 captive elephants (79% of the population) have been tested using the ElephantTB STAT-PAK Assay® (Chembio Diagnostic Systems, Inc., 3661 Horseblock Road, Medford, NY 11763, USA). Nineteen elephants are receiving treatment for TB; one elephant has completed treatment, and one old elephant is under permanent quarantine. Culture-confirmation of TB infection has been unrewarding due to 1) difficulty in performing the trunk wash procedure, 2) sample contamination, and 3) limited laboratory capacity to process elephant samples. Investigation of alternative direct methods for diagnosis are being pursued. TB has not been detected in currently employed elephant caretakers tested by the public health system.

Tuberculosis will be a main focus of the newly established One Health-Nepal, spearheaded by the National Trust for Nature Conservation (a Nepal NGO) and the Zoological Society of London. Elephant Care International, the Cummings School of Veterinary Medicine at Tufts University, and the Institute of Agriculture and Animal Science are among the organizations that will collaborate to address cross-species TB issues in Nepal.

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LITERATURE CITED

INTEGRATED HEALTH APPROACH TO GORILLA CONSERVATION

Mike Cranfield, DVM

The Mountain Gorilla Veterinary Project Team (MGVP, Inc.) c/o Maryland Zoo in Baltimore, Baltimore, MD 21217 USA

Abstract

Conservation medicine focuses on the intersection of animal health, human health, and ecosystem health. It differs from classical public health epidemiology in that conservation medicine aims to protect and improve ecosystem and animal health, in addition to human health. Conservation medicine involves studying diseases shared among species and interactions with environmental variables over the relevant range of biologic, temporal and spatial scales. Zoonotic diseases and the emergence of new diseases are therefore of primary concern, and are particularly important when threatened or endangered great ape populations are involved. The effective practice of conservation medicine demands an integrated team approach involving wildlife and livestock veterinarians, local physicians, public health professionals, ecologists, politicians and communities. Common interests, improved data collection, and economies of scale argue for combining animal and human health surveillance and delivery efforts. This team approach needs to be tailored to the infrastructure and sophistication of the host country’s human and livestock health systems, and must also be appropriate for the size and characteristics of the great ape population.

Examples from gorilla conservation programs range from those involving small populations with individually identifiable gorillas surrounded by dense human populations, to large unhabituated gorilla populations in areas of very low human density. It is often, by default, the wildlife veterinarian who coordinates the ‘One Health’ approach, because of his / her training in wildlife and livestock medicine as well as zoonotic and emerging disease issues.
THE EMERGENCE OF CLINICAL ‘ONE HEALTH’: REFLECTIONS ON THE COLLABORATION OF PHYSICIANS AT UCLA AND VETERINARIANS AT THE LOS ANGELES ZOO

Barbara Natterson Horowitz, MD¹* and Curtis Eng, DVM²

¹Division of Cardiology, University of California, Los Angeles (UCLA) Department of Medicine, David Geffen School of Medicine at UCLA, Los Angeles, CA 90027 USA; ²Gottlieb Animal Health and Conservation Center, Los Angeles Zoo and Botanical Gardens, Los Angeles, CA 90027 USA

Abstract

In the past decade, ‘One Health’ has emerged largely out of concerns in the areas of public health, zoonotic illness and even homeland security. Collaborations to meet challenges in the areas of environmental conservation, bioterrorism and infectious disease are becoming more commonplace. Still infrequent, however, are formalized clinical collaborations between veterinarians and their physician colleagues. Over the past 3 yr, the veterinarians at the Los Angeles (LA) Zoo have fostered a collaborative relationship with members of the University of California, Los Angeles (UCLA) Division of Cardiology and UCLA Division of Cardiothoracic Surgery in order to better treat and prevent cardiovascular disease in their patients. This close collaboration has benefitted not only the animals at the LA Zoo but has had a significant impact on the perspective of the human cardiologists, house officers and students at the UCLA School of Medicine.

Introduction

Veterinary and human medicine subspecialties have operated largely on two parallel and rarely intersecting paths. Yet, the vast majority of the diseases treated by one group are routinely encountered and treated in the other. The experiences and resources of each group may contain benefit and potential for improvement in patient care on both sides. Many zoos around the country utilize the expertise of human health professionals in the treatment of their patients. The benefits to animal and human health through such collaborations are important to consider and document.

Objectives and Methods

Over a 3-yr period, faculty of the UCLA Division of Cardiology were consulted to assist with a variety of cardiovascular conditions in patients at the LA Zoo. Most of these patients were primates including western gorilla (Gorilla gorilla gorilla), common chimpanzee (Pan troglodytes), orangutan (Pongo pygmaeus), golden lion tamarin (Leontopithacus rosalia), and sooty mangabey (Cercocebus torquatus atys). Non-primate patients included California condor (Gymnogyps californianus), sea lion (Zalophus californianus), and African lion (Panthera leo). Consultation was typically requested in association with ultrasonic imaging (echocardiography—
transesophageal or transthoracic). Discussions regarding clinical scenarios occurred prior to, during and after the imaging procedures. Cardiovascular diagnoses encountered included cardiomyopathy (fibrosing, hypertrophic and dilated), hypertension, atherosclerotic disease of the aorta, and endocarditis. Some of these cases were discussed with appropriate clinical experts at UCLA Medical Center and pathology specimens were reviewed by human pathologists as an adjunct to conventional veterinary pathologic assessment. Published clinical guidelines used routinely with human patients (cardiomyopathy) at UCLA’s Cardiomyopathy Center were shared and discussed with the veterinarians at the LA Zoo.

Animal cases were also presented informally and formally in several venues at the UCLA Medical Center including Internal Medicine Grand Rounds and Chief Resident’s Rounds. House officers and medical students were encouraged to review the veterinary literature to enhance their understanding of the pathophysiology of disease by learning about its presentation in non-human patients.

Results

This collaboration yielded many benefits, some expected and others not. The exchange of clinical guidelines from the UCLA cardiologists to the LA Zoo staff had some influence in the approach to some patients with heart failure. Assistance with transesophageal echocardiography (TEE) allowed for more precise characterization of disease of the heart and great vessels. In one lion, pericardiocentesis was made possible by TEE visualization of a large volume pericardial effusion causing tamponade physiology. An echocardiographically based screening program for evidence of early cardiomyopathy in tamarins was undertaken. Identification of plaque (via TEE visualization) in the aortas of primates including gibbon (Hylobates gabriellae) and western gorilla influenced clinical decision making in the areas of lipid management and use of aspirin.

Bringing awareness of animal correlates of human disease impacted medical students and residents at UCLA. Following presentation of animal cases, multiple medical students and house officers expressed great interest in further collaborations with veterinarians in the areas of subspecialty medicine. Some internal medicine house officers have selected ‘One Health’ based projects for their senior projects. Knowledge that the results of human clinical trials are used in veterinary medicine stimulated many discussions and much interest. Senior residents expressed interest in joint programs in veterinary and human subspecialty medicine at the post-graduate level.

Discussion

Clinical ‘One Health’ is emerging through informal collaborations between animal and human physicians. How these collaborations may further benefit both animal and human patients is yet to be seen. However, the UCLA/LA Zoo collaboration has yielded benefits to both the animal patients and veterinarians at the Zoo and to human patients, physicians and medical students at UCLA.
From the veterinary perspective, this alliance has permitted a direct conduit between academic cardiologists (results of clinical trials, advanced instrumentation) in a major urban city and the veterinarians caring for animals in that city. Clinical benefits to animal patients in the areas of imaging and intervention have been demonstrated. From the human medical perspective, since the first presentation of animal cases at UCLA, a multi-species medical conference has been conceived and is being organized. ‘One Health’ projects involving public health and zoonotic infections have been initiated by several senior residents. Clinical investigators, having been made aware of the use of clinical trials in the care of non-human patients, have expressed interest in facilitating clinical ‘One Health’ activities. UCLA’s Electrophysiology Group’s arrhythmia specialists have reached out into the veterinary community and have invited veterinary cardiologists in Los Angeles to present complex arrhythmia cases at UCLA. Thought leaders in the field of lipid function are considering the clinical management of plaque in the nonhuman primate heart and bringing these considerations into their discussions of the management of dyslipidemia in humans.

The collaboration between the veterinarians at the Los Angeles Zoo and academic cardiologists at UCLA has stimulated much interest and thought about the emerging role of clinical ‘One Health’ in the management of the shared cardiovascular diseases of patients of multiple species.
TRAINING ‘ONE HEALTH’ PROFESSIONALS: ENVIROVET SUMMER INSTITUTE

Kirsten Gilardi, DVM, Dipl ACZM,1* Scott Citino, DVM, Dipl ACZM,2 Terry Norton, DVM, Dipl ACZM,3 Rob Hilsenroth, DVM,4 Dave Hunter, DVM,5 John Lukas, MSc,2 Steve Osofsky, DVM,6 and Val Beasley DVM, PhD, Dipl ABVT7

1Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, CA; 2White Oak Conservation Center, Yulee, FL; 3St. Catherines Island Foundation, Midway, GA and Georgia Sea Turtle Center, Jekyll Island, GA; 4American Association of Zoo Veterinarians, Yulee, FL; 5Turner Enterprises, Inc. and Turner Endangered Species Fund, Bozeman, MT; 6Wildlife Conservation Society, New York, NY; 7Department of Veterinary Biosciences, College of Veterinary Medicine, University of Illinois

Abstract

The goal of Envirovet Summer Institute is to educate, inform, engage and inspire veterinarians of all backgrounds and nationalities to become integral members of teams protecting animal, human and ecosystem health by applying the prioritized, practical, and solution-oriented perspective of medicine to ecosystem health challenges. Started in 1991, Envirovet has now trained more than 440 veterinarians and veterinary students from 47 nations: 25 individuals each year, mostly veterinarians and veterinary students, but also wildlife biologists, ecologists, and environmental educators with a particular interest in health issues and perspectives. Envirovet is an intensive, immersion-style learning experience comprised of lecture, laboratory and field experiences and is organized into three sessions held in Florida, Georgia, and a developing country (currently Tanzania), with students engaged in 60-70 hr each week of instruction for 7 wk. Led by the University of Illinois College of Veterinary Medicine and the University of California, Davis School of Veterinary Medicine, the course is hosted and co-directed by White Oak Conservation Center, St. Catherines Island, Harbor Branch Oceanographic Institute, Tanzania National Parks and the Sokoine University of Agriculture, Faculty of Veterinary Medicine (Tanzania). The impact of Envirovet Summer Institute is enduring: each year’s cohort of Envirovet students maintains lifelong ties that form a long-lasting network of like-minded wildlife and ecosystem health professionals. Envirovet is funded each year through a combination of grants, gifts, in-kind contributions and student course fees. Course fees have been a limiting factor for some applicants. Envirovet Summer Institute is establishing itself as a 501(c)3 organization to galvanize and ensure additional brainpower and fundraising capabilities to contribute to the financial stability of and strategic vision for the program, which includes more expansive engagement with the human medical / public health sector.

Introduction

Veterinary medicine, as a discipline and profession, is fertile ground for creating future environmental leaders. Veterinarians apply a disease prevention and resolution perspective to their professional practice, and are inherently skilled and experienced as problem-solvers. The demand for education and training in wildlife and ecosystem health among veterinarians and
veterinary students worldwide continues to grow, and while some veterinary schools have developed curricula to address this need, the majority of veterinary schools around the world remain focused on traditional tracks in veterinary medicine and are not serving the unique needs of students who wish to focus their animal health careers on the environment. Furthermore, there are many veterinarians who, having spent several years as practitioners, now wish to explore environmental health as a new career path, but who do not see a clear route for doing so.

The paucity of educational training opportunities in wildlife and ecosystem health is even more apparent for veterinarians and veterinary students in developing countries, where veterinary medical training is basic and emphasizes food animal medicine. In essence, too few educational institutions offer specific programs to facilitate the application of veterinarians' comparative medicine and problem-solving skills to benefit wildlife and ecosystems. In this situation, the difficulty in knowing when and how to either embark upon or successfully implement environmentally-focused careers too often prevents promising veterinarians from realizing their full potential as wildlife and ecosystem health practitioners. Furthermore, veterinarians in developing countries who have been given the responsibility to ensure the health of free-ranging wildlife in protected areas like parks and game reserves may not have extensive training and education in diseases at the domestic animal / wildlife interface, zoonoses, environmental toxicology, land and water management, conservation biology, or other key components of ecosystem health.

Objectives and Methods

The goal of Envirovet Summer Institute is to educate, inform, engage and inspire veterinarians of all backgrounds and nationalities so that they become integral members of teams protecting animal, human and ecosystem health by applying the logical and solution-oriented perspective of medicine to ecosystem health challenges. Each year, Envirovet trains approximately 25 individuals from around the world, mostly veterinarians and veterinary students, but also wildlife biologists, ecologists, and environmental educators with a particular interest in building greater expertise in health issues and perspectives. Envirovet illustrates the many ways by which veterinarians can contribute to the improvement of ecosystem integrity across landscapes and seascapes, with special attention paid to the interface of wild areas with areas intensively managed by humans. The course is designed to guide participants towards matching their aims and resources to an educational plan and career in wildlife and ecosystem health. Because the faculty roster includes specialists from academia, government, non-governmental organizations, and the private sector, Envirovet students are exposed to a broad range of perspectives and gain access to outstanding role models.

Envirovet is an intensive, immersion-style learning experience, with students engaged in 60-70 hr each week of instruction for 7 wk. The course is comprised of lecture, laboratory and field experiences organized into three sessions. Session I is hosted by White Oak Conservation Center, as well as the St. Catherines Island Foundation, and introduces wildlife and ecosystem health as over-arching frameworks for environmental problem-solving. Students are confronted with the realities of global ecosystem degradation, declines in wildlife abundance and distribution, and the full range of threats to biodiversity, and then introduced to a myriad of
strategies available for reversing these trends (e.g., flagship species conservation, habitat restoration, fostering robust and transparent governance, etc.). Students acquire knowledge, tools and hands-on experience with a variety of wildlife and ecosystem health topics, including (but not limited to): terrestrial ecology and disease ecology, conservation genetics, wildlife epidemiology, population viability analysis, conservation genetics, theriogenology, ecological risk assessment, diseases of wildlife, animal health implications of translocations, and principles of wildlife telemetry. Interspersed among didactic sessions are hands-on laboratories on wildlife necropsy techniques, radio-tracking of free-ranging animals, wildlife capture, chemical immobilization of wildlife for sampling and health care, and wilderness navigation using global positioning system technologies. Students also learn about natural resource economics, environmental law and policy, grantsmanship, cultural sensitivity, and communications via the media.

Session II is held for 10 days at Harbor Branch Oceanographic Institute in Ft. Pierce, FL. This session introduces students to aquatic (marine and freshwater) animal and ecosystem health, starting with a primer on aquatic ecology, and on the utilization of aquatic biodiversity as an early warning system for environmental contamination. A major focus of this session is on the comparative morphology and physiology of aquatic animals, and on both sources and effects of physical, infectious, and toxic stressors in aquatic ecosystems and animals. Students examine the sources and movements of anthropogenic contaminants through aquatic ecosystems and the ways through which human activities may contribute to the accumulation of toxigenic phytoplankton that directly impact freshwater and marine species. Students participate in field and laboratory exercises examining fish hematology, parasitology and pathology. Amphibian declines, waterfowl diseases, and marine mammal toxicology and infectious diseases are all emphasized. Necropsy exercises focus on multiple species of both aquatic birds and marine mammals available from recent die-off events in the field.

Session III takes place in a developing country: from 2000 to 2002, Envirovet studied in Kenya, in 2003 in Brazil, and in 2004 to 2007 in South Africa. In 2008 and 2009, Envirovet Session III took place in Tanzania and was conducted in close cooperation with Sokoine University of Agriculture and Tanzania National Parks. This 3-wk component of Envirovet confronts students with the realities and unique challenges of applying the knowledge and tools gained in Sessions I and II in an international developing country context. Students are introduced to the missions and programs of in-country governmental agencies and academic initiatives focused on environmental health, and have the opportunity to work alongside leading experts while visiting a number of field sites where the students participate in ongoing research and environmental monitoring activities. Underlying themes for the developing country unit, no matter where it is held, are: health and conservation at the wildlife / livestock / human interface; challenges with diagnosis, surveillance and control of zoonotic and emerging infectious diseases in developing countries; wildlife health and conservation challenges in protected areas; health and conservation policy at the national and global level; and threats to tropical freshwater and marine ecosystems. Students receive didactic instruction from resident scientists and wildlife managers, in addition to participating in ongoing projects and activities. Students spend time in local communities, learning directly from citizens who are often living with challenges to their food and livelihood security in the face of environmental degradation.
Overall direction of Envirovet Summer Institute is provided by Dr. Val Beasley, Professor of Veterinary Biosciences, University of Illinois, Urbana-Champaign (UIUC). Beasley started Envirovet in 1991 with a focus on aquatic ecosystem health; in 2000 he expanded the scope and breadth of the course by inviting key partners to join him in implementing a broader program. The UC Davis Wildlife Health Center (WHC) now directs Sessions I and III of the course, while UIUC in close coordination with Harbor Branch Oceanographic Institute directs Session II.

Students are recruited via course announcements sent to veterinary schools in the US and abroad, and posted in newsletters and on websites of relevant professional organizations. Many prospective students learn of the course from their peers or mentors. Admittance to the course is a competitive process, with interested students being required to submit an application that includes a statement of purpose, a résumé, academic transcripts, and two letters of recommendation. Currently, students pay a fee for the course, which contributes to the overall cost of instruction, travel, food and lodging. These costs are heavily subsidized by grant support for the program, although to date tuition for North American / developed country students remains significant ($7,500 in 2009 by necessity in the face of less than optimal grant support), as the true total investment per student in terms of actual expenditures and in-kind support is approximately $25,000. Ability to pay has been a limiting factor for many prospective applicants, and indeed, international participants are largely sponsored through grants to Envirovet that specifically support the enrollment of veterinarians from developing countries. Ultimately, Envirovet Summer Institute aims to achieve a sufficient and sustained funding base that will allow admittance of students on a needs-blind basis.

Envirovet faculty members are selected based on their capacity for superb and enthusiastic teaching, and for the extent to which they are actively engaged in the subject matter they cover. They serve as role models, not only by imparting their wisdom and enthusiasm, but also by offering real world perspectives and sharing their absolute commitment to their fields. They utilize non-didactic teaching methods frequently, including hands-on field and laboratory exercises and experiences, games, computer simulations, and role-playing. Faculty specialize in a range of fields, from ecological, biomedical and agricultural sciences, to protected area management, game ranching, engineering, economics, ecotourism, sustainable development, and environmental law and policy.

Results

To date, Envirovet has trained 440 individuals from 47 nations, including: the United States, Canada, Mexico, El Salvador, Costa Rica, Panama, Colombia, Guyana, Bolivia, Brazil, Argentina, Ethiopia, Kenya, Tanzania, Uganda, Nigeria, Botswana, Zimbabwe, South Africa, the United Kingdom, Spain, France, Italy, Switzerland, Norway, Lithuania, Germany, Poland, Hungary, Israel, Nepal, India, Pakistan, Thailand, Mongolia, Sri Lanka, Taiwan, Japan, and New Zealand.

The effectiveness of Envirovet is gauged in part by the responses of the students, which we obtain through mandatory course evaluations completed at the end of each session. A majority of the students describe Envirovet as a life-changing experience: “This is the best educational
experience I have ever had. I feel fortunate to have been exposed to the information and professionals that I was.” “This was an unbelievable experience.” “There are so many ways in which I can be a piece of the conservation puzzle, and I now have tools... and great ideas about how I can fit.” “I had a completely wonderful experience and feel more confident in the direction that I am headed. I learned a lot of science at White Oak, a lot about life in Kenya and of course, a lot about myself at Envirovet.” “I loved the course, and don't want to go home.” These types of comments are typical and are heard year after year.

More important than student feedback is where alumni go in their careers after their programs of study. Envirovet alumni have gone on to work in the areas of ecological risk assessment and risk management, endangered species recovery, and habitat conservation planning. Some have served in the U.S. Peace Corps, become university professors, and written and edited leading textbooks on conservation medicine. Others are public health epidemiologists, marine mammal veterinarians, and oil spill responders. Many have gone on to obtain Master’s and / or Doctoral degrees in toxicology, wildlife biology, ecology, epidemiology, and public health. Many Envirovet graduates presently serve in key positions: as Coordinator of the National Marine Fisheries Service’s Marine Mammal Stranding Program; Director of Veterinary Health Services for Israel’s Fish Health Laboratory; Head Veterinarian for the Tanzanian National Park System; Director of Conservation Medicine for Wildlife Trust, USA; Public Health Veterinarian of the Zoonotic Disease Program of the Ohio Department of Public Health; Chief of the Communications Center at the U.S. Department of Defense, Global Emerging Infections Surveillance and Response System; Head Field Veterinarian for the California Condor Reintroduction Program in Baja California, Mexico; Principal of the Kenya Wildlife Service Training Institute; and Assistant State Public Health Veterinarian for New York.

Discussion

The impact of Envirovet Summer Institute on participants is enduring. Each year's cohort of Envirovet students maintains lifelong ties that form a robust network of like-minded wildlife and ecosystem health professionals who are committed to their careers and to supporting their colleagues. Envirovet alumni apply the lessons learned and the tools acquired at Envirovet to their work as veterinarians and wildlife managers, and impart this same knowledge to their colleagues, staff, and students. In this way, Envirovet has a ripple-like effect through the local, national, and regional professional communities of each of our alumni that builds on the philosophy and perspectives of the program.

Long-range goals for Envirovet Summer Institute include financial sustainability: while Envirovet has been taught 15 times since 1991, the course has been funded year-to-year through a combination of grants, gifts, in-kind contributions and student tuition. In order to ensure the long-term sustainability of Envirovet Summer Institute, course leaders met in October 2007 for strategic planning purposes, and elected to establish Envirovet Summer Institute as a 501(c)3 organization to galvanize and ensure additional brainpower and fundraising muscle for the program through the time and energy of a Board of Directors and leaders of partner institutions who can contribute to the financial stability of and strategic vision for the program. As a part of this effort, Envirovet Summer Institute aims to better engage the human medical / public health
communities, conceivably becoming a ‘One Health’ course open to veterinary and medical students and professionals alike. A step in this direction was taken last year, when the Board of Directors established an Envirovet Advisory Council comprised of representatives from the public health, agriculture and conservation sectors, to guide course leaders in broadening the scope of Envirovet to better serve ‘One Health’ goals.
**DIETARY TREATMENT OF IRON STORAGE DISEASE IN CAPTIVE BIRDS OF PARADISE (Paradisaea raggiana)**

Kelly E. Helmick, DVM, MS, Dipl ACZM,¹* Erin L. Kendrick, MS,² and Ellen S. Dierenfeld, MS, PhD, CNS³

¹Woodland Park Zoo, Seattle, WA 98103 USA; ²Saint Louis Zoo, Saint Louis, MO 63110 USA; ³Novus International, Inc., St. Charles, MO 63304 USA

Abstract

Elevated serum iron parameters were lowered through dietary manipulation in captive Bird of Paradise (Paradisaea raggiana) using a modification of previously published low-iron diets.²,³ Study birds were part of a captive breeding program consisting of two males and one female, captive born, 3.5-9 yr of age. Serum iron, total iron binding capacity (TIBC), percent transferrin saturation, body weight, and hematocrit were monitored through routine examinations and blood samples collected before dietary treatment and at regular post-treatment intervals for 18 mo. Routine diet consisted of a variety of fruits, vegetables, a multivitamin supplement, and a commercial low-iron avian pellet, with a total dietary iron content of 55 mg/kg (dry matter) or 1.12 mg iron/bird/day on an as-fed basis. Dietary treatment involved removal of the commercial avian pellet for 30 days at 12-mo intervals, for a total iron content of 42 mg/kg (dry matter) or 0.64 mg iron/bird/day on an as-fed basis. Average serum iron and TIBC were significantly decreased by 75% (TIBC) to 80% (serum iron) of pre-treatment values after one 30-day treatment, achieving levels below published normal values for similarly susceptible species.⁴ Average percent transferrin saturation levels were lowered by 10% of pre-treatment values after one 30-day treatment but remained above the target value of 80%.¹ Average hematocrit and body weight remained unchanged. No adverse effects were noted throughout the 18-mo evaluation period and breeding behavior was undisturbed. Periodic removal of low-iron commercial pellets from the diet of captive Bird of Paradise is a safe and effective method for lowering serum iron values without need for handling. Periodic application of this technique also may be useful as a preventive tool to maintain appropriate serum iron values in other avian species susceptible to iron storage disease.

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**LITERATURE CITED**


NORMAL SERUM VITAMIN E VALUES IN GIANT ANTEATERS (Myrmecophaga tridactyla)

Sally A. Nofs, DVM,1* Ellen S. Dierenfeld, PhD,2 and Lisa A. Leuchner, MS, RD3

1Nashville Zoo at Grassmere, Veterinary Services, Nashville, TN 37072 USA; 2Novus International, Inc., St. Charles, MO 63304 USA; 3University at Buffalo, Department of Exercise and Nutrition Sciences, Buffalo, NY 14214 USA

Abstract

Baseline serum α-tocopherol (α-toc) values in captive giant anteaters have not previously been defined. Cats and dogs are typical models for carnivore nutritional physiology and may prove useful for evaluating vitamin E (vit E) nutrition in zoo carnivores. The objective of this study was to determine serum α-toc as a measure of vit E status in captive anteaters, for comparison with reported norms.

Twenty-one blood samples were opportunistically collected from 16 individuals, and fresh or frozen serum was analyzed for α-toc using high-pressure liquid chromatography. Clinically normal animals averaged 2.58 ± 1.37 µg/ml. Three severely compromised animals had values of 0.29, 0.31, and 0.46 µg/ml. By comparison, serum vit E levels of free-ranging adult giant anteaters in apparent good health from Parque Nacional de Serra da Canastra (Brazil) were 1.0 µg/ml (n=4), and 3.0 µg/ml (n=1).1 Normal values for dogs range from 2.7 to 12.4 µg/ml, and range from 3 to 11 µg/ml for cats.2 Thus, anteaters display values at, or below, the ranges that are considered to be normal for domestic carnivores. Oxidative stress, and/or dietary deficiencies have been shown to decrease circulating vit E concentrations.2 Anteaters have been reported to have cardiomyopathies associated with taurine deficiency3,4 and this condition has been linked to low vit E status in other carnivores5. Thus, vit E deficiency should not be discounted as a possible contributor to cardiomyopathy in giant anteaters. Additional samples, and correlation of data with health status and diet evaluations from multiple animals/collections will further our understanding of vit E nutrition in giant anteaters.

ACKNOWLEDGMENTS

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Super Vet Techs of the Nashville Zoo – Rita Buice, BS, LVT, and Melissa Julien, LVT
Dr. Thomas Herdt and the Nutrition Section of Michigan State University College of Veterinary Medicine Diagnostic Center for Population and Animal Health, East Lansing, MI

LITERATURE CITED

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INFLUENCE OF DIET ON SERUM CHEMISTRY VALUES IN CAPTIVE GIRAFFE OVER FOUR YEARS

Cheryl Dikeman, PhD,1* Danielle Pogge, BS,1 Elizabeth Koutsos, PhD,2 Doug Armstrong, DVM,1 Julie Napier, DVM,1 and Mark Griffin, PhD2

1Omaha’s Henry Doorly Zoo, Omaha, NE 68107 USA; 2Mazuri Exotic Animal Nutrition, St. Louis, MO 63166 USA

Abstract

Over the past several years, herbivore diet formulations have transitioned toward lower starch and sugar and higher concentrations of structural carbohydrates such as neutral detergent fiber. Following the Giraffe Nutrition Workshop in 2005, recommendations were released that encouraged diets containing less than 5% starch and less than 0.5% phosphorus for captive giraffe. In December 2005, seven giraffe (Giraffa camelopardalis reticulata) were transitioned to a pellet that contained less than 4% starch, and 0.35% phosphorus (Mazuri®, PMI, St. Louis, MO); the previous pellet contained approximately 16% starch and 0.75% phosphorus. Giraffe were offered hay (alfalfa/grass blend) and pellets at a rate of 60 and 40% of dietary weight, respectively. Blood samples were collected bi-annually in the summer and winter, and were analyzed for Ca, P, and serum chemistries. Data were analyzed using the Mixed Models procedure of SAS® (SAS Institute, Inc., 100 SAS Campus Drive, Cary, NC 27513-2414 USA) with a probability of P<0.05 accepted as statistically significant. Phosphorus concentrations decreased 21% (P<0.05) between 2005 (8.33 mg/dl) and 2008 (6.60 mg/dl). Calcium-to-phosphorus ratios increased 28% (P<0.05) between 2005 (1.22) and 2008 (1.44). Mean corpuscular volume and mean corpuscular hemoglobin increased (P<0.05) 22 and 18%, respectively, between 2005 and 2008; however, values were considered to be within reference ranges. In contrast, platelet counts were reduced 66% (P<0.05) from 2005 (456 × 10³/µl) to 2008 (151 × 10³/µl); the latter value is considered to be below reference range. When considering the impact of season, phosphorus concentrations were 14% higher (P<0.05) in the winter (7.89 mg/dl) compared with summer (6.76 mg/dl), resulting in 16% (P<0.05) higher Ca:P in the summer (1.38) compared with winter (1.19) months. The linear reduction in platelet count is unclear and needs further study. Comparison of free-ranging giraffe calcium and phosphorus concentrations of 9.5 and 9.1 mg/dl, respectively, warrant further study and discussion regarding optimal diets for captive giraffe.1,2

LITERATURE CITED

STUDY OF CALCIUM METABOLISM IN CAPTIVE ELEPHANTS BY MEANS OF FEEDING TRIAL INVOLVING BOTH CALCIUM AND VITAMIN D SUPPLEMENTATION

Willem Schaftenaar, DVM,1* Linda van Sonsbeek,2 Johannes P.T.M. van Leeuwen, PhD,3 and Johannes. H. van der Kolk, DVM, PhD, Dipl ECEIM2

1Rotterdam Zoo, Rotterdam, The Netherlands; 2University of Utrecht, Department of Equine Sciences, Medicine Section, Utrecht, The Netherlands, 3Erasmus University Medical Center, Department of Internal Medicine, Rotterdam, The Netherlands

Abstract

Hypocalcemia in elephants is a concern that needs attention. Cases of calcium-responsive dystocia have been reported anecdotally and the number of bone fractures in hospitalized working elephants in Thailand is relatively high.2,3 A feeding trial in 4 Asian elephants at the Rotterdam zoo showed that an increase in the calcium concentration of the roughage resulted in a significant rise in blood calcium levels.1,4 The results of a follow-up study in 5 European zoos, including 12 Asian elephants and 6 African elephants are discussed in this presentation. Blood calcium levels taken during periods in the summer in which normal food was supplemented with either calcium or vitamin D were compared. The study was repeated in the winter in order to determine the influence of low UV light on blood calcium levels. The following parameters were measured in heparinized plasma and/or whole blood: ionized calcium, total calcium, phosphate, 1,25(OH)2vitD, and 0,25(OH)vitD. In addition, the plasma levels of markers for bone formation (bone alkaline phosphatase--BAP), and for bone resorption (N-terminal of telopeptide of collagen I--NTx), were measured to find out whether the induced changes in ionized calcium, total calcium and phosphate could be related to an increase/decrease of mineral exchange between blood and bones.

Results indicate that Asian elephants depend more on dietary calcium concentration than African elephants. The latter species, however, seems to profit more from vitamin D supplementation in the food.

ACKNOWLEDGMENTS

The authors would like to thank the zoo veterinarians and elephant keeper staff of Amsterdam Zoo, Antwerp Zoo, Hannover Zoo, Safaripark Beekse Bergen and Rhenen Zoo for their close cooperation during the feeding trials and the staff of the Department of Internal Medicine, Erasmus University Medical Centre, Rotterdam, The Netherlands.

LITERATURE CITED


NORMAL URINARY MINERAL EXCRETION LEVELS IN AFRICAN ELEPHANTS
(Loxodonta africana)

Michele Miller, DVM, PhD, 1 Jill N. Yoshizawa, DVM, 2* and Scott P. Terrell, DVM, Dipl ACVP 3

1 Palm Beach Zoo, West Palm Beach, FL 33405 USA; 2 Kailua Animal Clinic, Kailua, HI 96734 USA; 3 Disney’s Animal Programs and Environmental Initiatives, Bay Lake, FL 32830 USA

Abstract

Metabolic bone disease has occurred in several incidences of elephant neonates hand-reared on milk replacement formula. Monitoring for metabolic bone disease historically has been done through serum calcium and phosphorus concentrations. Serum concentrations are tightly regulated and changes in concentration are typically not evident until skeletal changes have already occurred. Urinary calcium and phosphorus excretion levels may provide earlier evidence of nutritional secondary hyperparathyroidism and allow intervention before development of severe and irreversible bony changes. Free-catch urine collection also offers a less-invasive and less-stressful alternative to blood collection, particularly when working with non-domestic species. In this study, we establish normal urinary mineral excretion values based on six healthy African elephants of various ages.

Six clinically-healthy African elephants (4 calves and 2 adults) from Disney’s Animal Kingdom were used in this study. All calves had been, or currently were, raised in a cow-calf pair. Free-catch urine samples were opportunistically collected from the elephants and without restraint by the keeper staff. Samples were submitted to Antech Diagnostics (Antech Diagnostics, Inc., 1111 Marcus Avenue, Suite M-28, Lake Success, NY 11042 USA) for analysis. Nineteen urinary creatinine, calcium, and sodium concentration measurements were obtained, as were 18 phosphorus measurements. Calcium:creatinine and phosphorus:creatinine ratios were calculated to eliminate the flow rate factor in excretion values. The calcium:creatinine ratios ranged from 0.422 to 1.844, with a mean of 1.31 and no significant differences among ages. The phosphorus:creatinine ratios ranged from 0 to 2.227, with a mean of 0.213. The phosphorus:creatinine ratio was significantly higher for the two calves under 3 yr of age (mean 0.636) versus the two older calves and two adults (mean 0.002).
DIETARY TAURINE SUPPLEMENTATION AND CARDIAC FUNCTION IN THE GIANT ANTEATER (Myrmecophaga tridactyla): PRELIMINARY FINDINGS

J. Andrew Teare, DVM, MS,¹*D Alan D. Weldon, DVM, Dipl AVCIM,² and Nikolay Kapustin, DVM¹

¹Jacksonville Zoo and Gardens, Jacksonville, FL 32218 USA; ²Jacksonville Equine Associates, Jacksonville, FL 32205-9333 USA

Abstract

Taurine is not considered an essential amino acid in most mammals as it can be synthesized from cysteine. Cats are an exception, lacking an enzyme necessary for this conversion and a lack of dietary taurine has been linked to central retinal degeneration and dilated cardiomyopathy. This form of feline cardiomyopathy is reversible with a dietary taurine supplement. More recently, a taurine-responsive, dilated cardiomyopathy has been described in dogs, leading to speculation that some species able to convert cysteine to taurine may still have a dietary requirement for taurine.

The giant anteater (Myrmecophaga tridactyla) has a lower metabolic rate and lower average body temperature (34.0 °C/93.2 °F) than most other placental mammals. On radiographs of the thorax, the size of the cardiac shadow is quite large, which has led to speculation within the literature and within the zoo medical community about the potential for cardiomyopathy in this species. The natural diet of termites, ants and other insects is difficult for most zoos to provide in captivity and many diets for captive animals are based on ground dog chow, a food item that can be relatively low in taurine. The natural extension of this speculation has been concern that captive diets were leading to enlarged hearts in the giant anteater and that inadequate dietary taurine may play a role. This study is a first attempt to evaluate cardiac parameters in the giant anteater, to provide baseline reference values for taurine blood levels and to evaluate the effect of long-term taurine supplementation.

In 2004, seven giant anteaters all received ultrasound cardiac evaluations and blood samples were collected for baseline taurine measurements. One animal was almost immediately sent to another zoo and was lost to further follow-up. Three of the remaining six anteaters were placed on a daily taurine supplement of 500 mg. Eight months after the initial evaluations, two animals (one supplemented and one not supplemented) received cardiac evaluations and taurine levels were determined prior to these animals being sent to other institutions. The remaining 4 animals were evaluated at varying intervals over the next 4 yr. One supplemented animal was diagnosed with right atrial enlargement and mild tricuspid regurgitation in November 2008 and currently is being treated with daily pimobendan (Vetmedin®, Boehringer Ingelheim, Vetmedica Inc., St. Joseph, MO 64506 USA; 0.143 mg/kg p.o. s.i.d.). Findings, excluding the final cardiac parameter values for the animal with cardiac disease, are summarized in Table 1.
The number of animals in this study is too small for rigorous statistical analysis, but there is a suggestion of a slight increase in cardiac function with taurine supplementation. While very preliminary, these results are intriguing and are worthy of further investigation with a larger number of animals.

### Table 1. Blood and plasma taurine concentration and cardiac function.

<table>
<thead>
<tr>
<th></th>
<th>No taurine supplement</th>
<th>With dietary supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Mean</td>
</tr>
<tr>
<td>Whole blood (nmol/ml)</td>
<td>192</td>
<td>195.4</td>
</tr>
<tr>
<td>Plasma (nmol/ml)</td>
<td>69</td>
<td>72.1</td>
</tr>
<tr>
<td>Cardiac ejection fraction (%)</td>
<td>57.5</td>
<td>57.4</td>
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<tr>
<td>Cardiac fractional shortening (%)</td>
<td>30</td>
<td>31.1</td>
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IRON DEFICIENCY ANEMIA IN CAPTIVE MALAYAN TAPIR CALVES (*Tapirus indicus*)

*Kelly E. Helmick, DVM, MS, Dipl ACZM*

*Woodland Park Zoo, Seattle, WA 98103 USA*

Abstract

Subclinical iron deficiency anemia was diagnosed in a captive neonatal female Malayan tapir (*Tapirus indicus*) through blood samples obtained as part of an in-house training program for venipuncture. Routine blood testing performed at day 2 of age was within in-house and ISIS normal values for this species. Microcytic hypochromic anemia (HCT = 16%; MCV = 38.4 fl; MCH = 13.3 µg; MCHC = 34.6 g/dL) with thrombocytosis (platelets = 1018 * 10^3/µL) and poikilocytosis was diagnosed at day 38 of age. Iron dextran (10 mg/kg i.m.) was administered at day 40 and day 68 of age. Blood sampling at day 88 of age indicated improving hematocrit (32%) and low serum iron (45 µg/dl; ISIS normal = 154 +/- 54 µg/dl). Total iron binding capacity (TIBC; 438 µg/dl), percent saturation (10%), ferritin (240 ng/ml), and haptoglobin (16 mg/dl) were also measured, but normal values are not established for this species. Repeat blood sampling through day 529 of age showed normalization of hematocrit and serum iron parameters between day 145 and day 173. Retrospective record review and iron testing on banked serum was performed for previous Malayan tapir calves born at the same institution. Serum iron parameters were decreased in two male calves that died at day 40 (iron=40 µg/dl; TIBC=482 mcg/dl; percent saturation=4%; ferritin=177 ng/ml; haptoglobin=202 mg/dl) and day 72 (iron=26 µg/dl; TIBC=470 µg/dl; percent saturation=6%; ferritin=770 ng/ml; haptoglobin=196 mg/dl), respectively. Cause of death in both calves was attributed to disseminated intravascular coagulation and bacterial septicemia. A link between iron deficiency anemia and increased susceptibility to infection has been examined in human infants. Iron deficiency anemia may be a predisposing factor for neonatal septicemias in captive Malayan tapirs, especially in the first 3 mo of life. Prophylactic iron dextran administration may be considered as part of a neonatal care program for captive tapirs. Early training to facilitate blood collection will better help characterize this concern in other tapir collections.

ACKNOWLEDGMENTS

The author would like to thank Woodland Park Zoo veterinary technicians, keeper, and curatorial staff for their assistance and support of this case study. In particular, the author would like to thank zoo keeper Mr. River Pullins, who trained this patient for repeated blood sample collection.

LITERATURE CITED

“TB OR NOT TB...THAT IS THE QUESTION.” THE PATHOLOGY ASSOCIATED WITH Mycobacterium kansassi INFECTION IN TWO BONTEBOKS (Damaliscus pygargus dorcas)

Scott P. Terrell, DVM, Dipl ACVP,1* Bruce V. Thomsen, DVM, PhD, Dipl ACVP,2 and Beth Harris, PhD3

1Department of Animal Health, Disney’s Animal Kingdom, Bay Lake, FL 32830 USA; 2Pathobiology Laboratory, National Veterinary Services Laboratories, Ames, IA 50010 USA; 3Diagnostic Bacteriology Laboratory, Mycobacteria and Brucella Section, National Veterinary Services Laboratories, IA 50010 USA

Abstract

An 11-yr-old female bontebok, Damaliscus pygargus dorcas, was euthanatized due to clinical evidence of lethargy, anorexia, interstitial pneumonia, and inability to rise from a sternal position after immobilization. At necropsy, miliary granulomatous lesions measuring 3–10 mm in diameter were present in the liver, kidneys, spleen, lungs, pleural surfaces, and multiple thoracic and abdominal lymph nodes. Granulomas were also found in the bones of the 4th and 5th lumbar vertebrae causing spinal cord compression. Cytologic examination of touch impressions from the granulomas revealed acid-fast staining material interpreted as Mycobacterium sp. organisms. Another bontebok (a 6-yr-old female) in direct contact with the aforementioned case was euthanatized due to concerns about mycobacterial disease and the fact that the animal needed multiple immobilizations to treat a recently diagnosed lameness. At necropsy, miliary granulomatous lesions similar to those seen in the other bontebok were found in the liver, spleen, kidneys, lung, pleural surfaces, and multiple lymph nodes.

Histopathologic examination in both cases confirmed the presence of systemic granulomatous inflammation. Fites-Furaco acid-fast staining of the formalin fixed tissues revealed acid-fast positive bacteria that were extremely rare (estimated one bacteria per 20 granulomas examined; fewer than five bacteria seen in an entire section of lung). The bacteria were present in the cytoplasm of multi-nucleated giant cells, were filamentous in shape, and measured approximately 10-12 μm in length. Samples of lymph node and lung from both cases were submitted to the National Veterinary Services Laboratories in Ames, IA for mycobacterial culture and PCR. PCR testing on the formalin fixed tissues was negative using primers for M. tuberculosis-complex species, M. avium species, and M. avium subspecies paratuberculosis. Culture of lung and lymph nodes from both animals using standard mycobacterial isolation techniques yielded Mycobacterium kansassi.

These cases were challenging in that both the gross and microscopic lesions in the bontebok were suggestive of M. bovis infection, however it was felt that the filamentous acid-fast bacteria were significantly longer than the typical morphology of M. bovis. The possibility of M. bovis infection raised significant management and regulatory concerns until the final culture results
were received 8 wk after the first necropsy. *M. kansasii* is an atypical mycobacterial organism that can cause tuberculosis-like disease in a variety of species.1-3

**LITERATURE CITED**


DANGER IS ONLY SKIN DEEP: DERMAL NEOPLASMS IN AFRICAN HUNTING DOGS (Lycaon pictus)

Dalen W. Agnew, DVM, PhD, Dipl ACVP,1* John Trupkiewicz, DVM, Dipl ACVP,2 Alisa C. Newton, VMD, Dipl ACVP,3 and Michael Garner, DVM, Dipl ACVP2

1Michigan State University, College of Veterinary Medicine, Diagnostic Center for Population and Animal Health, Lansing, MI 48910 USA; 2Northwest ZooPath, Monroe, WA 98272 USA; 3Wildlife Conservation Society, Bronx, NY 10460 USA

Abstract

African hunting dogs (Lycaon pictus) are critically endangered African canids that are actively managed by an SSP in zoos. A review of cases in two pathology databases, Northwest ZooPath and Michigan State University, identified 45 individual wild dogs in their archives. Of these, 20 individuals had tumors of the skin. These skin tumors included apocrine hyperplasia, adenomas, and adenocarcinomas; mammary adenomas and adenocarcinomas; mast cell tumors; a hemangioma; and a lipoma.

The apocrine tumors were most common (14 of 20 animals) and ranged from areas of glandular hyperplasia to adenocarcinoma. An additional three cases were also reported previously by two of the authors.1 As seen in these dogs, the behavior and morphology of these tumors are unusual, in that they are typically multiple and found along the dorsal midline, often between the scapulae. These tumors are usually well-demarcated and multi-lobular arranged on a thin fibrovascular network. Distinct ducts were variably present. Individual cells are discrete polygonal with abundant eosinophilic granular cytoplasm, though vacuolation of the cytoplasm is often present suggesting some degree of sebaceous differentiation. Malignancy in these tumors is usually demonstrated by local invasion. In one case, apocrine gland adenocarcinoma was the likely cause of death. A gender predilection for females and possibly a history of contraception are being investigated. Further characterization of these tumors by immunohistochemistry is also pending.

Mammary neoplasia was also observed in 5 of 20 animals. These tumors included adenomas and adenocarcinomas, leading to death in at least one individual. In some cases, these tumors coexisted with apocrine tumors of the dorsal midline. Mast cell tumors were present in 2 of 20 animals with skin tumors. One hemangioma and one lipoma were also reported.

In contrast to this review, a retrospective study of wild dog disease and mortality in captivity in South Africa demonstrated no skin tumors from 87 animals.3 A similar review of morbidity and mortality in a wild population examined 46 animals, and though 85% of the dogs had skin disease, none had neoplasia.2
LITERATURE CITED


COMPARING MORTALITIES ACROSS FAMILY LINES: A RETROSPECTIVE ANALYSIS OF MORTALITIES IN THE FAMILIES MACROSCELIDIDAE AND TUPAIIDAE AT THE SMITHSONIAN NATIONAL ZOOLOGICAL PARK

Meredith M. Clancy, DVM,1* Margarita Woc-Colburn, DVM,2 Tabitha Viner, DVM, Dipl ACVP,2 Carlos Sanchez, DVM, MSc,2 and Suzan Murray, DVM, Dipl ACZM2

1Texas A&M University, College Station, TX, 77843 USA; 2Department of Animal Health, 3Department of Pathology, Smithsonian National Zoological Park, Washington, D.C., 20008 USA

Abstract

Elephant shrews and tree shrews each belong to singular family orders with unique position in mammalian evolution. Elephant shrews (family Macroscelididae) and tree shrews (family Tupaiidae) both have been kept in captivity for the better part of the last century, with three species from each family currently kept in zoos across North America.1 Only a limited amount of information is known about the health of these animals in the wild or in captivity,2-5 but their lifespan and populations in captivity allow for a unique opportunity to study the morbidities and mortalities of a large population over time. This study reviewed the pathology reports for all individuals that lived at the Smithsonian National Zoological Park from 1976 until October of 2008, for greater than 30 days in the families Macroscelididae (n=118) and Tupaiidae (n=89). Causes of mortality were sorted according to etiology and body system to identify important disease processes in either family and to examine trends across species and families. Infectious disease processes were the most important causes of death in both families, causing 28.8% of elephant shrew mortalities (n=34) and 33.7% of tree shrew mortalities (n=30), with bacterial agents causing roughly half of those. Cryptococcosis was the single most prevalent disease process in both families, with 6.8% and 13.5% mortalities in elephant and tree shrews, respectively. The similarities largely end there, with inflammatory causes (n=23), mostly in the respiratory (n=9) and gastrointestinal tract (n=7), causing the second most deaths in the family Macroscelididae, and iatrogenic causes of death third-most common (n=16). Traumatic causes of death were the second-most common in the family Tupaiidae (n=25), and nutritional causes, mainly inanition, were a distant third (n=11), indicating that these animals were extremely susceptible to mortalities due to social stressors. Additional lesions in both families included changes related to age, stress and immunosuppression, such as cataracts, gastric ulcers, metabolic changes in the liver, and candidiasis of the tongue. In the family Macroscelididae, lesions included ringtail or distal extremity necrosis syndrome (n=9) and a mineralization complex manifested as arteriosclerosis, medial calcification or metastatic mineralization (n=23). In the family Tupaiidae, parasitism was far more common, especially by the spiruid nematode Gongylonema (n=11). These differences highlight the variations in husbandry and medical needs of each family, and the need for further investigation into the diseases of these families.
LITERATURE CITED

MYOCARDIAL DISEASE IN CAPTIVE MEERKATS (*Suricata curicata*)

Adrian Mutlow, MA, VetMB, MSc, MRCVS1* and Michael M. Garner, DVM, Dipl ACVP2

1San Francisco Zoo, San Francisco, CA 94132 USA; 2Northwest ZooPath Monroe, WA 98272 USA

Abstract

A review of 108 necropsy reports of captive meerkats (*Suricata suricatta*) from multiple institutions revealed 38 individuals with cardiovascular pathology. The majority of these cases (82%) reported myocardial disease. The most frequent histologic changes observed were cardiomyopathy consisting of multifocal myodegeneration with interstitial fibrosis (30 cases). These lesions occurred in both ventricular free walls and the interventricular septum. Gross and/or histologic lesions of cardiac insufficiency were noted in half of these cases. The age of affected animals ranged from 3-13 yr of age with a mean of 8.3 yr and both sexes were equally represented.

The typical presentation of these cases was as an acute illness or sudden death without premonitory signs and there was often little opportunity for treatment. Based on the high prevalence of myocardial disease, evaluation of myocardial function in early adulthood is recommended so that treatment of affected animals may begin at an earlier stage of the disease.

Although cardiomyopathy appears to be a common disease in meerkats, there is only one previously reported case in the literature.1 A single case of Ebstein anomaly, a malformation of the tricuspid valve, is the only other cardiac disease reported in this species.2 In domestic species possible etiologies for cardiomyopathy include familial, nutritional deficiencies (taurine, L-carnitine, vitamin E), infectious/postinfectious or idiopathic.3 The risk factors for the condition in this species is not identified and further research is needed.

ACKNOWLEDGMENTS

We would like to acknowledge the following institutions for providing information on clinical cases: Buffalo Zoo, Capron Park Zoo, Cheyenne Mountain Zoo, Dallas Zoo, Fort Worth Zoo, Los Angeles Zoo, Miami Metrozoo, Oklahoma City Zoo, Santa Barbara Zoo, Sedgwick County Zoo and Toledo Zoo.

LITERATURE CITED

ELODONTOMAS IN CAPTIVE RED-BACKED VOLES

Julia Rodriguez-Ramos, LV,¹* Marie E. Pinkerton, DVM, Dipl ACVP,¹ Dennis M. Heisey, PhD,² Jay Schneider, Biological technician,² Lacey Stickney, CVT,² and David Sanchez-Migallon Guzman, LV, MS, Dipl ECAMS³

¹Department of Pathobiological Sciences, University of Wisconsin, Madison, WI 53706 USA; ²National Wildlife Health Center, Madison, WI 53711 USA; ³Department of Surgical Sciences, University of Wisconsin, Madison, WI 53706 USA

Abstract

Red-backed voles (Myodes gapperi; order Rodentia, family Cricetidae, subfamily Arvicolinae) are a relatively uncommon laboratory animal useful as a model for prion diseases. The red-backed vole dental formula is I 1/1, C 0/0, P 0/0, M 3/3¹ with elodont incisor teeth. Voles were obtained by live-trapping in Wisconsin and Pennsylvania during the fall of 2006 and were kept in the National Wildlife Health Center Research Facility. They were maintained in pairs or same-sex groups in rat boxes, on a 14 hr light 10 hr dark cycle. A mixture of six parts commercial rabbit diet, one part rodent diet, one part in-shell black sunflower seeds, one part cracked corn, one part whole oats, and apples, were provided. Five red-backed voles of the first generation of the wild caught breeding colony presented with lesions of the maxillary incisors consistent with elodontomas.

Affected animals presented with a history of chronic weight loss. Voles affected had ages over 499 days and were siblings. Examination of the oral cavity revealed overgrown mandibular incisor teeth, and absence of visible maxillary incisor teeth with a gingival ulcer. Radiologic findings indicated irregular mineral density masses at the apices of the maxillary incisors. Microscopically, these masses were composed of well-differentiated but disorganized dental tissue, including odontogenic epithelium, dentin, cementum, and enamel matrix, and were consistent with elodontomas. Elodontomas are hamartomas of odontogenic tissues at the apex of elodont teeth.²⁻⁴ This condition has been described in degu,² prairie dogs and other squirrel-like rodents.³⁻⁴ Clinical signs in the voles did not include severe respiratory signs as described in prairie dogs, degus and tree squirrels.²⁻⁴ Voles were observed chewing on metallic water bottle hardware, so persistent trauma and genetic factors are considered predisposing factors.

LITERATURE CITED

DIAGNOSTIC INVESTIGATION OF *Pseudomonas aeruginosa* INFECTION IN CHICKS OF GOLDEN EAGLE (*Aquila chrysaetos*), SCARLET MACAW (*Ara macao*) AND HORNED GUAN (*Oreophasis derbianus*) IN CAPTIVITY

Arely G. Rosas Rosas, MVZ, José G. Pérez, QFB, Alberto Parás, MVZ, Marco A. Benítez, MVZ, Carles Juan-Sallés, LV, Dipl ACVP, and Michael M. Garner, DVM, Dipl ACVP

*Africam Safari, C.P. 72007 Puebla, Pue. México; Northwest ZooPath, Monroe, WA 98272 USA*

Abstract

This paper describes seven cases of fatal infection by the bacteria *Pseudomonas aeruginosa* in the avian nursery unit of Africam Safari Zoo during two outbreaks in 2007 (three cases) and 2008 (four cases). The affected species include three golden eagles (*Aquila chrysaetos*), two scarlet macaws (*Ara macao*) and two horned guans (*Oreophasis derbianus*). With the exception of the horned guan chicks, all animals were hand-fed in the nursery unit; they also shared the same environment. Four of the seven cases died without clinical signs. The main lesions in the golden eagle and horned guan chicks were necrosuppurative omphalitis and pneumonia, whereas macaw chicks had hydrocoelom, fibrinous pericarditis and suppurative airsacculitis. One horned guan also had necrosuppurative osteomyelitis in the skull. *P. aeruginosa* was isolated from the lung or the pericardial exudate of all cases. Additionally, one eagle had cryptosporidiosis in the bursa and cloaca, and crop emphysema attributed to clostridiosis.

Cultures were performed on samples obtain from the facility, equipment, material and animals inside the nursery unit in 2008. *P. aeruginosa* was isolated from all the materials related to the feeding of the golden eagles and macaws. The source of the bacterium was believed to be the quail meat that was used to feed the eagles.

*P. aeruginosa* is an opportunistic gram-negative bacteria that affects immunosuppressed patients, it is common in human hospital-acquired infections and avian incubators and nurseries. Avian neonates may be susceptible because their immune system is not fully developed.

LITERATURE CITED

Salmonella typhimurium OUTBREAK IN HOUSE SPARROWS: CONTRACTION TO CONTROL

Tabitha C. Viner, DVM, Dipl ACVP,1* Betty L. Ackerman, MT(ASCP),1 and Peter Marra, PhD2

1Department of Pathology and 2Migratory Bird Center, National Zoological Park Washington D.C. 20008 USA

Abstract

Wild passerines worldwide frequently experience outbreaks of salmonellosis associated with strains of (Salmonella typhimurium). From January through April of 2008, the National Zoo experienced an outbreak of salmonellosis in 12 wild house sparrows (Passer domesticus) in two geographic locations on zoo grounds. Affected birds had inflammation and necrosis in the liver, spleen, crop, skin, eyes, adrenal gland, lung, intestine and ovary. Two birds also had bacterial granulomas in the brain. Abatement was attempted during the third month of the outbreak via depopulation of the house sparrow complement in one geographic location. All depopulated birds were examined grossly and carrier status or early infection was found in one of these birds via culture. Salmonella-positive birds continued to be submitted for necropsy following abatement indicating that depopulation may slow, but does not halt, outbreaks of Salmonella.

Introduction

Salmonellosis in wild passerines is a relatively common occurrence in late winter and early spring and has been documented worldwide, including in Norway,6,7 Japan,8 Canada,1 and in multiple states in the United States.3-5 Outbreaks usually occur from January through April and are associated with several different strains of S. typhimurium, most commonly DT104, though Copenhagen and DT40 strains have also been commonly implicated.

During the first 4 mo of 2008, the National Zoo experienced an outbreak of S typhimurium in house sparrows in the elephant house and around the bird house. This paper describes the pathologic aspects of the outbreak and the abatement efforts undertaken to halt or slow the outbreak in one portion of the zoo.

Materials and Objectives

Throughout the year, wildlife found dead or euthanatized due to illness on the grounds of the National Zoo is submitted to the Department of Pathology for gross examination. Certain cases are processed further for histopathology, cytology, culture or other ancillary diagnostic procedures. During this time, 112 wild birds were examined grossly and 33 were evaluated histologically. Cultures were obtained from 34 birds with sources including heart blood, and swabs of the coelomic cavity, crop wall, intestinal lumen, and brain granuloma. Samples were inoculated onto Difco™ SS Agar, BBL™ MacConkey Agar, and BBL™ GN Broth which were prepared according to package directions (Becton, Dickinson and Company, Sparks, MD 21152). After 24
hr of incubation, suspected colonies were inoculated onto one of each TSI and LIA agar. Further identification was made using the api® 20E identification system. If the organism was identified as *Salmonella* sp., a subculture on nutrient agar was sent to the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, National Veterinary Services Laboratories in Ames, IA 50010 for further classification.

Abatement practices undertaken on 12 March included capture of wild birds via mist net within the indoor elephant enclosure and euthanasia of house sparrows. Birds of other species were released. Cursory gross necropsies were performed on the 61 euthanatized house and nine birds were cultured for *Salmonella*.

**Results**

From January through April 2008, 51 wild birds that were found dead on zoo grounds were submitted for necropsy examination. These included 23 house sparrows (*Passer domesticus*), 20 mallards (*Anas platyrhynchos*), 6 European starlings (*Sternus vulgaris*), 2 American robins (*Turdus migratorius*), and 1 each Carolina wren (*Thryothorus ludovicianus*), piliated woodpecker (*Dryocopus piliatus*), cardinal (*Cardinalis cardinalis*), common grackle (*Quiscalus quiscula*), white-throated sparrow (*Zonotrichia albicollis*), downy woodpecker (*Picoides pubescens*), mourning dove (*Zenaida microauroa*), horned grebe (*Podiceps auritus*), and domestic chicken (*Gallus gallus*). An additional 61 house sparrows were euthanatized in the abatement effort. Of these 112 birds, 12 (10.7%) were found to be positive for *S. typhimurium* via culture (nine) or had gross or histologic lesions consistent with salmonellosis (three). All affected birds were house sparrows found dead or ill in the elephant house or around the bird house. Lesions were generally necrotizing, but in some areas such as the brain, the inflammatory process produced a granuloma. All birds examined histologically had two or more organs affected by salmonellosis with up to 5 organs showing necrotizing or granulomatous lesions. Lesion location and other conditions are outlined in Figure 1. Grossly, fat and/or muscle depletion was seen in 10 (83%) affected birds. Splenomegaly was documented in five (42%). Histologic lesions specifically attributed to *Salmonella* infection were most commonly seen in the liver (eight), crop (seven), and spleen (six). Lesions in the brain, skin, eyes, adrenal gland, and lung were seen in two animals each. The intestinal serosa and ovary was affected in one bird each. All house sparrows captured in the abatement effort were grossly unremarkable. One grew *S. typhimurium* from a coelomic swab.

The temporal distribution of the outbreak is outlined in Figure 2. In the first week of the outbreak, two birds were found to be *Salmonella*-positive, with one positive bird found in each of the subsequent 6 wk until the abatement effort. One week after abatement, no birds were found dead within the zoo; however, in the following 3 wk, three birds were found with lesions of salmonellosis. The last *Salmonella*-positive sparrow of 2008 was submitted for necropsy on April 14, 2008.

**Discussion and Conclusions**

Lesions found in the birds of this study, most notably necrotizing hepatitis, splenitis, and fibrinonecrotic ingluvitis, are similar to those described in other surveys involving multiple species
of songbirds.\textsuperscript{1,4,8} This is the first documentation, to our knowledge, of cerebral granulomas and ocular lesions associated with \textit{S. typhimurium}. One report of meningitis in a rock pigeon (\textit{Columba livia}) was associated with \textit{S. typhimurium},\textsuperscript{4} but the lesion was not further characterized. In one sparrow of this report, a cerebral granuloma was associated with retinitis, suggesting that bacterial infection spread along the route of the optic nerves. As histopathology of this condition in wild birds is not reported in detail, it is possible that microscopic alterations in birds of previous reports went unnoticed. Additionally, the brain may not be consistently examined in some studies.

\textit{Salmonella} is long lived in the environment and will persist for up to 16 mo in highly organic material.\textsuperscript{2} Outbreaks have been associated with bird feeders where songbirds may aggregate and contract the bacterium from carrier animals or fomites.\textsuperscript{1,2,7} Eight of the 12 (67\%) affected house sparrows in this case came from the elephant house, a large enclosure housing three elephants, two hippopotamuses and three capybaras around a large, central, public area. No concentrated feeding of wild birds takes place, but sparrows are regularly seen in the hay feed area. Three affected sparrows came from outside the bird house area and one had been handled by a giant panda. Interestingly, fecal cultures of the collection species in proximity to where the affected sparrows were found, including outdoor species of bustard and crane, were consistently negative for \textit{Salmonella}. This may reflect the host adaptation that some variants of \textit{Salmonella} display.\textsuperscript{2}

Broad scale capture by mist netting and euthanasia of 61 house sparrows in the elephant house was undertaken primarily to reduce the number of birds that could possibly transmit or carry the bacterium and secondly to survey the population for carriers of the disease. The activity only temporarily stalled the 7-wk trend of carcass submissions that were positive for \textit{Salmonella}, and the outbreak continued into April. Most studies describe outbreaks peaking from January into April,\textsuperscript{1,7} as was the case here, and most hypotheses point to the heavier use of bird feeders during this time as a cause. Removal of this variable in the birds studied at the National Zoo, and a smaller, though similar \textit{Salmonella} outbreak at NZP at the same time the following year, may indicate that other factors play a significant role in spread of the disease. Further evaluation into the epidemiology and pathology of passerine salmonellosis is warranted.

**ACKNOWLEDGMENTS**

Many thanks to necropsy processors: Linda Meola, Mauricio Guayasamin, Gwynne Kinley, Elizabeth Arguelles, Todd Bell, Tim Walsh, and Katrina Villiard, and to Ann Bratthauer for sample processing.

**LITERATURE CITED**


Figure 1. Pathologic changes in house sparrows infected with Salmonella typhimurium.

Figure 2. Salmonella-positive house sparrow submission by week. Abatement occurred on 3/12/2008.
ULTRASONIC ASSESSMENT OF THE AFRICAN ELEPHANT (*Loxodonta africana*) EYE

Priya Bapodra, BVetMed, MSc, MRCVS,1,2* Tim Bouts, DVM, MSc, MRCVS,2 Paul Mahoney, BVSc, DVR, DipECVDI, FHEA, MRCVS,4 Sally Turner, MA, VetMB, DVOPththal, MRCVS,3 Ayona Silva-Fletcher, BVSc, MSc, PhD,1 and Michael Waters, BVSc, MSc, MRCVS1

1Royal Veterinary College, Hertfordshire, UK; 2Zoological Society of London, Bedfordshire, UK; 3Stone Lion Veterinary Centre, London,; *Present address: Department of Wildlife and Conservation Medicine, The Wilds, Cumberland, OH 43732 USA

Abstract

It is recommended that an ophthalmic examination is conducted as part of the annual physical examination of captive elephants.6 The ability to perform an ophthalmic examination in elephants is dependent on their level of training; hence lack of patient cooperation may create safety issues for handlers.6,8 Transpalpebral ultrasonography is regarded as a rapid and non-invasive imaging modality and would therefore prove useful in the examination of the live unsedated elephant.1,3,5,7 As there is no published work related to the use of ocular ultrasonography in elephants, the objective of this study was to describe the normal ultrasonographic appearance and measurements of the African elephant eye. This knowledge could then serve as a base for clinical ocular ultrasonographic examinations, where pathology may have caused alterations in the appearance and structural dimensions of the globe and intraocular structures.2,4,5

Six African elephants from the United Kingdom and Germany had bilateral transpalpebral ultrasound scans performed. Five females and one male with a mean age of 14.67 ± 0.82 yr (mean ± standard deviation) were included in the study population. Animals within the study group were maintained in free contact management systems. Ultrasound examinations were performed with animals in lateral recumbency, in a stretched position or standing. Continuous flow of low-pressure water was used as the contact medium between the ultrasound transducer (4-7 MHz broadband curvilinear) and the eyelid skin. Ocular biometry measurements were taken from images obtained by scanning through both the upper and lower eyelids.

Mean biometry measurements recorded for adult African elephants (n=6) were axial length 3.37 ± 0.09 cm, equatorial diameter 3.80 ± 0.24 cm, corneal thickness 0.17 ± 0.03 cm, anterior segment depth 0.45 ± 0.05 cm, lens diameter 1.99 ± 0.25 cm, lens thickness 0.98 ± 0.10 cm and posterior segment depth 1.75 ± 0.10 cm. The ultrasonographic appearance of the globe and intraocular structures of the African elephant eye is similar to that in other species.2,4,5

Transpalpebral ultrasonography was found to be a useful imaging modality for the rapid and non-invasive assessment of the African elephant eye. Chemical restraint and local/topical anesthesia was not required to perform ocular ultrasonography and images of diagnostic quality
were produced from all animals despite variable levels of training and handling. In summary, transpalpebral ultrasonography is a valuable imaging technique to produce useful information regarding the health of the globe and intraocular structures without the need for chemical restraint.

LITERATURE CITED

SELECTED DIAGNOSTIC OPHTHALMIC TESTS IN THE RED KANGAROO
(Macropus rufus)

Ginger L. Takle, DVM,1* Wm. Kirk Suedmeyer, DVM, Dipl ACZM,1 and Amy Hunkeler, DVM, Dipl ACVO2

1Kansas City Zoo, Kansas City, MO 64132 USA; 2Hunkeler Animal Eye ClinicLees Summit, MO 64064 USA

Abstract

The following tests were performed on a total of 20 eyes: Schirmer tear test, intraocular pressure, assessment of conjunctival flora, and pupillary diameter pre- and post application of topical tropicamide in ten healthy captive red kangaroos (Macropus rufus) under manual restraint. The mean Schirmer tear test value was 22.6 +/- 6.07 mm/min. The mean intraocular pressure was 17.45 +/- 7.23 mm Hg. Values did not differ between eyes or gender for either test, but significant differences were identified for IOP values according to age. The most common bacteria isolated from the conjunctival fornix were Staphylococcus epidermidis (54.5%) and Corynebacterium sp. (18.2%). The mean onset of mydriasis after instillation of 1% tropicamide ophthalmic solution, USP (Falcon Pharmaceuticals, Ltd., Fort Worth, Texas 76134, USA) was 16.7 +/- 3.34 min and the mean duration of effect was 17.6 +/- 8.26 hr. The data obtained in this investigation will aid veterinary ophthalmologists and zoo veterinarians to accurately diagnose ocular diseases in the red kangaroo.

ACKNOWLEDGMENTS

The authors would like to thank the Kansas City Zoo Outback keeper staff for their dedication to animal care, Aaron J. Bonham, MS for statistical analysis, and Andrea Lowery, RVT, William Fales, MS, PhD, Tony Mong, MS and John Dodam, DVM, MS, PhD for technical support. The authors also wish to acknowledge the University of Missouri-College of Veterinary Medicine and Safariz for their support of the residency program.
ANTERIOR UVEITIS AS AN ATYPICAL PRESENTATION OF LYMPHOMA IN A CARACAL (Caracal caracal)

Copper Aitken-Palmer, DVM, MS,1* Trevor Girlach, BS,1 Sarah Blackwood, DVM,1 Ramiro Isaza, DVM, Dipl ACZM,1 and Kathy Russell2

1University of Florida, Veterinary Medical Center, Gainesville, FL 32610 USA; 2Santa Fe Teaching Zoo, Santa Fe College, Gainesville, FL 32606 USA

Abstract

An adult female, spayed caracal (Caracal caracal) presented with a 3-mo history of intermittent anorexia, vomiting and weight loss previously attributed to severe dental disease. After multiple dental extractions, unilateral anterior uveitis with anisocoria developed in the right eye. Examination of the eye under anesthesia revealed copious thick fibrin obscuring the ventral pupil margin and ventral iris in the anterior chamber. There was also a mild amount of pink debris at the ventral aspect of the anterior chamber which appeared to be a mixture of mild hypopyon and hyphema. Examination of the small portion of anterior lens visible through the dorsal pupil margin revealed fibrin on the anterior lens capsule. Fine needle aspiration of the anterior chamber revealed a cytologic diagnosis of granulocytic lymphoma. Additional diagnostics (computed tomography and abdominal ultrasound with fine needle aspiration) revealed evidence of metastatic granulocytic lymphoma with intestinal perforation and septic peritonitis. Abdominal exploratory with surgical resection was pursued, but the individual was euthanatized when multiple perforations throughout the length of the small intestine were found. Necropsy indicated multicentric lymphoma consistent with metastatic granulocytic cell lymphoma present in the right eye, small intestine, mesenteric lymph nodes and right kidney.
DETERMINATION OF THE APPROPRIATE SIZE INTRAOCULAR LENS FOR CATARACT SURGERY IN THE GREVY’S ZEBRA (Equus grevyi)

Alina L. Evans, DVM, MPH, 1* Renee T. Carter, DVM, Dipl ACVO, 1 Annajane B. Marlar, DVM, Dipl ACVO, 2 and Scott B. Citino, DVM, Dipl ACZM 3

1Louisiana State University, Department of Veterinary Clinical Sciences, Baton Rouge, LA 70803 USA; 2 Fort Worth Zoological Association, Fort Worth, TX 76110 USA; 3 White Oak Conservation Center, Yulee, FL 32096 USA

Abstract

Our study sought to determine if intraocular lens recommendations for the domestic horse can be extrapolated to other equidae and to provide recommendations on intraocular lens selection likely to achieve emmetropia in Grevy’s zebra. Anterior chamber depth, lens thickness, axial length and corneal curvature of 12 eyes of 8 Grevy’s zebra aged 4-14 yr were measured with ultrasound biometry. Theoretical replacement lens powers (D) were calculated using the Binkhorst and Retzlaff equations. Using 10MHz B-scan ultrasonography, mean and standard deviation of axial length, anterior chamber depth; lens thickness and cornea to posterior capsule distance were 40.65 +/- 1.11mm, 6.85 +/- 0.30mm, 13.83 +/- 4.24mm, and 19.47 +/- 0.52mm respectively (n=12). Mean anterior chamber depth utilizing 20 MHz B-scan ultrasonography was 6.67 +/- 0.19mm (n=12). Utilizing A-scan ultrasound, mean axial length, anterior chamber depth and lens thickness were 41.33 +/- 0.84mm, 7.05 +/- 0.42mm and 12.46 +/- 0.32mm, respectively (n=4). Corneal curvature calculated from 20MHz images was 29.87 +/- 1.19 D (n=9). The estimated IOL powers with the Binkhorst and Retzlaff formulas were 8.62 +/- 1.62 D and 9.19 +/- 1.58D, respectively. The mean and standard deviation of the intraocular pressure using applanation tonometry was 21.77 mmHg with a 95% confidence interval of 19.09-24.45mmHg. Use of the equine model for IOL calculation in Grevy’s zebras is not appropriate, but with ultrasound, IOL strength is readily calculated. Further study is warranted to determine appropriate artificial lens characteristics/specifications for equids other than horses.

Abbreviations: IOL – Intraocular lens, D – Diopter.
TREATMENT OF BILATERAL CORNEAL ULCERS IN AN AFRICAN LIONESS USING HUMAN AMNIOTIC MEMBRANE ALLOGRAFTS

Sam Rivera, DVM, MS, Dipl ABVP(avian),1,* Maria M. Crane, DVM,1 Gail Powell-Johnson, DVM,2 Rita McManamon, DVM,3 and Richard R. Dubielzig, DVM4

1Zoo Atlanta, Atlanta GA 30315 USA; 2Atlanta Veterinary Eye Clinic, Avondale Estates, GA 30002 USA; 3Infectious Diseases Laboratory and Department of Pathology, University of Georgia, Athens GA 30602 USA; 4Pathobiology, University of Wisconsin, Madison, WI 53706 USA

Abstract

An 18-yr-old spayed female African lioness (Panthera leo) developed bilateral ulcerative keratoconjunctivitis, which was suspected to be secondary to depressed lacrimal function. The lioness was under treatment with steroids (prednisolone 1 mg/kg p.o. s.i.d.) for immune mediated anemia. The animal was treated with pilocarpine (0.02 mg/kg p.o. b.i.d.) to enhance tear production and oral systemic antibiotics (cephalexin 20 mg/kg p.o. b.i.d.). Two weeks later, bilateral allografts (OASIS Acelagraft Dehydrated Human Amniotic Membrane; www.oasismedical.com) were applied to the left and right corneal ulcers, and were sutured in place. Subconjunctival injections of flurbiprofen and gentamicin were performed. Complete corneal healing, with corneal scars, were documented 5 wk postsurgically. The animal died from unrelated causes, and a necropsy was performed.

Ulcervative corneal lesions occur in many species, including humans, domestic and exotic animals. Predisposing causes include trauma, suboptimal tear film production and/or composition due to aging or other reasons, immune system compromise, or immunosuppressive therapy. Prompt and effective repair of corneal defects is desirable in order to maintain or restore vision.1,2 Human amniotic grafts have been used as a biologic membrane to repair corneal defects in humans.3 The membrane provides mechanical protection, decreases the inflammatory response, acts as a basement membrane layer, contains growth and trophic factors, and expands the limbal stem cell population. In this case, histologic examination confirmed the presence of an effective healing response, through the use of this commercially available human product.

ACKNOWLEDGMENTS

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LITERATURE CITED

UTILIZATION OF URINARY BILE ACIDS TO EVALUATE LIVER FUNCTION IN A WHITE BENGAL TIGER (Panthera tigris tigris)

Carol Bradford, MS, DVM

Potawatomi Zoo, South Bend, IN 46615 USA

Abstract

Serum bile acid concentrations have been measured in domestic and captive wild animals as an ancillary test to diagnose and monitor the progression of liver disease. Bile acid tests are a measure of liver function while elevations of liver enzyme concentrations represent hepatocyte damage or cholestatic disease. Urinary concentrations of sulfated and nonsulfated bile acids have been shown to be significantly higher in domestic cats with liver disease than in cats without liver disease.1 The specificity and sensitivity of urinary bile acid measurement for liver disease diagnosis are similar to that of serum bile acid measurement in domestic cats. Urinary bile acids are compared to urinary creatinine concentrations (urine bile acid to urine creatinine ratio) to allow interpretation of urine collected at arbitrary times. The advantages of urinary bile acid measurement include no requirement for venipuncture, it provides a time-averaged sample that lessens the effects of daily physiologic variation, and the procedure is completely non-invasive.

Upon incidental discovery of elevated liver enzyme concentrations and serum bile acid concentrations in a white Bengal tiger (Panthera tigris tigris), serial urinary bile acid tests were used to evaluate and monitor liver function while avoiding repeated anesthetic procedures for venipuncture. The urine bile acid to urine creatinine ratio is a non-species-specific, non-invasive, clinically significant laboratory test that can help to diagnose and monitor liver disease in captive exotic felines.

LITERATURE CITED

SKIN CONDITIONS IN CAPTIVE ANDEAN SPECTACLED BEARS (*Tremarctos ornatus*)

Meg Sutherland-Smith, DVM, Dipl ACZM, 1* Russ VanHorn, PhD, 2 Megan Owen, MS, 2 and Gaylene Thomas 3

1 Veterinary Services Department, 2 Institute for Conservation Research, 3 Collection Husbandry Sciences, San Diego Zoo, San Diego, CA 92112 USA

Abstract

Skin disease has been reported in captive Andean spectacled bears (*Tremarctos ornatus*) from the US, Europe, and South America. A web-based survey was undertaken to better characterize skin disease in the US population. Based on survey results females are more likely to develop skin conditions than males. Several females have been identified with similar clinical symptoms consisting of pruritus with progressive alopecia. Investigations are underway to determine common factors in these cases.

Discussion

Over the past 10 yr, a 21-yr-old female Andean spectacled bear at the San Diego Zoo developed progressive alopecia and experienced episodes of pruritus and dermatitis. Thinning of the haircoat was initially observed and progressed to bilaterally symmetric alopecia over the caudal half of the body. Multiple diagnostic procedures revealed responses to certain allergens and presumed secondary bacterial/yeast dermatitis. It is unclear if these were the primary cause(s) of the observed clinical signs. Equivocal response to therapy was observed with allergen desensitization, nutritional supplements, antihistamine, antimicrobial and antifungal medications. Pruritus and skin lesions resolved with steroid therapy, however alopecia persisted.

The authors became aware of other female spectacled bears in the United States and Europe with similar clinical conditions (Lydia Kolter, personal communication). Animal care staff and veterinarians from the San Diego Zoo and researchers from the San Diego Zoo’s Institute for Conservation Research developed an interest in further investigating this problem. A web-based survey was initiated to gather information on skin conditions in the SSP population and to evaluate if underlying risk factor(s) could be identified. The survey was divided into husbandry and veterinary sections.

The 2007 SSP studbook lists 67 (40.27) Andean spectacled bears in 35 institutions. The institutional representative for each institution was contacted via e-mail and asked to participate in the survey. In addition, veterinary staff in 27 of the 35 institutions were contacted via e-mail regarding the veterinary portion of the survey. Husbandry and veterinary data was collected from 15 and 13 institutions, respectively, however both veterinary and husbandry information was available from only 9 institutions. Technical difficulties with the on-line survey prevented some institutions from responding.
Evaluation of combined husbandry and veterinary data for 36 bears identified 4 of 19 (21%) males and 10 of 17 (59%) females had reported some type of skin problem. Ages of affected animals ranged from 3.5 to 19 yr of age. One male had seasonal recurring non-symmetric alopecia, pruritus, moist pyoderma (“hot spots”) and bacterial dermatitis. Another male was noted to have a skin condition but without pruritus, alopecia, erosions, or exudate. Bilaterally symmetric alopecia was noted in a third male. The fourth male had two episodes of non-pruritic alopecia associated with skin exudate and a bacterial dermatitis.

Of the 10 females, seasonal pruritus, seasonal hot spots, and a chronic non-healing skin lesion were reported in 3 females. A fourth female had a single episode of pruritus, ocular inflammation and alopecia that resolved with a change in bedding substrate. The remaining six had multiple recurrent episodes of pruritus and alopecia; alopecia was bilaterally symmetric and progressive over time. Periocular and conjunctival inflammation were seen in five of these six females. Five of the six bears had one or more episodes of bacterial dermatitis associated with clinical signs. Three had some seasonal component to episodes. Skin conditions occurred more frequently in females despite a population sex ratio skewed towards males. Of the spectrum of dermatologic conditions reported 6 of 17 females (35%) exhibited chronic progressive bilaterally symmetric alopecia associated with pruritus.

Etiologies for the spectrum of diseases reported include infectious, endocrine and/or allergic causes. Diagnostic testing included complete blood cell counts, serum chemistry panels, endocrine testing, cytologic examination of skin scrapings, histopathologic examination of skin biopsies, skin cultures, and allergen testing.

This survey indicated that skin disease has affected a large proportion of the captive US spectacled bear population, similar to results of a survey conducted in Europe (Lydia Kolter, personal communication). Since our survey was conducted, the authors are aware of similar skin conditions in captive Andean spectacled bears in Venezuela (Andrés Bracho, personal communication) and Peru. The above information is primarily descriptive at this time with further analyses ongoing. A future goal is to make recommendations to the SSP for diagnostic screening of Andean spectacled bears in the US population.

ACKNOWLEDGMENTS

The authors wish to thank the following institutions for their participation in this survey: Gladys Porter Zoo, Cincinnati Zoo, Cleveland Metroparks Zoo, Granby Zoo, Houston Zoological Gardens, Montgomery Zoo, Philadelphia Zoological Gardens, Phoenix Zoo, Racine Zoo, Rolling Hills Wildlife Adventure, Salisbury Zoological Park, San Antonio Zoological Gardens, San Francisco Zoological Gardens, Sedgwick County Zoo, St. Louis Zoological Park, Tulsa Zoo and Living Museum, and Oglebay’s Good Children’s Zoo.

LITERATURE CITED

GUIDELINES FOR MANAGING CASES DIAGNOSED WITH A ZOONOTIC DISEASE AGENT

Donald L. Janssen, DVM, Dipl ACZM,1* Beth Bicknese, DVM,2 Russell Burns, DVM,1 Rebecca Papendick, DVM, Dipl ACVP,3 Meg Sutherland-Smith, DVM, Dipl ACZM,2 Nadine Lamberski, DVM, Dipl ACZM,1 and Patrick Morris, DVM, Dipl ACZM2

1San Diego Zoo’s Wild Animal Park, Escondido, CA 92027 USA; 2San Diego Zoo, San Diego, CA 92112-0551 USA; 3Wildlife Disease Laboratories, San Diego Zoo’s Institute for Conservation Research, San Diego, CA 92112-0551 USA

Abstract

Zoo veterinarians are often faced with the task of how to deal with situations in which a zoonotic disease agent is identified or suspected in one of their patients. The implications to the animal, its caretakers, the public, their institution, and themselves may quickly become overwhelming. Failure to respond properly can lead to unnecessary human and animal illness or overreaction to perceived risks. This presentation suggests a systematic process that zoo clinicians can follow when managing cases where a zoonotic disease agent has been identified or is highly suspected. For the purposes of this discussion, a zoonotic disease agent is one that can be transmitted directly from animals to humans and cause disease in humans.

When an animal is diagnosed with a confirmed or highly suspected zoonotic disease agent, several steps can be taken. First, notify key stakeholders in the institution including animal care supervisors and the employee health care provider. Provide a summary of the disease1 to animal care supervisors and remind employees to report signs and symptoms of zoonotic disease. Second, the animal care staff should be instructed to isolate the animal if appropriate considering the feasibility and risk. This is especially important in animal contact areas.2 This is a good opportunity to remind staff of the importance of proper hygiene and use of appropriate personal protective equipment. Third, instruct animal care staff on proper waste disposal including contaminated bedding to avoid spreading contamination. Follow local and regional regulations for disposal of biomedical wastes.3 Fourth, report the disease, if required, to local public health officials.4 It also may be useful to track zoonotic diseases occurrences in your facility. Fifth, if indicated, treat the animal with appropriate antimicrobials and perform follow-up diagnostics as appropriate. Be sure to establish criteria for an end of isolation (e.g., test negative and/or clinically normal).

LITERATURE CITED

PREVALENCE OF RESORPTIVE DENTAL LESIONS IN MALAYAN TAPIRS (*Tapirus indicus*)

Mads F. Bertelsen, DVM, DVSc,* Mari Ann Otkær da Silva,†,‡ Hanne Kortegaard, DVM, PhD,‡ Choong Siew Shean, DVM, MVSc,§ and Jens Arnbjerg, DVM, Dipl ECVDI‡

*Centre for Zoo and Wild Animal Health, Copenhagen Zoo, Frederiksberg, Denmark; †Department of Small Animal Clinical Sciences, Copenhagen University, DK-1870 Frederiksberg C, Denmark; §Department of Wildlife and National Parks, Jalan Cheras, Kuala Lumpur, Wilayah Persekutuan, Malaysia

Abstract

Dental disease as well as facial swelling and osteomyelitis is a commonly reported entity in tapirs, but little is known about actual etiology or prevalence of these lesions.3,4

Resorptive lesions to the roots were diagnosed in the extracted teeth of two Malayan tapirs (*Tapirus indicus*) by histopathology. In order to evaluate the prevalence of this problem in the species, 38 skulls of deceased tapirs were visually examined and radiographically evaluated. Resorptive lesions were graded according to severity on a scale from 0-5.1,2 Animals were divided into four groups based on their age (juvenile/adult) and origin (captive/free-ranging). Data are presented in Table 1.

Overall, 37% of the investigated skulls had dental lesions with decreased radiodensity. In adult zoo animals the prevalence was 82% (9/11), while in their wild counterparts the prevalence was 57% (4/7). The difference in prevalence between captive and free-ranging animals was not statistically significant. Only 1 of the 21 juvenile animals (5%) was affected.

This study suggests that a very high proportion of tapirs are affected by radiolucent dental lesions believed to represent root resorption. Age appears to be a highly significant factor in the development of these lesions. These preliminary results suggest that free ranging animals are affected to a comparable extent as captive tapirs.

ACKNOWLEDGMENTS

The authors thank the Museum of Natural history in Copenhagen, Denmark, Museum für Naturkunde, Berlin, Germany, and Naturalis in Leiden, Holland, as well as the following individuals for help during the study: Mr. Bent R. Nelson, Mr. Mogens Andersen, Dr. Frieder Mayer, Dr. Helmut Rux, Dr. Erik Eriksen, Dr. Jesper Reibel, Dr. Paul Clausen, Mr. Hein van Grouw, Dr. Willem Schaftenaar, Dr. Zainal Zahari Zainuddin, Mr Osman Asnawi, Mr. Boyd Simpson, and Dr. Carl Traholt.

LITERATURE CITED

1. American Veterinary Dental College website: http://www.avdc.org/Nomenclature.html#resorption
Table 1. Distribution of radiolucent tooth root lesions in captive and free ranging Malayan tapirs (n=38).

<table>
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EFFECTS OF A GNRH VACCINE ON THE ESTROUS CYCLE OF AN ASIAN ELEPHANT *(Elephas maximus)*

Nancy C. Boedeker, DVM, Suzan Murray, DVM, Dipl ACZM, David M. de Avila, and Janine L. Brown, PhD

1Smithsonian Institution’s National Zoological Park, Washington D.C. 20008 USA; 2Department of Animal Sciences, Washington State University, Pullman, WA 99164 USA

Abstract

Repro-BLOC® gonadotropin-releasing hormone (GnRH) vaccine (Amplicon Vaccine LLC, Pullman, WA 99163 USA) is effective at suppressing estrous cyclicity in heifers. The production of antibodies to a GnRH fusion protein neutralizes GnRH, thereby preventing follicle-stimulating hormone and luteinizing hormone (LH) release from the anterior pituitary, leading to sterility in both genders. GnRH vaccines have been evaluated as a management tool in horses, ruminants, cervids, swine, dogs, and cats. GnRH vaccination has been used in male African and Asian (Thomas Hildebrandt, personal communication) elephants to decrease aggression.

Repro-BLOC® was administered to a geriatric female Asian elephant for management of suspected uterine leiomyomas associated with anemia and hemorrhage, although leiomyomas are not uncommon in this species and typically benign. We speculated that GnRH vaccination would be effective at suppressing ovarian activity in female elephants and would thereby reduce the size of the leiomyomas and minimize the risk of further hemorrhage. Five vaccinations in increasing doses from 3 to 30 mg were administered over 20 mo before efficacy was documented. Serial serum analyses showed estrous cycle suppression in association with a rise in GnRH antibody binding and a decrease in progesterone and LH. Ultrasonographic examinations were performed to evaluate uterine changes. The hematocrit normalized soon after the initial hemorrhage with no recurrence of anemia. To the authors’ knowledge this is the first reported use of a GnRH vaccine in a female elephant. GnRH vaccination in elephants shows great potential for reversible contraception and management of uterine pathology in older females and warrants further investigation.

ACKNOWLEDGMENTS

We would like to thank Drs. Jerry Reeves, Valeria Conforti, Dennis Schmitt, and Thomas Hildebrandt as well as the National Zoo’s elephant keeper and curatorial staff for their invaluable assistance with this case. We would also like to thank Amplicon Vaccine for their generous donation of the Repro-BLOC vaccine and for covering the costs of GnRH titer analysis.

LITERATURE CITED


MULTIFOCAL CERVICAL INSTABILITY AND CERVICAL SPINAL CORD IMPINGEMENT IN A MASAI GIRAFFE (Giraffa camelopardalis tippelskirchi)

Roy B. Burns, DVM,1* Wynona C. Shellabarger, DVM,2 and Zoltan S. Gyimesi, DVM1

1Louisville Zoological Garden, Louisville, KY 40213 USA; 2Toledo Zoological Gardens, Toledo, OH 43609 USA

Abstract

A female, hand reared, Masai giraffe calf (Giraffa camelopardalis tippelskirchi) presented with an acute onset of localized swelling on the mid-lateral neck region at 18 wk of age. The lesion progressed to a mild kink or lateral deviation of the neck and within 1 wk was associated with incoordination, weakness, head resting behavior, and occasional regurgitation. Radiographs showed complete destruction and collapse of the joint between cervical vertebrae 4 and 5 (C4, C5) with shortening, lysis, and proliferative remodeling of the adjacent vertebral bodies. Differential diagnoses considered included trauma (fracture, subluxation), osteomyelitis (discospondylitis), and neoplasia. Treatment consisted of stabilization of the neck by an external splint (Orthoplast™, AliMed®, Dedham, MA 02026 USA; 15 wk), and systemic antibiotics (15 wk). Upon removal of the splint, radiographs showed osseous bridging and callus formation. The giraffe developed a permanent bend, decreased range of motion, and decreased flexibility in the neck associated with the eventual fusion of C4 and C5. No other obvious clinical, developmental, or neurologic problems were noted.

The giraffe was transferred to another zoo at 1.5 yr of age. At about 3 yr of age, the giraffe began showing clinical signs of intermittent regurgitation, decreased activity, abnormal gait, frequent resting of the head and neck, a low neck posture, and progression of the bend in the neck. Radiographs revealed hyperflexion at C2-C3, fusion of C4-C5, lateral displacement and hyperflexion of C5-C6 with extensive bone proliferation ventrally and narrowing of the vertebral canal, and hyperextension and malalignment at C6-C7 with bone proliferation. Within 2 wk of the radiographs, the giraffe became laterally recumbent and unable to rise due to paraparesis and ataxia. The giraffe was humanely euthanized. Postmortem dissection and computed tomography of the cervical spine confirmed the antemortem diagnoses.

ACKNOWLEDGMENTS

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FATAL RESPIRATORY ARREST FOLLOWING INTRATHecal RESINIFERATOXIN INJECTION IN AN AMUR TIGER (Panthera tigris altaica)

Marie-Josée Limoges, DMV, MVSc,1,2* Marion Desmarchelier, DV, DES,2 and Éric Troncy, DV, MSc, PhD, DUn2

1 Granby Zoo, Granby, Quebec J2G 5P3 Canada; 2 Faculté de médecine vétérinaire, Université de Montréal, Saint-Hyacinthe, Quebec J2S 7C6 Canada

Abstract

A 16-yr-old male Amur tiger was immobilized to attempt alleviation of chronic pain from severe right elbow osteoarthritis by intrathecal injection of resiniferatoxin (RTX). Resiniferatoxin is a naturally occurring compound similar to capsaicin, the active ingredient in hot pepper.3,5 It is being investigated for the treatment of certain types of chronic pain in humans and dogs.1,3,4 The tiger’s treatments over the past 4 yr had included several oral, subcutaneous, intramuscular and intraarticular medications, but despite these treatments, the tiger’s lameness had progressed. The RTX injection was felt to be a last-resort treatment, with the other option considered being euthanasia.

The tiger was immobilized, the dorsal cervical area was surgically prepped, cerebrospinal fluid was collected from the cisterna magna, and then RTX was slowly injected over a period of 15 min, followed by a flush of sterile saline. Initial physiologic responses were an increase in heart rate, no change in blood pressure, and a short period of tachypnea followed by apnea. Anesthesia was discontinued and doxapram (Dopram-V, Wyeth-Ayerst Canada Inc., Montreal, Quebec, Canada) was administered to stimulate respiration. Peripheral reflexes slowly returned, but spontaneous respiration never resumed and the tiger suffered fatal cardiac arrest 3.5 hr after completion of the RTX injection. Necropsy results revealed severe cardiac and vascular amyloidosis and severe chronic osteoarthritis of the right elbow but no CNS changes attributable to the RTX injection. The respiratory arrest experienced by this tiger suggests either a species-specific reaction to RTX, or an idiosyncratic reaction of this particular individual.

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LITERATURE CITED


SERIAL ULTRASONOGRAPHIC EVALUATION OF THE NON-GRAVID AND GRAVID UTERUS OF THE GIANT ANTEATER (Myrmecophaga tridactyla) FOR DETERMINATION OF PREGNANCY, ESTIMATION OF PARTURITION DATE AND BREEDING MANAGEMENT

Anne Elise Napier, DVM,1* Sally A. Nofs, DVM,2 and Nancy C. Boedecker, DVM3

1Ultrasound Solutions, Nashville, TN 37211 USA; 2Nashville Zoo at Grassmere, Nashville, TN 37211 USA; 3Smithsonian Institution’s National Zoological Park, Washington, D.C. 20007 USA

Abstract

Successful breeding programs are dependent on reliable pregnancy detection for care of the gestating female and the neonate. Since giant anteaters (Myrmecophaga tridactyla) do not significantly alter estrus behavior during pregnancy and their body type is not conducive to detection by abdominal palpation, alternative methods of confirmation must be employed. Indirect means of evaluation such as vaginal cytology and fecal estrogen/progesterone assay have been established in the giant anteater.1,2 Additionally, transabdominal ultrasound has been utilized as a direct means of establishing pregnancy.1 The goal of this study was to provide a complete description of ultrasonographic findings in both non-gravid and gravid females in order to establish objective criteria for identification and staging of pregnancy in the giant anteater. Ultrasonographic exams were performed in non-sedated, stationed, healthy, reproductively active female giant anteaters to provide ultrasonographic images for various stages of the non-gravid uterus and for the gravid uterus beginning at 5 wk post copulation. Exams were performed at regular intervals to monitor growth of the fetus and establish ultrasonographic criteria for estimation of fetal age. Pregnancy was first identified at 10 wk post copulation, established by identification of amniotic fluid, fetal structure, motion and heart beat. By 14 wk all fetal structures were identified. Serial structural measurements (heart girth diameter, length of the long bones and cranium) were evaluated in gestating animals to prepare a growth curve from identification until parturition.

LITERATURE CITED

EASTERN EQUINE ENCEPHALITIS VIRUS (EEEV) TITERS IN AFRICAN ELEPHANTS (Loxodonta africana) AT DISNEY’S ANIMAL KINGDOM

Christy L. Rettenmund, DVM,1* Scott P. Terrell, DVM, Dipl ACVP,2 and Michele Miller, DVM, PhD3

1Gulf Coast Veterinary Specialists, Avian and Exotics, Houston, TX 77057 USA; 2Department of Animal Health, Disney’s Animal Kingdom, Lake Buena Vista, FL 32830 USA; 3Palm Beach Zoo, West Palm Beach, FL 33405 USA

Abstract

Eastern equine encephalitis virus (EEEV) is a mosquito-borne viral disease reported in numerous species.2 Of all US states, Florida has the greatest number of cases of EEEV reported in horses and humans.2 Vaccination is recommended in horses in endemic areas1,5 and has also been used in other species. There are no clinical reports of EEEV in elephants although elephants have shown seropositivity to other mosquito-borne diseases such as Japanese encephalitis virus and West Nile virus.4 Vaccination of elephants at Disney’s Animal Kingdom against EEEV was elected since EEEV is endemic in Florida2 and cases of EEEV have been documented in other species at the park.

In this study, 10 African elephants at Disney’s Animal Kingdom were vaccinated annually with Encevac-T with Havlogen (Intervet Inc., Millsboro, DE 19966 USA) for EEEV. Blood was drawn annually or biannually to evaluate EEEV titers via hemagglutination inhibition assay at Cornell University. Few studies have been done to evaluate EEEV titers to the vaccine3,6 and a protective titer has not been determined. Five elephants remained seronegative for EEEV despite yearly vaccination, while the other five elephants displayed low, inconsistent titers. Possibilities for these results include poor antigenic stimulation, short-lived antibody response, low antigenic mass compared to muscle mass, stimulation of primarily cell-mediated immunity or vaccine failure. In the future, it may be prudent to vaccinate more frequently during vector season to maintain titers for longer periods of time or use techniques to evaluate cell-mediated immunity against EEEV.

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LITERATURE CITED


MANAGEMENT OF CRITICAL JUVENILE ASIAN ELEPHANTS (*Elephas maximus*)

*Martha Weber, DVM, Dipl ACZM,* Randall Junge, DVM, MS, Dipl ACZM, Peter Black, DVM, Martha Fischer, BSc, Sarah O’Brien, RVT, and Cory Nordin

*Saint Louis Zoo, Saint Louis, MO 63110 USA*

Abstract

Juvenile elephants may be affected by many conditions, including infectious diseases and nutritional imbalances, which can impact overall health and survivability. The strength of even very young elephants can prevent easy physical restraint, with the result that some ill animals may not receive diagnostic exams or treatments until they are too weak to resist handling. Our experiences with two young Asian elephants have shown that early intervention, using operant conditioning or sedation, has allowed us to monitor, manage, and stabilize these animals. Ongoing communication and cooperation between the elephant management staff and the veterinary staff have allowed identification of training priorities for juvenile elephants which make diagnostic testing and therapeutic management less stressful for all involved parties. This document discusses several aspects of the management of critical juvenile Asian elephants in captivity: early calf training priorities, calf sedation, hand-rearing using milk replacement formulas, and monitoring and treating calves for elephant endotheliotropic herpesviral infection.

Discussion

The Saint Louis Zoo’s elephant training philosophy supports the introduction of training early in an elephant calf’s life. As soon as the bond between the mother and calf is secure and nursing is consistent, the calf is introduced to simple behaviors. The primary objective of the training program is to begin within the first weeks of a calf’s life to build a trusting and cooperative relationship between the calf and the keepers so that the calf will not only be consistently cooperative with all learned husbandry behaviors, but will also be accepting of unexpected diagnostic evaluations and treatments that may be required during times of compromised health. With consistent training and acclimation from the elephant care team in its first year of life, an elephant calf can be expected to present many of the same husbandry behaviors as the adult elephants. To give the best opportunity for day-to-day health care, nutritional monitoring, and husbandry, and to be reasonably prepared for a health crisis, it is ideal for an elephant calf to understand the training “bridge” and be proficient with target training, and allow the following as early as possible: present and position all parts of its body for physical examination and external ultrasonography, lie sternally and laterally upon request, present feet and limbs for radiographs, present ear for heart-rate monitoring, open mouth for oral exams, step on a platform scale for weighing, accept medications orally, rectally, and parenterally, stand for urine collection, and allow blood sample collection. Blood collection is one of the more challenging behaviors to introduce, but we feel that this behavior is vital for monitoring health and nutritional status in young elephants and its importance should not be underestimated.
Sedation has been a critical component of our medical management of juvenile elephants, allowing intervention while an elephant is still active and strong. Sedation dosages for adult African and Asian elephants have been published, but little work seems to have been done recently with juvenile animals. We routinely use detomidine-butorphanol combinations for standing sedation in our young elephants. The youngest age at which an elephant at our facility has been sedated is 2 mo (body weight 144 kg). The dosages used produce a plane in which the animal is immobile but stable on its feet. An animal that has been taught to lie down on cue can be persuaded into lateral recumbency if necessary. Dosage ranges are as follows: butorphanol 0.02 - 0.03 mg/kg i.m., detomidine 0.02 - 0.03 mg/kg i.m., atipamezole 0.1 - 0.16 mg/kg i.m., and naltrexone 2.0 - 3.5 mg/kg i.m.

One multiparous cow showed evidence of decreased milk production in the first 2 mo of lactation, possibly in association with retained placental tags. Dietary and social changes were implemented to encourage milk production. In addition, the cow was initially treated with metoclopramide 100 mg p.o. q 8 hr for 5 days. No significant change was seen following the husbandry changes and treatment, so we changed to the dopamine antagonist, domperidone, administered orally (initially 500 mg q 24 hr, increased over time to 3800 mg q 24 hr) for 30 days. Evidence of increased milk production was appreciated after this treatment and the calf began to gain weight again. The calf was sedated for passage of a stomach tube and administration of milk replacer at 14 - 20 ml/kg daily for 10 days for nutritional support while waiting for the dam’s milk production to return.

As recommended by the AZA Elephant TAG Nutrition Advisory Committee, we have used Grober’s Asian elephant milk replacer formula to supplement one calf. This animal became dehydrated and constipated when this milk replacer was offered at the recommended concentration, requiring sedation and intravenous fluid therapy. When this milk replacer was diluted, the calf digested the formula well, gained weight, and maintained hydration. However, the diluted formula, in conjunction with the hay and grain the animal was consuming, did not offer adequate dietary calcium. To address this we began adding calcium carbonate to the formula and no further concerns have been noted either with formula tolerance or systemic calcium status.

Use of serum calcium or blood ionized calcium concentrations to monitor for calcium deficiency is relatively ineffective as blood calcium concentrations do not decrease until the animal reaches a critical state of hypocalcemia. Ionized calcium in our formula-supplemented calf was 1.36 mg/dl at the same time that radiographs and urine chemistry analyses strongly suggested nutritional hyperparathyroidism.

Monitoring urine for calcium and phosphorus excretion allowed us to document significant differences in our formula-supplemented calf before and after calcium was added to the formula. Urinary calcium and phosphorus values for a mother-reared calf and for adult animals suggest that excretion is relatively consistent for juveniles and adults (Table 1).

Radiographs were used to document signs of presumptive nutritional osteodystrophy in an 11 mo old calf. The formula-supplemented calf showed flaring at metaphyses and hypomineralization.
Radiology is a relatively insensitive tool for monitoring overall calcium status as significant changes may have occurred to the skeleton before they may be detected on radiographs.

Management of cases of elephant endotheliotropic herpesviral (EEHV) infection is challenging. Early detection and early intervention are key for a positive outcome. A 23 mo old elephant showed lameness of 2 days duration, decreased appetite, and subdued behavior. Although other “classic” symptoms were not evident at the time, as a precaution a voluntary blood sample was collected and submitted to the EEHV lab for testing and oral famciclovir treatment was initiated (see dosages below). Two days later we received PCR-positive results from the EEHV lab and began aggressive management of the animal.

Hypotension is a significant concern in EEHV patients and maintenance of hydration is critical. Colloids may be beneficial, especially in animals with compromised vasculature. Intravenous catheters were very hard to maintain, especially with an ambulatory animal. We used a combination of intravenous and rectal fluid administration to help maintain hydration. Whole blood transfusions may be indicated if severe anemia or thrombocytopenia develop.

Monitoring of an EEHV infected calf includes the following: blood pressure measurement; check for retinal hemorrhages and hematuria; monitor hematocrit and platelet count regularly; echocardiography for heart rate measurement and to monitor for pericardial fluid accumulation; peripheral blood oxygen saturation.

Dosages used for oral famciclovir administration were as follows. For an asymptomatic PCR-positive 36-mo-old calf in contact with the clinically affected calf, 7.8 mg/kg famciclovir was given p.o. b.i.d. For the clinically affected PCR-positive 23-mo-old calf, a 12 mg/kg loading dose of famciclovir was given p.o., followed by 8 mg/kg p.o. t.i.d.

Alternatively, ganciclovir was given instead of famciclovir. The dosage for intravenous use of ganciclovir in humans is 5 mg/kg b.i.d. We used ganciclovir orally in elephant calves at the same dosage, 5 mg/kg b.i.d. Preparation of ganciclovir for oral use was as follows: mix each vial of injectable ganciclovir (500 mg) with 3 ml sterile water, withdraw drug and place into beaker, add 50 ml oral sweetener, add 1 ml 3% hydrogen peroxide, mix well, and add sweetener to a final total volume of 100 ml.

| Table 1. Urinary calcium and phosphorus concentrations in Asian elephants. |
|---------------------------------|-----------------|-----------------|
| Calf prior to supplementation   | < 5 mg/dl       | 113 mg/dl +/- 30.7 mg/dl |
| Calf after supplementation     | 65 mg/dl +/- 52 mg/dl | < 3 mg/dl       |
| Mother-reared calf              | 93.8 mg/dl +/- 61 mg/dl | < 3 mg/dl       |
| Adults                          | 92 mg/dl +/- 54 mg/dl | < 3 mg/dl       |

2009 PROCEEDINGS AAZV AAWV JOINT CONFERENCE 63
BUILDING A “GREEN” ZOO HOSPITAL: BEFORE, DURING AND AFTER

Lisa A. Harrenstien, DVM, Dipl ACZM,1* Holly Reed, DVM,1 Stan Chapin,2 and Lee Campbell1

1Oregon Zoo, Portland, OR 97221 USA; 2Point Defiance Zoo & Aquarium, Tacoma, WA 98407 USA

Abstract

Awareness of environmental impact is integral to the mission of the modern zoological facility, therefore environmentally-sound “green” ideas have become embedded into the processes of designing, building and using a new zoo veterinary hospital. Use of sustainably-produced construction materials, reduction of usage of mainstream power sources (natural gas or coal) for electricity, reduction of water usage, and minimization of landscape disruption can all contribute to a smaller environmental impact than traditional methods. Some of these non-traditional methods do not cost more than traditional methods; some do involve a greater initial cost that is recouped by lower utility costs or greater educational/conservation benefit in the long run. “Green” design features that were proposed prior to construction of two zoo veterinary hospitals in the Pacific Northwest, as well as those that have been in use for several years, are listed and compared in this presentation.

Introduction

The voting taxpayers of the Portland, Oregon region approved a bond measure in 2008 that will provide approximately $125 million for improvements to the Oregon Zoo, including approximately $9 million for the design and construction of a new veterinary hospital and quarantine facility. Taxpayers of the Tacoma, Washington region approved a similar bond measure in 1999 for $35 million, $3.1 million of which was directed toward the construction of Point Defiance Zoo & Aquarium’s (PDZA) new 9000 ft² zoo hospital and quarantine facility in 2004. The governing authorities of both facilities realized that the construction and design features used in these two projects represented an unusual opportunity for public education regarding resource conservation; therefore “green” ideas were given great consideration in the design process.

Discussion

For each facility, a hospital design team was formed, comprised of zoo staff including veterinary team representatives, construction staff, and project managers. Oregon Zoo’s hospital design team held several brainstorming sessions and solicited other zoo and Metro staff members for additional ideas. Proposed “green” ideas could be grouped into several categories: choosing a site, schematic design, building systems (water, power, heating & ventilation), building construction materials, and procedures for use of the building once it is a functional zoo hospital (including community support and education). Oregon Zoo’s governing authority (Metro)
decided that Leadership in Energy and Environmental Design (LEED) certification of their new hospital/quarantine building was an important step to increase public understanding/awareness of sustainability and resource conservation at Oregon Zoo.

Some of the suggested construction elements were already considered to be part of standard “green” construction practices in the Pacific Northwest and therefore were not anticipated to add significant costs to the construction budget. These included the following:

- Basic stormwater management. Avoid directing all stormwater into drains, and instead collect and store it for other uses or use it for landscaping before slowly sending overflow to the storm sewer.
- Use of recycled materials in the site fill and site preparation (e.g., recycled glass cullet).
- Use of recycled content in construction materials, including steel, metal siding, gypsum board, ceiling, and fly ash concrete.
- Use of sustainable materials such as wood from certified forests or quickly renewable materials (e.g., bamboo).
- Management of demolition and construction waste, for example using old concrete from this demolition as nonstructural fill in later projects.
- Using materials produced locally/regionally, for example windows or concrete.
- Use of natural daylight for lighting (e.g., solatubes, skylights, and larger windows).
- Sensor control of lighting and heating/ventilation/air conditioning (HVAC) needs.
- Use of materials with low emission rates of volatile organic compounds.
- Low-flow plumbing fixtures.
- Design that captures solar energy for heat and/or light (e.g., designing the building with southern exposure).

Several rather non-traditional features were proposed that were anticipated to be more significant parts of the construction budget. These included the following:

- Roof landscaping / “green roof” / landscape islands. Approximate cost $40,000.
- Incorporation of a waste water treatment facility (a packaged pre-engineered “bioreactor”) to treat effluent sewage from the hospital/quarantine building so that it does not need to enter the sanitary sewer system. Approximate cost $55,000.
- An additional level of stormwater management – Harvesting rainwater from the roof and rooftop planters, using minimal filtration, then storing the water to use it for flushing toilets or rinsing down animal stalls in the same building.
- Solar water pre-heat – A prefabricated solar system on roof of hospital/quarantine building that would preheat the water that goes into the building’s hot water heater system. Approximate cost $10,000.
- Photovoltaic solar – Use solar exposure on roof of hospital/quarantine building to produce electricity that would be used in the same building. Estimated cost $50,000 or more.

Reduction of use of artificial light and reduction of energy use overall was an important goal to address in the design process. The following energy and lighting related features were proposed:
• Programmable HVAC and lighting in human and animal areas, with energy-saving settings in human areas
• Heated flooring. Although this is usually considered a human/animal comfort element, rather than a “green” element, “enhancement of human and environmental health” is a component of the LEED certification process.
• On-demand hot water heaters, instead of traditional stored volumes of hot water.
• Natural lighting if at all possible including skylights, solatubes (www.solatube.com), louvered windows, light scopes/shelves, and window light panels that reflect light onto the ceiling of the indoor space.
• Natural ventilation instead of air-conditioning, using openable windows especially in human areas.
• Compact fluorescent lights (lower-mercury type), extended life lamps, LED lighting.
• Metal roof without black glue, to reduce temperature of roof.
• Passive solar for water heating.
• Active solar (photovoltaic production).
• Fuel cell as backup for 12 volt LED lighting.
• Generate power (or at least heat) from “Zoo Doo.” At Oregon Zoo, it was determined that this would be cost-effective only on a whole-zoo basis, not developed just for the hospital/quarantine building.
• Use heat exchangers in HVAC system.
• Wind turbines for energy production.
• Incorporate good insulation on indoor/outdoor animal area shift doors.

Community support, community awareness and therefore education regarding our low-environmental-impact goals were addressed with the following proposed features:
• Decrease noise (disturbance to animals and neighbors) by enclosing or wrapping the electrical backup generator that is next to the hospital/quarantine building. Like heated floors, this feature addresses “enhancement of human and environmental health” as mentioned in the LEED certification process.
• Incorporate the sustainability/resource conservation message into public presentations at/about the hospital/quarantine building. Tell the story of what design choices were made and why. Give building tours to other zoo and Metro staff once it is complete.
• Install video link ability in hospital/quarantine area to send images to other more convenient visitor areas, so visitor amenities do not have to be built in hospital/quarantine building. However, will have explanatory displays and a small visitor-ready area in hospital for behind-the-scenes tours.
• Alternatively, if space is available in the hospital/quarantine building itself, build a classroom in the hospital building that can be used for “green/sustainable” training events or meetings, not just hospital tours.
• LEED certification of the hospital/quarantine building to increase public understanding/awareness of sustainability and resource conservation at the zoo.
• Install interpretative signs that are visible from the visitor train track, noting hospital location.
• Develop ways to measure the benefits of “green” design and procedures.
• Incorporate art into educational/interpretative space of hospital (e.g., art made from old radiographs).
• Minimize tree removal during site prep for building construction. Native plants that are removed from site during construction should be replanted either adjacent to building or elsewhere.
• Could combine art and solar power collection together, making artistic-looking solar panels.

General efficiency and “green-ness” of building design was addressed with the following proposed ideas:
• Integrate hospitalized and quarantine animal housing into the same building, reducing the amount of redundancy in facility space and materials.
• Re-use existing buildings for office space, instead of building office space into the new hospital/ quarantine building. This eliminates the need for a second story in Oregon Zoo’s new building and potentially saves 25% in overall project costs. At PDZA, existing buildings were incorporated into the new hospital footprint to provide personal locker space, a staff kitchen and animal commissary.
• Incorporate space for recycling bins.
• Use recycled/reused building material from existing/old building and from local sources.
• Use quarantine building’s demolition materials (cinder block concrete) as nonstructural fill, grinding it up and keeping it on zoo grounds for new structures.
• Flooring material made of recycled or renewable-resource materials (linoleum, polished ground concrete, terrazzo or glass tile, cork).
• Animal pools which use minimally-toxic methods for waste treatment instead of chlorine.
• Use recycled paint for walls.
• Use compacted gravel instead of asphalt in newly “paved” areas, thereby reducing asphalt use and distributing drainage in parking areas, for example.
• Improve kitchen compost program, for animal food/waste as well as human. Composting of human bathroom waste is not yet an option in the region.
• Use “carbon-neutral” products whenever possible.

Water use reduction was an important component of the design, especially for Oregon Zoo, since the Oregon Zoo has the highest water use of all Metro facilities and Metro has a goal of 50% water use reduction. This was addressed with the following proposed features:
• Bio-reactor waste treatment system active on stormwater, making stormwater available for a variety of uses. This could include plant irrigation, animal enclosure washdown, and possibly toilets.
• Landscaped islands on roof, using native plants that are butterfly or bee attractants; this reduces the need for irrigation but still provides plant growth. Some of these plants are able to be harvested as browse sources for animal nutrition and enrichment. Or could maintain the entire roof as a “green roof”, other than skylight portals.
• Aquatic animal holding area’s pool should have a filtration system installed, to reduce need for dump and fill.
• Low-flow shower heads in human areas.
• Low-flow dual-flush toilets in human areas.

Unique challenges are encountered during the design, construction and use of any new zoo hospital and quarantine facility. The “brainstorming” phase is extremely important during hospital design planning, considering many more design features than will ever be possible or practical. Communication with other zoo facilities, learning from their experiences, helps prioritize those design features that be of greatest benefit in the long term for both your zoo and the planet.

LITERATURE CITED

LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED) CERTIFICATION OF GREEN BUILDINGS

Holly Reed, DVM\textsuperscript{1} \textasteriskcentered{} and Karen Davis Smith, LEED AP\textsuperscript{2}

\textsuperscript{1}Point Defiance Zoo & Aquarium, Tacoma, WA 98407 USA; \textsuperscript{2}Jones + Jones Architects and Landscape Architects, Seattle, WA 98104 USA

Abstract

The idea of certifying a “green” building under the Leadership in Energy and Environmental Design (LEED) rating system is becoming a more common consideration for new building projects. The point of LEED certification is to address all aspects of building a new facility, from design considerations, site prep, use of recycled materials and creating a healthier working environment for the staff and, in the case of zoos and aquaria, living situation for the animals. LEED certification communicates to the public that your building addresses functional elements in the areas of energy savings, water efficiency, CO\textsubscript{2} emissions reduction, improved indoor environmental quality, and stewardship of resources along with sensitivity to their impacts. In order to meet the requirements for this certification, detailed documentation must be initiated early in the design process. There are several resources available on-line to aid in defining LEED certification, determining eligibility, and initiating the process. This presentation will explore considerations involved, summarize the process, and identify helpful resources and alternatives.

Introduction

Since its inception in 1998, the LEED green building rating system, developed and administered by the U.S. Green Building Council, a Washington D.C.-based, nonprofit coalition of building industry leaders, was designed to promote design and construction practices that increase profitability while reducing the negative environmental impacts of buildings and improving occupant health and well-being.\textsuperscript{1} This rating system has promoted a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. As zoos and aquaria continue to seek ways to actively live their mission as conservation organizations, LEED certification of new building projects is a concrete and public way to accomplish this and educate the community at the same time. The certification process is tedious, requires extensive documentation, must be initiated early in the design phase, may extend building deadlines, and will be an added expense. Increased construction costs due to the incorporation of green features can be mitigated somewhat by seeking donation of materials or taking advantage of incentive programs, property tax exemptions, and zoning allowances designated for buildings that qualify for LEED certification. In the long run, organizations building LEED certified facilities are seeing decreases in overall operational costs and creating healthier environments for building occupants, whether human or animal, as well as demonstrating leadership, innovation and environmental stewardship.
Why Build Green?

Buildings can have a significant impact on the environment of the planet. In the U.S., buildings account for 65.2% of total electricity consumption, 30% total greenhouse gas emissions, 136 million tons of construction and demolition waste, 12% potable water, and 40% raw materials used globally. Five billion gallons of potable water are used solely to flush toilets, and a typical North American commercial construction project generates up to 2.5 pounds of solid waste per square foot of completed floor space.²

Green buildings can considerably reduce or eliminate negative environmental impacts. They can increase worker productivity, reduce operating costs, and add to marketability.³ A sustainably-designed building, habitat, or campus can celebrate and communicate the unique features of a zoo by emphasizing environmental responsibility. Other benefits of sustainable design include reducing natural resource consumption, improving the bottom line, enhancing occupant comfort and health, and minimizing strain on local infrastructures. Green design fosters environmental, economic and social benefits for both building stakeholders and the public at large.

What is LEED Certification?

LEED certification is a voluntary, third-party verified rating system designed by the US Green Building Council (USGBC) for developing high-performance, sustainable buildings. The standards established for LEED certification rating systems are developed through an open, consensus-based process led by LEED committees. Each volunteer committee is composed of a diverse group of practitioners and experts representing a cross-section of the building and construction industry. The key elements of USGBC’s consensus process include a balanced and transparent committee structure, technical advisory groups that ensure scientific consistency and rigor, opportunities for stakeholder comment and review, member ballot of new rating systems, and a fair and open appeals process.⁴

Certification can be sought for the following project types: New commercial construction and major renovation projects (LEED-NC), Existing building operations (LEED-EB), Commercial interiors projects (LEED-CI), Core and shell projects (LEED-CS), Homes (LEED-H), and LEED for Schools. Pilot programs include LEED for Retail, Neighborhood Development (LEED-ND), and LEED for Health Care. Projects may be eligible for Certification under more than one rating system. Different versions of the rating system are available for specific project types. Of specific interest is the Green Guide for Health Care (GGHC), which is published jointly by USGBC and GGHC. It is a toolkit for health care institutions to guide them in the sustainable planning, design, construction, operations and maintenance of their facilities.⁵

Within the LEED-NC rating system, a Multiple Building or Campus approach can be taken. This allows for several options including certifying an entire campus of new buildings with one certification achieved as if they were equivalent of one building, certifying a new building within a setting of existing buildings that are considered a campus, and certifying new buildings within a campus setting with individual ratings.⁶ These approaches can result in increased economy
through shared credits that can reduce documentation efforts, especially for site and infrastructure, energy and water credits.

The rating system levels for commercial construction are Certified, Silver, Gold and Platinum. These correspond to the number of credits accrued in five green design categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources and indoor environmental quality, and one additional Innovation in Design category that allows for new ideas. To earn LEED certification, a project must satisfy all prerequisites and earn a minimum number of points outlined in the LEED Rating System under which it is registered.

Regional Prioritization by zip code has been incorporated into the rating system. Some credits are given more points for some areas of the country. Largely, this is split by rural versus urban, but there are more specific differences by locale. So far, projects outside the United States are not weighted differently, but in 2003, the Canada Green Building Council received permission to create its own version of LEED based upon LEED-NC 2.0, now called LEED Canada-NC v1.0

What is the LEED Certification Process?

To gain a more in-depth understanding about LEED, visit the U.S. Green Building Council (http://www.usgbc.org), Green Building Certification Institute (http://www.gbcio.org), or Natural Resources Defense Council (http://www.nrdc.org) websites or consult a LEED Accredited Professional (LEED AP). Simply put, the process involves:

1. **Determining eligibility** – If you are unsure whether your building project is a candidate for LEED certification, review the LEED Rating System Checklist that applies to your project and tally a potential point total. Your project is a viable candidate for certification if it meets all prerequisites and can achieve the minimum number of points necessary to earn at least Certified level. An integrated project team should be established, including major stakeholders of the project, such as the developer/owner, LEED AP, architect, engineer, landscape architect, contractor, and asset and property management staff.

2. **Registration** – Go to www.leedonline.com to register your project on-line once the rating system has been determined and the registration fee has been paid. The Green Building Certification Institute (GBCI) administers this process. Registration and Certification fees will vary depending on USGBC membership status. Certification fees are based on the rating system under which the project is certifying and the size of the project. This fee is paid when the project team submits documentation for review via LEED-Online. Certification fees are refunded if project achieves Platinum rating for NC, EB, CI, CS, and schools. A reasonable number of Credit Interpretation Rulings (CIRs) should be estimated and fees apply per CIR. From here, the project team is assembled to begin the documentation process.

3. **Application Preparation** – Throughout the design and building phase, each LEED credit and prerequisite requirement must be completed and documented as a part of the application process. While preparing the application, the project team selects the credits it has chosen to pursue and assigns the credits to the responsible team members. When the necessary documentation has been assembled, the project team will upload the materials to LEED Online and start the application review process.
4. Application Submission – To initiate the review process, a complete application must be submitted via LEED-Online by the Project Administrator. Requirements for a complete application vary according to the review path, but will always include payment of the appropriate certification review fee. For design & construction rating systems (all rating systems except EB), the project team administrator has two options for submission: Combined Design & Construction Review, or Split Design & Construction Review. The Combined Review is available only to projects that have reached substantial completion. The Split Review is available to projects that are ready to submit "Design" credits for review prior to substantial completion of the project.

5. Application Review and Certification – Upon receipt of a complete submission, a formal review will be initiated. All documentation is reviewed for completeness and compliance, each prerequisite and credit will be designated as ‘anticipated’, ‘pending’ or ‘denied’, and all project information forms are designated as ‘approved’ or ‘not approved’ with technical advice supplied. There is an optional final review in which credits will be ‘awarded’ or ‘denied’. An appeal process is available. Certified projects receive a formal certificate of recognition, information on how to order plaques, certificates, photo submissions, and marketing, and may be included in the online directory and the U.S. Department of Energy High Performance Buildings database.⁸

Tips for Success

Tips for getting LEED certified as recommended by the Natural Resources Defense Council (NRDC) include setting clear environmental targets (i.e., LEED certification level), establishing a clear and adequate budget, and maintaining the environmental and economic integrity of your project. Planning for more points than needed for your intended target certification level is beneficial. Additionally, as your project is value-engineered, be sure to examine green investments in terms of how they will affect expenses over the entire life of the building. Before you decide to cut a line item, look first at its relationship to other features to see if keeping it will help you achieve money-saving synergies, as well as LEED credits. Many energy-saving features allow for the resizing or elimination of other equipment, or reduce total capital costs by paying for themselves immediately or within a few months of operation. Some points have critical relationships with other points, so removing one could eliminate others. Prior to beginning, set your goals for "life cycle" value-engineering rather than "first cost" value-engineering.⁹ Hiring LEED-accredited professionals can streamline your process. They can also suggest ways to earn LEED credits without extra cost and identify means of offsetting certain expenses with savings in other areas. The project should be reviewed prior to starting construction using the LEED design submittal. Following these tips should help lead to a successful LEED Certification.

Is LEED Certification the direction to take for your building project?

Consistent with the mission of conservation at the core of all AZA accredited institutions, acquiring LEED certification for all building projects would be ideal. Many real life issues including project budgets and the economy make that a challenging goal. LEED Certification and Silver ratings are generally achievable without additional construction costs, but with simply good design and attention to goal. LEED Gold and Platinum can add to construction costs
depending on the size and complexity of the project and the technologies implemented. Additional costs are incurred for LEED documentation in all cases to varying degrees, but these can be offset by savings gained by lower operating and maintenance costs, lower energy and water usage, synergies between design disciplines and technologies, increased project value, and natural resource benefits. Additional oversight and management required for the project is another disadvantage, but good planning and early team integration can minimize this issue.

LEED Certification offers many advantages, including that plaques can be made visible to zoo or other patrons as a tangible benchmark of sustainability that is recognized and valued by an international public, certifications achieved can be used in marketing strategies to increase visitor attendance, third party validation of achievement, use as a communications tool to help tell the story of conservation and sustainable efforts, illustrate to the community the high level of consideration for animal and employee well-being, and reinforce the importance of environmental responsibility while providing a tangible platform for learning.

There is great long-term value in LEED certification contributing to the quality of life and good stewardship of our planet, but if actual certification doesn’t work out for a building project there are still sustainable alternatives. There is still the ability to incorporate green features and prepare the site and building for future green additions. The organizations referenced in this paper and LEED certified professionals are valuable resources for determining which green features are the most beneficial for your building. LEED requirements can be utilized as guidelines for the design of the project even if formal submittal is not undertaken, and there are other green building standards and ratings that are useful as well. These include the Green Guide for Health Care, Green Globes, BREEM, Energy Star, Cascadia’s Living Building Challenge, and World Wildlife Fund’s One Planet Living. Simply hiring a knowledgeable design team will go a long way towards accomplishing a sustainable project. Every step taken in a building project toward incorporating sustainability, reducing carbon footprint and improving environmental quality is a step in the right direction.

Resources

BRE Environmental Assessment Method http://www.breeam.org
Cascadia Region Green Building Council http://www.cascadiagbc.org/lbc
Energy Star http://www.energystar.gov
Green Building Certification Institute http://www.gbcio.org
Green Globes http://www.greenglobes.com
One Planet Living http://www.oneplanetliving.org

LITERATURE CITED

2. LEED Reference Guides by USGBC
3. LEED Reference Guides by USGBC
6. LEED-NC Application Guide, Multiple Buildings & On-Campus Building Projects by USGBC
MEDICAL AND MANAGEMENT CHOICES FOR GREENING VETERINARY CLINIC OPERATIONS

Gretchen E. Kaufman, DVM

Tufts Cummings School of Veterinary Medicine, North Grafton MA 01536 USA

Abstract

Options and approaches for greening every day activities in a zoo veterinary practice will be presented with major emphasis on energy, waste management, recycling and methods for choosing materials used in common veterinary practice. Every year more than 2 million tons of waste is produced by medical facilities in the United States.\(^1\) While the number of zoo veterinary hospitals does not significantly contribute to this number, veterinary practices nationwide should not be left out of the larger sustainable health care movement. In most cases, changing the culture in a veterinary hospital to follow the simple rules of “reduce, reuse, recycle” can be easily implemented with minimal effort and often great savings in energy costs, waste management costs, and inventory. This requires up front effort to systematically assess the inputs and outputs in a hospital operation and identifying priority changes that will lead to more careful and less wasteful practices.

A multi-year study was conducted at Tufts Cummings School of Veterinary Medicine hospitals to identify the most commonly used products in medical practice and identify their environmental and health impacts from manufacture to disposal. Alternative products were identified where possible for products that had particularly negative impacts. A veterinary practice assessment guide was created and tested in a local veterinary clinic to help practice managers conduct their own assessment and identify areas for improvement. This information has been transformed into a website, GreenVetPractice.com, that also includes basic strategies and suggested options for energy reduction, responsible water and waste management practices and options for greening building and grounds.

LITERATURE CITED

Abstract

While not generally considered charismatic mega-vertebrates, iguanas of the genus Cyclura are the largest endemic vertebrates in the Caribbean, among the most endangered lizards in the world, and are in fact, quite charismatic! The International Union for the Conservation of Nature (IUCN) Iguana Specialist Group (ISG) has been developing Species Recovery Plans (SRP) for several of the most critically endangered species, and veterinary work has played a prominent role in these conservation efforts. Hispaniola is the only island in the Caribbean with two sympatric species of Cyclura. Ricord’s iguanas (Cyclura ricordii) are critically endangered (CR) according to the IUCN Red List and found only in 4 small, isolated populations. Rhinoceros iguanas (Cyclura cornuta) are considered vulnerable (VU) and are found in numerous habitats on the island. In 2002 the ISG met in the Dominican Republic to develop the Ricord’s Iguana SRP. This plan detailed a recovery process including surveys of iguana populations, floristic and ecological surveys, biomedical and genetic work, behavioral assessments, captive breeding, public awareness and fund raising. Progress has been slow but steady. The local Non-governmental Organization (NGO) Grupo Jaragua has concentrated its efforts on the populations south of Lago Enriquillo, and has done considerable nest mapping, local education and land procurement. An exciting recent development is the discovery of a small C. ricordii population in Haiti, and Grupo Jaragua is conducting a socioeconomic study of the people in the area, in relation to the iguanas and their habitat, as a first step in protecting that population.

The Indianapolis Zoo has been working for the past 9 yr with the population of C. ricordii on Isla Cabritos, which is a Dominican National Park. Vitamin D, serum chemistry, microbiology, and morphometrics have previously been published as have preliminary survey data. In 2005 collaborative efforts between Grupo Jaragua, Parque Zoologico Nacional (Zoodom; the national zoo of the Dominican Republic) and the Indianapolis Zoo produced an iguana conservation curriculum designed for the third grade classroom. This curriculum was very popular during teacher workshops in 2006, and is now being implemented in Dominican schools. Indianapolis Zoo also partners with Zoodom to assess the health of the animals in Zoodom’s thriving captive breeding program for C. ricordii. A comparison of biomedical parameters of the captive and free-ranging population of both C. ricordii and C. cornuta revealed some interesting differences. Preliminary results show that captive C. cornuta white blood cell counts are subjectively than for free-ranging animals, with no clinical signs of disease. This was not the case for C. Ricordii, where no difference could be detected. The captive C. cornuta are held in very large, multi-
gender groups, in relatively small enclosures, while the *C. ricordii* are in pairs in large enclosures. The observed increase WBC in captive *C. cornuta* may be attributable to chronic stress, and Zoodom staff are investigating other housing options. In 2008 a floristic study was initiated in hopes of developing a comprehensive nutritional profile of the food plants endemic to the iguana’s natural habitat. These data will not only allow for the distinction of individual plant species but also the determination of frequency and density of all plant populations including food plants found on the island. At the same time plasma samples were submitted to a commercial laboratory to determine mineral status from both captive and free ranging iguanas. Preliminary data analysis has yielded interesting results with extensive discrepancies observed in both *C. ricordii* and *C. cornuta*. For example, selenium, which can be toxic in large doses to multiple species, was determined at an approximately seven times higher prevalence in free ranging versus captive iguanas. The elevated levels of this metabolite yielded no apparent deleterious pathologies in the free ranging subjects. Upon analysis, two plant species, *Prosopis juliflora* and *Conocarpus erectus* both exhibited selenium concentrations above 5.0 ppm. This information combined with fecal dissection data and extensive coverage class scores within the island terrain identifies them as potentially significant food plants within the wild type diet.

In addition to the biomedical, nutritional and floristic work Indianapolis Zoo and Zoodom staff continue annual iguana population surveys and hope to begin telemetry tracking in the coming years. This long-term, cooperative conservation program has been rewarding. Steady progress has been made in increasing our understanding of the biology and ecology of these animals, in local public conservation education, and finally in moving toward better protection for the fragile populations of this critically endangered species.

**ACKNOWLEDGMENTS**

The authors thank Dr. Gerard Garcia-Dubus, Jennifer Niederlander, Renae Burks, Jon Pilarski, John Wyatt, Richard Searcy, and Richard Reams, the Lago Enriquillo Guides, Zoodom and Grupo Jaragua for their hard work and support of this project. We also thank the Maine Community Foundation, US Fish and Wildlife – Wildlife Without Borders Program, AZA Conservation Endowment Fund, International Iguana Foundation, International Reptile Conservation Foundation, AAZV Mazuri Grant, AZVT Member Grant Fund, and Indianapolis Zoo for financial support.

**LITERATURE CITED**


EVALUATING THE EFFICACY OF ORAL VS INTRAMUSCULAR ADMINISTRATION OF DISTEMPER VACCINE AND INTRAMUSCULAR RABIES VACCINE IN CAPTIVE AFRICAN WILD DOGS (Lycaon pictus)

Maren Connolly, DVM,1* Patrick Thomas, PhD,2 Rosie Woodroffe, PhD,3 and Bonnie L Raphael, DVM, Dipl ACZM1

1Global Health Program, Wildlife Conservation Society, Bronx, NY 10460 USA; 2Living Institutions, Wildlife Conservation Society Bronx, NY 10460 USA; 3 Institute of Zoology, Regent's Park, London, NW1 4RY

Abstract

A series of three vaccinations (Purevax Ferret™, Merial Limited, Athens, GA 30601) was administered at 1-mo intervals, orally (n=8) or intramuscularly (n=7), to 15 previously unvaccinated juvenile African Wild Dogs (AWD) at the Bronx Zoo. Titers were measured by serum neutralization at each vaccination and 3 mo post-3rd vaccination. All titers were negative for orally vaccinated animals; 5/7 animals of the injection group were positive at 3 mo post-3rd vaccination.

One dose of rabies vaccine, (Imrab3™, Merial Limited, Iselin, NJ, 08830), was administered i.m. to 29 Bronx Zoo AWD. Titers, measured by Rapid Fluorescent Focus Inhibition Testing (Kansas State University) at the time of vaccination were negative (<1:5) and were measured up to 43 mo post vaccination. All animals, sampled from 3-43 mo post vaccination, had positive titers and no vaccinated animal seroconverted to negative.

Oral vaccination with Purevax Ferret™ cannot be recommended for use in AWD. Additionally, 29% did not have protective titers 3 mo following i.m. vaccination series. No recommendation can be made regarding frequency of subsequent vaccinations based on these data. A single rabies vaccination resulted in titers in all vaccinated AWDs up to 43 mo post injection, supporting the use of a single i.m. vaccination to provide long-term protection for free-ranging AWD populations.
SUMATRAN ELEPHANT VETERINARY MEDICINE WORKSHOP

Jeffry S. Proudfoot, DVM,1* Christopher Stremme, DVM,2 and Jennifer Niederlander, RVT1

1Indianapolis Zoo, Indianapolis, IN 46222 USA; 2Veterinary Society for Sumatran Wildlife Conservation, Medan, Sumatra 20126 Indonesia

Abstract

Sumatra is the home range of the most endangered Asian elephant subspecies Elephas maximus sumatranus. An increasing human population, loss of forest for agricultural use and poaching has resulted in human-elephant conflicts. Due to these increasing threats on the long-term survival of the elephants of Sumatra, the Indonesian government elected to capture elephants for placement in Elephant Conservation Centers (ECC). Beginning in 2006 there are about 600 captive Sumatran elephants residing in elephant conservation centers under governmental management or in privately managed facilities like zoos, safari and recreation parks and timber companies.2 There are a number of problems in all these elephant conservation centers which include a lack of veterinary supplies and equipment, poorly trained staff, and sporadic veterinary services.1 Following a trip on behalf of the International Elephant Foundation (IEF), to the Seblat ECC in Benkulu province, Sumatra, we obtained funding to conduct a veterinary training workshop. This funding was sought due to the current veterinary practice at the Seblat camp which consisted solely of annual visual examinations and vaccinations for rabies and tetanus, anthelmintic treatment orally with ivermectin, and body weight determinations. We believed that with proper training of staff, a more thorough annual examination could be accomplished as well as additional veterinary services. The workshop conducted in June 2008 was hosted by the ECC in Way Kambas, southern Sumatra, and attended by camp veterinarians, veterinary paramedics and mahouts. Goals of the workshop were as follows: 1) improve knowledge of the elephant caretakers through presentation of lectures on preventive health care, anatomy, physiology, common diseases, medical treatments and surgical techniques; 2) use workshops to provide instruction on collection and processing of biologic samples, performing a complete physical exam, complete blood count, fecal parasite exams, urinalysis and parasite identification; and 3) distribute a laboratory manual describing the proper care of laboratory equipment (e.g., microscope, centrifuge, refractometer, hemacytometer), processing of biologic samples and images depicting blood cell types and common parasites. The workshop although originally designed for 15 participants, was attended by over 50 individuals including veterinarians, government officials, veterinary paramedics and mahouts representing the six ECC’s in Sumatra as well as other elephant facilities in Indonesia. The President of the Indonesian Veterinary Medical Association indicated the interest was a result of this being the first workshop of its kind for veterinary paramedics in Indonesia. Participants were enthusiastic and many demonstrated a desire to increase their knowledge and develop skills necessary to perform laboratory tests and assist camp or visiting veterinarians in providing care for the elephants. The knowledge base, experience level and skill set varied considerably among participants. Some participants reported that their camps lack the necessary equipment to perform the laboratory tests while others reported they had the equipment but expressed doubts this would be considered a priority.
by their camp managers. Future workshops will seek funding to address the specific needs of each camp, help obtain equipment, provide camp managers with a first hand demonstration of the benefits of an improved health care program and tailor the laboratory curriculum to the individual veterinary paramedic and mahout. We feel continuation of elephant care workshops for veterinary paramedics and mahouts will result in sufficient and sustainable health care for this genetically valuable population of Sumatran elephants.

ACKNOWLEDGMENTS

This workshop was funded by the International Elephant Foundation, the Disney Worldwide Conservation Fund and the Veterinary Society for Sumatran Wildlife Conservation. The authors thank the staff at the National Park and Elephant Conservation Center at Way Kambas for hosting this workshop particularly Pak Nazaruddin, the translators Drh. Andriansyah (Sumatran Rhinoceros Sanctuary) and Drh. Wahdi Azmi (FFI) as well as Drh. Muhammad Wahyu (Vesswic) and Heidi Riddle (IEF).

LITERATURE CITED

HEALTH ASSESSMENT OF EASTERN HELLBENDER (*Cryptobranchus alleganiensis alleganiensis*) POPULATIONS IN OHIO AND WEST VIRGINIA

**Rachael B. Weiss, DVM,¹ * Tiffany M. Wolf, DVM,² Allan P. Pessier, DVM, Dipl ACVP,³ Joe Greathouse,⁴ and Barbara A. Wolfe, DVM, PhD, Dipl ACZM¹**

¹The Wilds, Cumberland, OH 43732 USA; ²Minnesota Zoo, Apple Valley, MN 55124 USA; ³Wildlife Disease Laboratories, Zoological Society of San Diego, San Diego, CA 92112 USA; ⁴Good Zoo at Oglebay Resort, Wheeling, WV 26003 USA

**Abstract**

The Eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) is listed as an endangered species in Ohio and is considered to be a Species of Greatest Need of Conservation in every state in which it occurs. Populations of the Eastern hellbender have declined in distribution and abundance due to a variety of anthropogenic factors. The objective of the current study was to conduct health assessments for hellbender populations in both Ohio and West Virginia to establish baseline information and lay groundwork for future studies evaluating the impact of various environmental factors on hellbender health. Health assessments were performed on hellbenders captured as a part of ongoing hellbender population surveys in Ohio and West Virginia during the natural breeding season (June to September) in 2006-2008. Physical examinations were conducted on all individuals and included body weight, snout-vent length, blood collection for hematology and serum chemistry, skin swabs for chytridiomycosis (*Batrachochytrium dendrobatidis*) identification (PCR) and cloacal swabs for ranavirus (family iridoviridae) detection (PCR). To date, a total of 73 animals have been sampled in Ohio and West Virginia [n=32 (OH), n=41 (WV)]. Hellbender populations in OH and WV differ significantly with respect to hematologic profiles. Specifically, OH hellbenders demonstrate a higher proportion of lymphocytes (μ ± sem: 70.3 ± 2.5%) than WV hellbenders (60.4 ± 2.3%, P<0.01), whereas WV hellbenders show a higher proportion of heterophils (30.2 ± 2.0 vs. 20.4 ± 2.1%, p<0.01), total protein (1.46 ± 0.13 vs. 1.01 ± 0.09 g/dl, p<0.01) and globulin levels (1.85 ± 0.11 vs.1.55 ± 0.06 g/dl, P<0.05) compared to OH hellbenders. Interestingly, during the sampling period of June to September, it appears that serum calcium levels are higher in female (9.9 ± 0.5 mg/dl), than in male hellbenders (7.3 ± 0.1 mg/dl), in both states (P<0.01). *Batrachochytrium dendrobatidis* has been identified in both Ohio (n=1; 2007) and West Virginia (n=3; 2007) hellbender populations. These data provide a reference point that will be utilized to continue the health monitoring program and will help to direct further research to identify specific factors impacting hellbender populations in Ohio and West Virginia.

**ACKNOWLEDGMENTS**

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CONSERVATION OF THE BLACK-FOOTED FERRET (*Mustela nigripes*) IN THE CONATA BASIN AREA OF SOUTH DAKOTA

Jerry Murray, DVM

Animal Clinic of Farmers Branch, Dallas, TX, 75234 USA

Abstract

The black-footed ferret (*Mustela nigripes*) is a highly endangered species that has been reintroduced into several sites in South Dakota. Veterinarians have played an important role in establishing a preventive health program for the free-ranging South Dakota black-footed ferret population, and in the development of reproductive techniques for use in the captive breeding program. Routine veterinary care of free-ranging black-footed ferrets in South Dakota happens twice each year. Each fall, starting in 1997, as many of the young kits and adults of the roughly three hundred ferrets in the Conata Basin area are captured. The kits and adults without a microchip are sedated with isoflurane gas (IsoFlo, Abbott Laboratories, 100 Abbott Park Road, Abbott Park, IL 60064-3500 USA) and oxygen. While they are sedated, they are vaccinated for canine distemper with a commercial, recombinant vaccine (Purevax Ferret Distemper, Merial Limited, 3239 Satellite Blvd., Duluth, GA 30096-4640 USA), vaccinated with a recombinant F1-V fusion protein plague vaccine (Dr Tonie Rocke, U. S. Geological Survey, National Wildlife Health Center, 6006 Schroeder Road, Madison WI 54711 USA), implanted with an AVID microchip (AVID Identification Systems, Inc., 3185 Hamner Ave., Norco, CA 92860 USA), and topically treated with Frontline spray (0.29% fipronil, Merial Limited, 3239 Satellite Blvd., Duluth, GA 30096-4640 USA) for flea and tick control. Adults that already have a microchip receive a booster of the distemper vaccine and plague vaccine without any sedation. In the spring adult males are captured for semen collection. The semen is cryopreserved and used in the captive breeding program.

Infectious disease outbreaks have wiped out entire populations of black-footed ferrets. Sylvatic plague (*Yersinia pestis*) is one of these devastating diseases, and it threatens the long-term survival of the black-footed ferret throughout its entire range. In May of 2008, plague was discovered in the Conata Basin recovery site in the Buffalo Gap National Grassland. Federal agencies decided to dust the prairie dog colonies in an attempt to reduce fleas and limit the outbreak. Roughly eleven thousand acres were treated with DeltaDust (0.05% deltamethrin, Bayer Environmental Science, 95 Chestnut Ridge Road, Montvale, NJ 07645 USA). In addition the black-footed ferrets in the area were captured and vaccinated with the recombinant F1-V plague vaccine and topically treated with Frontline spray. Two hundred and sixteen black-footed ferrets were vaccinated between June and November. Despite this labor intensive effort, roughly fifty to sixty black-footed ferrets succumbed to plague in 2008. Overall this number represented approximately 20% of the ferret population in this site, and thus the vaccination and flea reduction program was considered very successful as plague epizootics can have up to 100% mortality.
CONSERVATION OF THE ANDROS IGUANA (Cyclura cychlura cychlura)

Trevor T. Zachariah, DVM, MS,1* Charles R. Knapp, MS, PhD,2,3 L. Michael Romero, MS, PhD,4 and Rimme S. Singh, DVM5

1Chicago Zoological and Aquatic Animal Residency Program, College of Veterinary Medicine, University of Illinois, Urbana, IL 61802 USA; 2John G. Shedd Aquarium, Chicago, IL 60605 USA; 3San Diego Zoo’s Institute for Conservation Research, Escondido, CA 92027 USA; 4Department of Biology, Tufts University, Medford, MA 02155 USA; 5Department of Pathobiology, College of Veterinary Medicine, University of Illinois, Urbana, IL 61802 USA

Abstract

The Andros iguana (Cyclura cychlura cychlura) is the largest endemic terrestrial vertebrate species in the Bahamas. Yet, with less than 5000 individuals estimated remaining in the wild, the Andros iguana is considered endangered under the International Union for Conservation of Nature (IUCN) Red List criteria and is listed under Appendix I of the Convention on International Trade of Endangered Species (CITES). The Andros iguana is threatened by multiple natural and anthropogenic factors, and enforcement of wildlife laws is lacking. Since 1999, scientists from the John G. Shedd Aquarium have been studying the biology and natural history of C. c. cychlura. Efforts have also been made to promote education and conservation of the species through outreach in local communities on Andros Island. In conjunction with the Bahamas National Trust, researchers hope ultimately to establish a national park within the southern part of Andros Island for protection of the iguana and other native plant and animal species.

In March 2009, we initiated a veterinary component to the ongoing studies of C. c. cychlura. In conjunction with a long-term mark-recapture study, 35 sub-adult and adult iguanas (14 male, 21 female) were captured. Blood was collected within 3 min, and then each iguana was placed in a cloth bag for up to 6 hr. After a specified amount of elapsed time, a second blood sample, along with additional biologic data, was collected before releasing iguanas at the site of capture. The initial blood samples were used to determine reference intervals for blood gas, complete blood count (CBC), standard biochemical profile, plasma protein electrophoresis, vitamin D nutritional (i.e., vitamins A and E, beta-carotenes, trace minerals), and corticosterone (CORT) values. The second blood samples were used to determine iguana stress response to short-term confinement, via changes in the CORT and CBC values after various time intervals. Blood smears to establish CBC differentials were made with and without 22% bovine serum albumin to determine if the product increases the quality of cell preservation in this species. By partnering with field biologists, and linking a veterinary medical component to an ecological study of the Andros iguana, we increase our ability to manage an endangered species effectively. We hope that this study is only the beginning of research into the conservation of the Andros iguana from a veterinary medical perspective.
ACKNOWLEDGMENTS

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REHABILITATION AND RELEASE OF INJURED AND ORPHANED FLORIDA PANTHERS (*Puma concolor coryi*) AS A MANAGEMENT TOOL FOR POPULATION RECOVERY

**Mark W. Cunningham, DVM, MS,** *Karen Zeigler-Meeks,* **Scott B. Citino, DVM, Dipl ACZM,** **E. Darrell Land, MS,** and **Linda Penfold, PhD**

1Florida Fish and Wildlife Conservation Commission, Gainesville, FL 32601 USA; 2White Oak Conservation Center, Yulee, FL 32097 USA; 3Florida Fish and Wildlife Conservation Commission, Naples, FL 34104 USA

**Abstract**

The Florida panther (*Puma concolor coryi*) historically ranged over southeastern North America but by the late 20th Century had been reduced to a single remnant population occupying the remote regions of South Florida. Several management actions beginning in the early 1980s, including genetic restoration, increased law enforcement, highway underpasses, habitat conservation, prey management, and panther rehabilitation, led to a rebound from as few as 20-30 to at least 87 by 2003.

With a population numbering <100, individual panthers represent a significant proportion of the genetic structure of the population. Therefore the rescue, treatment, and rehabilitation of individuals unable to survive in the wild may contribute to the genetic diversity of the population if the individual can be returned to the population. Additionally, the maintenance of a captive population also may serve as insurance against a catastrophe extirpating the entire subspecies and provide secondary public education.

The removal of a panther from the wild generally occurs when a panther is too injured, debilitated, or immature (orphaned) to survive in the wild, or if the panther is believed to pose a safety concern to humans. Due to inherent risks in removing panthers for treatment or rehabilitation, panthers are treated in the field if possible, and population managers err towards keeping the panther in the wild if there is a reasonable chance of survival. Risks to removal include escape, treatment or anesthetic complications, self-injury (e.g., broken teeth), loss of home range, stress, and habituation to humans. When removing a panther the primary goal is to return the panther to the wild unless the panther is removed for human safety reasons or if the risk of habituation is too great (e.g., orphaned neonatal kittens).

Injured panthers were stabilized in the field and then transported to the University of Florida College of Veterinary Medicine (Gainesville, Florida) or other veterinary facilities or zoos for initial treatment and/or surgery. Panthers received further treatment and rehabilitation at White Oak Conservation Center (Yulee, Florida), a private captive wildlife conservation center. Consistent with the stage of recovery (e.g., severity of injuries, presence of external fixation devices, need for direct monitoring, and type and frequency of treatment) panthers were housed in progressively larger enclosures. When completely recovered (or sufficiently mature in the case...
of orphaned kittens), panthers were moved to a 12 acre wooded enclosure containing free-ranging prey until deemed suitable for release. At all times during recovery contact with humans was minimal. Recovered panthers were immobilized, radio-instrumented, crated, and transported to South Florida for release usually close to or within their former home range.

Since 1984, 37 panthers have been removed from the wild including 17 injured juveniles/adults (due to vehicular trauma \( n=9 \), capture-related injuries \( n=3 \), intraspecific aggression \( n=1 \), and other injuries \( n=4 \)), eight orphaned kittens, one adult for reproductive evaluation, and one adult due to human safety concerns. In 1991-92 ten panther kittens were removed as part of a now defunct captive breeding project.\textsuperscript{5} Eight remained in captivity permanently and two were released in 1997 but died within 6 mo due to suspected toxicosis. As these panthers were not removed for rehabilitation they are not included in this report.

Orphaned neonatal kittens requiring hand-feeding and panthers removed for human safety reasons were permanently maintained in captivity. Due to severity of their injuries, three panthers remained in permanent captivity and six were euthanatized or died during treatment. Of the 25 panthers removed for treatment/rehabilitation 13 (52\%) were released back into the wild. One adult female was killed by vehicular collision three days after release and one juvenile male was killed by an adult male 1.5 mo after release. However, 11 (85\%) went on to establish home ranges and become integrated into the population. Five rehabilitated female panthers went on to produce at least 22 kittens in the wild, and rehabilitated males have sired numerous litters.

By preventing the death of individuals, the rehabilitation and release of orphaned/injured panthers has effectively reduced the mortality rate and improved overall survival. Rehabilitation of an endangered species can be an important population recovery tool.

ACKNOWLEDGMENTS

The authors thank biologists, technicians, keepers, and veterinarians of the Florida Fish and Wildlife Commission, National Park Service, US Fish and Wildlife Service, Lowry Park Zoo, Jacksonville Zoo, Busch Gardens – Tampa Bay, and White Oak Conservation Center.

LITERATURE CITED

HEALTH OF THE COMMON LOON (Gavia immer) IN NEW YORK’S ADIRONDACK PARK

Stephanie B. James, DVM, Dipl ACZM, * Nina Schoch, MS, DVM, and David C. Evers, PhD

1 Global Health Program, Wildlife Conservation Society, Bronx, NY 10460 USA; 2 Adirondack Program, Wildlife Conservation Society, Saranac Lake, NY 12983 USA; 3 BioDiversity Research Institute, Gorham, ME 04038 USA

Abstract

The Wildlife Conservation Society has performed health assessments on the common loon (Gavia immer) in New York State’s Adirondack Park since 2003 in conjunction with a multi-institutional long-term banding and mercury project. Sixty loons (28 males, 25 females, 7 unsexed juveniles) have been evaluated. Not all testing was performed on all birds. Serum was evaluated for exposure to avian viruses (avian influenza (n=48), adenovirus (n=48), infectious bursal disease (n=40), avian encephalitis (n=47), avian reovirus (n=40), paramyxovirus 1 (Newcastle disease virus, n=48), paramyxovirus 2 (n=40), paramyxovirus 3 (n=40), and infectious laryngotracheitis (n=37)); pesticides (aldrin (n=47), benzene hexachloride (BHC (n=47)), endosulfane (n=32), chlordane (n=32), dichlorodiphenyldichloroethane (DDD (n=47)), dichlorodiphenyltrichloroethylene (DDE (n=47)), dieldrin (n=47), endrin (n=44), heptachlor (n=47), nonachlor (n=44), polychlorinated biphenals (PCBs, (n=46)); and heavy metals (lead (n=48), zinc (n=12), arsenic (n=48), cadmium (n=48), thallium (n=48), mercury (n=40)). Complete blood counts, serum biochemistries (n=30), and fecal endoparasite evaluations (n=13) were also performed.

The results demonstrate that 20% of the loons were exposed to avian influenza (typing not performed), and a small percentage of birds were exposed to avian encephalitis (2%) and paramyxovirus 1 (9%). There was very little exposure to other avian viruses, with no serologic evidence of adenovirus, infectious bursal disease, avian reovirus, paramyxovirus 2, paramyxovirus 3, or infectious laryngotracheitis. There was evidence of ongoing exposure to metabolites of pesticides that have been banned for decades (Table 1). There was no exposure to aldrin, BHC, endosulfane, chlordane, endrin, heptachlor. Two adult loons had low lead levels, while one juvenile had a lead level (12.3 ppm) that may have been high enough to affect the animal’s behavior. Mercury levels were high enough in some of the study birds to impact their reproductive success. Fecals were performed on 13 animals, 61% had trematodes, 23% had Eimeria sp., 15% had both parasites, and 31% of the loons were negative. Complete blood counts were similar to those published1, although the heterophil percentages were higher and eosinophil percentages were lower than published values. There are no published reports of serum biochemistries in loons, but when compared to plasma biochemistries of another piscivorous bird, flightless cormorants (Phalacrocorax harrisi),2 loons had lower aspartate transferase, total protein, and albumin and higher levels for glucose, chloride, and uric acid. Both species had similar values for globulins, calcium, and sodium.
ACKNOWLEDGMENTS

The authors thank the Global Health Program veterinary technicians and High Peaks Animal Hospital for their assistance with this project.

LITERATURE CITED


Table 1. Results of pesticide and heavy metal testing in common loons in the Adirondack State Park from 2003-2008.

<table>
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<th></th>
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<th>Mean (+ SD)</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td>Dieldrin (ppm)</td>
<td>47</td>
<td>0.00057 ± 0.00168</td>
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</tr>
<tr>
<td>Nonachlor (ppm)</td>
<td>44</td>
<td>0.00186 ± 0.00179</td>
<td>0.000</td>
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<tr>
<td>DDT&lt;sup&gt;a&lt;/sup&gt; (ppm)</td>
<td>47</td>
<td>0.00013 ± 0.00074</td>
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<tr>
<td>DDE&lt;sup&gt;b&lt;/sup&gt; (ppm)</td>
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<td>0.06143 ± 0.08800</td>
<td>0.000</td>
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<tr>
<td>DDD&lt;sup&gt;c&lt;/sup&gt; (ppm)</td>
<td>47</td>
<td>0.00034 ± 0.00167</td>
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<tr>
<td>PCBs&lt;sup&gt;d&lt;/sup&gt; (ppm)</td>
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<td>0.237 ± 0.217</td>
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<tr>
<td>Zinc (ppm)</td>
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<td>2.398 ± 0.494</td>
<td>1.600</td>
<td>3.070</td>
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<tr>
<td>Lead (ppm)</td>
<td>48</td>
<td>0.259 ± 1.77</td>
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<td>12.30</td>
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<tr>
<td>Mercury (ppm)</td>
<td>40</td>
<td>1.92 ± 1.46</td>
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<td>6.350</td>
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</tbody>
</table>

<sup>a</sup>DDT-dichlorodiphenyltrichloroethane

<sup>b</sup>DDE-dichlorodiphenyldichloroethylene

<sup>c</sup>DDD-dichlorodiphenyldichloroethane

<sup>d</sup>PCBs-polychlorinated biphenals
THE LINK BETWEEN CAPTIVE AND WILD ANIMAL HEALTH IN VENEZUELA: RISKS ASSOCIATED WITH POOR MANAGEMENT

Ezequiel Hidalgo-Hermoso, DVM1* and Marco A. Enciso, DVM, MS 2

1Conservation Medicine PhD Program, Andres Bello University, Santiago, Chile; 2Faculty of Veterinary Medicine, Universidade de São Paulo, Cidade Universitária, São Paulo, Brazil

Abstract

Ex-situ management of threatened species has been widely discussed during the last 20 yr, where emphasis has been put on the need to define conservation goals for zoological captive populations.1 In Venezuela in recent years, the release of wild animals not within a planned reintroduction program has been a common practice managed by small animal veterinarians and wildlife government officials. We performed an in-deep review of the new legislation for biodiversity management in Venezuela with emphasis on the link that exists between the health of captive animals and the health of the ecosystems where they are released. The new Venezuelan legal frame allows the release of all native captive wild animals from zoos and other ex-situ management institutions back into the wild.2,3 These captive populations, slated for movement back to the wild, consist of animals predominantly confiscated from illegal wildlife trade which have often been kept under poor management conditions, receiving little or no veterinary care; all significant risk factors for pathogen introduction into wild populations.4,5 As a consequence of poor attention to information and knowledge generated in other countries, this regrettable release of wild animals from ex situ management centers is a common practice in other countries of Latin America in addition to Venezuela.6 We recommend a review on the current legislation in all Latin American countries, similar to our review of the current status in Venezuela, in order to evaluate the management risks and possible effects of animal movements on the health of ecosystems where they are reintroduced.

LITERATURE CITED

COMPARISON OF VITAL SIGNS AND BIOCHEMICAL PARAMETERS IN WILD WHITE-TAILED DEER (Odocoileus virginianus) EITHER HAND INJECTED IN CLOVER TRAPS OR REMOTELY INJECTED BY DART WITH BUTORPHANOL-MEDETOMIDINE

Jordyn M. Boesch, DVM,1* William A. Horne, DVM, PhD, Dipl ACVA,1 Hollis N. Erb, DVM, PhD,1 Jason R. Boulanger, PhD,2 Paul D. Curtis, PhD,2 and R. D. Gleed, BVSc, Dipl ACVA1

1College of Veterinary Medicine, Cornell University, Ithaca, NY 14853 USA; 2College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14853 USA

Abstract

Our objective was to compare the effects of immobilization of wild deer (Odocoileus virginianus) with butorphanol-medetomidine via either hand-injection in Clover traps or remote injection by dart. Trapped (n=6; weighing 55 [31, 58] kg, median [minimum, maximum]) and darted (n=16; 56 [28, 65] kg) female deer were injected with 0.64 [0.43, 0.75] mg/kg butorphanol (Wildlife Pharmaceuticals, Inc., Fort Collins, CO 80524, USA) plus 260 [170, 300] µg/kg medetomidine (Wildlife Pharmaceuticals, Inc.) for tubal ligation. Differences between groups were tested using the Wilcoxon rank-sum test, and a Bonferroni correction was made to account for multiple comparisons. Most deer in both groups had PaO₂ values less than 80 mmHg, but darted deer were significantly more hypoxemic. pH and standard base excess were lower in trapped deer than darted deer, and the trapped deer had a metabolic acidemia. Median plasma lactate was more than five-fold higher and median serum creatine kinase was more than seven-fold higher in trapped deer. Plasma cardiac troponin was undetectable in 11 out of the 14 darted deer tested; it was significantly higher in the trapped deer. Median body temperature in trapped deer was 1.4 °C higher than in darted deer. These data suggest that deer anesthetized by hand-injection in Clover traps are more physiologically stressed than deer remotely injected by dart, to the extent that myocardial damage is produced. The hypoxemia seen in both groups is likely due to medetomidine administration.
IMMOBILIZATION OF ADULT EMUS (Dromaius novaehollandiae) WITH THIAFENTANIL AND MEDETOMIDINE

Andrew Cushing, BVSc MRCVS* and Modesto McClean, DVM

Wildlife Safari, Winston, OR 97496 USA

Abstract

Emus (Dromaius novaehollandiae) are a popular display animal in zoological institutions and are also raised for commercial purposes of meat and oil. Anesthesia in these species is challenging, with previously published combinations requiring intravenous administration or showing extended recovery times. Thiafentanil is a potent opioid that has been used in combination with medetomidine in a variety of species. Both can be effectively antagonised by the use of naltrexone and atipamezole, respectively.

Thirteen adult emus were successfully anesthetized for routine physical examinations and minor surgical procedures using 0.167 ± 0.045 mg/kg thiafentanil (ZooPharm Inc., Laramie, Wyoming 82070, 10 mg/ml) and 0.095 ± 0.015 mg/kg medetomidine (ZooPharm Inc., 20 mg/ml) i.m. via remote injection. Venous blood gas analysis was performed prior to administration of i.v. 0.205 ± 0.03 mg/kg atipamezole (Pfizer Animal Health, New York, 10017, 5 mg/ml) before maintenance on 2-3% isoflurane (Vet One, Meridian, ID, 83680) with 2 l/min oxygen flow. Heart and respiratory rate were monitored throughout anesthesia while electrocardiogram readings, venous blood samples for biochemistry and full blood counts were taken. The birds were weighed and recovered in a crate following i.v. administration of 8.36 ± 2.25 mg/kg naltrexone (ZooPharm Inc., 50 mg/ml) for antagonism of thiafentanil. During recovery, 5 mg i.m. midazolam (Baxter Healthcare Corporation, Deerfield, Illinois, 60015, 5 mg/ml) was provided for post-procedural sedation.

Due to smooth and quick induction and recovery times (6.8 and 3.2 min, respectively), the combination of thiafentanil and medetomidine is recommended by the authors for the safe and effective anesthesia of adult emus.

LITERATURE CITED


BLUE BLOOD IN BROWN BEARS (*Ursus arctos*): EFFECTS OF INTRANASAL OXYGEN THERAPY ON HYPOXEMIA DURING ANESTHESIA

Åsa Fahlman, DVM, VetMedLic, PhD,1,2* Jon M. Arnemo, DVM, PhD,3,4 and John Pringle, DVM, PhD, Dipl ACVIM, Dipl ECEIM2

1Section of Anesthesiology, Department of Clinical Sciences, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences, Uppsala, Sweden; 2Department of Pathology and Wildlife Diseases, National Veterinary Institute, Uppsala, Sweden; 3Faculty of Forestry and Wildlife Management, Hedmark University College, Koppang, Norway; 4Department of Wildlife, Fish and Environmental Studies, Faculty of Forest Sciences, Swedish University of Agricultural Sciences, Umeå, Sweden

Abstract

During anesthesia of wild animals hypoxemia is often not treated, or not even recognized, even though hypoxemia can result in morbidity and mortality. Both free-ranging and captive brown bears (*Ursus arctos*) anesthetized with medetomidine-zolazepam-tiletamine (MZT) commonly develop mild to marked hypoxemia.1 The aim of this study was to determine the minimum effective flow rate of intranasal oxygen for prevention or treatment of hypoxemia in anesthetized brown bears. The study included 26 free-ranging brown bears (yearlings, subadults and adults, body mass 12-250 kg) in Sweden which were darted with MZT from a helicopter. During anesthesia, oxygen was administered via a nasal line inserted 2-5 cm into the nasal cavity. Arterial blood samples were collected before and during oxygen therapy and immediately processed with an i-STAT® Analyzer (Abbott Laboratories, Abbott Park, Illinois, USA). Rectal temperature, respiratory rate, heart rate and pulse oximetry derived hemoglobin oxygen saturation were recorded. Intranasal oxygen supplementation at a flow rate of 0.5-3 L/min increased the partial pressure of arterial oxygen >100 mmHg. In relation to the body mass of the bears, the following flow rates were adequate: 0.5 L/min to bears up to 25 kg, 1 L/min to bears up to 36 kg, 2 L/min to bears up to 184 kg, and 3 L/min to bears up to 250 kg. In conclusion, low flow rates of intranasal oxygen were sufficient to improve arterial oxygenation in anesthetized brown bears.

ACKNOWLEDGMENTS

We thank the Scandinavian Brown Bear Research Project and the field supervisor Sven Brunberg for invaluable collaboration. Also thanks to Ulf Grinde and Åke Pettersson, pilots at Jämtlands Flyg.

LITERATURE CITED

COMPARISON OF TWO FENTANYL/PROPOFOL ANESTHESIA PROTOCOLS IN CHEETAHS (*Acinonyx jubatus*)

A. Margarita Woc Colburn, DVM,* Carlos R. Sanchez, DVM, MSc, and Suzan Murray, DVM, Dipl ACZM

Smithsonian National Zoological Park, Washington D.C. 20008 USA

Abstract

Total intravenous anesthesia (TIVA) is widely being used in veterinary medicine due to its rapid induction, improved cardiopulmonary effects and fast recovery time. Two different fentanyl-propofol protocols, fentanyl-propofol TIVA (FP-CRI) and fentanyl-propofol-isoflurane (PF-I), were compared for the maintenance of anesthesia in six fentanyl-propofol induced adult captive cheetahs (*Acinonyx jubatus*). Both groups were induced, in a squeeze cage, with 2 ug/kg of fentanyl (Baxter, Deerfield, IL 60015 USA) and 5.0-6.5 mg/kg of propofol (Abbott, Chicago, IL 60064, USA) i.v. to effect, followed by endotracheal intubation. Group A (n=3) was maintained on a constant rate of infusion (CRI) of 0.1-0.2 ug/kg/min fentanyl and 0.05-0.2 mg/kg/min propofol i.v.; whereas Group B (n=3) was maintained on 2-5% isoflurane (MWI Veterinary Supply, Meridian, ID 83680, USA). Length of anesthesia was similar in both groups. Physiologic variables measured included heart rate, respiratory rate, tidal volume, oxygen-hemoglobin saturations, end-tidal CO₂, arterial blood gases, and rectal temperature. Induction time, muscle relaxation, and time and quality of recovery were assessed. The combination of fentanyl and propofol provided smooth i.v. induction in all six cheetahs while the FP-CRI and FP-I protocols both provided a safe and effective maintenance of anesthesia throughout their procedures. Intermittent apneic episodes were seen with FP-CRI combination and improved with intermittent positive pressure ventilation. Blood pressures were mildly decreased with PF-I protocol. Recovery times were prolonged in cheetahs receiving FP-CRI when compared with the FP-I protocol. Due to prolonged recovery times, we recommend that for procedures lasting more than 20 min, anesthesia is maintained with isoflurane.
The agent of choice for wild equid immobilization and anesthesia is the potent opiate etorphine. A major advantage in the use of opiates is the specific opiate antagonists that allow for the complete reversal of the anesthetic effects. In North America, due to difficulty in obtaining etorphine, a similar, more potent opiate, carfentanil (Wildlife Pharmaceuticals, Fort Collins, Colorado 80522, USA) has been used extensively in non-domestic equids. However, the quality of anesthesia from carfentanil are sometimes inferior to those of etorphine, including rough inductions and significant muscle contractions.

Here we present the field capture of six Przewalski's horses (Equus ferus przewalskii) in Hortobágy National Park, Hungary (www.hnp.hu) and subsequent surgical anesthesia for the implantation of subcutaneous heart-rate telemetry units.

The horses were darted from foot or vehicle with a CO₂ propelled dart gun (Daninject JM™, Wildlife Pharmaceuticals, Fort Collins, CO 80522, USA) and 3 ml darts (Daninject, Wildlife Pharmaceuticals). A combination of 10 mg butorphanol (Torbugesic, Fort Dodge Animal Health, Fort Dodge, Iowa 50501, USA), 10 mg detomidine-HCl (Domosedan, Orion Corp. Farmos Finland) and 0.7 - 1.4 mg etorphine (M99, C-Vet Veterinary Products, Lancs, UK. This combination has previously been used successfully in wild Przewalski's horses in Mongolia. Weights of the animals were estimated and ranged from 270 - 350 kg.

However, this chemical capture drug combination, at the doses provided, does not offer the necessary depth of anesthesia for surgical procedures as significant muscle contractions and uncontrollable movements can occur. Following dart administration, the horses became recumbent (n=4) or were pulled to the ground (n=2) in 5-10 min. In all cases, the head was controlled and a peripheral venous catheter was placed in the jugular or saphenous vein. Once the catheter was in place, an i.v. infusion of guaifenesin-ketamine-xylazine (1 L of 5 % guaifenesin (Myolaxin, Vëtoquinol UK Ltd, Buckingham, MK18 1PA, UK) 1000 mg ketamine (Ketamidor, Richter Pharma, 4600 Wels, Austria) and 500 mg xylazine (Rompun, Bayer Austria Ges.m.b.H, 1160 Vienna, Austria) was started. Nasal oxygen at a flow rate of 10 l/min was provided. Heart rate, respiratory rate, temperature and saturation of hemoglobin with oxygen (SpO₂) were measured and recorded every 5-10 min. Arterial blood gases were obtained at
irregular intervals.

On average the duration of the procedure was 80 min after the initial dart. Depth of anesthesia was easily controlled with the triple drip combination and in all cases resulted in very good surgical anesthesia. The animals received on average 733 ml of the triple drip at an average rate of 12.6 ml/min. With exception of one individual that exhibited significant respiratory acidosis, monitoring data was satisfactory with SpO2 ranging between 71-94% and arterial pH never dropping below 7.3. However, despite oxygen supplementation all individuals where hypoxemic and slightly hypercapnic throughout the procedure.

Approximately 10 min before the surgical procedure was finished, the iv infusion was stopped. Subsequently, the opiate anesthesia components were reversed with 150 mg i.v. naltrexone (Wildlife Pharmaceuticals). All horses were standing 2-17 min after naltrexone administration. The alpha-2 agonist detomidine was not reversed.

The authors feel this multi-drug procedure is well adapted for surgical anesthesia in Prezwalski's horses in a field setting. However, we strongly recommend that adequate anesthesia monitoring is available for the early recognition of critical respiratory and metabolic problems.

ACKNOWLEDGMENTS

We acknowledge the support of the Cologne Zoo, Dr. Franz Schober in the initiation of this project, Dr. Waltraut Zimmermann, Moritz Zimmermann and Ing. Joep van de Vlasakker with help in the field.

LITERATURE CITED

ANESTHESIA OF FREE RANGING AFRICAN ELEPHANTS (*Loxodonta africana*) DURING LAPAROSCOPIC VASECTOMY

Jeffery R. Zuba, DVM,1,* Douw Grobler, BVSc, MSc,2 JJ van Altena, BSc,2 Li-Ann Small, LVT,2 Dean A. Hendrickson, DVM, Dipl ACVS,3 and Mark Stetter, DVM, Dipl ACZM4

1San Diego Wild Animal Park, Escondido, CA 92027 USA; 2Catchco Africa, Inc., Silver Lakes, Pretoria, South Africa; 3College of Veterinary Medicine, Colorado State University, Fort Collins, CO 80523 USA; 4Disney’s Animal Programs, Bay Lake, FL 32830 USA

Abstract

A successful method to vasectomize free ranging African bull elephants (*Loxodonta africana*), as an alternative to controversial culling in areas of overpopulation, has been developed by the authors. Patients are anesthetized, intubated, placed into a modified standing position with a sling and crane/capture truck, ventilated as needed, clinically monitored and vasectomized using specialized laparoscopic equipment and protocols. To provide safe anesthesia for elephants undergoing prolonged field procedures, unique anesthetic protocols and equipment were developed. Elephants are anesthetized by dart injection from a helicopter with a combination of etorphine (Novartis Ltd., Isando, 1600, South Africa) and azaperone (Stresnil, Janssens Pharmaceutica, 1685, South Africa) and reversed with i.v. injections of diprenorphine (Novartis Ltd.) and naltrexone (Kyron Laboratories, Benrose, 2011, South Africa). A portable venturi-jet ventilator, powered by compressed oxygen, was designed to provide energy and flow characteristics capable of controlling ventilation of elephants up to 7000 kg. Elephant-sized endotracheal tubes were produced with internal diameters of 35-45 mm and lengths of 1.8 m. All patients were monitored at various intervals for temperature, pulse, respiration, blood gas analysis, end tidal CO2, pulse oximetry, direct and indirect blood pressure. Anesthetic related complications noted prior to surgery included severe lactic acidosis and hypertension. During surgery, complications included hypertension; opioid-induced hypoventilation; and iatrogenic hypoventilation due to significantly elevated intra-abdominal pressures needed for surgical visualization during laparoscopy. Once reversed and standing, brief neuropraxia and mild lameness was noted in some animals due to pressure exerted by axillary and inguinal positioning of the support sling during surgery. The ability to control ventilation in the field on mega-vertebrates during prolonged surgery greatly contributed to the success of anesthesia.

ACKNOWLEDGMENTS

The authors would like to thank the following for their intellectual input and insight: Drs. Deena Brenner, Jessica Siegal-Willot, Stan Perkins, David Brunson, Jim Oosterhuis and David Fagan. We also thank the numerous contributions from Karl Storz Veterinary Endoscopy of America, Surgivet/Smiths Medical, Mallard Medical, Dick Munns Company and Colyer Institute.
DRUG RESISTANCE DETERMINANTS IN HERRING GULLS (*Larus argentatus*) AND HUMAN WASTEWATER IN CAPE COD

Karen Alroy* and Julie Ellis, PhD

Tufts Cummings School of Veterinary Medicine, North Grafton, MA 01536 USA

Abstract

Antimicrobial-resistant bacteria are an emerging public health concern. This study aimed to determine the prevalence of antibiotic resistant strains of *Escherichia coli* cultured from wild herring gulls (*Larus argentatus*) and from human wastewater at Cape Cod, Massachusetts, USA. Bacterial sensitivity by disc diffusion was tested with seven antibiotics: ampicillin (10μg), ciprofloxacin (5μg), chloramphenicol (30μg), gentamicin (10μg), streptomycin (10μg), sulfamethoxazole-trimethoprim (23.75/1.23μg), and tetracycline (30μg). Of the 49 wastewater isolates 59.2% percent were resistant to at least one antibiotic, and 40.8% demonstrated multi-drug resistance. Of the 115 gull isolates, 15.6% were resistant to one antibiotic, and 0.9% demonstrated multi-drug resistance. Ampicillin, streptomycin, and tetracycline resistant isolates were the most common type of resistance phenotypes in both gull and wastewater isolates. Strains of *E. coli* that exhibited resistance phenotypes were genetically analyzed to identify the presence of antibiotic resistance and virulence genes. Shared resistance genes (including *blaTEM*, *strA*, and *tetB*) were documented in both gull and wastewater *E. coli* samples. One or more virulence genes (including STa, iss and tsh) were identified in 3/12 (25%) of the antibiotic resistant gull isolates. This research is one of the first studies documenting the genetic determinants of antibiotic resistance in wildlife of the United States.
ELECTROLYTES, pH, AND IONIZED CALCIUM AS HEALTH INDICATORS IN FREE-LIVING NESTLING MACAWS

J. Jill Heatley, DVM, MS, Dipl ABVP (Avian) Dipl ACZM,1* Karen Russel, DVM, PhD, Dipl ACVP,2 Bo Norby, DVM, PhD,3 and Donald Brightsmith, MS, PhD2

1Department of Small Animal Clinical Sciences, 2Department of Pathobiology, 3Department of Veterinary Integrative Biosciences, College of Veterinary Medicine and Biomedical Sciences, Texas A&M University, College Station, TX 77843 USA

Abstract

Electrolytes, ionized calcium and pH as health indicators are routinely used in small animal medicine to assess health and prognosis in the critical patient. However, baseline values from healthy free living nestling parrots are extremely limited. The Tambopata macaw project has access to baseline biologic data from nestling macaws, predominantly Ara macao. In the last two field seasons, 56 blood samples from 31 healthy scarlet macaw and other parrot nestlings were analyzed. Sodium, potassium, ionized calcium and pH, and HCT were determined bird-side using an i-STAT portable analyzer which reliably determines these analytes in avian species including parrots.1,3 Sodium and chloride increase with age as has been reported in captive juvenile blue and gold macaws.4 Age-related changes in wild macaws may be attributable to the crop contents of nestling macaws, which have relatively high potassium and low sodium when compared to captive hand feeding diets.5 The blood pH of nestling scarlet macaws (7.569 ± 0.061) is also higher than adults (7.421 ± 0.618). Ionized calcium was not affected by age or weight in 35 samples from 25 juvenile scarlet macaws. The normal distribution of this analyte allows creation of a 95% confidence interval of 0.96-1.33 mmol/L, comparable to reported values in other parrot species.2 Both HCT and PCV increase with age in nestling macaw. The calculated hematocrit of the i-STAT is consistently lower then the gold standard of a spun hematocrit (PCV), however at this time variability is too great to create a standardized correction factor.

ACKNOWLEDGMENTS

The authors wish to acknowledge the staff and multiple field biologists and guides working at TRC. In addition, Dr. Sharman Hoppes and Lizzie Ortiz-Cam, MedVet were instrumental in the collection of these data.

LITERATURE CITED


UPDATE ON THE USE OF THE TUBULAR EXTERNAL FIXATOR (F.E.S.S.A.) IN THE TREATMENT OF FRACTURES AND LUXATIONS IN BIRDS

Jean-Michel Hatt, Prof Dr Med Vet, MSc, Dipl ACZM, Dipl ECAMS* and Panagiotis N. Azmanis, DVM

Clinic for Zoo Animals, Exotic Pets and Wildlife, Vetsuisse Faculty University of Zurich, Zurich, Switzerland

Abstract

This presentation summarizes the developments in the use of the tubular external fixator (Fixateur Externe du Service de Santé des Armées; F.E.S.S.A.) in avian surgery since its first presentation in 2003.1 Special emphasis is given to the different applications and practical experiences.

In addition to the company Medical Solution (Hünenberg, Switzerland) the system is now also marketed by two additional companies (Jorgensen Laboratories, Loveland, USA and Veterinary Instrumentation, Sheffield, UK). The original set of stainless steel connection bars (Diameter 6, 8, and 12 mm; length range 31 to 118 mm) has been expanded with bars up to 200 mm in length.

Different publications have documented the successful use of the F.E.S.S.A. system in variety of captive and wild birds including psittacines, pigeons, and birds of prey with a body weight range from 100 to 2000 grams.2-4 The system has been used as a type 1, type 2, and tie-in external skeletal fixator to treat fractures of the humerus, radius and ulna, femur, tibiotarsus, and tarsometatarsus. In addition, the connection of two bars with a hinge to form a hinged linear external fixator (HLESF) has allowed the treatment of luxations in pigeons. Of special interest over current systems used in avian surgery was the possibility to perform early controlled physical therapy without removing the fixator.

Days from first pin removal until removal of last pin have been reported in a range from day 28 post-surgery until day 42.4 In a study involving hunting falcons that had been treated for tibiotarsal fractures, four out of five falcons were sent back to intensive training and were used successfully for hunting within 2-3 mo post-surgery.4

In psittacine birds it has been recommended to cover the screws of the fixator with a drop of tissue glue, as it was observed that these birds tend to play with the screw and might loosen them.3

The authors have found the light weight, easy application, early return to normal limb function, re-usability, and cost effectiveness to be significant advantages of the F.E.S.S.A. system. The flexibility of the system allows removal of pins during the healing process without disturbing other, remaining pins. It was also found that the potential to insert up to six pins over a distance of 15 mm offers advantages in the treatment of fractures in small birds (e.g., < 500 g body
Moreover, the use of the hinge to perform physical therapy did not lead to any side effects (e.g., pin loosening, hinge centre disorientation, increased skin/muscle trauma or swelling around the pin insertion entrances).

In conclusion, the system continues to find increasing interest due to its different advantages and offers a viable alternative to currently used external skeletal fixation techniques.

LITERATURE CITED

PHARMACOKINETICS OF NALBUPHINE HCL IN HISPANIOLAN AMAZON PARROTS (Amazona ventralis)

Dominique L. Keller, DVM, PhD,*† David Sanchez-Migallon Guzman, LV, MS, Dipl ECAMS,‡ Julia Klauser, BS,† Steven A. Barker, PhD, Julia Rodriguez-Ramos, LV,§ and Joanne Paul-Murphy, DVM, Dipl ACZM¶

1Department of Surgical Sciences, School of Veterinary Medicine, University of Wisconsin, Madison, WI 53706 USA; 2Department of Comparative Biomedical Sciences, Louisiana Veterinary Medical Diagnostic Laboratory, School of Veterinary Medicine, Louisiana State University, Baton Rouge, LA 70803 USA; 3Department of Pathobiological Sciences, University of Wisconsin, Madison, WI 53706 USA; 4Department of Veterinary Medicine and Epidemiology, School of Veterinary Medicine, University of California, Davis, CA 95616 USA

Abstract

Opioids are frequently used in veterinary medicine and are the most effective class of analgesic drugs for perioperative pain. Previous studies have validated the clinical use of opioids for birds, particularly those substances with kappa (κ)-opioid receptor affinities. Butorphanol, a κ-opioid receptor agonist and mu (μ)-opioid receptor antagonist, is currently considered the opioid of choice for pain management in birds. However, butorphanol has a short plasma half-life in birds and is a controlled substance in the United States. Nalbuphine, an opioid that is not controlled by the DEA, has the same mechanism of action as butorphanol. Nalbuphine has been used to treat humans with acute and chronic pain, and has been shown to have anti-nociceptive effects in rats. Preliminary data from analgesimetry studies suggest that nalbuphine also produces analgesia in Hispaniolan Amazon parrots (Guzman, unpubl. data). The pharmacokinetic profile of nalbuphine (12.5 mg/kg) following intramuscular (i.m.) or intravenous (i.v.) administration was determined using eight birds in a complete cross-over experimental design. Serum samples were collected at 5, 15, 30, 60, 90, 180, 360 and 540 min for the i.m. dose and at 1, 5, 15, 30, 60, 90, 180 and 360 min for the i.v. dose. Nalbuphine concentrations in plasma were determined by high performance liquid chromatography/tandem mass spectrometry (LC/MS/MS) and pharmacokinetic values were determined by using mean plasma nalbuphine concentrations at each time point. Data suggest that there is high nalbuphine bioavailability following i.m. administration, and that peak plasma concentration of nalbuphine is approximately 3 µg/ml. The elimination half-life following both i.v. and i.m. administration is less than 60 min, suggesting that frequent dosing may be required with nalbuphine.

LITERATURE CITED


ASSESSMENT OF THE ANALGESIC EFFECTS OF MELOXICAM ON POSTOPERATIVE PAIN IN PIGEONS (Colombia livia)

Marion Desmarchelier, DMV, DES,1* Stéphane Lair, DMV, DES, DVSc, Dipl. ACZM,1 Eric Troncy, DV, PhD,2 and Guy Fitzgerald, DMV, MSc1

1Service de médecine zoologique, Département de sciences cliniques; 2Groupe de recherche en pharmacologie animale du Québec, Département de Biomédecine; Faculté de médecine vétérinaire, Université de Montréal, Québec J2S 7C6, Canada

Abstract

The objective was to evaluate postoperative analgesic efficacy of meloxicam. Femoral fractures were surgically created in 21 male pigeons and immediately repaired with an intramedullary pin. All pigeons were administered butorphanol (1 mg/kg i.m.) before the surgery, as well as at 4 and 8 hr following the first dose. Pigeons were randomly assigned to three groups: meloxicam low dose (MxL) and meloxicam high dose (MxH) groups, which received respectively 0.5 and 2 mg/kg p.o. q 12 hr for 10 days, and a placebo group (Sal) that received saline at an identical frequency. Pain assessment included weight-bearing measurements using an Incapacitance meter, clinical observations, pain scores and ethograms using video records. Blood parameters were monitored throughout the study and complete necropsies were performed 3 wk after the surgery. Non-parametric tests were used. When compared to the Sal and MxL groups, weight-bearing on the altered limb after the first postoperative day was higher and postoperative pain scores lower in the MxH group. Time spent on the perch was not altered in group MxH, whereas it was reduced during the first two postoperative days in group Sal and for four postoperative days in group MxL. Time spent exploring the environment was reduced during the first two postoperative days in group Sal and group MxL. No signs of toxicity were detected with these doses in pigeons. Our results suggest that 2 mg/kg of meloxicam p.o. q 12 hr provides better analgesia than dosages reported in the avian literature (0.1 to 0.5 mg/kg) in pigeons.

ACKNOWLEDGMENTS

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PHARMACOKINETICS OF TRAMADOL HYDROCHLORIDE AND ITS METABOLITE O-DESMETHYLTRAMADOL IN PEAFOWL (Pavo crustatys)

Peter A. Black, DVM,1* Sherry Cox, PhD,2 Michael Macek, BS,1 and Anne Tieber, BS1

1Saint Louis Zoo, Saint Louis, MO 63110 USA; 2University of Tennessee College of Veterinary Medicine, Knoxville, TN 37996 USA

Abstract

Tramadol is a centrally-acting opiate analgesic that has not been well-studied in avian species. Tramadol and its metabolites exert their effects at multiple sites, including opiate (μ, κ, and δ), adrenergic (α-2), and serotonin (5HT) receptors. This multi-receptor mode of action is advantageous for avian patients since the mechanisms for analgesia have not been fully elucidated in all species. Furthermore, in species studied, the κ-opioid receptors appear to be more important for analgesia than μ-opioid receptors.2,3  Tramadol has several advantages when compared to other analgesic agents more commonly used in birds. It is not regulated by the Drug Enforcement Agency, it is well-absorbed after oral administration in humans and dogs, and it has not been shown to have significant adverse side effects.1,4  The objective of this study was to document the pharmacokinetics of tramadol and its active metabolite O-desmethyltramadol (M1) in common peafowl (Pavo cristatus). Based on results from a pilot animal, six adult peafowl (three male, three female) judged to be clinically healthy based on physical exam and routine bloodwork were selected for this study. Each bird was anesthetized for placement of a jugular catheter, and tramadol was administered via gavage tube. Blood samples were collected. Plasma levels of tramadol and M1 were measured and the pharmacokinetics for each drug was calculated. Based on these data, tramadol may be a practical option as an orally-administered analgesic agent in avian patients. Further studies, including antinociceptive studies, are needed.

ACKNOWLEDGMENTS

The authors wish to thank the animal care staff and veterinary technicians at the Saint Louis Zoo for their help in this project.

LITERATURE CITED

REAL-TIME PCR ASSESSMENT OF BIOSECURITY METHODS FOR A REPTILE REOVIRUS

Copper Aitken-Palmer, DVM, MS,* James Wellehan, DVM, MS, Dipl ACZM, Dipl ACVM, April L. Childress, and Li-Wen Chang

University of Florida, College of Veterinary Medicine, Gainesville, FL 32610 USA

Abstract

As has been seen with production of other animals, biosecurity issues arise when dealing with reptile populations. Emerging viral diseases pose significant concern within large breeding populations because of ease of transmission amongst more susceptible juvenile animals. Adequate surveillance and sanitation measures are key measures to prevention of disease outbreaks. Orthoreoviruses, a genus of noneveloped segmented double stranded RNA viruses, have been shown to cause significant morbidity and mortality in reptiles.1 A reovirus previously found in Greek tortoises (Testudo graeca)2 has emerged as a pathogen with high mortality rates in leopard geckos (Eublepharus macularius). Real time PCR (qPCR) is a rapid and reliable method for detecting the presence and amount of a virus. A qPCR was developed for the detection and quantitation of this reovirus. Samples were run with qPCR and quantified against a known standard curve for virus quantification. This qPCR protocol was used to compare the potential of commonly used cleaning products (alcohols, hypocholorites, biguanides and quaternary ammonium compounds) to inactivate this virus.

LITERATURE CITED

COLLECTION-WIDE AMPHIBIAN SCREENING FOR Batrachochytrium Dendrobatidis AT FIVE ZOOLOGICAL PARKS

Carlos E. Rodriguez, DVM, Dipl ACVP,1,‡ Allan P. Pessier, DVM, Dipl ACVP,2 Timothy A. Georoff, VMD,3 Denise McAloose, VMD, Dipl ACVP,1 and Jennifer Pramuk, PhD4

1Global Health Programs, Pathology and Disease Investigation, Wildlife Conservation Society, Bronx, NY 10464 USA; 2Wildlife Disease Laboratories, San Diego’s Institute for Conservation Research, San Diego, CA 92112-0551 USA; 3Global Health Programs, Department of Clinical Care, Wildlife Conservation Society, Bronx, NY 10464 USA; 4Department of Herpetology, Wildlife Conservation Society, Bronx, NY 10464 USA

Abstract

A fatal outbreak of amphibian chytridiomycosis in a group of critically endangered Kihansi spray toads (Nectophrynoides asperginis) prompted institution-wide testing for Batrachochytrium dendrobatidis (Bd) infection in the amphibian collections of the Wildlife Conservation Society (WCS). Animal sampling was accomplished following established protocols.1,2 A total of 363 samples from 45 amphibian species at the WCS’ four zoological parks and one aquarium were collected and tested over a period of 5 mo. Quantitative real-time TaqMan PCR (qPCR) for Bd was performed by the Molecular Disease Laboratories at San Diego’s Institute for Conservation Research. Several individuals belonging to 7 of the species tested (dyeing arrow frog (Dendrobates tinctorius); green and black poison arrow frog (Dendrobates auratus); splashback poison arrow frog (Dendrobates galactonotus); red-eyed tree frog (Agalychnis callidryas); grey tree frog (Hyla versicolor); wood frog (Rana sylvatica); tiger salamander (Ambystoma tigrinum); and aquatic caecilians (Typhlonectes natans)) were positive for Bd qPCR. None of the test-positive animals showed any evidence of clinical disease. All PCR-positive animals were treated prophylactically and subsequently re-tested. The results of this survey highlight the value of collection-wide amphibian Bd surveillance in identifying clinically unaffected animals and the importance of disease screening as part of routine quarantine protocols to prevent introduction of this disease into established animal collections.

LITERATURE CITED

COMPARISON OF ORAL AND TOPICAL VITAMIN A SUPPLEMENTATION IN AFRICAN FOAM-NESTING FROGS (Chiromantis xerampelina)

Richard R. Sim, DVM,1* Kathleen E. Sullivan, MS,2 Eduardo V. Valdes, PhD,2 Gregory J. Fleming, DVM, Dipl ACZM,2 and Scott P. Terrell, DVM, Dipl ACVP2

1School of Veterinary Medicine, University of Wisconsin, Madison, WI 53706 USA; 2Department of Animal Health, Disney’s Animal Kingdom, Bay Lake, FL 32830 USA

Abstract

A captive population of African foam-nesting frogs (Chiromantis xerampelina) with a history of hypervitaminosis A had higher than expected incidence of sudden death, bacterial osteomyelitis, stunted growth, and lethargy. This study was undertaken to compare vitamin A oral supplementation to topical treatment with water-miscible vitamin A palmitate (AQUASOL A® Parenteral; Mayne Pharma Inc., Paramus, New Jersey 07652 USA) in this population. Eighty-four frogs, weighing 2 - 7 grams, were divided into a control and three treatment groups (normalized weight distribution). The control group received standard daily nutrition of “dusted” crickets containing 342,000 IU vitA/kg. The treatment groups consisted of: (1) oral supplementation with a supplement designed for carnivores containing 822,510 IU vitA/kg, (2) topical vitamin A palmitate 50 IU every other day, and (3) topical vitamin A palmitate 50 IU once per week. After 30 days, all frogs were euthanatized and 12 frogs from each group were analyzed for whole-body vitamin A levels. The control and treatment groups 1, 2, and 3 had average whole-body vitamin A levels (IU/kg) of 1371.4 (SE 284.4), 908.7 (186.5), 6385.9 (675.9), and 3521.8 (575.1), respectively. These results suggest that oral supplementation using a product high in vitamin A is ineffective at raising whole-body vitamin A levels above those achieved with standard nutrition in this trial. This requires further investigation as the bioavailability of the oral supplement for amphibians is uncertain. Topical administration on an every other day and once per week dosing schedule achieved levels 4.5- and 2.5-fold higher than standard nutrition, respectively.
MORBIDITY AND MORTALITY OF PANAMANIAN GOLDEN FROGS (Atelopus zeteki) IN A ZOOLOGIC COLLECTION, 2001-2008

Allison N. Wack, DVM,1* Sarah Beck, DVM,2 and Ellen Bronson, Vet Med, Dipl ACZM1

1Maryland Zoo in Baltimore, Baltimore, MD 21217 USA; 2Johns Hopkins University, Department of Molecular and Comparative Pathobiology, Baltimore, MD 21205 USA

Abstract

The Maryland Zoo in Baltimore is holder of the largest breeding colony of Panamanian golden frogs (Atelopus zeteki) in North America, dating back to the 2001 wild collection of the founder population as part of Project Golden Frog. Population in the collection has ranged from approximately 300 to 750 individuals, with variation primarily due to export to other institutions. Mortality rate has been fairly constant, although a spike in mortality associated with staff turnover and movement of the collection was seen in 2004. There have been 247 necropsies with histopathology, performed primarily at the Johns Hopkins University. A primary cause of death (COD) was identified in 130 (52.6%) cases. The most common COD was fungal dermatitis (63%). Fungal species were considered similar to Saprolegnia and Basidiobolus histologically. Other frequent CODs were: euthanasia (12.3%), gastrointestinal disease (7.8%), bacterial sepsis (4.6%), and renal failure (3.8%). Regardless of COD determination, histopathology was noted in the following subset of organs with high frequency: skin (73.3%), gastrointestinal tract (38.8%), kidney (27.5%), liver (26.7%), and lung (14%). A review of morbidity was also undertaken, with 285 cases identified. The most frequent causes of morbidity were paresis (29%), dermatitis (19%), edema (11%), hyphema (4%), and uveitis (4%).
BEHAVIORAL AND PHYSIOLOGIC ASSESSMENT OF RADIO TRANSMITTER PLACEMENT ON CUBAN TREE FROGS (*Osteopilus septentrionalis*) AS A MODEL FOR GLIDING TREE FROGS (*Agalychnis spurrelli*)

Sonia M. Hernandez-Divers, DVM, Dipl ACZM, PhD,¹,²* Robert V. Horan,¹ Foonseng Choy,³ Stephanie Kern,¹ M. Kevin Keel, DVM, Dipl ACVP, PhD,² Michael J. Yabsley, MS, PhD,¹,² and Stephen Hernandez-Divers, BVetMed, DZooMed, Dipl ACZM³

¹Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602 USA; ²Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, Athens, GA, 30602 USA; ³Department of Small Animal Medicine and Surgery, College of Veterinary Medicine, University of Georgia, Athens, GA 30602 USA

Abstract

Radio telemetry methods available for amphibian studies are still limited, due to the small body size of most species and complicated by behaviors such as burrowing, climbing, swimming, and gliding. Little data exists for the habitat requirements of the terrestrial life cycle of most amphibians, however, understanding these requirements have important conservation implications and telemetry can be used to determine the movement of amphibians away from their aquatic breeding grounds. The objective of this experiment was to determine both the behavioral and physiologic effects of three methods of radio transmitter attachment on a surrogate species, the Cuban tree frog (*Osteopilus septentrionalis*), for the purpose of applying it to the gliding leaf frog (*Agalychnis spurrelli*).

Frogs were assigned to four groups: Group 1 (transmitter glued to a cloth harness), Group 2 (transmitter sutured to the skin of the dorsum directly), Group 3 (transmitter sutured to subcutaneously-implanted stents) and Group 4 (control group). Behavioral trials were performed by placing ten crickets in the enclosure and recording each frog’s movements, jumps, and successfully-captured crickets for a period of 10 min. Physiologic measurements included: organ weights, histopathologic evidence of disease or direct effects by the transmitter (e.g., skin lesions), CBC’s, presence/absence of hemoparasites, and prevalence/diversity of gastrointestinal parasites. The harness material caused severe injury to the tissues of the pectoral girdle. The stents (Group 3) were rejected and although skin wounds healed, cannot be recommended. Preliminary results indicate that transmitters sutured directly to the skin did not result in significantly different behavioral or physiologic measurements.
TRAMADOL ANALGESIC AND RESPIRATORY EFFECTS IN RED-EARED SLIDER TURTLES (Trachemys scripta)

Bridget B. Cummings, MS,1* Kurt K. Sladky, MS, DVM, Dipl ACZM,2 and Stephen M. Johnson, MD, PhD1

1Department of Comparative Biosciences, University of Wisconsin School of Veterinary Medicine, Madison, WI 53705 USA; 2Department of Surgical Sciences, University of Wisconsin School of Veterinary Medicine, Madison, WI 53705 USA

Abstract

Tramadol (Ultram®, PCCA, Houston, TX, 77099) is a non-controlled opioid drug with a dual mechanism of action as a μ-opioid agonist and serotonin/norepinephrine reuptake inhibitor, both of which contribute to analgesia in mammals.1-4,6,7 Respiratory depression is less severe with tramadol compared to morphine in dogs and cats.5,9 Based on these findings, we hypothesized that tramadol would also produce analgesia in reptiles with less respiratory depression than morphine. Thus, we studied the dose- and time-dependent changes in analgesia and respiration caused by tramadol in red-eared slider turtles.

Using a crossover design, oral tramadol (1, 5, 10, and 25 mg/kg), injectable tramadol (10 and 25 mg/kg), and controls were administered to adult, red-eared slider turtles. Analgesia was measured with hindlimb withdrawal latencies to noxious thermal stimuli at 0, 3, 6, 12, 24, 48, 72, and 96 hr post-drug administration. Respiration was measured in freely swimming turtles in individual tanks with access to a small breathing hole. Tramadol (10 mg/kg p.o.) increased thermal withdrawal latencies for 6-96 hr post-drug compared to controls. In contrast, tramadol (10 mg/kg s.c.) only increased latencies between 12 - 48 hr post-drug. Tramadol (25 mg/kg p.o. or s.c.) increased latencies for 6-96 hr post-drug, but this dosage was associated with mouth gaping and flaccid limbs and necks. Respiratory depression was observed in all turtles given tramadol (5, 10, 25 mg/kg p.o.), but, unlike morphine,8 breathing continued at all dosages. Thus, tramadol (10 mg/kg p.o.) is an effective, long-lasting analgesic drug that may be safer than morphine.

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LITERATURE CITED


SURVEY OF LESIONS IN RATTLESNAKES, SUBFAMILY CROTALINAE

Robert E. Schmidt, DVM, PhD, Dipl ACVP* and Drury R. Reavill, DVM, Dipl ABVP [Avian], Dipl ACVP

Zoo/Exotic Pathology Service, Greenview CA 96037 USA

Abstract

The records of the Zoo/Exotic Pathology Service were studied and the most common types of lesions, causes of lesions/disease, and organs involved from rattlesnake submissions were characterized. Lesions or disease caused by bacteria was the most common single etiologic diagnosis.

Introduction

A number of papers on disease condition of rattlesnakes are in the literature, but few are more than single case reports. In one survey of reptile diseases, rattlesnakes were one of the four most frequently affected species. No indication was given of the percentage of rattlesnakes affected as compared to the percentage in the population.

Methods

The records of the Zoo/Exotic Pathology Service were examined to characterize the types of lesions submitted from animals classified in the Crotalinae subfamily (rattlesnakes of both genus Crotalus and Sistrurus). These animals comprise 15.3% of snake submissions (225 of 1475 snakes). This paper presents the etiologies (if determined), morphologic diagnoses, and organs involvement for the species submitted.

Results and Discussion

Twenty-two different types of rattlesnakes were identified, and there was also a group only identified as ‘rattlesnake’ (15.5%). The most common type was the Mohave rattlesnake (65.5%). The four other most common species were the Aruba (3.1%), Black tail and Diamondback (2.2% each), and Massasauga (2.7%).

Lesions/disease caused by bacteria was the most common single etiologic diagnosis (37.5%). In most cases this was a morphologic diagnosis, and follow-up or additional information from the contributor as to culture results was usually not available. Bacterial disease may be more common in rattlesnakes than in the general snake population. The percent of bacterial diseases diagnosed in all snakes in our database was 25.3%. Bacterial osteomyelitis is reported in a variety of snakes; however our data indicate that it may be more common in rattlesnakes. A previous study identified osteomyelitis in Ridgenose (Willards) rattlesnakes (Crotalus willardi) associated with Salmonella enterica SS arizonae.
Other common etiologies were undetermined (21.9%), neoplastic (12.5%), and parasitic/protozoal and nutritional/metabolic (6.3% each). Neoplasia in rattlesnakes has an incidence that is essentially the same as the incidence of neoplasia in all snakes overall (12.9%). A variety of neoplasms were seen, with no particular tumor being more common.

The most common morphologic diagnoses were hepatitis (10.2%), glomerulonephritis (4.0%), hepatic atrophy (3.1%), and osteomyelitis (2.2%). Hepatitis was most commonly due to bacteria and was often associated with lesions in other organs. Although exact organism(s) were not identified in this review, an infection rate of 37% of snakes has been associated with Salmonella spp. causing lesions in the liver and other internal organs.¹

Hepatic atrophy may not be a legitimate diagnosis, but only a reflection of the time since the animal’s last meal. The glomerulonephritis seen was most commonly membranous or membranoproliferative and the cause usually was not determined. Since approximately 80.0% of diagnoses were other than the four most common, it is obvious that a wide variety of morphologic lesions occur in rattlesnakes.

Organs/organ systems most commonly affected were the liver (33.6%), kidney (19.1%), gastrointestinal tract (8.4%), heart and ovary (4.9% each), bone (4.4%), and lung (3.6%). The incidence of liver and bone involvement was due primarily to the high incidence of bacterial infection in these organs.

LITERATURE CITED

COMPARISON OF SEROLOGIC TITERS BETWEEN A TRADITIONAL KILLED FELINE VACCINE AND A KILLED FELINE VACCINE WITH AN ADDITIONAL CALICIVIRUS STRAIN IN CAPTIVE TIGERS

Tara M. Harrison, DVM, MPVM, Dipl ACZM,1,2* James G. Sikarskie, DVM, MS, Dipl ACZM,2 and Douglas Armstrong, DVM3

1Potter Park Zoo, Lansing, MI 48912 USA; 2Michigan State University College of Veterinary Medicine, East Lansing, MI 48824 USA; 3Henry Doorly Zoo, Omaha, NE 68107 USA

Abstract

Vaccine recommendations have been similar in tigers for years.1,3 Research has not been done in exotic cats to evaluate if newer vaccines provide greater protection. Strains of viral antigens have changed in feline vaccines since the development of the initial vaccine protocol recommended by the Species Survival Plan (SSP). There has also been one outbreak of virulent systemic calicivirus in a zoological institution.2 The current vaccine is not protective against this strain. This study retrospectively evaluated viral titers of 24 tigers vaccinated with the currently recommended vaccine (Fort Dodge Felovax PCT). These 24 tigers were vaccinated with a new vaccine which included an additional calicivirus antigen which is protective against virulent systemic calicivirus (Fort Dodge Felovax with calicivax).

There were three species of tigers represented including Amur (Panthera tigris altaica) (14), Bengal (Panthera tigris tigris) (3), and Malayan (Panthera tigris jacksoni) (1). The remaining tigers included were hybrids (6) including 18 females and 6 males. There were no reports of adverse vaccine reactions.

Serologic titers of most tigers was minimal prior to vaccination with the new vaccine, despite routine vaccination protocols ranging from 1-2 yr. The new vaccine with the addition of the calicivirus antigen produced higher titers for longer in comparison to the previously recommended vaccine. Titers of calicivirus and herpesvirus declined within a year’s time to potentially non-protective levels. In areas with risks of exposure to herpesvirus or calicivirus it would be recommended to vaccinate animals yearly with the newer vaccine to provide continued protection.

ACKNOWLEDGMENTS

The authors would like to thank the veterinarians, staff and tigers of: Columbus Zoo, Detroit Zoo, Gladys Porter Zoo, Henry Doorly Zoo, Indianapolis Zoo, Pittsburg Zoo, Potter Park Zoo and Toledo Zoo for their participation in this study. The authors would also like to thank Fort Dodge for their assistance in this project.

LITERATURE CITED

VARIATIONS IN GASTROINTESTINAL PARASITES IN MULTIPLE HOOFSTOCK SPECIES IN DIFFERENT ZOOLOGICAL FACILITIES

Allyson Kinney-Moscona, BS,1* Deidre K. Fontenot, DVM,2 James E. Oosterhius, DVM,3 Ray L. Ball, DVM, MRCVS,4 Miachel S. Burton, DVM,4 John H Olsen, DVM,4 and James E. Miller, DVM, MPVM, PhD1

1Louisiana State University School of Veterinary Medicine, Department of Pathobiological Sciences, Baton Rouge, LA 70803 USA; 2 Walt Disney World Animal Programs, Disney’s Animal Kingdom, Bay Lake, FL 32830 USA; 3San Diego Zoo’s Wild Animal Park, Escondido, CA 92027 USA; 4Busch Gardens Tamp Bay, Tampa, FL 33612 USA

Abstract

Gastrointestinal parasites (GIP) are frequently significant contributors to negative health status in captive exotic hoofstock as well as domestic livestock species.1 Individual zoological facilities have different management protocols for animal husbandry and parasite control, but there are frequently similarities as well. Neither the differences nor similarities in management cannot explain all differences in seasonalities of GIP. No less than 24 sequential monthly fecal samples were collected from hoofstock species at three participating facilities. Fecal egg count (FEC) and culture larval count data was collected on all samples submitted for testing, and results demonstrated some obvious trends in seasonality. In the Southeast US, seasonal spikes in FEC are in late summer and late fall; in Southern California, spikes are usually in late winter.

Haemonchus species are generally associated with warm, moist environments, so they are frequently blamed for morbidity and mortality in hoofstock in the SE US 2; however culture data indicates that they may be more common in dry areas than previously believed. This may be due to artificially altering the environment by irrigation. Some animal species also seem to be more greatly affected by GIP than others, including giraffe (Giraffa camelopardalis), blackbuck (Antilope cervicapra), scimitar-horned oryx (Oryx dama), Thomson’s gazelle (Gazella thomsonii), and blesbok (Damaliscus pygargus phillipsi). Trends in GIP infection are not necessarily the same when comparing the different facilities or the different animal or parasite species.

LITERATURE CITED

NUTRITIONAL AND BEHAVIORAL CONTRIBUTIONS TO DENTAL DISEASE IN CAPTIVE RED KANGAROOS

Poorna Chowdry, MS,1* Julie Funk, DVM, PhD, Mary Ann Raghanti, PhD,2 Christopher D. Peterson, RVT,2 and Patricia M. Dennis, DVM, PhD, Dipl ACZM2

1Michigan State University College of Veterinary Medicine, East Lansing, MI 48824 USA; 2Cleveland Metroparks Zoo, Cleveland, OH 44109 USA

Abstract

Captive macropods often suffer from dental disease frequently requiring tooth extractions. Evidence of bone resorption surrounding affected teeth has been found in some recent clinical cases at the Cleveland Metroparks Zoo. Plausibly, this bone resorption is secondary to inflammation and infection surrounding the affected tooth. However, an alternative hypothesis is that the resorption is evidence of a systemic problem relating to an overall calcium-phosphorus imbalance. In animals with similar digestive processes to those of kangaroos, phosphorus levels are regulated in part by saliva production, which increases with more time spent foraging and chewing. This study addresses the oral health of red kangaroos, Macropus rufus, at the Cleveland Metroparks Zoo. This study determined the effect of providing hay to the animals on-exhibit during the day. No change was made to the standard feeding routine of offering hay and formulated diet (pellets) when animals were brought off-exhibit in the evening. Behavioral data was collected on each of the kangaroos with a focus on time spent chewing and/or foraging. Hay was offered on exhibit every other week and weeks without hay provided baseline data. Oral health and disease progression were evaluated through blood analyses (serum calcium phosphorus and osteocalcin), CT scans of jaws, and dental radiographs. Bloodwork, CT scans, and radiographs were taken before and 6 mo after the addition of timothy hay on exhibit. The goal of this study was to evaluate the effect of increased time spent feeding on bone resorption, serum calcium-to-phosphorus ratios, and dental disease in captive red kangaroos.
ENVIRONMENTAL AND SOCIAL FACTORS ASSOCIATED WITH ZOONOTIC DISEASE AT THE WILDLIFE-LIVESTOCK INTERFACE IN TANZANIA

Deana Clifford, DVM, MPVM, PhD,1* Rudovick Kazwala, BVSc, MVM, PhD,2 Peter Coppolillo, PhD,3 Jon Erickson, PhD,4 Julius John, BVM, MPVM,2 Harrison Sadiki, BVM, MVM,2 Michel Masozera, MS, PhD,4 and Jonna Mazet, DVM, MPVM, PhD1

1Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, CA 95616 USA; 2Department of Medicine and Public Health, Faculty of Veterinary Medicine, Sokoine University of Agriculture, Chuo Kikuu, Morogoro, Tanzania; 3Yellowstone Rockies Program (Formerly Ruaha Landscape Program), Wildlife Conservation Society, Bozeman MT 59715 USA; 4Rubenstein School of Environment and Natural Resources, University of Vermont, Burlington, VT 05405 USA

Abstract

Sharing of diminishing water sources may increase disease transmission and illness in livestock, wildlife, and people; reduce livestock productivity; and impact non-agricultural means of livelihood improvement, such as wildlife tourism. We assessed interactions between disease transmission and water scarcity in the high conservation value but water-limited Ruaha ecosystem, Tanzania. We tested wildlife and livestock for bovine tuberculosis (BTB); determined if water availability and proximity to wildlife protected areas were associated with livestock disease losses or BTB; and surveyed pastoralists’ perceptions about zoonotic disease. Bovine tuberculosis infection was detected in wildlife and livestock; with 27% of 102 sampled households having ≥ one positive or suspect reactor in their herd. Households located farther from villages and from water sources tended to report greater livestock disease losses. The presence of wildlife and proximity to roads were not associated with livestock disease losses. Many households lacked awareness about the risks of contracting disease from livestock or from sharing contaminated water with livestock. Although pastoralists living closer to wildlife may not suffer more livestock disease losses; the presence of BTB in wildlife suggests that disease transmission between livestock and wildlife has occurred. Our data support the importance of water availability for livestock health and productivity and demonstrate a need for remote households have greater access to veterinary extension services. Since people in water restricted households were more likely to share water with livestock, educational interventions regarding zoonotic disease risk and hygiene practices must go hand-in-hand with efforts to improve water access and quality for pastoralists.
DISEASE RISK ANALYSIS: WHAT IS THE RISK OF AZA EMPLOYEES ACQUIRING HERPES B VIRUS FROM MACAQUES?

Yvonne Nadler, DVM, MPH,1* Dominic Travis, DVM, MS,2 Old World Monkey Taxon Advisory Group B Virus Risk Workshop

1Davee Center for Epidemiology and Endocrinology, 2Department of Conservation and Science, Lincoln Park Zoo, Chicago, IL 60614 USA

Abstract

In 2008, the Old World Monkey Taxon Advisory Group requested the assistance of Lincoln Park Zoo epidemiologists in conducting a Risk Analysis that sought to answer the question “What is the risk of AZA employees acquiring Herpes B infection from macaques?” While there are no documented cases of B virus infection in humans from an exposure occurring in an AZA (Association of Zoos and Aquariums) institution, the Advisory Group sought to further understand the risk that may exist.

The Risk Analysis exercise involved the participation of veterinarians, epidemiologists, animal husbandry experts and B virus diagnosticians. AZA zoos that house macaques completed institutional surveys. Using these survey results, best available data, existing AAZV Occupational Primate Disease Safety Guideline and expert opinion, a basic risk model was created and presented for comment at a Workshop held at Lincoln Park Zoo. While the risk is not zero, it appears to be extremely low. This presentation will highlight the most recent version of the Risk Model.

A thorough Risk Analysis exercise also includes Risk Management and Risk Communication components. Various management and communication strategies across AZA institutions will be explored, and limitations of the model will be discussed.
CORONAVIRUS-ASSOCIATED WINTER DIARRHEA IN MIXED UNGULATE HERDS

Nadine Lamberski, DVM, Dipl ACZM,1 Colleen Lambo, DVM,2,∗ Carmel L. Witte, MS,3 James E. Oosterhuis, DVM,4 Rebecca Papendick, DVM, Dipl ACVP,3 and Donald L. Janssen, DVM, Dipl ACZM1

1San Diego Zoo’s Wild Animal Park, Escondido, CA 92027 USA; 2Louisiana State University, School of Veterinary Medicine, Baton Rouge, LA 70803 USA; 3Wildlife Disease Laboratories, San Diego Zoo’s Institute for Conservation Research, San Diego, CA 92112 USA

Abstract

An outbreak of winter dysentery occurred in 8 mixed-species enclosures between January and February, 2009. Cases were identified from animals present in the population during the outbreak and included ruminants over 3 days of age with diarrhea for at least 48 hrs. Duration of illness ranged from 2 to 14 days. Most cases resolved within 1 wk. At least two animals died. Diagnostic tests showed a strong association with bovine coronavirus by EM and PCR in several animals.

Prevalence was estimated at 12.5% (81/649). Affected animals ranged from 2-mos to 16-yrs and included 20 out of 46 species/subspecies. Affected animals were in the family Bovidae. Cervids and giraffe were unaffected. The highest species prevalence was observed among ankole, Ellipsen Waterbuck, Lake Victoria Defassa Waterbuck, Uganda Kob, Nile Lechwe, and Zambesi Lechwe. The outbreak spread spatially through the facility with prevalence varying significantly across the eight enclosures. Differences in enclosure prevalence may be due to species susceptibility, animal density, and/or environmental contamination.

Univariate contingency table analyses were used to estimate the relative risk of infection by sex and age groups. There was no significant difference in infection risk between males and females, but young animals (< 5 yr), were two times more likely to be infected than older animals. Twenty-eight percent of cases occurred among animals under 1 yr of age.

Findings from this study are enabling us to identify high risk groups to better understand coronavirus and diarrhea outbreaks in multiple species and guide future management efforts.
CARDIAC ULTRASOUND EVALUATIONS OF CAPTIVE GORILLAS: AN INITIAL REPORT OF THE GORILLA CARDIAC DATABASE

Hayley Murphy Weston, DVM,1,* Ilana Kutinsky, DO, FACC,2 and William Devlin, MD, FACC2

1Zoo Atlanta, Atlanta, GA 30315 USA; 2Michigan Heart Group, Troy, MI 48098 USA

Abstract

There is increasing evidence that captive gorillas can develop cardiac disease. Diagnoses include fibrosing cardiomyopathy (FCM), congestive heart failure (CHF), hypertensive heart disease (HHD), aortic dissection (AD), and an isolated report of “atherosclerotic coronary artery disease”. The impact of these diseases in great apes is of significant concern, and has been the cause of profound morbidity and mortality. Knowledge of both normal and abnormal cardiac values is essential for early detection and treatment. Therefore development of the Gorilla Cardiac Database was initiated. All AZA institutions housing gorillas were invited to participate in a population based cohort study examining cardiovascular data collected from captive gorillas. This data included signalment, echocardiographic findings, electrocardiograms, blood pressure, and heart rate readings. Anesthetic regimes and physical examination findings were also requested. All participating institutions were sent a standardized data collection sheet. Echocardiographic findings were reviewed by investigators. Basic cardiac parameters measured in all gorillas were aortic root diameter (cm), and left atrial size (cm). Left ventricular (LV) internal diameter and septal and posterior wall thickness were measured in end diastole (LVIDd) (cm) and end systole (LVIDs)(cm). Left ventricular internal diameter and wall thickness measurements were performed at or just below the tips of the mitral leaflets in long and short axis views. Right sided chamber sizes were recorded when available. Fractional shortening (FS) and estimated EF were also measured. Color flow doppler analyses were examined and diastolic parameters, although not frequently available, were also reviewed. This is the initial report generated from the data collected.
TREATMENT OF HYPERTROPHIC CARDIOMYOPATHY IN A WESTERN LOWLAND GORILLA (Gorilla gorilla gorilla)

Doreen M. Harris, DVM, 1,* Ilana B. Kutinsky, DO, FACC, 2 Gwen E. Myers, DVM, 1 and Michael T. Barrie, DVM 1

1 The Columbus Zoo and Aquarium, Powell, OH 43065 USA; 2 Michigan Heart Group, Troy, MI 48098 USA

Abstract

Cardiovascular disease is being diagnosed with increasing regularity in captive gorillas and is a leading cause of mortality in this species. Regular cardiac evaluation can allow for early diagnosis and subsequent treatment, in order to attempt to slow or prevent disease progression.

In January 2007, a 23-yr-old male gorilla was anesthetized in order to perform a complete cardiac evaluation, including transesophageal echocardiogram. Measurements in M-mode included left atrial diameter (4.03 cm), intraventricular septal thickness (1.87 cm), posterior wall thickness (2.3 cm), left ventricular end diastolic diameter (5.38 cm) and left ventricular end systolic diameter (3.47 cm). The ejection fraction was 44%. Color flow Doppler showed trivial mitral regurgitation, but no other valvular lesions. Brain natriuretic peptide (BNP) level was <20 pg/ml. Overall, the study was classified as abnormal, showing evidence of left ventricular hypertrophy, with mild to moderate left ventricular systolic impairment. Twice daily therapy with 50 mg carvedilol was initiated at this time. In November 2008, the patient was anesthetized for a second cardiac evaluation. An echocardiogram was performed with comparative measurements including left atrial diameter (3.2 cm), intraventricular septal thickness (2.1 cm), posterior wall thickness (2.1 cm), left ventricular end diastolic diameter (4.22 cm) and left ventricular end systolic diameter (2.5 cm). Ejection fraction was 58%. A dramatic improvement in ejection fraction and a significant reduction in most measurements were noted. BNP remained <20 pg/ml. Based on these findings, the patient’s carvedilol dosage was maintained and lisonopril was added at an increasing dose until a maintenance level of 40 mg twice daily was achieved. This patient concurrently receives levothyroxine and Zoloft. To date, no negative side effects have been noted to any medications. The findings in this case demonstrate the importance of early detection of cardiovascular disease in Western Lowland gorillas, as early treatment has the potential to slow and even reverse some changes associated with disease.
HYALURONIC ACID JOINT INJECTIONS IN A TIGER WITH ELBOW ARTHRITIS

Danielle R. Graham, DVM,1* Catherine Monger, LVT,1 and Ramiro Isaza, DVM, MS, Dipl ACZM2

1Feld Entertainment, Vienna, VA 22182 USA; 2University of Florida College of Veterinary Medicine, Gainesville, FL 32610 USA

Abstract

An 18-yr-old intact male tiger, diagnosed radiographically with severe bilateral elbow osteoarthritis was becoming progressively lame in his front legs despite ongoing treatment with a variety of oral pain medications. The tiger was immobilized and then maintained on gas anesthesia. 20 mg of hyaluronic acid (HA) (Hylartin V, Pfizer Animal Health, New York, NY 10017 USA), 18 mg of triamcinolone (Vetalog, Fort Dodge Animal Health, Fort Dodge, IA 50501 USA) and 500 mg of amikacin (Amyglide-V, Fort Dodge Animal Health, Fort Dodge, IA 50501 USA) were combined and split into two equal doses for injection into the left and right elbow joints. Both elbows were clipped and prepared aseptically using chlorhexadine and alcohol. A cranial approach was used by locating the lateral collateral ligament between the palpable lateral epicondyle proximally and the origin of the lateral digital extensor distally. An 18 g 3.5 inch spinal needle was placed cranial to the collateral ligament and the HA mixture was injected. Sterile technique was used throughout.

After recovery from anesthesia, the tiger’s lameness improved significantly. His activity level increased and he was noted playing with his toys and jumping onto perches in his enclosure. The duration of the improvement lasted 9-10 wk before the lameness recurred. At that time, a second series of injections were administered exactly like the first. These injections were as efficacious as the first and results lasted until the tiger was humanely euthanatized for health issues unrelated to lameness 11 wk later. Intra-articular injections are a relatively simple technique that should be considered in the management of large cats with osteoarthritis.
BILATERAL URETERAL STENT PLACEMENT AND LITHOTRIPSY IN AN ASIAN SMALL-CLAWED OTTER (*Aonyx cinerea*) WITH NEPHROLITHIASIS

Kimberlee B. Wojick, DVM,1* Kathryn C. Gamble, DVM, MS, Dipl ACZM,2 Owen Slater, DVM,2 Allyson C. Berent, DVM, Dipl ACVIM,3 and Chick Weisse, VMD, Dipl ACVS3

1Chicago Zoological and Aquatic Animal Residency, University of Illinois, Urbana IL 61802 USA; 2Lincoln Park Zoo, Chicago IL 60614 USA; 3University of Pennsylvania School of Veterinary Medicine, Philadelphia, PA 19104 USA

Abstract

Bilateral ureteral stent placement and lithotripsy were performed in a 12-yr-old intact female Asian small-clawed otter (*Aonyx cinerea*) following a 7-yr history of nephrolithiasis and increasing renal insufficiency. The otter had previously presented with acute abdominal pain due to suspected fracture of the left renal calculus. Renal scintigraphy at this time revealed a 50% decrease in renal function. Nephrectomy or nephrotomy were considered as surgical options, but not performed.

As the otter’s clinical condition continued to decline, interventional imaging was used for placement of ureteral stents to prevent obstruction of the ureters with stone fragments from subsequent extracorporeal shock wave lithotripsy. Nephrolith appearance was followed radiographically over 5 wk post lithotripsy. Shifting in stone position was observed without significant decrease in stone mass. An initial increase in azotemia was observed immediately post procedure, but normalized to pre-procedural values over 5 wk.

Due to declining quality of life related to severe osteoarthritis, the otter was euthanatized at 5 wk after the procedure. Postmortem analysis of the stones confirmed 100% calcium oxalate monohydrate, consistent with other reports in this species. Gross and histologic evaluation of the kidneys revealed moderately severe chronic interstitial nephritis and loss of functional parenchyma.

Extracorporeal shock-wave lithotripsy was not successful at nephrolith disruption in this otter, possibly due to prolonged duration of the stones, extent of stone formation, and the resulting renal fibrosis. However, the technique may remain a useful tool for other Asian small-clawed otters presenting earlier in the course of disease.
THYROID NEOPLASIA IN CAPTIVE RACCOONS (*Procyon lotor*)

*Stephanie McCain, DVM,* 1* Matt Allender, DVM, MS,* 1 *Ed Ramsay, DVM, Dipl ACZM,* 1 *Federica Morandi, MS, DVM, Dipl ACVR,* 1 and *Kim Newkirk, DVM, PhD, Dipl ACVP* 2

1*Department of Small Animal Clinical Sciences, University of Tennessee, College of Veterinary Medicine, Knoxville, TN 37996 USA;  2Department of Pathology, University of Tennessee, College of Veterinary Medicine, Knoxville, TN 37996 USA

Abstract

Two cases of thyroid neoplasia were diagnosed in privately owned raccoons. The first case involved a 9-yr-old female spayed raccoon that presented with a palpable cervical mass. A complete blood count, biochemistries, chest radiographs, and total T-4 were within normal limits. A pertechnetate thyroid scan was consistent with non-functional thyroid neoplasia. A thyroidectomy was performed and histopathology demonstrated follicular adenocarcinoma. The mass locally recurred twice after thyroidectomy, and currently there is evidence of pulmonary metastases.

The second case involved an 11-yr-old female spayed raccoon. Ultrasound showed bilateral cystic masses in the area of the thyroids. Total T-4 was elevated, while clinical pathology and chest radiographs were unremarkable. A thyroid scan demonstrated bilateral infiltrative neoplasia. No evidence of renal insufficiency was seen after a 3 wk trial of methimazole gel (0.1 ml of 25 mg/ml gel applied inside alternating ears BID). A right thyroidectomy and partial left thyroidectomy were performed, leaving a grossly normal portion of the left thyroid. Histopathology displayed bilateral cystic follicular adenomatous hyperplasia. At a recheck exam 4 wk post-op, the total T-4 had increased, therefore methimazole was re-initiated, decreasing the dose to once daily because the total T-4 the day of surgery was low.

Thyroid pathology has been documented in raccoons in Europe but is not reported in the United States. Thyroid neoplasia in raccoons can occur as a non-functional adenocarcinoma, as is commonly reported in dogs, or as a functional adenoma, as is commonly reported in cats. Raccoons with adenocarcinomas should be evaluated for pulmonary metastasis.

LITERATURE CITED

DIAGNOSIS AND TREATMENT OF A THYMOMA IN A RED PANDA (Ailurus fulgens styani)

Gwen E. Myers, DVM,1,2* Liza I. Dadone, VMD,3 Brian G. Stockinger, DVM,4 and Jennifer M. Lang, DVM2

1Columbus Zoo and Aquarium, Powell, OH, 43065 USA; 2MedVet Medical Center for Pets, Worthington, OH, 43085 USA; 3Calgary North Veterinary Hospital, Calgary, AB T2K 1A2, Canada; 4Burke, VA, 22015 USA

Abstract

A 10-yr-old female red panda (Ailurus fulgens styani) was diagnosed with a cranial mediastinal mass during routine annual physical examination. She exhibited no clinical signs of disease and physical exam findings were unremarkable. Routine diagnostics performed included radiographs, complete blood cell count, serum biochemistry, heartworm antigen test, urinalysis, and abdominal ultrasound. The mass was noted on thoracic radiographs, and located cranial and ventral to the heart. The results from the remaining diagnostics were unremarkable.

Thoracic ultrasound revealed a 5 × 3.5 × 3.3 cm mass. A fine-needle aspirate was performed and approximately 60 ml of brownish-yellow fluid was collected and submitted for culture and cytology. Aerobic and anaerobic culture yielded no growth, and cytology of the aspirate was suggestive of thymoma. Further diagnostics were performed over a 2-mo period, and included radiographs, ultrasound, hematology, additional fine-needle aspirates, and computed tomography. CT revealed the mass to be closely associated with the heart causing slight displacement, but no evidence of metastasis. During this time period the mass had increased in size to 5.1 × 3.7 × 8.7 cm. A median sternotomy was performed and the entire mass removed without complication. Histopathology identified the mass as a benign thymoma. The panda recovered without complication and has had no evidence of tumor recurrence for 2 yr.
LONG-TERM MANAGEMENT OF DYSTOCIA, RETAINED FETUS, AND SURGICAL INTERVENTION IN AN AFRICAN ELEPHANT (Loxodonta africana)

Wm. Kirk Suedmeyer, DVM, Dipl ACZM

The Kansas City Zoo, Kansas City, MO 64132 USA

Abstract

A 31-yr-old female African elephant (Loxodonta africana) was documented as being pregnant in late 1999 through observation of natural breeding, serum progestin levels, transrectal and transabdominal ultrasound.1-2 The elephant failed to give birth to a full term fetus during the onset of natural labor. The elephant was managed as a clinical dystocia with a retained fetus by observing clinical abnormalities, monitoring complete blood counts, select sera chemistries and routine progestin levels. Rotational analgesics and antibiotics were administered for 8 mo after the onset and discontinuance of labor. Analgesics were administered during times of perceived pain occurring during subsequent estrus cycles.

Five years later, the female demonstrated the onset of naturally induced labor but failed to pass the retained calf beyond the horizontal portion of the vestibule. A vestibulotomy was performed and produced a mummified but headless bull calf. Despite four surgical procedures to close the vestibulotomy site, the incision dehisced and the elephant is currently managed with a urinary fistula. She is otherwise clinically normal and on exhibit.

LITERATURE CITED

TREATMENT OF A RETAINED PLACENTA IN A PRIMAPAROUS AFRICAN ELEPHANT (*Loxodonta africana*)

Nadine Lamberski, DVM, Dipl ACZM,1 James E. Oosterhuis, DVM,1 Jeffery R. Zuba, DVM,2 G. Lynn Richardson, DVM, Dipl ACVS,3 Jeffrey Andrews, MA,1 Allan P. Pessier, DVM, Dipl ACVP,3 Barbara Durrant, PhD,3 and Richard Fayrer-Hosken, DVM, PhD, Dipl ACT4

1San Diego Zoo's Wild Animal Park, Escondido, CA 92027 USA; 2San Louis Rey Equine Hospital, Bonsall, CA 92003 USA; 3San Diego Zoo’s Institute for Conservation Research, Escondido, CA 92027 USA; 4University of Georgia, Department of Large Animal Medicine, College of Veterinary Medicine, Athens, GA 30602 USA

Abstract

A 17-yr-old primaparous African elephant (*Loxodonta africana*) gave birth to a live female calf following a 642-day gestation. The fetus passed 22 min after the amniotic sac and 5.5 hrs after the mucus plug. The placenta did not pass. Lethargy, persistent vulvar discharge, decreased appetite, weight loss, and agalactia ensued over the next several weeks. Hematologic changes included leukocytosis, hyperfibrinogenemia, and anemia. Dam was anesthetized on day 23, 36, 42, 56, and 71 post partum for endoscopic exam and uterine lavage. Endoscopic uterine biopsies were obtained and endometritis confirmed. During the fourth anesthetic procedure, a 4 kg piece of placenta was removed using a modified shop vacuum. A vestibulotomy was performed on the same day to facilitate inserting a tube through the vulva and into the cervix. This allowed for the infusion of 210 mil IU penicillin G potassium (Pfizerpen, Pfizer/Roerig, NY, NY 10017) and 12 g gentamicin sulfate (GentaVed™ 100, Vedco, Inc., St. Joseph, MO 644507) in 3 L saline (0.9% NaCl Injection USP, Baxter Health Care Corp., Deerfield, IL 60015) into the uterus while the animal stood in an elephant restraint device on days 62-69 post partum. Serial endoscopic uterine evaluations before and after treatment confirmed improvement. A final piece of placenta weighing 2.6 kg passed 87 days post partum. Decrease in white blood cell count, resolution of anemia, cessation of vaginal discharge, surgical wound healing, and increase in body weight were used to monitor improvement and determine resolution.
CONTINUITY OF BUSINESS PLANNING: PANDEMIC PREPAREDNESS IN ZOOLOGICAL INSTITUTIONS

Dominic Travis, DVM, MS,* Julia Chosy, PhD, Megan Ross, PhD, Kathryn Gamble, DVM, MS, Colleen Lynch, MS, and Steve Thompson, PhD

Lincoln Park Zoological Society, Chicago, IL 60614 USA

Abstract

Best business practice dictates planning for continuity of business during times of disaster. Traditionally, these plans have not included preparation for infectious disease. Zoological institutions must be prepared to minimize the risk and consequences of emerging infectious diseases to both their collection and patrons. ‘Zoo Animal Health Network’ is a joint initiative between Association of Zoos and Aquariums (AZA) and the United States Department of Agriculture (USDA) that is designed to help zoological institutions watch and prepare for the possibility of a zoonotic or foreign animal disease outbreak. The surveillance component will help zoos detect the presence of disease at their facility early enough to institute predetermined outbreak management plans. Additionally, it will increase the robustness of current disease surveillance in wildlife, thus offering important data to public health agencies. The preparedness component will teach zoo professionals techniques for standardized observation that will aid in rapid response to diseases of concern.

ACKNOWLEDGMENTS

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DISASTER PLANNING FOR ZOOS AND AQUARIA: HOW FAR HAVE WE COME OR SHOULD WE GO?

Carin Wittnich BSc, MSc, DVM* and Michael Belanger, ALAT

Oceanographic Environmental Research Society, Barrie, Ontario, L4N 2R2, Canada

Abstract

Although there is controversy in the scientific literature, Oxfam International and the United Nations both believe that climatic disasters are increasing particularly those on a small to medium scale. Tsunamis, hurricanes, floods, ice storms, droughts, fires, earthquakes, pandemics and foreign animal diseases are some of the types of disasters that can cause damage on a large or small scale and can occur with some or little warning. Recent large scale disasters such as Hurricane Katrina or Avian Influenza outbreaks have caused a surge in disaster preparedness and response worldwide. As seen with several large scale disasters, the welfare of animals especially pets and other valued animals such as those kept in zoos and aquaria have become a critical issue when evacuating individuals or communities.

As disasters may occur without any advanced notice and at any time, zoos and aquariums would be expected to have protocols in place that look after the welfare of their guests, their employees and, one hopes, their many animal species. This places huge responsibilities and stress on the management and staff as they must sort through the ethical dilemma of putting priorities in place. Several questions must be answered and circumstances considered depending on the type of disaster and geographic locations of the facility. A zoo might be within a large area of wildfires or an aquarium might face the onslaught of a hurricane. In situations where their animals have open access to the natural environment, a local outbreak of foreign animal diseases or even the quarantines accompanying such an outbreak can have catastrophic consequences for the animals in their collections. During a disaster of any scale, what are the reasonable expectations when it comes to saving large numbers of animals or species found in today’s zoos or aquariums, some of which might be highly endangered or threatened? Present ‘disaster response plans’ to various types of disasters from many of the existing zoos and aquaria in Canada show that regarding the animals themselves, very little other than ‘shelter in place’ plans exist. What about alternatives, such as preplanned evacuations in order to preserve the integrity of the species in the collections. Do we plan now and think outside the box, or are we best served to react once that disaster hits hoping that ‘sheltering in place’ is enough to save the exhibits. A view from the outside - looking into Noah’s Ark, is there a leak below the waterline?
KITE STRING INJURIES IN BIRDS: DISASTER RESPONSE

Dananjaya Karunaratna, BVSc, MSc Wild Animal Health(student),1* Andrew Routh, BVSc CertZooMed MRCVS,2 Soham Mukherjee,3 and Rahul Sehgal4

1MSc Wild Animal Health student, Royal Veterinary College, London, UK; 2Zoological Society of London, London, UK; 3Madras Crocodile Bank - Centre for Herpetology, Tamil Nadu, India; 4Animal Help Foundation, Gujarat, India

Abstract

Kite string injuries of birds have been identified as a man-made disaster causing major welfare and conservation issues. Traditional kite flying throughout the Indian subcontinent, especially in India, Pakistan and Bangladesh, is celebrated every year.1 Kite-flying takes place in the first 2 wk of the New Year, both in crowded cities and the countryside. Birds may be injured by the flying kites or the vast quantity of discarded string that often festoons trees. Ahmedabad, a “mega-city” in Gujarat, sits on a major bird migratory route and still has a small population of the highly-endangered Gyps vultures. Local and international non-government organizations (NGOs) have now committed themselves to providing disaster response. This includes the collection of injured birds, transportation to veterinary treatment facilities, triaging of patients, providing medical and surgical treatment, hospitalization and rehabilitation or euthanasia.

Over a period of 3 yr, a team headed by a veterinarian collected injured birds, such as vultures from the city.2 Basic first aid measures, including hemostasis and intravenous fluids, were given at point of collection. At the hospital birds were triaged according to the type of injury, conservation status and rehabilitation prospects. The majority of the injuries pertain to the wings, with laceration injuries to the propatagium, muscles and tendons of brachium and antebrachium being the most frequently recorded. Long-legged species (e.g., cranes) most frequently present with leg injuries sustained when they are brought down in flight. Fractures of the humerus and radius, dislocations and severe joint capsule damage of the elbow joint also present. Surgical repair of lacerated wing soft tissues was performed under inhalation general anesthesia using isofluorane. Markedly higher survival rates and fewer disabilities were observed in the years 2006 to 2008 when compared with previous years. Wing amputation of some endangered species was performed after critical evaluation of future welfare in captivity. Disabled endangered birds were distributed among breeding programs and zoological gardens. Birds deemed fit were released back into the wild.

Factors that have contributed to the success of the rescue efforts include the capability of a local, primarily stray dog neutering, NGO to provide facilities and veterinary staff familiar with a high surgical throughput, a highly motivated volunteer network and logistical support. This was augmented through one member of staff having previously attended a training course on avian medicine and surgery, (with this knowledge having been cascaded down), high-quality equipment (including isofluorane vaporisers) being available and a skills-base that included ornithologists and aviculturalists. Participation of wider-community, including religion-based
animal welfare organizations and the government sector, and changes in public perception in later years have influenced the disaster response, especially regarding welfare issues such as euthanasia. The kite festival, “Uttayan,” has a religious base. Thus reduction of the effects of the festival in the future must be based on mitigation (e.g., through the use of different kite string), and education (e.g., requesting that kites not be flown in areas of significant wildlife importance), rather than through an expectation that it can be halted or banned.

LITERATURE CITED


RESCUE CENTER MANAGEMENT AND OUTREACH WORK AT THE ANIMAL’S ASIA FOUNDATION’S CHINA BEAR RESCUE CENTRE DURING THE 2008 SICHUAN EARTHQUAKE

Heather Bacon, BSc, BVSc, MRCVS

Animals Asia Foundation, Sichuan Longqiao Black bear rescue centre, Longqiao, Xin Du District, Chengdu, 610505, China

Abstract

On May 12th 2008 an earthquake measuring 8.0 on the Richter scale hit the south-western Chinese province of Sichuan. The earthquake killed at least 69,000 people with many more missing. Hundreds of companion animal and livestock species were affected by the quake, and whilst relief efforts were initially focused on humanitarian support, a secondary wave of animal-focused relief efforts was also initiated.

The Animals Asia Foundation’s China Bear rescue centre, situated approximately 30 miles from Wenshuan, the epicenter of the earthquake suffered significant damage to buildings although fortunately no damage to animals or people. During the earthquake and in the following months, the importance of our pre-existing response plans became evident. Prior planning allowed us not only to ensure the safety of our staff and animals on site, but also enabled us to offer outreach services to others affected by the earthquake.

Mitigation

Contingency planning for natural disasters or other emergencies should form an integral part of any rescue centre management. Areas to consider are fire, flood, wild animal escape, disease outbreak and geophysical disasters. Additionally contingency planning for potential natural disasters is a necessary part of the development of a centre, as mitigation is often the most cost-effective stage of disaster planning. This can be challenging, particularly in developing countries where issues such as construction safety standards may be difficult to address. Our thorough approach to construction meant that whilst, many older buildings collapsed around us, our hospital and bear areas, home to approximately 180 bears, remained intact and safe.

Preparation

Staff training is of paramount importance to reduce panic that may arise during an emergency situation. Immediately following the initial earthquake, steps were taken to secure the site, checks on water, electric and gas supplies were made, buildings were inspected and secured to prevent entry where necessary, and bears were accounted for and managed to ensure both animal and human safety was maintained. Bear enclosures were checked to ensure fence lines, enclosure furniture and trees were still stable, thus safeguarding the local populace against the possibility of a bear escape. If a bear escape had occurred, our pre-existing bear escape
procedure would have been implemented. As a charitable facility relying entirely on public support and positive government relations to continue our work, the escape of large carnivores into the local area could have had disastrous consequences for our work. Fortunately the contingency plans that we had developed with regard to bear management, prevented any problems.

Safety remained paramount; alternative, makeshift staff accommodation was provided by converting more secure hospitalization and storage areas and foreign staff remained in constant embassy contact, whilst Chinese staff kept us regularly updated with local information. Our pre-existing flood preparation protocols were implemented as soon as we were advised of a possible dam breach upstream with the potential to devastate the local area (the rescue centre is sited on the banks of the River Pi, downstream from the Zi Ping Pu dam and Dujiangyan irrigation centre). Life jackets, first aid kits, food and water and other useful items were placed at strategic points,²,³ essential staff was briefed on flood procedure and other staff was evacuated from the centre. All staff remaining on site were briefed thoroughly on the prospective dangers and required to sign waivers acknowledging the risks to them.

Response

Our ability to mitigate the damage to our own centre and the work spent on staff preparation meant that we were able to offer supplies and services to others affected by the earthquake. Our initial response focused on the enormous humanitarian relief effort; delivering water and medical supplies to local towns devastated by the earthquake and ensuring that our staff and their families were secure. We also allied with the Red Cross to deliver food and water supplies to local villages that had been cut off by landslides. During this period, aftershocks, floods and landslides were regularly reported throughout the local area and so we maintained regular communication with the local authorities to ensure the safety of all staff participating in the outreach effort.

As a bear rehabilitation facility with an excellent medical centre, we liaised with the local government by offering advice on securing local bear farms and basic bear husbandry requirements, but sadly due to the political nature of the bear farming issues, our direct assistance was not accepted, despite documented bear escapes from farms in the post-earthquake period. Although frustrated by this, we determined to channel our efforts elsewhere; we quickly initiated programs to protect local people and their animals from disease outbreaks. Dog and cat fostering programs were developed to support owners forced to relinquish their pets and vaccination programs covering both owned and stray dogs started up in local towns to reduce the likelihood of rabies outbreaks triggering further panic and a backlash against animals by local authorities. Once again the safety of our own staff was weighed against the risks of travel into affected areas and exposure to disease. All staff received pre-exposure rabies vaccination and post-exposure treatment was given as required.⁴ We also worked with local dog and cat rescue facilities to provide long-term care for companion animals affected by the earthquake, and this is an ongoing project.
Recovery

Recovery from a natural disaster is a slow and difficult process. Despite our best efforts at mitigation and preparation, our centre suffered severe damage to a number of older buildings, resulting in an increase in construction costs over the coming years. The local populace has suffered incredible hardship in terms of the ongoing financial losses through lack of tourism, and subsequent floods and landslides, in addition to the obvious damage caused by the original earthquake.

Conclusions

Lessons learned, are an important part of the self-auditing process. Since the earthquake our fire, flood and bear escape protocols have been revised, and a brand new earthquake protocol has been developed. We have more stringent guidance for staff on disaster risks in the local area, including the signing of waivers for all new staff, and recommendations on emergency evacuation and embassy contact prior to arrival in China. Additionally, whilst assisting with humanitarian relief efforts was rewarding, we had to balance this against the potential risks to our staff when visiting disaster-hit areas, and this is not something to be taken lightly. Ultimately our expertise lay in the prevention of disease outbreaks and provision of veterinary assistance, which manifested primarily in the companion animal programs that we developed. However the instigation of such programs, which are time and labor-intensive and require a heavy financial commitment, should not be entered into lightly.

LITERATURE CITED

THE STORM OF THE CENTURY: A VETERINARY PERSPECTIVE ON HURRICANE KATRINA

Elizabeth E. Hammond, DVM, 1* Roberto Aguilar, DVM, 2 Marsha Fernandez, MA, 3 and Daniel Sosa, DVM 4

1 Lion Country Safari, Loxahatchee, FL 33470 USA; 2 New Zealand Wildlife Health Centre, Phoenix, AZ 85032 USA; 3 Audubon Zoo, New Orleans, LA 70118 USA; 4 Palm Beach Veterinary Specialists, West Palm Beach, FL 33406 USA

Abstract

Hurricane Katrina struck New Orleans as a Category 3 storm on August 29, 2005. In spite of the fact that the zoo was prepared for a storm of that intensity, the failure of the levees caused catastrophic flooding in the city. Members of the Hurricane Team cared for the animals at the Audubon Zoo without outside help for 1 wk. Physical isolation, the inability to gather and receive information regarding the situation, and large-scale human tragedy made the zoo’s plight secondary to other rescue efforts. The zoo’s isolation, lack of specialized food supplies, and a lack of a long-term emergency plan complicated assistance efforts in the days and months following the storm flooding. A situation of normal activity was not achieved for months, and visitors were unable to return to the zoo for 3 mo. A clear long-term plan may greatly assist zoos and veterinary staff if an emergency situation becomes prolonged past the immediate planned availability of resources.

Introduction

On 29 August 2005, Hurricane Katrina made landfall just east of the city of New Orleans as a Category 3 storm, with maximum wind speeds of 130 mph. In the wake of the storm the levees surrounding this city below sea level failed, flooding 80% of the urban area. Over a thousand of the city’s residents died, and water rose 6-10 feet in the lower-lying parts of the city. Thousands of people were stranded without food and water for five days or more. Metropolitan services such as power, water and sanitation ceased, and cell phone communication was limited. With only one large highway to enter or exit the city, New Orleans became isolated and inaccessible by land.

The Audubon Zoo implemented its Hurricane Protocol as the hurricane approached. This protocol guided employees to secure animals, documents, equipment, and buildings, among other things, to minimize losses in the event of severe wind and water damage to the zoo. As part of this protocol, a team of 14 various volunteer zoo employees (aka “Hurricane Team”) stayed at the zoo during and after the storm. Volunteer staff had been staying at the zoo during the threat of hurricanes since 1989, but 2005 was the first time the Hurricane Protocol had fully been implemented. The Hurricane Team stayed in the hurricane-proof reptile building and slept on cots in the visitor’s area. Important food and supplies were stored in this building, which also included an escape hatch in the roof. The hurricane procedures were updated yearly, including
adaptations from lessons shared by staff from the Miami MetroZoo, which was damaged when Hurricane Andrew, a Category 5 storm, devastated southern Florida in August 1992. In recent years, the Hurricane Protocol supplies included boats, life preservers and the storage of food and water in the upper parts of the reptile building in the event of severe flooding. In the wake of Hurricane Katrina, the Audubon Zoo suffered severe tree destruction, downed fences and enclosures, and moderate building damage. However, unlike the rest of the city, the zoo did not flood because it is located on a ridge adjacent to the Mississippi River and is one of the highest parts of the city.

Although the zoo lost two young otters, a raccoon, and a flamingo during the storm, the rest of the animals fared well. There were no animal escapes or injuries. However, in the days following the storm when the city of New Orleans spiraled into chaos, it became clear that the short-term plan to care for the animals would quickly become inadequate.

**Short-term Plan and Challenges Faced**

The Hurricane Team stayed at the zoo without outside help for 1 wk. During this time, there was no electricity or running water. Limited power was available by using generators. Gas, food and water stores were only planned for five days without outside assistance and thus were quickly exhausted. In addition, the New Orleans Police Department commandeered gasoline to power more than 20 vehicles. As time went by, the safety of the staff and zoo animals was in question because there was a threat of looting. The Hurricane Team made every effort to avoid being visible to outsiders, including limiting the use of lights at night. Armed staff patrolled the perimeter fence of the zoo in shifts to ensure the safety of the people and animals.

After the hurricane, communication with those outside the hurricane zone was difficult. Cell phones were unreliable, although text messaging was possible. A satellite phone procured for the hurricane season did not work. There were three working phone lines in several areas around the zoo that enabled communication with those outside the hurricane zone. Additional phone lines were added for the next hurricane season. Also, changes were made to the cell phone service for future hurricane seasons. The hurricane team cell phone numbers are now changed to outside area codes so that they have a better chance of working. The cell phones also include text messaging, which worked reliably after Hurricane Katrina.

The members of the Hurricane Team were a diverse group, including veterinarians, curators, keepers, a horticulturist, and security guards. However, this group was given the task of caring for a collection of 1500 animals from a variety of mammalian, avian and herptile taxonomic groups. Simple things, such as knowing where animals were located, what their identification was and what they ate, were not always clear, especially for someone who normally would not have cared for the animals. Thus, an updated and accurate hard copy inventory for all animals and their diet needs is essential. A standard operating procedure for the animals should also be available in appropriate areas. This documentation is important for people who may be caring for animals that are not normally under their care and if animals must be evacuated to another facility. In addition, diet and medication information should be posted in the vicinity of the
animals. If there is no electricity, it may be difficult or impossible to access electronic documents.

Because of the diverse animal collection with specialized diets, maintaining adequate nutrition for the animals became a major challenge. Food supplies for small amphibians that require crickets of a specific size exhausted quickly. Fresh fruit and vegetables were used within 1 wk, and supplies of hay and grain dwindled.

Providing adequate water for the animals was a serious concern. Initial water stores for the megafauna, such as rhinoceros and elephants, only provided water for three days. With the warm ambient temperature these animals rapidly consumed this supply. Although there was potable water available in two large 800-gallon bladders on the ground, it was difficult and time-consuming to move large stores of water to different areas of the zoo. Future protocols call for securing larger amounts of water distributed around the zoo prior to the onset of the hurricane. Although battery-powered flashlights and headlamps were available, without electricity this lighting was inadequate when working around dangerous animals in dark hallways. In future protocols, more substantial emergency lighting through the use of generators is planned.

Prior to the storm, many animals were placed in temporary hurricane housing for safekeeping. However, the storm damaged pens, fences and habitats, which made it impossible to return the animals to their exhibits. Thus, these animals were kept in areas that were inadequate for long-term occupation as the Hurricane Team scrambled to secure their normal enclosures.

Aquatic animals can be challenging to maintain without water or electricity, as demonstrated by the devastating losses at the Audubon Aquarium of the Americas despite back-up generators. Since their health is linked closely to water quality, a generator is necessary to keep their life support system running. Back-up generators can fail, especially if they are needed for more than several days. The generator to power the sea lions’ water filtration system failed soon after the storm. The five animals were kept in their exhibit for ~five days without active filtration. The water became uninhabitable for the sea lions. Thanks to the support of several local zoological facilities (Alexandria, Baton Rouge and Houston Zoos) and the Louisiana State University, the sea lions and otters were safely evacuated to holding facilities with appropriate habitats. In the future, it would be helpful to have a post-storm evacuation plan and supplies ready prior to the start of hurricane season.

Although birds may be slightly easier to maintain without electricity or water, avian species present their own challenges. The generator-run air conditioning system failed in the indoor aviary at the Audubon Zoo. With the clear ceilings and warm ambient temperatures, the enclosure turned into a greenhouse. As a solution, small mesh screened doors were constructed in order to open the aviary doors to the outside to allow air to circulate. Future plans include solar-powered fans to improve air circulation throughout holding facilities.

Two hornbills were housed in a temporary holding space that did not allow natural sunlight. They were unable to return to their normal exhibit due to extensive hurricane damage. Without electricity, these birds were in the dark 24 hr/day, and they would not eat. It was only after they
were moved to an outdoor area that their appetite returned to normal. When designing holding facilities, providing natural sunlight should be considered to allow for the normal circadian rhythms of animals in the event of a power outage.

Zoo animal medical records posed a major challenge during the crisis and in the months following. Multiple copies of medical records were sent to a sister zoo in another state for safekeeping prior to the hurricane. However, access to these medical records was not possible for several months after the storm. The veterinary staff was unable to access computerized medical records for many months, and some paper records were incomplete. Thus, hard copies of medical records should be kept up to date and accessible prior to the hurricane season. This is especially important if an outside veterinarian provides relief veterinary care.

The members of the Hurricane Team were faced with personal challenges during the post-hurricane period. Many did not know the fate of their families, pets and houses. Rescuing fellow employees’ pets was a post-storm reality that had not been anticipated. Some employees were out of town prior to the hurricane, trapping pets in flooded homes. In addition, several Hurricane Team staff had left their pets in their homes thinking they would be able to return home after the storm. The Hurricane staff improvised to find a place for all of these rescued animals. Rescued cats, dogs and birds were housed in offices and bathrooms within the animal hospital and administration area. Flea control was applied to most of the rescued animals. However, one cat missed the topical flea treatment, and a coworker’s office was infested with fleas for months after the storm!

Rescuing employees pets was a necessity and done with pleasure. However, doing so exposed the rescuers to potentially hazardous conditions. The rescuers boated through dangerous neighborhoods and unsanitary water in order to find these animals. Also, caring for these pets took time away from providing for the Audubon Zoo’s animals.

Based on experiences with Hurricane Team members’ pets during Hurricane Katrina, a new strategy was implemented for the 2006 hurricane season. A veterinary clinic in Baton Rouge agreed to reserve kennel space for the Hurricane Team members’ animals. The veterinary staff at Audubon Zoo provided vaccinations and micro-chipping free of charge to all Hurricane Staff pets prior to the start of the hurricane season. Transportation for these animals prior to a hurricane was coordinated. Although this plan did not need to be implemented during the 2006 hurricane season, it gave the Hurricane Staff peace of mind that their personal pets would be taken care of and allowed them to focus on the task at hand. In addition, by providing safe hurricane housing for pets, more zoo employees were willing to volunteer for the hurricane team.

**Long-term Plan in a City in Chaos**

Zoo staff outside the hurricane zone quickly recognized the need to assist the Hurricane Team soon after the storm because it was impossible to establish when services, supplies and safety would be secured. Based on the knowledge that the Hurricane Team had limited gas, food and water supplies and the perceived threat of looting, the zoo’s staff outside the hurricane zone made a plea for specific assistance. Working at the military command post in Baton Rouge and
through the Louisiana School of Veterinary Medicine, outside staff mobilized food and personnel reinforcements and organized the purchase and delivery of two dozen large (450 gallon) plastic water reservoirs for distribution throughout the zoo. Military rescue personnel donated the use of a large potable water pipe truck that could easily transport water around the zoo. Manual water delivery and re-supply was maintained for 25 days after the storm, until the safety of the city’s potable water was established for certain.

By the fifth day after the storm, limited communications, constant physical labor and concern over safety contributed to a sense of isolation and exhaustion in the fourteen volunteer staff. A plan was devised outside the zoo to relieve fatigued staff. Two teams of employees outside the hurricane zone were created. The teams were devised so that a person with certain skills could be replaced by another without interrupting basic animal care and emergency procedures. These teams were rotated every 2 wk. Veterinary staff from the Houston and Tulsa Zoos provided relief for the zoo’s veterinarians.

On day seven after the storm, the National Guard and special forces occupied Audubon Park adjacent to the zoo in a military bivouac that remained in place for months. Several hundred soldiers were based in the park to provide security and rescue services to New Orleans. In addition, they also provided supplies, in gas and water, and materials to the zoo. Soldiers volunteered to clear debris and repair fences at the zoo in their spare time. They were allowed to wander the zoo freely. Most military staff remained armed and alert after the storm.

One week after the storm, the outside zoo staff coordinated a convoy of food, water, and supplies. Donated materials came from the Houston and Alexandria Zoos. The police escorted a convoy of eight supply trucks with donated materials, veterinary supplies, specialized animal food, 50,000 gallons of water, and transport cages. Potable water and materials reached the zoo on the ninth day after the storm. Veterinary zoo staff secured animal transport cages so that the sea lions, otters and other small animals could be trucked to other facilities for their safe-keeping and in an effort to decrease the work load at the zoo. Unfortunately, the supply effort was hampered by a lack of clear designation of chain-of-command among outside staff and between outside staff and those in the hurricane zone. A chain-of-command both inside and outside the crisis zone should be established in the emergency protocol.

During the first 30 days after the storm injuries to several staff members occurred. Several minor accidents and one serious injury (hand crushed by a sliding gate) were treated by medics from the National Guard. There were no other available human medical services in the city. In addition, several Hurricane Team members’ supply of medications ran out. In future hurricane protocols, Hurricane Staff are encouraged to ensure they have a 3-mo supply of essential medications during the hurricane season.

Animal veterinary services in the post-storm city were non-existent. The zoo veterinarian was the only veterinarian within the city. Police officers and residents resorted to coming to the zoo for veterinary care for injured and sick pets. Staff pets as well as strays from the area (including rabbits and an ostrich) were brought to the zoo. In an effort to protect the zoo collection, these animals were maintained in separate/quarantine areas.
Conclusion

The Audubon Zoo’s hurricane plan was successful. It was a dynamic process and important lessons were learned along the way to improve the protocol for the future. However, there was a false assumption that a situation normal would be re-established within 1 wk of the storm. Instead, the Audubon Zoo was closed to the public for 3-mo, causing a severe financial strain. Almost 80% of the zoo staff was furloughed, leaving the remaining 20% to care for the same number of animals.

In addition, at least half of the staff lost their homes to flooding, and many more sustained significant damage to their properties. Thus, the employees were under great physical and emotional strain in the months after the hurricane. Post-storm counseling should be included in the recovery phase of any emergency protocol. In order to navigate the post-Katrina life, a shift of thinking was necessary: accepting that everything personally and professionally is changed forever.
THE WILD SIDE OF DISASTER: PLANNING TO PROTECT CAPTIVE WILDLIFE FACILITIES

Lisa B. Done, DVM, MPVM

1121 Windward Way, Oxnard, CA 93035 USA

Abstract

With natural disasters occurring throughout the country it is important for captive wildlife facilities to effectively plan on how to handle these disaster. This emergency preparedness should be for the worst category of the event (i.e., category 5 hurricane). Regardless of the type of disaster there are basic general considerations to take into consideration for this preparedness. These include developing: 1) an emergency preparedness handbook, 2) auxiliary volunteer support teams, 3) zoo visitor evacuation plans, 4) list of priority for endangered species 4) adequate backup for electricity, ventilation, lighting and heating 5) supplies.

General Considerations

The emergency preparedness handbook defines the chain of command, communication pathways and alternatives. It is clearly written and concise so that employees know their role. The auxiliary volunteer support teams are under the direction of the emergency preparedness team and can function as spotters and observers of the public, assessors of the animal inventory and assistants for any other jobs. Zoo evacuation plans need to be thorough, planned and orderly. These evacuation plans should be made for both pre and post disaster. Concerning the priority of endangered species, these animals will need separate contingency plans and specialized teams to deal with such species. Adequate backup needs to be in place for all of the environmental support functions. Supplies include backup food and water for anywhere between 3 days to 3 wks, bilge pumps, plastic sheeting, sandbags, and ropes. Capture equipment and veterinary medical supplies are of utmost importance.

Disaster Types

Each type of disaster has its own challenges and difficulties. Hurricanes are prevalent in certain geographic areas and recently have caused serious and devastating damage. Many zoos are at risk; both major and smaller facilities can be affected. Normally extensive preparation can be made before a hurricane hits, as there is usually advanced warning. Hurricane Katrina was massive, and much of the damage occurred from post-event flooding. Although the Audubon Zoo was seriously affected, the physical damages to facilities and the grounds were fairly minor. The widespread effects of Katrina on the infrastructure of New Orleans and Audubon Zoo staff availability were immense and became the primary problem. The zoo was closed for a period of time, which puts staff out of work, and affects the public.
Flooding even without a hurricane can also cause immense damage and serious problems. Floods are likely the most common disaster zoos might face as many zoos are near creeks, rivers, and flood plains. Besides the immediate danger an excess amount of water in abnormal places can pose (i.e., drowning), there can be several other hazards and threats. At the Huston Zoo a gorilla died of shigellosis after consuming contaminated water from a backed up drain. There is also the risk of hypothermia if animals are exposed to cold water especially for prolonged periods of time.

Tornados usually do not allow for much notice. No above ground structure can withstand a major tornado. Besides building collapses and immediate injury and death from this, items strewn around zoo grounds and exhibits can pose threats in and of themselves.

Earthquakes can occur anywhere, but certainly geographic areas, which are prone to earthquakes, are know. Facilities here need to take preemptive precautions for securing items that can fall and that can be particularly dangerous if they do (i.e., oxygen tanks, heavy items). As with hurricanes many times the after event sequela can be more dangerous, (i.e., fires from broken gas lines, inaccessibility).

Fires have become particularly dangerous especially in certain regions. Fires can be extremely unpredictable in their course and their level of severity. If it is not possible to evacuate the facility, well thought out plans for constructing fire breaks in cooperation with the fire department and firefighters need to have been worked out ahead of time. There are wildlife facilities, which have successfully done this multiple times but only with these well laid out plans and advanced chain of command instructions in place.

Farther down the list of probable occurrence are toxic spills. But these are real possibilities especially since many zoos are in proximity to freeway and railways where these spills can occur. Again a plan of action should be worked out with the appropriate local authorities.

Blizzards are a common occurrence in many parts of the country and with blizzards intense cold can also be present. Having appropriate equipment in place to adequately heat not only enclosures but also infrastructure elements is mandatory. On the flip side drought and intense heat causes it own problems. Zoos which are located in very hot environments have to deal with this problem sometimes on a daily basis and many times have shortened day time hours so that animals do not have to be outside during the worse part of the day. Zoos should also keep in mind what species are not compatible with their geographic climate extremes.

Acts of war, a man made disaster may effect some zoos more than natural disasters. This seems to be the case outside of the U.S. The zoo in Baghdad suffered immensely during the current war in Iraq, where many animals were lost to starvation and lack of care. European Zoos have also been severely affected during world wars.

Species-Specific Concerns

There are species-specific concerns and needs, which should be thought of and taken into
consideration after a disaster.

**Birds**

Birds are difficult to deal with especially since this group is so diverse with 28 or more different orders. A thorough needs assessment is advised for each collection since each species may require a different diet; mixed seed diets, pellets, commercial chow, canned substitutes for protein, vegetables, fruit and other related products should also be considered as emergency provisions. Birds should have identification bands, tattoos, microchips, or DNA fingerprinting to help identify them if they escape. Behavior can be different for wild caught versus captive reared birds. Birds have a high tendency to flee but territorial birds may stay in close proximity and others will return to be with their flock members. Almost immediately after the disaster food-seeking activity will begin. To capture escaped birds suggestions include taking advantage of nocturnal resting habits, using conspecifics as lures, and using baited traps and mist nets.

**Reptiles and Amphibians**

Reptiles and amphibians present their own unique challenges for handling during and after a disaster. They are likely to leave their enclosures if a suitable opening occurs and tend to be secretive typically hiding or fleeing to avoid interactions with large vertebrates such as humans and domestic dogs. They can aggregate in areas with appropriate environmental conditions. Some reptiles such as crocodilians (alligators, caimans, crocodiles, and gavials), large monitor lizards (e.g., water monitors, Komodo dragons, Nile monitors, and any other species or specimen in excess of 2 ft snout-vent length), large tegu lizards, large iguanas (green iguanas and rock iguanas), large constricting snakes (e.g., anacondas, reticulated pythons, Burmese pythons, African rock pythons, or any other species or specimens in excess of 8 ft SVL), venomous snakes (e.g., elapids, viperids, and rear-fanged colubrids and large aquatic turtles (e.g., snapping turtles, alligator snapping turtles, softshell turtles). are dangerous and can inflict severe bodily harm. Many can have unpredictable behavior; even normally placid specimens can become aggressive when removed from their normal environment. When trying to recapture these dangerous reptile species people should not work alone and should always work with at least another person, so that if an altercation occurs, help can be obtained. Safety is the priority. If a dangerous and/or venomous reptile cannot be captured and contained safely it should be killed in as humane a manner as possible. Injured and ill reptiles will need medical attention. All moribund and dangerous animals without safe housing should be humanely destroyed. Aquatic species can move towards large bodies of water, and once in a river or lake can be extremely difficult to recapture. Reptiles need to be housed separately and fed appropriately. Herbivores can be fed fresh grass clippings and or allowed to browse 3x/wk. Small insectivores need to be fed 2-3x/wk and other can go without food for days to weeks at a time. Each institution should have an up to date and accurate inventory so that all reptiles and amphibians in a disaster can be accounted for. Dangerous reptiles need to be identified ahead of time and appropriate information disseminated to the institutions staff so that they are prepared to handle a dangerous reptile during a crisis.
Large Hoofstock

Large hoofstock such as elephants, rhinos, giraffe and buffalo can readily become disoriented, panic and flee from perceived threats. Social hoofstock will attempt to regroup after the disaster. Only experienced handlers should attempt to control trained elephants in unfamiliar surroundings. An attempt may be made to direct movement of any hoofstock with the manipulation of visual barriers (such as opaque plastic sheeting) and vehicles. Their long flight distance can easily produce panic and/or stampede. Chemical immobilization may need to be used. Stadiums, heavily roped off large stands of trees with visual barriers may be used as temporary enclosures. Loud noises, sudden movements and unfamiliar human presence can easily stress large hoofstock. Quiet areas away from traffic, noise (such as heavy machinery), and inquisitive humans need to be setup. Potable water should be available at all times. Grass hays can be used for short-term nutrition. Legumes and grains should only be used in limited amounts if at all. Produce may supplement the diet but is not necessary. Adequate shade and ventilation are critical. Shelter from wind, rain, and snow and bedding should be used in cold weather.

Small Hoofstock

Small hoofstock tend to be grazers and browsers with herding tendencies. There is a high risk of injury from predators (including dogs), vehicles, humans, and from digestive disorders from overeating, or ingestion of toxic plants, and foreign bodies. Small ruminants attempt to re-group after the disaster, and may form mixed species groups. Males of most species are territorial and dangerous especially to other males and humans who enter their perceived territory. Group of animals may be herded to the holding area by manipulation of a visual barrier such as opaque plastic sheeting or baffle boards. The key is to move SLOWLY and quietly. Perimeter fence height is dependent on the species contained; eight feet high fences are usually adequate for most species. Exotic goats are very agile and can scale most barriers. Visual barriers around the fence can help to make animals feel secure. Burlap can be attached to the fence on the outside to prevent ingestion. Visual barriers should also be placed within the enclosures (bales of straw or hay, large boxes, etc.). Fresh water and adequate shade must be provided. With multiple feeding stations subordinate animals must have access to feed. Grass and hay are adequate for short-term nutrition. Small ruminants will usually consume 2 to 4% of body weight daily. Inadequate ventilation causes respiratory problems therefore totally enclosed environments not recommended. Most small ruminants can tolerate low temperatures if adequate bedding and shelter from wind, rain, and snow are provided. South American camelids are especially at risk from hyperthermia in hot or humid environments.

Nonhuman Primates

Most nonhuman primates will resort to trees or other high places when stressed. All are dangerous and unpredictable. While at large, they are at risk from vehicles and humans.

Large primates may be able to be moved by providing directed escape routes. Baiting enclosures with a preferred food item (i.e., fruit) may be used if the animals are human oriented. Cornering
an animal in a tree and chemical immobilization is also an option.

Unless the social status of individuals is known and the animals are monitored closely, primates should be individually housed. Since large primates can be very destructive and are extremely manipulative and intelligent, cages must be sturdy and locked at all times. Animals should be kept in quiet surroundings and away from inquisitive humans. Potable water and adequate nutrition must be provided. Primate chow and produce are sufficient.

Unsanitary conditions may develop in holding cages. Enteric pathogens (*Salmonella*, *Shigella*, *Campylobacter*, *Balantidium*) will take a toll, especially on neonates, weanlings, and geriatrics. Stress and inadequate ventilation may lead to pneumonia, colds, and flu. These diseases are zoonotic, so proper hygiene of caretakers is critical. Masks and gloves are recommended when servicing these animals.

**Carnivores**

Carnivores can become disoriented during the disaster, flee from perceived threats if possible, and may attack if no escape route is available. Cats will usually begin searching for food at night. Bears explore sooner, usually during the day. All carnivores are a threat to approaching humans, especially if no escape route is available. Some animals may return to familiar holding areas if baited with food and the area is kept quiet and free of humans. Directed movement by providing directed escape routes is difficult at best, but can be tried by experienced personnel if animals present no immediate danger to people. Keep human presence to a minimum. Chemical immobilization is usually the best option. Carnivores are individually housed unless compatibility in small enclosures is known. Portable water is essential. Cats can be fresh meat or a commercial frozen diet daily at approximately 5% of body weight. If fresh meat is used long term, vitamin supplementation will be required to correct the Ca:P imbalance. Bears are more adaptable and will usually consume dog chow fed at 3-5% of body weight daily. Their diet should be supplemented with meat, fish, and produce. Carnivores are susceptible to hyperthermia. Shade and water should be provided at all times. Mistling the crates may also provide relief. Most species are fairly cold tolerant if shelter from wind is provided.

**Small Mammals**

Small mammals are primarily solitary and most are very susceptible to stress and flight injuries, with high mortality after capture. They tend to flee and find the first available safe hiding spot and remain hidden until hunger and thirst become driving forces. Small mammals tend to venture out during periods of decreasing light and outside activity to begin foraging or hunting for food. These animals will rarely be seen. Setting baited live traps is probably the best method of capture. You may be able to net an animal if spotted. These animals are not aggressive unless threatened and unable to flee. Many will dig or gnaw so crate material should be impervious and inspected frequently for damage. Mortality will be high after capture. Animals should be kept in a quiet darkened area, away from loud noises, traffic, and inquisitive people to minimize injuries.
Diets are varied. Insectivores can survive on a chopped meat, hard-boiled egg, milk, and produce diet. Herbivores should be given pellets (rodent or rabbit chow), produce, and good quality hay. Potable water should be available at all times. Bacterial diseases, especially enteric, can be fatal.

Fish and Aquarium Species

Fish have strict and unforgiving environmental needs. The Aquarium of the Americas (NO) lost virtually all of its 10,000 fish, except for eight large tarpons, the only fish survivors. Before Hurricane Katrina struck, officials closed the aquarium early. When the storm hit the aquarium lost power and relied on their generator for keeping critical equipment operational. The Aquarium had plenty of food and freshwater, but within days of Katrina's passing the back up power supply failed, killing the facility's life support systems. Thousands of fish died due to lack of oxygen and irregular temperatures (with higher temperatures, less oxygen is dissolved in water and more aeration is required). The aquarium staff had help from local police officers. "We actually had New Orleans police officers and National Guardsmen around and they were given a crash course in how to take care of some of the animals," staff member was quoted. "Even when our staff had to be evacuated out for our own safety, the police officers were able to stay back and get food to those animals and keep a good number of them alive."

Conclusions

The captive wildlife facility must be prepared with a concise plan in place and must anticipate specific disaster needs. It is vital to know what specific animals’ needs are and what your responses to these needs will be. Appropriate back up plans should be made and most importantly coordinate with the zoo and aquarium community.

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TRANSTHORACIC ECHOCARDIOGRAPHY IN A WESTERN LOWLAND GORILLA (Gorilla gorilla) USING BEHAVIORAL RESTRAINT: A MODEL FOR AT-RISK ANIMALS

Wm. Kirk Suedmeyer, DVM, Dipl ACZM1* and Deborah M. Fine, DVM, MS, Dipl ACVIM (Cardiology)2

1The Kansas City Zoo, Kansas City, MO 64132 USA; 2The University of Missouri-Columbia College of Veterinary Medicine, Department of Veterinary Medicine and Surgery, Columbia, MO 65211 USA

Abstract

Fibrosing cardiomyopathy is a significant cause of gorilla morbidity and mortality.1,2 A 33-yr-old male lowland gorilla was conditioned through positive reinforcement to participate in transthoracic echocardiography on a twice-weekly basis. The gorilla had subtle signs of cardiac and respiratory insufficiency, including exercise intolerance. A specially designed PVC portal was installed in the cage wall that allowed the gorilla to place his thorax against the open-end of the barred portal, permitting 2-D, M-mode and Doppler echocardiography. A standard 3.5 mHz convex linear-array probe was used with either a standard B-mode ultrasound unit (VFI-Ausonics Impact, Universal Ultrasound, Bedford Hills, New York 10507 U.S.A), or digital ultrasound with color flow Doppler (MyLab 30-Universal Ultrasound). The right and left ventricles, mitral and tricuspid valves, pulmonary and aortic outflow tracts were fully imaged. Hepatic imaging demonstrated no evidence of passive congestion. Evidence of mural hyperechoic densities compatible with fibrosing cardiomyopathy were documented in the left and right myocardium and hyperechoic densities associated with the mitral valve were documented and monitored over a 1-yr period. Due to significant areas of hyperechogenicity throughout the myocardium, and hyperechoic densities in the mitral valve leaflets, routine examination has been delayed. Routine ultrasound was performed to monitor the progress of cardiac health without the use of immobilizing drugs which may influence cardiac function. Use of behavioral restraint allowed for consistent evaluation of cardiac health in this gorilla and may serve as a model for consistently monitoring gorilla cardiac health.

LITERATURE CITED


PRIMATE SUMMER AND WINTER 25-HYDROXY-VITAMIN D$_3$ VALUES ASSOCIATED WITH UVB LEVELS AT A UK ZOO

Rowena Killick, BVM&S MSc(Wild Animal Health) MRCVS* and Sharon P. Redrobe BSc(Hons) BVetMed CertLAS DZooMed MRCVS, RCVS, Dipl ACZM

Veterinary Department, Bristol Zoo Gardens, Clifton, Bristol BS8 3HA, UK

Abstract

Disorders of calcium metabolism have been reported in captive primates on many occasions. Dietary supplementation and outdoor access (exposure to natural UVB radiation) are two techniques commonly employed to provide adequate vitamin D levels to prevent these disorders. However, whether outdoor access in northern Europe provides sufficient UVB for primates which originate from regions much closer to the equator has not been proven. The natural habitat of New World primates is a range in Central and South America that lies between latitudes 20° north and 20° south. Lemurs naturally inhabit Madagascar and the Comoro Islands, which lie between 11° and 26° south. The UK zoo in which the current study was carried out lies on latitude 51° north.

In order to determine whether outdoor access was beneficial to New World primate and lemur species at the UK zoo in terms of UVB exposure, serum levels of 25-hydroxy-vitamin D$_3$ and environmental UVB levels were measured in summer and winter. All of the primates received vitamin D$_3$ supplementation in their diet and these dietary levels remained constant throughout the year.

Environmental UVB levels at the zoo were shown to be substantially lower than those that occur in the native habitats of the primates. UVB levels at the zoo were also shown to be substantially lower in winter compared to summer. In the majority of New World species sampled, mean vitamin D$_3$ levels were found to be low compared to previously published values and did not vary significantly between summer and winter. In contrast, the mean lemur vitamin D$_3$ levels were generally found to be high compared to previously published values and did vary significantly between summer and winter, summer levels being greater than winter values.

Possible reasons for the difference observed between the New World primates and lemurs in terms of variation of vitamin D$_3$ levels between summer and winter include the lemurs’ sunning behaviour allowing them to make better use of the UVB levels available, or an innate New World primate requirement for higher levels of UVB than lemurs in order to produce vitamin D$_3$.

This study shows that simply providing outdoor access in northern Europe (and therefore other regions of similar latitude) cannot be relied upon to supply UVB levels sufficient to prevent vitamin D deficiency in New World primate species.
ACKNOWLEDGMENTS

The authors wish to thank the veterinary staff and primate keepers at Bristol Zoo Gardens, Adrian Sayers, Frances Baines, Christoph Schwitzer, Kate Robson Brown and Pinmoore Animal Laboratory Services for their help with this project. Rowena Killick’s residency is sponsored by Bristol Zoo Gardens and the RCVS Trust.
THE EFFECT OF ARTIFICIAL UV LIGHT SUPPLEMENTATION ON VITAMIN D SERUM CONCENTRATION IN CALLIMICO (Callimico goeldii)

Lisa Naples, DVM,1,2* Jennifer Langan, DVM, Dipl ACZM,1,3 John Kanzia,3 and Mark Warneke3

1Chicago Zoological and Aquatic Animal Residency Program, Chicago, University of Illinois, College of Veterinary Medicine, IL 61802 USA; 2University of Illinois, College of Veterinary Medicine IL 61802 USA; 3Chicago Zoological Society's Brookfield Zoo, Brookfield, IL 60513 USA

Abstract

In 2004, seven Goeldi’s monkeys (Callimico goeldii) housed at a zoological institution developed metabolic bone disease associated with nutritional deficiencies in vitamin D.1 Despite dietary adjustments and oral supplementation of vitamin D, serum levels for all affected individuals remained significantly lower than other species of New World primates, and lower when compared to conspecifics.

Primates can convert vitamin D to a usable hormone through either dietary consumption or ultraviolet light exposure. Yet dietary supplementation has been implicated previously in renal disease development. Although this association has not been reported in New World primates, renal disease is a major cause of morbidity and mortality in captive callimico, suggesting that vitamin D supplementation through UV light conversion would be more appropriate for this species. Studies with humans demonstrated that adequate amounts of vitamin D can be acquired after only 15 min of sunlight biweekly. To the investigators’ knowledge, there are no reports on the daily requirements of UV light exposure in nonhuman New World primate species.

This study was developed to determine the impact of artificial UV light supplementation on vitamin D levels in callimico with no natural light exposure, and ongoing vitamin D deficiencies. The amount of time an individual callimico spends in front of an artificial UV light source was monitored with a PIT-tag monitoring system (Biomark®, Boise, ID 83702, USA). Activity was recorded based on the identification of individual callimico with implanted microchips (KHZ Super Tag, Biomark®, Boise, ID 83702, USA) on a platform facing a UV light source mounted with a remote antenna. Blood was collected to measure serum concentrations of vitamin D immediately prior to exposure to UV light, while monitoring time spent basking in front of the UV light source, and after the light source had been removed. Statistical analysis was performed to assess the relationship between exposure time and effect on serum vitamin D levels. To the authors’ knowledge this is the first report of baseline vitamin D levels for callimico housed indoors on a controlled diet with and without UV light exposure.
ACKNOWLEDGMENTS

The authors would like to thank Vince Sodaro for his extensive advice and support, the veterinary technicians, laboratory staff, and Tropic World staff of the Chicago Zoological Society’s Brookfield Zoo for their support, and the Chicago Board of Trade for their financial support of this project.

LITERATURE CITED

SHOULD THIS GORILLA BE ON LIPITOR? ECHOCARDIOGRAPHIC IDENTIFICATION OF PATIENTS AT RISK FOR AORTIC DISSECTION

Barbara Natterson Horowitz, MD1* and Janna Wynne, DVM2

1UCLA Division of Cardiology, David Geffen School of Medicine at UCLA, Los Angeles, CA, USA; 2Los Angeles Zoo and Botanical Gardens, Los Angeles, USA

Abstract

Echocardiography plays an important role in identifying risk factors for aortic dissection in humans. Transesophageal echocardiography (TEE) in particular permits close inspection of the descending and ascending aorta, the left ventricular wall thickness, and the aortic valve. TEE may be used as a means of screening adult gorillas for markers of risk for aortic dissection. Previous investigations have identified the following as important factors in the pathogenesis of aortic dissection in gorillas: hypertension, atherosclerosis, elevated cholesterol and pregnancy. TEE can be used to identify the presence or absence of some risk factors. Left ventricular hypertrophy (as a marker for poorly controlled systemic hypertension), aortic atherosclerotic plaque, aortic dilatation, aortic valve insufficiency, and intramural hematoma can all be identified by TEE. The risk of dissection can be reduced with appropriate medical therapy if patients with increased risk are appropriately identified. The potential for prevention underscores the important role for TEE in the routine screening of gorillas. While there are technical diagnostic challenges including the limitations of echocardiographic imaging, the acquired information may be used to implement preventive medical therapies for affected animals.

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LITERATURE CITED

TREATMENT OF DIABETES MELLITUS WITH ORAL HYPOGLYCEMIC AND ANTIHYPERGLYCEMIC AGENTS IN TWO COTTON-TOP TAMARINS (Saguinus oedipus)

John M. Sykes IV, DVM,* Nancy Thomas, Nicki Piepers, and Kelley Greene

Los Angeles Zoo and Botanical Gardens, Los Angeles CA 90027 USA; *Current address: Global Health Program, Wildlife Conservation Society, Bronx NY 10460 USA

Abstract

Two related cotton-top tamarins (Saguinus oedipus) were diagnosed with diabetes mellitus via persistent glucosuria and elevated glycosylated hemoglobin percentages (GlyHg.) Diet changes included removal of all simple sugars from the diet, including fruit, “marmoset jelly,” and sweet corn from a porcupine’s diet (mixed species exhibit.) Multiple oral hypoglycemic and anti-hyperglycemic agents were compounded and administered in different combinations including: metformin (50 mg/kg s.i.d.), acarbose (2-5 mg/kg b.i.d.), glipizide (0.5-4 mg/kg s.-b.i.d.), pioglitazone (3-9 mg/kg b.i.d.), and glimepiride (1-3 mg/kg b.i.d.) (Diamondback Compounding Pharmacy, Scottsdale, AR 85151 USA) Metformin was not accepted regardless of flavor used for compounding. Animals were target-trained to a clean platform for opportunistic urine collection. Response to treatment was monitored by daily measurement of glucosuria and periodic measurement of GlyHg. The younger animal responded well to a glipizide (1 mg/kg b.i.d.) and acarbose (2 mg/kg b.i.d.) combination. Pretreatment GlyHg was 8.6% and post-treatment values ranged from 4.6-5.8% (human normal <6.0%). It was eventually weaned off medications and appears to have been a transient non-insulin dependent diabetic. The older animal did not respond to any medication combination over 18 mo (pretreatment GlyHg = 13%; post-treatment 10.0-11.3%) and as a result was thought to be an insulin-dependent diabetic. This presentation highlights the challenges and solutions of treating diabetes mellitus in small nonhuman primates, including appropriate diet in a mixed species exhibit, training for urine collection, and difficulty in medication administration. It also demonstrates that this disorder can be treated successfully, without insulin injections, if diagnosed early in its progression.
COMPARISON OF THE ANESTHETIC EFFECTS OF ORAL VERSUS INJECTABLE MEDETOMIDINE IN COMBINATION WITH TILETAMINE-ZOLAZEPAM FOR IMMOBILIZATION OF CHIMPANZEES (Pan troglodytes)

Lisa M Naples, DVM,1,2* Jennifer N. Langan, DVM, Dipl ACZM,1,3 and Karen S. Kearns DVM, Dipl ACZM4

1Chicago Zoological and Aquatic Animal Residency Program, Chicago, University of Illinois, College of Veterinary Medicine, Urbana-Champaign, IL 61802 USA; 2University of Illinois, College of Veterinary Medicine, Urbana-Champaign, IL 61802 USA; 3Chicago Zoological Society’s Brookfield Zoo, Brookfield, IL 60513 USA

Abstract

Seventeen adult chimpanzees (Pan troglodytes) with an average age of 37 yr were immobilized with a combination of tiletamine-zolazepam (TZ) and medetomidine (MED) in one of two modes of delivery. Group A animals received the drug combination intramuscularly at 3 mg/kg and 0.05 mg/kg respectively. Animals in Group B received 0.1 mg/kg of medetomidine orally, mixed with marshmallow crème, followed by 3 mg/kg of TZ intramuscularly. All chimpanzees were compliant with oral transmucosal drug administration, although two chimpanzees preferred oral MED mixed with applesauce. All animals exhibited some anxiety and excitatory behavior associated with darting, but this was reduced in Group B which was premedicated with oral transmucosal MED. The mean time from TZ administration to sedation sufficient for human contact was 16.4 and 14.7 min with and without oral transmucosal premedication respectively. The mean time for recovery for those chimpanzees offered oral transmucosal premedication was 13.8 min, which was significantly shorter than the time of recovery for the group not offered oral premedication. Oral transmucosal administration of MED provided a light sedation in 16/17 chimpanzees to the level of arousable recumbency and a heavier sedation in one chimpanzee with no adverse side effects. TZ combined with MED by either oral transmucosal or injectable administration provided safe, heavy, long, sedation with rapid, smooth, uneventful recoveries.

ACKNOWLEDGMENTS

The authors would like to thank veterinary technician Jennifer Best and the Chimp Haven staff for their support and assistance in this study, statistician Dr. Richard Evans, and Chicago Zoological Society, Brookfield Zoo for their support.
INNOVATIVE WOUND CARE IN FRESHWATER AND MARINE TURTLES

Terry M. Norton, DVM, Dipl ACZM,* Erika Kemler, Michelle Kaylor, and Jeannie Miller

Georgia Sea Turtle Center, 214 Stable Road, Jekyll Island, GA 31527 USA; ^St. Catherines Island Wildlife Programs, 182 Camellia Road, Midway, GA 31320 USA

Abstract

Traumatic injuries caused by boat propellers, automobile collisions, and a variety of predators are common in aquatic chelonians. The incidence of boat strike injuries in sea turtles in Georgia have increased over the last decade and now account for 15-20% of strandings. As coastal development increases, we expect to see an increasing level of interaction between boats and sea turtles. Several treatment modalities have proven useful for traumatic injuries encountered in sea turtles and other aquatic chelonians including:

1) A skull fracture caused by boat propeller strikes was repaired with a movable external fixator. This devise allowed the infected bone to be cleaned and debrided daily while slowly closing the fractured skull.

2) Deep boat strike wounds have been treated with heavy debridement and cleaning followed by packing the wound with honey and honey comb. Wound healing properties of honey include high osmolality, low concentration hydrogen peroxide activity, antibacterial phytochemicals, and stimulation of the immune system.

3) Vacuum assisted wound care has been used successfully on a number of aquatic patients. Aquatic turtles present challenges with this method of therapy because they must be kept out of water when the suction is on.

4) Bacterial osteomyelitis cases have been treated with bone cement impregnated with antibiotics and doxirobe gel (Pharmacia & Upjohn Co, Division of Pfizer Inc, NY, NY 10017) placed directly on the wounds. Both products protect the site being treated and provide very high concentrations of antibiotics directly on the wound over an extended period of time.
THE GEORGIA SEA TURTLE CENTER: NATIVE CHELONIAN REHABILITATION, EDUCATION AND RESEARCH

Terry M. Norton, DVM, Dipl ACZM1,2

1Georgia Sea Turtle Center, 214 Stable Road, Jekyll Island, GA 31527 USA; 2St. Catherines Island Wildlife Programs, 182 Camellia Road, Midway, GA 31320 USA

Abstract

The Georgia Sea Turtle Center (GSTC) officially opened on June 16, 2007 and has already experienced noteworthy accomplishments. The Exhibit Gallery houses custom-made, interactive exhibits featuring the life history of sea turtles and the threats they encounter, a window that allows the public to view the treatment room and an elevated walkway in the center of the rehabilitation pavilion which allows the staff to engage the general public by giving them a close up, personal view of the rehabilitation process. The hospital contains digital radiography, flexible and rigid endoscopy, ultrasound, a surgical suite, a treatment room and equipment to conduct numerous diagnostic tests on site. Advanced imaging modalities are available locally. The GSTC staff oversees the nest monitoring and saturation tagging program for loggerhead sea turtles nesting on Jekyll Island. Investigations on free ranging and stranded loggerhead nutritional health have led to utilization of the gathered information to develop a sea turtle vitamin supplement and formula for tube feeding debilitated loggerheads. The GSTC is leading a cooperative effort to standardizing an approach to handling sea turtle mortality events in the southeastern US. The staff has been involved in several international training workshops in the Caribbean and Panama. The GSTC has partnered with Ross University, the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), and others in the development and ongoing efforts of the St. Kitts Sea Turtle Monitoring Network. The GSTC has evolved into working with all native chelonians that occur in Georgia in its rehabilitation, education, and research programs.
COMPARISON OF ANTICOAGULANTS TO OBTAIN HEMATOLOGIC VALUES IN CAPTIVE BULL SHARKS (Carcharhinus leucas)

Theresa A. MacNab, DVM1, Karen Velguth, DVM2, and Cornelia Ketz-Riley, DVM3

1,3Department of Veterinary Clinical Sciences, College Veterinary Medicine, Center for Veterinary Health Sciences, Oklahoma State University, Stillwater, OK 74078 USA; 2Department of Veterinary Pathobiology, College of Veterinary Medicine, Center for Veterinary Health Sciences, Oklahoma State University, Stillwater, OK 74078 USA

Abstract

There are increasing numbers of elasmobranchs in captivity resulting in the need to closely monitor the general health of these species. Obtaining hematologic values for health assessment can pose unique obstacles, one of which is determining an appropriate anticoagulant.1,6 It has been suggested that heparin may not be as effective as EDTA in preventing clotting and that use of EDTA may result in cell lysis.3,6 There are no standard recommendations for anticoagulant use in elasmobranch blood analysis. In order to assess the differences between anticoagulants, blood was collected from five captive, wild-caught bull sharks using lithium heparin, EDTA and a mixture of both. A mixture of EDTA and heparin has been proposed to be more effective with less cell lysis then either used separately.6 Blood samples were collected from the caudal vertebral vein under manual restraint. Samples were immediately separated into three different anticoagulants: lithium heparin, dry EDTA, and a combination of heparin and liquid EDTA.5 Complete blood counts (CBCs) were performed from each sample within 6 hr of collection. Parameters assessed included differentials, hemoglobin via HemoCue® 201+analyzer (HemoCUe, Inc., 40 Empire Dr., Lake Forest, California, USA 92630.), and smudged cell counts as an estimate of cell lysis. CBCs were compared using the student’s t-test. To estimate cell lysis, smudged cells were used as a percentage of total cell numbers. No significant differences in CBC or smudged cells were noted between the three anticoagulant types used. No advantage was noted with the EDTA/heparin mixture as has been previously reported.5 Both dry EDTA and heparin would be reasonable choices to use as anticoagulants when obtaining hematologic data in bull sharks.

LITERATURE CITED

TGF-β, LYSOZYME AND S-100 PROTEIN IMMUNOEXPRESSION IN FRANCISCANA DOLPHIN (Pontoporia blainvillei) WITH PULMONARY INFLAMMATORY DISEASE

Patricia C. Souza, DVM,1,* Carla Pagliari,2 Maria I. S. Duarte,2 Isis A. Abrahamsohn, Elaine R. Fernandes,2 and José L. Catão-Dias, DVM1

1Departamento de Patologia da Faculdade de Medicina Veterinária e Zootecnia da Universidade de São Paulo, São Paulo, SP, Brasil; 2Departamento de Patologia da Faculdade de Medicina da Universidade de São Paulo, São Paulo, SP, Brasil; 3Departamento de Imunologia do Instituto de Ciências Biomédicas da Universidade de São Paulo, São Paulo, SP, Brazil

Abstract

Veterinary research with marine mammals in Brazil is infrequent, but recent studies indicated that the main factors contributing to the demise of these animals are multifactorial and may include infectious, parasitic, traumatic, metabolic and nutritional diseases.1,2 Among these, there is an increased incidence of respiratory disease.2 Understanding the role of different inflammatory proteins and cytokines during disease could lead to better knowledge of the marine mammal immune system and its relation to pathologic process. The aim of the current study was to investigate pulmonary and splenic transforming growth factor β (TGF-β), lysozyme and S-100 protein immunoexpression associated with inflammatory respiratory disease in Franciscana dolphins, Pontoporia blainvillei. Fixed tissues from 14 dolphins were divided in two groups: animals with (G2; n=7) and without (G1; n=7) pulmonary disease. Fragments of lung and spleen were examined with histopathology, immunohistochemistry and quantitative morphometric analysis. Results showed no significant differences between the two groups for TGF-β and lysozyme. Notably, a marked increase of S-100 protein was detected in dolphins with inflammatory lung diseases. Further studies are necessary to better understand the role played by different cytokines during inflammatory processes in marine mammals.

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LITERATURE CITED

GRANULOMATOUS NEPHRITIS IN THE SEA HORSE

Meredith Wainstein, DVM,1,* Michael Garner, DVM, Dipl ACVP,2 Michelle Bowman, DVM,1 Jeff Proudfoot, DVM,1 and Jan Ramer, DVM, Dipl ACZM¹

¹Indianapolis Zoo, Indianapolis, IN 46222 USA; ²Northwest ZooPath, Monroe, WA 98272 USA

Abstract

Nephropathies appear to be common in seahorses and have been associated with mycobacteriosis, myxozoanosis, and oxalate nephrosis.¹,² Four seahorses from two different captive Hippocampus species (H. erectus and H. procerus) were diagnosed with idiopathic granulomatous nephritis. Two seahorses presented with chronic lethargy and acute dyspnea during their quarantine period. The other two animals were found acutely moribund. The water quality parameters from all tanks were within normal limits prior to and at the time of death. All affected seahorses were euthanatized for humane and diagnostic purposes.

All seahorses had severe granulomatous, necrotizing tubulointerstitial nephritis on histopathology. Microscopic changes were consistent with an infectious disease process involving the kidney. Multiple special staining techniques failed to reveal microorganisms within the renal lesions using conventional light microscopy.

Electron microscopic examination of one H. erectus kidney revealed a protist resembling a protozoan agent within the regions of renal inflammation. The agent was pyriform with a polar flagella and was most consistent with a flagellate. This protozoan agent is possibly responsible for the granulomatous nephritis observed in these animals. Further electron microscopic examination and DNA sequencing are warranted to determine if this protozoan is the etiologic agent for this infectious disease process.

LITERATURE CITED

KNOWN AND SUSPECTED FACTORS CONTRIBUTING TO CHRONIC CORNEAL LESIONS IN CAPTIVE PINNIPEDS

Laurie J. Gage, DVM, Dipl ACZM

USDA APHIS Animal Care, Napa, CA 94558 USA

Abstract

Captive pinnipeds appear to have a disproportionally high incidence of chronic corneal problems when compared to the incidence of similar eye diseases in other captive mammalian species. Known or suspected causes include one or a combination of the following: trauma, periodic or persistent excessive chemical, oxidant, or noxious by-product levels in the water, osmolality of the water, pathogens, excessive UV light exposure, and nutritional imbalances.

Common corneal problems seen in pinnipeds are edema, opacities, and chronic keratitis. When trauma and infections can be ruled out as the cause, water quality is often to blame. Checking the water quality records for chemical spikes or imbalances over the course of a year may help to identify the problem. When pinnipeds housed at a facility develop chronic eye problems, outside of a typical ophthalmic exam, a thorough evaluation of oxidant levels, coliform counts, pool color, availability of shade, salinity, nutritional supplements, or exposure to pathogens is warranted.

The following outlines some probable causes of corneal lesions in pinnipeds:

Physical Trauma

Punctures of the cornea may occur from vibrissae or from negative social interactions. Eye trauma may also occur from excessive debris in the water, such as pine needles, or other plant materials. Fragments of fiberglass material have been found in pools where residual ozone was causing the lining of some of the filtration system components to disintegrate, causing bits of fiberglass to be introduced into animal pools.

Excessive Chemicals, Oxidants, or Noxious By-products in the Water

Most modern filtration systems utilize oxidants such as chlorine, bromine, or ozone to control pathogen levels in the water. Measurements of these chemicals should be done daily and recorded. Total chlorine levels may spike on occasion, however if these spikes occur repeatedly the chlorine, or its byproducts could cause damage to the cornea. If the makeup water is from a municipal source, levels of chlorine should routinely be measured to ensure the chlorine levels going into the pool out of the tap do not exceed 1-1.5 mg/L (PPM). In many cities in the United States, the total chlorine levels in municipal water measure over 2-3 PPM. The chlorine in some cities fluctuates seasonally between acceptable levels that may be used for source water for marine mammal pools, to levels of chlorine that are unacceptable. Optimally total chlorine levels
in the water should not exceed 1 PPM. If the chlorine levels in the source water are too high, methods to dechlorinate should be employed before the water is placed in the animal’s pools. By-products of disinfection, such as chloramines or trihalomethanes may also be irritating to the eye and screening for these compounds may be warranted. Ozone systems must have an efficient method to degas the water. Ozone is a powerful oxidant and there should be no measureable residual ozone in the animal pools. Simple, inexpensive test kits are available commercially to test for the presence of ozone in the water where the animals live. While these tests are not quantitative, they will adequately determine the presence of ozone in the water. If the test is positive, measures must be taken to eliminate residual ozone from entering water that is in contact with the animals.

UV Light

While pinnipeds typically come from a bright and sunny environment, they are not adapted to dealing with bright, reflective surfaces when diving. Noting that clear water absorbs very little UVA light and UVA light energy is very effectively reflected by light blue or light green surfaces, it stands to reason that pinnipeds housed in pools painted with these reflective colors will be exposed to a higher daily ocular level of potentially damaging UVA light than their wild counterparts. Over time, this exposure could lead to cumulative oxidative damage to the cornea or the endothelial layer of the cornea. Animals that are trained to accept fish at a set station may be forced to look directly into the sun at certain times of the day to accept their food. Keepers and trainers should be aware of this issue and either alter the feeding locations based on the position of the sun, or provide shade to prevent discomfort and potential eye damage during feeds.

Osmolality

It appears there are more cases of corneal damage in pinnipeds housed in fresh water, however there are some facilities utilizing fresh water (including those with no chemical additives) where few eye problems are observed. It should be noted that these facilities also have dark-colored, non-reflective pool surfaces. The eyes of pinnipeds housed in saltwater systems seem better able to withstand occasional oxidative insults than those housed in fresh water systems. Saltwater pools are optimal for these marine mammals; however a well-managed fresh water system may be adequate.

Pathogens

Corneal problems in pinnipeds may have fungal, bacterial or viral etiologies. Both bacterial and fungal etiologies have been diagnosed in captive pinnipeds with eye lesions. Herpesvirus has been suspected when other factors have been ruled out and because of the similarity of the appearance of some corneal opacities to herpesvirus-induced corneal lesions in other species. Hepsesvirus has never been proven to cause corneal disease in captive pinnipeds.
Nutritional Imbalance

Free radicals produced from biologic processes or in response to exogenous stimuli are controlled by various enzymes and antioxidants in the body. Antioxidants such as Vitamin E, Vitamin A or Vitamin C may aid in mitigating oxidative damage to the cornea and other eye structures.

LITERATURE CITED

COMPARISON OF THREE IMMERSION AGENTS (TRICAINE METHANESULFONATE, AQUI-S™ (ISOEUGENOL), AND EUGENOL FOR SHORT DURATION IMMOBILIZATION OF CAPTIVE SOUTHERN STINGRAYS (Dasyatis americana) FROM AN OPEN WATER SYSTEM IN THE BAHAMAS

Donald L. Neiffer, VMD, Dipl ACZM,1* Elizabeth C. Nolan, DVM, Dipl ACZM,1 and Allen B. Wilson, BS2

1Department of Animal Health, Disney’s Animal Programs, 1200 North Savannah Circle, East, Orlando, FL 32830-1000, USA; 2Disney’s Castaway Cay, Disney Cruise Line, Castaway Cay, Commonwealth of the Bahamas

Abstract

Fifty-one immobilizations were performed using southern stingrays (Dasyatis americana) over a period of 12 mo. Three immersion agents were used for 17 immobilizations per drug, including: eugenol (20 ppm), Aqui-S™ (Isoeugenol)(15.7 ppm), and tricaine methanesulphonate (MS-222)(65 ppm (N=6); 55 ppm (N=11). Immersion agent exposure lasted 10-15 min. Stingrays were placed in dorsal recumbency at 5 min for phlebotomy. A second blood sample was collected at the end of the trial (either at 10 or 15 min) to evaluate changes in lactic acid and pH. Cardiac and gilling rates were measured at 5-min intervals.

Induction associated excitation was observed in all three treatment groups (42 out of 51 trials) with a lower percentage observed with Eugenol. Of the three agents, Aqui-S™ resulted in more “no response to stimulus” trials (N=12) than Eugenol (N=10) and MS-222 (N=9). Gilling was maintained during all trials with exception of 2 Aqui-S™ trials during which gilling ceased for 20-30 sec, as well as one Aqui-S™ and one eugenol trial during which respiratory arrest also occurred. These latter two cases were transferred to recovery water and provided ram ventilation support; spontaneous gilling resumed within 1 min. Cardiac rates were stable and similar for all regimens. Stingrays were released from the recovery water when directed wing movement was noted. Median time from placement in recovery water to release was 9 min for MS-222 and 12 min for Aqui-S™ and Eugenol. Lactic acid increased during 65% of the trials with roughly equal distribution between the agents. For MS-222 and eugenol a decline in blood pH was noted for most trials.

Although variation was noted between the three immersion agents, they are all considered appropriate agents for short term immobilization in southern stingrays.
ENSURING ANIMAL WELFARE: WEIGHING THE OPTIONS AND UNDERSTANDING CHOICES

Gail C. Golab, PhD, DVM, MACVSc (Animal Welfare)

Animal Welfare Division, American Veterinary Medical Association, Schaumburg, IL 60173 USA

Abstract

Personal values, experiences and information gleaned from science all influence animal welfare decision-making. Understanding and accepting the various contributors to animal welfare decision-making is critical to veterinarians’ effectiveness in successfully addressing animal welfare and the related concerns of other veterinarians, clients, businesses, and the general public.

Introduction

Animal welfare is a term used by a great many people, but when asked whether a particular situation or condition in which an animal finds itself is welfare-friendly, respondents may have very different views.

Consider the question of whether the welfare of laying hens is better when they are kept in cages, barns, or allowed to range freely in a field? In cages, hens have easy access to feed and water, individual birds are easily observed, aggressive interactions are infrequent and cannibalism is minimal, and their eggs are protected and easily collected. However, in conventional cages movement is restricted, and nest boxes and litter for dust bathing (both of which support the behavioral aspects of animal welfare) generally are not provided. Laying hens raised in barns most often have access to nest boxes and litter for dust bathing, but aggression, cannibalism, and flightiness are other behavioral characteristics of that environment, and feed and water are less easily monitored. Free-range systems allow great freedom of movement, usually include enclosures for sleeping and nesting, and natural substrates are readily available that provide multiple opportunities for expression of natural behaviors. On the other hand, laying hens in free-range systems have increased exposure to adverse weather conditions, pests, and predators.

As the doctor, which of the three systems described would you recommend to best ensure the hens’ welfare? Would your colleague in the next town or state choose the same system? Which might your client be most comfortable with? Your neighbor? How about the public officials in your community? The answer that we each give depends upon our personal values, experiences, and various social influences, and may or may not be affected by our knowledge of the science behind animal care and use practices. Your challenge and responsibility as a veterinarian is to assist in the decision-making process, while recognizing that even veterinarians are not immune from prejudices when making animal welfare decisions.
Personal Values

Chances are that, as a veterinarian, you may be most comfortable with hens being kept in cages. That’s because veterinarians (and many other scientists, animal producers, and breeders) tend to emphasize measures of health, growth, and productivity in their evaluation of an animal’s welfare. The veterinarian recognizes that keeping hens in cages allows better monitoring and control of disease, minimizes the risk of attack by the hen’s conspecifics, protects the hen from predators, and ensures consistent provision of food and water. In other words, the veterinarian concludes that the hen is in a good state of welfare because its health, safety, and physical needs are met.

For other people, however, including veterinary clients, business owners, public officials, and even some other veterinarians, the answer may not be so clear-cut. Fraser et al.⁴ have suggested that views on animal welfare generally fall into three buckets: individuals who emphasize basic health and function of the body; those who are most concerned with how an animal ‘feels’ (i.e., its psychologic or affective states, such as pain, suffering, or contentment); and those who emphasize the animal’s ability to lead a reasonably natural life and perform behaviors in which it might normally engage. None of these views can be classified as being inherently ‘right’ or ‘wrong,’ nor are they mutually exclusive. Rather, they represent different areas of focus or emphasis. Physical and health scientists are generally most comfortable with the functional view of animal welfare, more recently trained animal behaviorists and psychologists tend to equate good animal welfare with positive affective states, and many members of the general public, particularly those who rebel against what they perceive to be the wrongs of an industrialized society, look for components of natural living.

Sometimes the various views of what constitutes good animal welfare go hand-in-hand. For example, allowing a pig to wallow in mud helps it maintain its body temperature (a function criterion), feel more comfortable (an affective state criterion), and perform a natural cooling behavior (a natural living criterion). Other times the various views conflict. For example, an owner feeding his/her dog treats on a regular basis may result in the dog having a positive psychologic response and, depending on how the treats are provided, may meet its needs for exploratory and/or play behavior, but too many treats can also cause the dog to become obese with negative effects on health.

Experiences and Social Influences

Public consensus on what constitutes appropriate animal use and care is tied to social influences and culture. Since the 1960s, there has been a shift in the American family unit from the nuclear family (represented by a mother, father, and children with grandparents often living nearby) to families that may comprise younger or older couples with no children in the household, single parents with children, single persons, or same-sex partners, with or without children. Grandparents, parents, children, aunts and uncles, nieces and nephews are often spread across the country, rather than being close by. Both mothers and fathers often work outside the home, and latchkey children are the norm rather than the exception. Substantial traditional social support has been removed in the process and pets have filled the void as dependable companions. Higher
per capita incomes have allowed owners to treat their animal companions more and more like the human companions they have replaced and to perceive such treatment as normal and appropriate. Almost simultaneously, direct experiences with animals as sources of food and fiber (i.e., functional animal uses) have been reduced. Since the 1950s, the United States has seen a dramatic trend toward urbanization with fewer than 2% of the American public currently residing on farms. Together these factors put the American public in the position of viewing all animals and expectations for their care with the same spectacles they apply to the family dog, cat, or bird.

While the structure of families has changed, businesses have changed as well. After World War II, the United States saw a market-driven intensification of almost all industries, including those using animals. Profit margins narrowed as production costs (especially wages) increased and prices dropped. Economies of scale and type were discovered and translated to animal production and care. A business culture emphasizing efficiency emerged, leading to increased specialization and economy of scale (e.g., farms became larger and shifted to a single species and, later, to a single phase of production), contract operations (e.g., biomedical research was outsourced), and selection for animal characteristics (e.g., increased muscle mass, hardiness, susceptibility or resistance to particular diseases [as beneficial to their particular use]) that maximize return on food, housing, and care investments. Animal care interests correspondingly moved from a focus on the health of individual animals to an emphasis on the health of the herd and the quality and quantity of the final product.

Deep down, most members of the American public recognize, accept, and support the need to use animals in research and as sources of food and fiber; however, the picture of animals as ‘commodities’ does present conflicts with their vision of animals as ‘friends.’

Attempts to resolve this ideologic conflict have resulted in:

♦ Closer scrutiny of traditional animal use and care practices.
♦ Increasing prominence and public support of existing nongovernmental organizations focused on ensuring animal welfare, as well as the emergence of new ones.
♦ Retailers and their suppliers recognizing that members of the public can vote with their pocketbooks and acquiescing to their demands by creating business centers focused on issues of social responsibility, including animal welfare.
♦ Governmental regulations and legal obligations directed toward aspects of animal use and abuse that the public finds most egregious.

But Doesn’t Science Tell Us What ‘Good’ Welfare Looks Like?

We all want to believe that decisions about animal care will be based solely (or at least primarily) on science. A look at the history of animal welfare decision-making, unfortunately, tells us otherwise. Science didn’t actually play a substantial role in animal welfare decision-making until the 1950s and 60s, in concert with the publication of *The Principles of Humane Experimental Technique* by Russell and Burch and the report of the Brambell Committee in Europe. Concerns about animal welfare, however, have been publicly addressed since at least as
early as 350 BC (in the time of Aristotle) and some people justifiably argue that mythologic, cultural, and religious histories suggest an even earlier focus.

Science (and scientists) actually emerged as a player in the animal welfare debate when it was proposed as a possible way to help resolve conflicting perspectives. The strongest growth in animal welfare science has occurred since the mid-1980s, and the field is inherently inter- and multi-disciplinary. Peer-reviewed information was initially published in journals of various established fields (e.g., animal science, laboratory animal science, animal behavior, veterinary medicine); more recently, animal welfare science-specific journals have been established.

Today’s approach to animal welfare science generally assumes that multiple parameters must be evaluated for a complete assessment of animal welfare. These parameters include the animal’s biologic function (e.g., growth, reproduction, ability to maintain homeostasis), its health (e.g., absence/presence of disease or injury), and its behavior and social functions (e.g., adaptation, emotional states [distress, suffering], cognition/awareness, preferences). Assessments may look at what is provided for the animal (also referred to as inputs, resource-based criteria, or engineering criteria) or the effects of these inputs on welfare performance (also referred to as outputs, animal-based criteria, or performance criteria). More recently, animal welfare science has shifted from an emphasis on easily measurable parameters (e.g., morbidity, mortality, production indices) to asking questions about the animal’s perception of its situation.

Interestingly, the basic parameters identified as being necessary components of a complete science-based animal welfare assessment mirror the ‘view buckets’ discussed previously. The implication of this, of course, is that any data obtained may be differentially interpreted and emphasized based on these view buckets. Therefore, a critical review and interpretation of the science demands the reviewer be cognizant of the views held by the researcher(s) involved, and consider those views during his/her interpretation. Science is almost never value-free or immune to experiential prejudice and animal welfare science is no exception to that truth.

It is also true that while science can determine what type or degree of animal welfare risk exists with regard to a particular animal care practice, it cannot determine what type or degree of risk is acceptable—that is a social question. This social component of decision-making means that if the overwhelming perception is that a particular welfare risk is unacceptable (i.e., that doing something is ‘wrong’) what the science says can become less relevant to those making the animal use/care decision. That science can be relegated to the back seat when animal welfare decisions are made is a reality that can be very difficult for scientists, including veterinarians, to understand and accept.

A Role for Veterinarians

Ultimately, whether we are comfortable with the concept or not, animal welfare decisions are value-laden ones. As a result, science and scientists don’t make animal welfare decisions by themselves—they can, however, contribute greatly toward informing those decisions. This dimension of animal welfare decision-making, in particular, is where veterinarians have a responsibility to (and can) play a critically important and influential role.
Leading in the animal welfare debate has consequences. Some are beneficial. We have a tremendous opportunity to improve the welfare of animals. We also have an opportunity to maintain (and potentially improve) a positive image and healthy social respect for the profession. Some are negative. Leading means we run the risk of alienating those veterinarians, clients, employers, association members, and other stakeholders who may not agree with our recommendations. It is also possible we will make mistakes and have to retract recommendations when we find their results are not as intended.

Not leading also brings consequences. If you do not help make decisions, you have no basis for complaining when they have been made for you. And, if history is any indication, they will be!

Veterinarians can be more influential and effective in animal welfare decision-making if they:

- Remember that veterinary medicine is a service industry and that animal use and care decisions are multi-stakeholder ones,
- Communicate with all kinds of individuals, even if it appears we will never agree with them,
- Accept that differing perspectives may be valid (not all ‘good,’ not all ‘bad,’ just ‘different’),
- Understand that while science informs decisions, it does not make them,
- Study the science and ethical theory of animal welfare decision-making,
- Become familiar with the players, but focus on the issues,
- Try to learn something from everyone they speak with,
- Try to teach something to everyone they speak with, and
- See animal welfare questions, issues, and challenges as opportunities, rather than liabilities.

LITERATURE CITED

THE FISH BOWL AS A CRYSTAL BALL: THE ROLE OF ZOO AND AQUARIUM PROFESSIONALS IN SECURING THE SUSTAINABLE FUTURE OF AQUATIC DISPLAY SPECIES—FOR ANIMAL WELFARE, FOR CONSERVATION AND AS A SOUND BUSINESS STRATEGY

Jeffrey R. Boehm, DVM

The Marine Mammal Center, Fort Cronkhite, Sausalito, CA 94965 USA

Abstract

Unlike land-based zoologic collections, aquatic collections in zoos and aquariums are largely comprised of animals that are sourced from the wild. This practice employs and supports a trade in marine (and to a lesser extent, freshwater) species that relies upon an international array of individual fishers and fishing communities who supply primary and secondary buyers, wholesalers and retailers eventually providing animals to consumers (or end-users). Home hobbyists are consumers, as are zoos and aquariums. The reliance upon this industry causes animal welfare, conservation, and sustainable business challenges.

With regard to conservation—the chief focus of most zoo and aquarium missions—we must consider that the world is facing environmental threats, the complexity of which we only begin to understand, and the consequences of which are monumental. In the aquatic realm, these issues are more extreme, largely due to what we don’t yet know or well understand. The zoo and aquarium community’s reliance on wild caught animals contributes to numerous inter-related issues: for example, over-exploitation of species, high mortality rates as animals move through the chain of custody, inequity among economic benefits realized by primary fishing community members and primary buyers (further fueling over-exploitation), and inadvertent release of non-native species. Animal welfare issues include collection techniques, population pressures, habitat loss and degradation, care in transit, acclimation, and long-term care.

Zoo and aquarium professionals can positively influence this trade by supporting and sourcing animals through certification programs such as the Marine Aquarium Council (www.aquariumcouncil.org), leveraging their education programs and their large public presence, community stature, and significant audiences, to provide education and promote action among constituents, supporting and advancing data collection systems, developing rigorous scientific programs that advance our understanding of these species and enhance or initiate ex-situ breeding programs, and collaborating with partners whose expertise and focus can be utilized to ensure progress on all these fronts. Further, to not move aggressively towards decreasing the impact of these practices and our community’s reliance upon them is to employ a business model that is decidedly unsustainable. Zoos and aquariums exist largely to advance missions that compel us to support and demonstrate environmental stewardship—developing a model for future aquatic displays that is sustainable is the correct thing to do, both by our ethics and by our missions.
EXCELLENCE IN ANIMAL CARE: IT'S MUCH MORE THAN THE TECHNICAL SKILLS

Mark Stetter, DVM, Dipl ACZM

Disney’s Animal Programs, Bay Lake, FL 32830 USA

Abstract

As zoological practitioners, we have spent the majority of our professional education and “on the job” training, learning details about animals and improving our medical and surgical technical skills. While this foundation of technical proficiency is paramount, the non-technical skills are equally important. The science and technology industry has commonly lumped all the non-technical skills into a bucket referred to as “soft skills.”1,2,6,7 These soft skills generally include communication, listening, relationship building and conflict resolution.2

As veterinarians we are always interested in improving our level of care. If a new medical or surgical technique became available for a commonly encountered disease, we would be lining up to learn more about it. Yet, when this skill is not uniquely technical, but still important and routinely needed, we have a tendency to pay it less attention. Research in human medicine has shown “that gaps in non-clinical skills are just as important as lack of medical knowledge.”2 Malpractice suits and complaints to state medical boards often do not stem from poor technical competency, but from issues around non-clinical skills.2,8 Human health care systems have shown that individuals or practices with poor soft skills not only directly affect patient care, but also indirectly reduce the level of care by eroding morale and causing a higher rate of turnover.2,8

Listening, verbal communication and relationship building are overlapping skill sets that, when done well, are associated with a high degree of success and elevated patient care.3 A surgeon’s overall success is only partly technical in nature.4 The surgeon must carefully listen to the client’s symptoms and concerns before he or she can determine the best course of action. For the recommendations to be accepted there must be a level of trust and a positive relationship with the client. Lastly, he or she must have the appropriate communication skills to influence the client on the next course of action. As zoological clinicians we may have the knowledge and skills to make a diagnosis, but will fall short of an effective treatment, if we do not have a trusting relationship or cannot effectively communicate the importance of our treatment plan.

Many veterinarians may consider the soft skills as more innate personality traits, rather than learned skills.2 Research in human medical and veterinary schools has shown that these skills already exist, but often need to be improved and enhanced.1,8 Just as postgraduate continuing education can offer lectures and workshops which enhance our technical skills and knowledge, we must also include development of our soft-skills in our continued professional growth.2 In medical teaching facilities the most effective teaching of soft skills is through experiential exercises.1,5,6,8 One of these exercises is by role playing in a safe, supportive environment.1,5,6,8
This allows the clinician or student the ability to experience various situations and learn before being placed in more difficult real situations.\textsuperscript{1,5,6}

In our zoological institutions, reviewing and critically evaluating complicated group situations or incidents of interpersonal conflict can offer important learning opportunities and ultimately improve animal welfare. Questions we might want to ask ourselves could include examples like this:

How would I or we approach this situation differently next time?  
What could I or we do to improve our communication?  
Do I or we have a good relationship with our key partners? If not, how can it be improved?  
Is there a high level of trust within the team and/or with our partners?  Are there things we can do to improve trust?

Animal welfare at zoological institutions is directly influenced by the level of teamwork we provide. These teams are not just the hospital employees, but cross all lines of animal management. Good animal care is directly associated with our technical and non-technical skills. Outstanding animal care integrates good soft skills and ensures it is the best it can be. Animal welfare is the responsibility of the team, working together and committed to shared principles.

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MANAGEMENT OPTIONS FOR RESIDENT AND TRANSIENT WILDLIFE IN ZOOS

Allison N. Wack, DVM* and Ellen Bronson, Vet Med, Dipl ACZM

Maryland Zoo in Baltimore, Druid Hill Park, Baltimore, MD 21217 USA

Abstract

Management of resident and transient wildlife in zoos is an important component of maintaining collection health and providing a safe environment for employees and visitors. Wildlife can introduce disease to, predate on, or compete for food with collection animals. They may also pose a risk for zoonotic disease transmission to zoo staff and visitors. In addition to wildlife, there is concern for feral or stray cats and dogs ranging through parks. These domestic animals pose risks to both collection animals and native wildlife. In designing a management plan for these populations, zoos must consider the legal, ethical, ecological, and organizational implications of their institutional policies, whether the plan involves removal, sterilization, or perhaps simple cohabitation. For example, the ecological benefits of a trap and remove program must be weighed against the potential institutional benefits of having a more static permanent population on grounds of known health and reproductive status. Additionally, the welfare of each animal affected must be evaluated and managed at or above generally accepted standards. At the Maryland Zoo in Baltimore, a protocol has evolved over the years in which raccoons are trapped and euthanatized, grey and red foxes are trapped, sterilized, vaccinated and released, and feral cats, dogs and opossums are trapped and removed to another location. Currently, a more cohesive plan for wildlife management is being evaluated for this institution. Other institutions may also need to consider reevaluating their plans as more information on efficacy of different control programs becomes available and options for management evolve.
A REVIEW OF PATHOLOGIES AND SUMMARY OF TREATMENT STRATEGIES IN BILE-FARMED ASIAN BEARS

Heather Bacon, BSc, BVSc, MRCVS

Animals Asia Foundation, Sichuan Longqiao Black Bear Rescue Centre, Longqiao, Xin Du District, Chengdu, 610505, China

Abstract

An estimated 7,000 bears are currently incarcerated in bile farms within China, where their bile is extracted for use in Traditional Chinese Medicine. This legal industry typically confines bears to body-sized cages or occasionally small bear-pit-type enclosures, requires the creation of a fistula between the gall bladder and abdominal wall to allow for bile collection, and sanctions the amputation of phalanges or the cutting out of the canine teeth.

Data are recorded regarding the clinical condition of bears on arrival from farms at the Animal’s Asia Foundation’s China Bear Rescue Centre. Clinical syndromes are also recorded throughout the lifetime of the bears and necropsy data are evaluated. So far 260 bears (primarily Ursus thibetanus (n=256), but also Ursus arctos (n=3) and Helarctus malanayus (n=1)) have been rescued, the majority directly from the bile industry within China. Of these, 238 bears have been used for bile extraction and 178 are still alive, having undergone intensive physical and behavioral rehabilitation at the rescue centre. Primary disease processes in this population include neoplasia, especially hepatobiliary, which accounts for 43% of deaths, clinical degenerative joint disease (18%), clinical ocular disease (13%), ocular disease diagnosed through histopathology (100%), and dental disease (approximately 40%)1. The probable existence of subclinical and as-yet-undiagnosed disease, means that actual prevalence of these pathologies is likely to be higher.

Various investigations and treatment strategies for diseases affecting locomotion, including MRI, CT, radiography, multimodal systemic analgesia2 and intra-articular anti-inflammatories, have been utilized. Dental disease has been successfully managed through extraction and root canal therapy. Various ocular diseases have been investigated and treated through intracapsular lens extraction, phacoemulsion, retinal laser surgery, nutritional therapy and enucleation. Hepatic support is maintained through the use of synthetic ursodeoxycholic acid and herbal supplements.

Collection of this data strengthens the welfare arguments against the continuation of bile farming. Investigation and management of these disease processes provide valuable clinical and husbandry information not only applicable to bile-farmed bears but also to any captive bear population where these disease processes exist.

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DISEASE SURVEILLANCE AND POPULATION CONTROL OF CALIFORNIA GROUND SQUIRRELS (Spermophilus beecheyi) IN A DRIVE-THROUGH ZOO

Julia Mynhier, MS,1* Modesto McClean, DVM, 2 Robert Bildfell, DVM, Dipl ACVP, 1 Andrew Cushing, BVSc, MRCVS, 2 and Wendy Hsu, DVM2

1 Oregon State University, College of Veterinary Medicine, Corvallis, OR 97331 USA; 2 Wildlife Safari, Winston, OR 97496 USA

Abstract

Zoological gardens offer excellent habitat for squirrels and other rodents by providing food and water resources, shelter, and some protection from natural predators. Moreover, zoos are generally a safe haven from rodent poisons because of the risk posed to zoo animals. However, ground squirrels are often considered pests at zoos due to their disease transmission potential and destructive burrowing behaviors1. In 2006, three non-human primates at Wildlife Safari were infected with tularemia; two died and one survived with treatment. In the summer of 2008, a disease surveillance and population control pilot program was initiated in the 600-acre drive-through zoo. This involved serosurveillance of California ground squirrels (Spermophilus beecheyi) plus population control measures using either vasectomy/hysterectomy or euthanasia. Our goals were to 1) determine the seroprevalence of tularemia, plague, leptospirosis, and toxoplasmosis, and 2) compare the success of two methods of population control – sterilization and euthanasia.

Squirrels were seronegative for Yersinia pestis (n=45, cELISA) and Toxoplasma gondii (n=20, agglutination test); prevalence was low (2%) for Francisella tularensis (n=45, MAT test) and moderate (57%) for Leptospira spp. (n=42, MAT test). This study provides a baseline for further serosurveillance, which could be useful in predicting years in which tularemia may be a risk to zoo animals. Vaccination of high-risk animals against leptospirosis is judicious. Preliminary population control data suggest euthanasia will not result in long-term squirrel control. The efficacy of sterilization following a breeding season has yet to be determined.

ACKNOWLEDGMENTS

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CRAZY ANTEATER TRICHS: TETRATRICHOMONAD-ASSOCIATED DIARRHEA IN A GIANT ANTEATER (Myrmecophaga tridactyla)

Dalen W. Agnew, DVM, PhD, Dipl ACVP,1,2* Steve Bolin, DVM, PhD,1,2 Ailam Lim, MS,1,2 Lisa Meader, BS,1 Nicole Grosjean, BS,1 Carol Flegler, BA,3 and Heather Jones, VMD4

1Michigan State University, College of Veterinary Medicine, Diagnostic Center for Population and Animal Health, Lansing, MI 48910 USA; 2Department of Pathobiology and Diagnostic Investigation, Michigan State University, College of Veterinary Medicine, Lansing, MI 48910 USA; 3Center for Advanced Microscopy, Michigan State University, Lansing, MI 48910 USA; 4Detroit Zoological Society, Royal Oak, MI 48067 USA

Abstract

A 14.5-yr-old male giant anteater (Myrmecophaga tridactyla) had a history of prolonged and gradual weight loss with loose stool. Fecal samples examined four days before death revealed abundant fecal flagellated protozoa and necropsy demonstrated moderate colitis as well as pneumonia, cardiomyopathy, and glomerulosclerosis. Feces were cultured in specific trichomonad media (InPouch™, Biomed Diagnostics, White City, OR 97503 USA) resulting in abundant growth of the parasite. Wright-Giemsa staining showed a 5-10 µm ovoid to pear-shaped trichomonad with 4-8 flagella. Scanning electron microscopy, including three-dimensional imaging, revealed an ovoid structure with a variable number of flagella and an undulating membrane. Polymerase chain reaction using primers that detected genomic DNA of trichomonad protozoa yielded an amplification product, while primers designed to detect genomic DNA of Tritrichomonas foetus did not produce an amplicon.2 Sequence analysis of the amplification product demonstrated 97% homology with Tetratrichomonas sp. and 91% homology with Tetratrichomonas buttreyi, an intestinal trichomonad of cattle.

The importance of the Tetratrichomonas to disease in the anteater is unknown. This anteater had significant pulmonary, cardiac, and renal disease which may have been exacerbated by chronic diarrhea and colitis. Tetratrichomonas buttreyi has been reported to proliferate in diarrheic feces,1 but trichomonads can also lead to chronic colitis, as seen in cats.3 Further investigation into the fecal flora of normal and diarrheic anteaters will provide more information on the potential role of protozoans in intestinal disease.

LITERATURE CITED

VIRTUAL ANIMAL WELFARE ASSESSMENT: EDUCATIONAL AND HUSBANDRY TOOLS FOR THE ZOO INDUSTRY

Dalen Agnew, DVM, PhD, Dipl ACVP,* Janice Siegford, PhD, Mollie E. Tubbs, MS, Courtney Daigle, MS, Richard Snider, PhD, and Janice Swanson, PhD

Animal Behavior and Welfare Group, Michigan State University, East Lansing, MI 48824 USA

Abstract

As animal welfare becomes an integral component of Association of Zoos & Aquariums (AZA) accreditation and animal care manuals, zoo managers and veterinarians must understand and be able to assess the welfare of animals at their institutions. The Animal Behavior and Welfare Group at Michigan State University (http://www.canr.msu.edu/animalwelfare/index.html) has developed digital animal welfare assessment scenarios that provide virtual opportunities to evaluate the welfare of a variety of animals, including those in zoos and aquaria. These scenarios can also be used to enhance the implementation of animal care manuals by providing zoo staff with an opportunity to evaluate their use and understanding of these manuals by practicing their application in hypothetical situations.

Welfare assessment scenarios compare and contrast animals in two hypothetical exhibits with regards to keeper practices, feeding routines, enrichment, veterinary care, and exhibit quality. Scenarios are tailored to emphasize relevant areas for the species of interest. Information and images from the literature, species experts, veterinarians, and multiple AZA institutions are used to create unbiased scenarios that present realistic, yet fictitious, situations to discourage specific judgment of existing zoos and exhibits. Contributing zoos play an important role in reviewing the scenario before the final product is created, allowing the contributors to agree upon the text, images, and video to be used. Assessment scenarios have been developed for captive Amur tigers, giraffes, North American river otters, and black rhinoceros. Institutions are being approached to participate in creation of additional scenarios. Scenarios could be valuable to the zoo industry, as they allow for internal assessment of current practices and conditions. Scenarios can be used to augment taxon-specific animal care manuals by reinforcing and demonstrating practices related to meeting the needs of animals physically, mentally, and psychologically. Welfare assessment scenarios will not only demonstrate zoos’ commitment to animal welfare by providing continuing education materials for zoo staff, but also by fostering collaborations between zoos to create welfare scenarios, which aim to support industry-wide goals of best meeting the needs of animals under their care.
DIFFERENCES IN TREATMENT AND MANAGEMENT OF FOOT ABSCESSSES IN A SOUTHERN WHITE RHINOCEROS (Ceratotherium simum simum) AND A SOUTHERN BLACK RHINOCEROS (Diceros bicornis minor) AT FOSSIL RIM WILDLIFE CENTER

Rebecca Bloch, DVM* and Holly Haefele, DVM

Fossil Rim Wildlife Center, Glen Rose, TX 76043 USA

Abstract

Differences in treatment and management of foot abscesses in a Southern white rhinoceros (Ceratotherium simum simum) and a Southern black rhinoceros (Diceros bicornis minor) are described. While some treatments were similar between animals, differences in temperament and lesion location dictated dissimilar management approaches.

A 22-yr-old male Southern white rhinoceros presented acutely with left front leg lameness. Upon visual examination, a longitudinal crack in the hoof wall extending from the coronary band to the palmar surface of the hoof wall was identified. Debridement of necrotic tissue associated with an underlying abscess was performed under anesthesia on two separate occasions. Initial debridement resulted in normal hoof growth for 3.5 mo before the abscess recurred. Treatment failure was attributed to inability to keep the defect clean and the animal’s weight, which caused the hoof defect to split laterally. At the time of the second debridement, the hoof defect was laced with 18 gauge stainless steel wire and reinforced with epoxy (Equi-Thane™ SuperFast™, Vettec, Inc., Oxnard, CA 93033 USA). This resulted in better distribution of forces along the defect and allowed for improved healing. Hoof recovery was achieved with daily treatment for over a year. Treatments included oral administration of biotin (Biotin, Purina-Mills, LLC, Gray Summit, MO 63039 USA), cleaning and packing the hoof defect on a daily basis, and application of products designed to moisturize the hoof and promote new hoof growth (Hoof-alive®, Don Gregory Sales, LLC, Buffalo, WY 82834 USA). Packing was done with a proprietary farrier’s mixture containing pine tar and fish oil soaked oakum.

An 18-yr-old female Southern black rhinoceros, with a 3-yr history of chronic intermittent abscess formation that culminated in a foot pad defect, required multiple immobilizations for treatment and management. In June 2006, a puncture wound was noted in the sole of the right front foot. The defect was debrided, cleaned with chlorhexidine diacetate (Nolvasan®, Fort Dodge Animal Health, Fort Dodge, IA 50501 USA) and packed to keep it clean. Although the sole defect appeared to be growing out, by late January 2007 a tract had opened in the interdigital space between the middle and medial toes. The tract was cultured, and the animal was started on trimethoprim-sulfamethoxazole (Sulfamethoxazole and Trimethoprim Tablets, USP, Double strength, Interpharm, Inc., Hauppauge, NY 11788 USA; 16 mg/kg p.o. b.i.d.). Antibiotics were changed to enrofloxacin (Baytril 68, Bayer Health Care LLC, Shawnee, KS 66216 USA; 5 mg/kg p.o. s.i.d.) when this animal developed a reaction to trimethoprim-sulfamethoxazole. Treatment consisted of flushing the wound with tincture of iodine 3.5% and then packing it to keep it clean. Although the defect healed over the next 5 mo, subsequently, at approximately 3-
mo intervals, the foot abscessed and then healed again. Twice this animal was treated with flunixin meglumine (Banamine Paste, Schering-Plough, Union, NJ 07083 USA; 1.6 mg/kg p.o. s.i.d.) for 4 days and enrofloxacin (5 mg/kg p.o. s.i.d.) for 21 days. Flushing with tincture of iodine was performed as the animal allowed. In the next 10 mo, from 9 April 2008 to 25 February 2009, this animal was immobilized five times for repeat radiographs, a single fistulagram, one ultrasound examination, repeated regional limb antibiotic perfusion treatments with cefazolin (Watson Pharmaceuticals, Inc., Morristown, NJ 07962 USA; 4 g) and amikacin (Amikacin Sulfate Injection, Phoenix Pharmaceutical, Inc., St. Joseph, MO 64503 USA; 2 g), debridement, packing with metronidazole (Metronidazole, PLIVA®, Inc., Pomona, NY 10970 USA; 1.2 g) mixed with oxytetracycline (Tetradure 300, Merial Limited, Duluth, GA 30096 USA) to form a paste, followed by bandaging and boot placement. Repeat cultures yielded bacteria sensitive to the antibiotics used or mixed bacterial populations. By February 2009, the wound showed healthy granulation tissue formation but was not completely healed. Aggressive treatment with frequent boot changes was curtailed by the presence of abrasions associated with bandaging the foot and boot placement. The animal also began to show avoidance behaviors and decreased appetite as a result of repeat, weekly immobilizations. Blood work at the time showed a hypophosphatemia, which has been seen with black rhinoceroses under stress.\textsuperscript{1} The temperament of this animal made daily wound care impossible. The combination of lesion location on the palmar surface of the foot, inability to work with this animal on a daily basis, and the development of complications with treatment made this case much more prolonged and less immediately successful than that involving the white rhinoceros.

LITERATURE CITED

USE OF KINESIO TEX GOLD® TAPE FOR CORRECTION OF ANGULAR LIMB DEFORMITY IN AMERICAN FLAMINGO (Phoenicopterus ruber) CHICKS

Diana Boon, DVM,1* John Hanks, DC,2 and Felicia Knightly, DVM1

1Denver Zoological Foundation, Denver, CO 80205 USA; 2HealthMark, Denver, CO 80222 USA

Abstract

Multiple methods to correct angular limb deformities in captive-reared long-legged birds, including taping methods, braces, and surgical techniques1-3 in addition to husbandry adjustments, have been attempted. A taping technique utilizing Kinesio Tex Gold® was used on two hand-reared American flamingo (Phoenicopterus ruber) chicks at the Denver Zoo. This tape has the properties of allowing normal range of motion of the intertarsal joint, application of variable tension along the length of tape to provide targeted correction, water resistance, no tape residue or damage to the skin, and stimulation of microcirculation and lymphatic drainage (http://kinesiotaping.com/Kinesio-concepts.php).

One male chick developed a unilateral angular limb deformity with laxity of the associated gastrocnemius tendon and medial rotation of the foot at 98 days old. Another male chick developed a unilateral angular limb deformity at 242 days old. Kinesio Tex Gold® tape was applied to provide joint support and stability of the gastrocnemius tendon. Tension was applied to the medial aspect of the proximal tarsometatarsus in an attempt to stimulate medial correction of the valgus bowing. Radiographs were obtained to document the age of closure of the epiphyseal plates. To establish normal intertarsal joint angles, age-matched flamingos were measured at 281-298 days of age. The angular limb deformity of both affected chicks was corrected over a 3-mo period of continual taping. The intertarsal joint angle of both chicks remains within the normal range for the flock after 300 days of age, and there is no evident angular limb deformity or lameness in either of these birds.

LITERATURE CITED

ECHOCARDIOGRAPHIC MEASUREMENTS IN CLINICALLY HEALTHY AFRICAN HEDGEHOGS (Atelerix albiventris) ANESTHETIZED WITH ISOFLURANE

Anne Burgdorf-Moisuk, DVM,* Julia K. Whittington, DVM, Mark A. Mitchell, DVM, MS, PhD, and Robert O’Brien, DVM, MS, Dipl ACVR

University of Illinois at Urbana- Champaign, Department of Veterinary Clinical Medicine, Urbana, IL 61802 USA

Abstract

Cardiomyopathy in African pygmy hedgehogs (Atelerix albiventris) has been reported in the literature, but to the authors knowledge there have been no reports of echocardiographic parameters in the hedgehog. The goal of this study was to establish reference ranges for echocardiographic parameters in apparently healthy hedgehogs. Twenty hedgehogs were determined to be healthy via physical exam and auscultation. They were anesthetized with isoflurane gas anesthesia for the echocardiogram. Diagnostic images were obtained with the animals in left and right lateral recumbency allowing for consistent evaluation of the left atrium, aorta, aortic, pulmonary and mitral valves, left ventricle and ventricular function. Due to the small size of patients and limited imaging window, tricuspid valve viewing was infrequent. Non-standard positioning of the probe was needed to obtain standard parasternal short and long axis views of the heart. Statistically significant differences for interventricular septum systole, ejection fraction, stroke volume, fractional shortening, E point to septal separation, aortic diameter, left atrium to aortic diameter ratio, mitral valve E velocity, right ventricular outflow tract velocity maximum and right ventricular outflow tract maximum pressure gradient were found in relation to age. Statistically significant differences were also found with left ventricular internal dimension in diastole, left ventricular internal dimension in systole, left posterior wall dimension in diastole, left posterior wall dimension in systole, aortic valve velocity maximum and aortic valve maximum pressure gradient in regards to gender. The results suggest that differences in echocardiographic measurements exist in hedgehogs and should be considered when evaluating these animals.
TRAINING AND SERIAL TRANSABDOMINAL ULTRASOUND OF A PREGNANT OKAPI (*Okapi johnstonii*)

*Maren Connolly, DVM* and *Bonnie L. Raphael, DVM, Dipl ACZM*

*Global Health Program, Wildlife Conservation Society, Bronx, NY 10460 USA*

**Abstract**

Keeper staff at the Wildlife Conservation Society’s Bronx Zoo trained an adult female okapi (*Okapi johnstonii*) to facilitate transabdominal ultrasound examination by veterinary staff. A horizontally barred gate was constructed to replace a solid stall door during ultrasound examination. The animal was encouraged with food to position her body within two feet of and parallel to the gate. The animal was acclimated to ultrasound gel by the keepers utilizing alcohol, gel and a substitute probe until the animal adjusted to and allowed the procedure. Training was performed over a period of 4 wk prior to the initial ultrasound examination.

Serial ultrasound examinations were performed every 2 wk from 6 mo post-breeding through parturition (14-mo gestation). An Aloka 500V ultrasound machine with a 3.5 mHz “backfat” probe (Corometrics Medical Systems, Inc., Wallingford, CT 06492 USA) was utilized, and the sessions were videotaped. The ultrasound probe was placed on the caudal and lateral abdomen. The heart, liver, ribs and vertebrae of the fetus were visualized at the majority of the procedures. Cardiac measurements were obtained when possible and used to document growth and health of the fetus. The placental cotyledons of the dam were readily visualized. Ultrasound images were obtained from both sides of the abdomen.

In addition to obtaining measurements, this training allowed assessment of fetal health during periods of concern. At 8 mo of gestation, abnormal behavior, gait and evidence of discomfort were apparent. Transabdominal ultrasound allowed for confirmation of fetal vitality in a rapid, minimally stressful and noninvasive manner.
REGROWTH OF FLIGHT FEATHERS AFTER SURGICAL REMOVAL IN AMERICAN KESTRELS (*Falco sparverius*)

Pauline Delnatte, DVM,* Guy Fitzgerald, DMV, MSc, and Stéphane Lair, DMV, DES, DVSc, Dipl ACZM

Service de médecine zoologique, Faculté de médecine vétérinaire, Université de Montréal. 1500, rue des vétérinaires, C.P. 5000, Saint-Hyacinthe, Québec, J2S 7C6, Canada

Abstract

The objective of this study was to evaluate if surgical removal of broken feathers was an efficient method to induce growth of new flight feathers as part of the rehabilitation process of raptors with damaged plumage. Primaries, secondaries and rectrices (four of each) were removed under general anesthesia from ten American kestrels (*Falco sparverius*) using two different techniques: with and without filling the follicle with bismuth subnitrate (OrbeSeal®, Pfizer Animal Health, Kirkland, QC, Canada) to prevent it from closing up. Birds were kept in large aviaries under natural daylight and outdoor temperatures. Growth of new feathers was assessed weekly for 4 mo in regards to the rate and quality. Results were significantly different between the types of feathers: 100% of rectrices, 58% of secondaries and 8% of primaries grew within the four winter months. The tail feathers began to grow between the second and the third weeks at about 2.4 mm per day, and growth was usually completed within 5 wk. Rate, starting time and duration of remiges growth were less predictable and varied widely among individuals. The use of OrbeSeal® did not improve the outcome. Bleeding during extraction was associated with a poor regrowth prognosis. We conclude that plucking damaged tail feathers in kestrels can successfully decrease the duration of a rehabilitation process instead of waiting for a natural molt. However, this procedure would not be recommended for wing feathers.
“NEVER SAY NEVER.” ANTIBIOTIC USE RECTIFIES DISEASED OVIDUCT IN A GALAPAGOS TORTOISE (Geochelone nigra microphyes)

Thomas W. deMaar, DVM* and Colette H. Adams

Gladys Porter Zoo, Brownsville, TX 78520 USA

Abstract

An approximately 100-yr-old, wild caught, 148.8-kg Galapagos tortoise (Geochelone nigra microphyes) had a long-term history of producing mucus and poorly shelled eggs. The materials were produced during observed Galapagos tortoise nesting season in south Texas (Nov. – May) and were randomly scattered throughout the enclosure. Histopathology of materials expressed from the cloaca occasionally contained fibrin and inflammatory cells. Biopsies obtained by endoscopy of the oviduct indicated salpingitis. Cultures showed consistent bacteria. Salpingitis has been reported in a variety of reptiles,3,5 including tortoises.4 Surgical oviduct removal has been recommended as treatment for salpingitis.1 Considering the genetic value of the animal, an extended course of antibiotics was instituted. Chloramphenicol (Viceton® Tablets, Bimeda, Inc, Oakbrook Terrace, IL 60181 USA; 3 g p.o. s.i.d.) was used for periods of up to 60 days. The initial choice of chloramphenicol was based on microbial sensitivity, membrane penetration and ease of oral administration (bland taste). Complete blood counts were monitored, and no erythron abnormalities were detected. On two separate occasions during the following season, the tortoise excavated a nest and deposited well-shelled eggs, of which five hatchlings emerged. Successive microbial cultures of materials of suspected reproductive origin yielded Klebsiella oxytoca and Citrobacter sp. in addition to enteric organisms, Staphylococcus sp. and Streptococcus sp.

Enrofloxacin Adverse Reaction

In order to rotate antibiotic therapy, other antibiotics were prescribed based on microbial sensitivities. The animal demonstrated malaise and anorexia with two attempts of oral enrofloxacin (Baytril® Taste Tabs®, Bayer HealthCare LLC, Shawnee Mission, KS 66201 USA; 680 mg p.o. s.i.d.), and it was discontinued. This parallels a published report of an adverse reaction to intramuscular injection of enrofloxacin in a Galapagos tortoise.2 However, the animal tolerated a 30 day course of oral ciprofloxacin (Cipro®, Ranbaxy Pharmaceuticals, Princeton, NJ 08540 USA; 1500 mg p.o. s.i.d.). For the following season, additional chloramphenicol therapy has been provided and further oviposition is anticipated.

LITERTURE CITED


ELECTROCUTION IN LARGE EAGLES IN SOUTHWEST SPAIN: A RETROSPECTIVE STUDY (1996-2008)

Julia Rodríguez-Ramos, LV,¹* Ursula Hoefle, LV, Dr. Vet (thesis Germany),² Juan M. Blanco, LV, Dr. Vet (thesis Spain),³ Vanessa Arias (Research Associate),³ and David Sanchez-Migallon, LV, MS, Dipl ECAMS⁴

¹Department of Pathobiological Sciences, University of Wisconsin, Madison, WI 53706 USA; ²National Institute for Game Research (UCLM-CSIC-JCCM), Ronda de Toledo s/n, 13005 Ciudad Real, Spain; ³Center for Studies on Iberian Raptors 45671 Sevilleja de la Jara, Spain; ⁴Department of Surgical Sciences, University of Wisconsin, Madison, WI 53706 USA

Abstract

Electrocution is one of the most common causes of mortality in eagles in Spain, representing one of the main threats to endangered species.¹²⁴⁵ We present a 12-yr study of electrocution in four large eagle species admitted to a rehabilitation center in southwest Spain: Spanish imperial eagle (Aquila adalberti), Bonelli’s eagle (Hieraaetus fasciatus), golden eagle (Aquila chrysaetos) and short-toed eagle (Circaetus gallicus). A total of 115 eagles were admitted with lesions consistent with electrocution and/or found dead under a power line/pole. Females (57%) suffered electrocution more frequently than males (43%). Most (72%) of the animals were received dead. Only 9% of the eagles admitted alive were released, whereas 31% were euthanatized, 27% died, and 27% were kept as non-releasable individuals. Forty percent of the imperial and golden eagles had lesions on both legs, whereas Bonelli’s eagles most commonly presented with lesions on wings and leg(s).

Electrocution continues to be one of the main causes of mortality of eagles in Spain, though major efforts are made by governments to implement mitigating measures.⁶ Because of their large size and the lack of natural perches higher than the electric poles, these species are more susceptible to suffer an electrocution.³ The higher mortality among females in the golden and imperial eagles supports size difference in dimorphic species as one among other factors potentially influencing higher female mortality.¹ The results of this study provide evidence that the patterns of electrocution observed in the different species can be important for determining the best mitigating measures to apply.

LITERATURE CITED


6. 2008. Real Decreto 1432: Medidas para la protección de la avifauna contra la colisión y la electrocución en líneas eléctricas de alta tensión, BOE.
MAMMARY GLAND ADENOCARCINOMA IN A MALAYAN SUN BEAR (*Helarctos malayanus*)

Jun-Cheng Guo, DVM, Ping-Hwan Yu, DVM, Fei Pang, DVM, PhD, and Chao-Hua Chi, DVM, PhD

1Taipei Zoo, Taipei 116 Taiwan; 2School of Veterinary Medicine National Taiwan University, Taipei 106 Taiwan

Abstract

Mammary gland tumors are common in dogs and cats but seldom found in bears. An 18-yr-old female Malayan sun bear (*Helarctos malayanus*) with no breeding history in Taipei Zoo was discovered to have three 1×2 cm² masses and one ulcerative lesion on the left abdomen in late 2006. Two mastectomy surgeries were performed to remove the masses and the mammary gland in January 2007. The masses were diagnosed as adenocarcinoma of the mammary gland and were considered metastasized by histopathologic examination. An incisional biopsy of an enlarged left axillary lymph node was performed later. Histopathologic examination revealed a sheet of vacuolated tumor cells with a high degree of atypia and nuclear pleomorphism. A complete blood count and serum biochemistry profile were within normal reference range, and radiologic films revealed no apparent metastasis to other organs. The human tumor markers for mammary gland tumors, CA 15-3 and CEA, which are thought to be helpful in clinical diagnosis, were detected in this case. Lymphadenectomy and ovariohysterectomy were later performed, and the bear has been in good health since the surgeries.

LITERATURE CITED

HEALTH ASSESSMENTS AND ANTIBIOTIC RESISTANCE OF FREE-RANGING ATLANTIC SHARPNOSE (Rhizoprionodon terraenovae) AND BONNETHEAD (Sphyrna tiburo) OFF THE COASTS OF FLORIDA AND GEORGIA

Katherine Haman, MS,1* Terry Norton, DVM, Dipl ACZM,2 Florina Tseng, DVM,1 Mike Arendt, MS,3 and Kirsten Gilardi, DVM4

1Tufts University School of Veterinary Medicine, North Grafton, MA 01536 USA; 2The Georgia Sea Turtle Center, Jekyll Island, GA 31527 USA; 3South Carolina Department of Natural Resources, Beaufort, SC 29901 USA; 4The University of California, Davis, School of Veterinary Medicine, Davis, CA 95616 USA

Abstract

This research presents baseline health assessments and the incidence rate of antibiotic resistance (ABR) in bacteria cultured from two species of free-ranging shark, the Atlantic sharpnose (Rhizoprionodon terraenovae) and the bonnethead (Sphyrna tiburo), from the coastal waters of Georgia and Florida. Health parameters and diagnostic testing include physical examination, body weight and morphometric measurements, complete blood counts and plasma biochemistry panels. These data are analyzed for correlation with the presence or absence of ABR in bacteria cultured from cloacal swabs. Geospatial analysis quantifies the variables in relation to (1) distance from shore and (2) distance from river outlet. This project is designed to provide health data from healthy, free-range sharks in order to improve the manner by which physical conditions are maintained in captive sharks. Specific aims addressed by these data are to (1) provide the normal reference ranges (mean +/- SD) for plasma biochemistry, vitamin, mineral and lipid levels, and heavy metal and organochlorine levels in two species of shark, (2) determine the normal bacterial flora in the gastrointestinal tract of sharpnose and bonnethead sharks captured off the coasts of Georgia and Florida, (3) quantify the prevalence of ABR in these bacterial flora and (4) correlate these health reference ranges and the ABR prevalence in the sharks with their geospatial distribution.
ADVEMENT FLAP AS A NOVEL TREATMENT FOR A PODODERMATITIS LESION IN A RED-TAILED HAWK (*Buteo jamaicensis*)

_Samantha Haskins,* Anne Burgdorf-Moisuk, DVM, Julia K. Whittington, DVM, Mark Mitchell, DVM, MS, PhD, and Avery Bennett, DVM, MS, Dipl ACVS_

_University of Illinois, Department of Veterinary Clinical Medicine, Urbana, IL 61802 USA_

Abstract

Pododermatitis, frequently referred to as bumblefoot, is a common condition among captive raptors involving swelling, excoriation, ulceration, cellulitis, and abscessation of the plantar aspect of the foot. The cause is often multifactorial. Treatment varies from medical to surgical and generally requires environmental alterations. Previous surgical techniques described include creating an elliptical defect in the metatarsal pad to remove the lesion and closing the wound with horizontal mattress or purse string sutures. This report describes the use of a single pedicle advancement flap using the interdigital skin web to treat chronic, non-responsive grade V/VII pododermatitis of the right metatarsal pad in a red-tailed hawk (*Buteo jamaicensis*). The advancement flap was developed using the interdigital skin between digits 3 and 4. The double layer of skin was incised and the leading edge of the flap advanced over the defect created by debridement of the wound so that the entire pododermatitis lesion was covered with healthy skin. Simple interrupted subcutaneous sutures were placed along the caudal, lateral, and medial aspects of the flap, and simple interrupted sutures were placed in the skin. A bandage was placed on the foot with a gauze donut over the surgical site to reduce pressure on the flap. Fifty-eight days after the surgery, the hawk was deemed medically sound with no signs of pododermatitis and was released to a wildlife rehabilitator. The use of a single pedicle advancement flap has not previously been reported for the treatment of pododermatitis.

LITERATURE CITED

Ezequiel Hidalgo,1* Angela Martino, PhD,2 and Jose Curiel, MSc2

1Conservation Medicine PhD Program, Andres Bello University, Santiago, Chile; 2Veterinary Medicine Program, Francisco de Miranda University, El Hatillo, Coro, Falcon, Venezuela

Abstract

The occurrence and distribution of parasitic diseases in captive wild mammals in four Venezuelan zoos were studied from 1998 to 2002. Rates and percentages of morbidity and mortality were calculated using a retrospective analysis of zoo archive data. Bararida was the zoo with the highest index of mortality (4.60%). Primates (66.70%) suffered the highest proportion of deaths. The most frequent genera of parasites were Strongylodes sp. (nematodes), Hymenolepis sp. (cestodes), Platynosomum sp. (trematodes) and Trichomonas sp. (protozoa). Primates, rodents, and hoofed animals were parasitized mostly by Trichomonas sp., whereas carnivores and edentates were parasitized mostly by Strongylodes sp. Platynosomum sp. represented a new discovery as a cause of death for primates in captivity.
METHICILLIN-RESISTANT Staphylococcus aureus INFECTION IN AN AFRICAN ELEPHANT (Loxodonta africana) CALF AND CARETAKERS

Donald L. Janssen, DVM, Dipl ACZM,1* Nadine Lamberski, DVM, Dipl ACZM,1 Taryn Donovan, DVM, Dipl ACVP,2 David E. Sugerman, MD, MPH,3 and Gundula Dunne, DVM, MPVM4

1San Diego Zoo’s Wild Animal Park, Escondido, CA 92027 USA; 2Wildlife Disease Laboratories, San Diego Zoo’s Institute for Conservation Research, San Diego, CA 92112-0551 USA; 3Centers for Disease Control and Prevention, San Diego County Community Epidemiology, San Diego, CA 92101 USA; 4Animal Disease Diagnostic Laboratory, County of San Diego, San Diego, CA 92124 USA

Abstract

A 3-wk-old African elephant (Loxodonta africana) calf, whose mother had a retained placenta and decreased milk production, was hand-reared but failed to thrive. At 7-wks-old, the calf developed a purulent discharge from a large, abraded skin wound on the left forelimb and smaller wound on the rear limb followed by cellulitis at a venous cutdown site. Cultures from the elbow and rear limb grew methicillin-resistant Staphylococcus aureus (MRSA). Approximately 1 wk later, several of the calf’s caretakers reported cutaneous pustules, some of which were laboratory confirmed as MRSA. The calf was treated with antibiotics, and the wounds healed. Nevertheless, the calf failed to thrive and was euthanatized. Postmortem examination of the calf revealed evidence of bacterial septicemia (Enterococcus spp.), though not consistent with MRSA. The calf’s skin lesions were chronic with superficial, opportunistic bacterial and fungal colonization.

A retrospective cohort study of all caretakers was conducted. Twenty MRSA wound infections (five laboratory-confirmed and 15 suspected cases) were identified among the calf’s caretakers (attack rate [20/55] = 36%). Most skin infections were mild, occurred on uncovered skin surfaces, and did not require hospitalization. Pulse-field gel electrophoresis results from the elephant calf, three caretakers’ wounds, and nasal isolates from two caretakers were USA300, the MRSA type most commonly identified in community-associated MRSA infections in the United States. No MRSA colonization or skin infections were found in other African elephants with which the calf shared living space. Among caretakers, activities involving direct contact with the calf (e.g., grooming, bathing, and playing with the calf) were associated with infection.1

The investigation determined that the elephant calf likely acquired its MRSA infection from a colonized human caretaker and then passed the infection to other human caretakers through close direct contact. This case demonstrates the importance of maintaining rigorous infection control procedures with sick animals, especially when caring for animals in critical care situations and/or with open wounds. The recent Compendium of Veterinary Standard Precautions provides a good starting point for developing practice standards for infection control in zoos.2
LITERATURE CITED


THE USE OF PORTABLE CORRAL SYSTEMS AND TAMERS® IN THE MANAGEMENT OF CAPTIVE AND FREE-RANGE HOOFSTOCK IN THE UNITED ARAB EMIRATES

Mark MacNamara¹* and Andy Blue²

¹Fauna Research, Inc., Red Hook, NY 12571 USA; ²San Diego Zoo’s Wild Animal Park, Escondido, CA 92027 USA

Abstract

The responsible management of captive collections of exotic hoofstock begins with the proper identification and tracking of each animal together with the provision of preventive veterinary care based on the individual animal’s biologic history. Essential and necessary equipment in this effort might include portable capture, sorting and holding corrals and Tamers® (Fauna Research, Inc., Red Hook, NY 12571 USA; faunaresearch@yahoo.com), restraint devices for individually handling each animal. The Tamer® is a restraint device designed so that each animal can be physically and safely restrained without the use of immobilizing drugs. Due to the variety of hoofstock species, Tamers® are adjustable in size, and due to the large number of specimens and expansive areas, often hundreds of hectares, Tamer® systems are easily transportable. Mobility allows collection managers to bring the equipment to the animals, rather than moving animals to established facilities that could be hundreds of kilometers away. During a five day period in February 2006, at the Endangered Wildlife Breeding and Conservation Center (EWBCC) in Al Ain, United Arab Emirates, a portable corral system and two mobile Tamers® were used to individually handle 263 antelope and wild goats, including: nubian ibex (Capra ibex nubiana), transcaspian urial (Ovis sp.), impala (Aepyceros melampus), springbok (Antidorcas marsupialis), markhor (Capra falconeri), Cretian goats (Capra aegagrus cretensis), and sable antelope (Hippotragus niger).

ACKNOWLEDGMENTS

We thank Tim Bouts, DVM, MSc in Wild Animal Health MRCVS, Department of the Presidents Affairs, Head of Veterinary Department, Management of Nature Conservation, P.O. Box 47087, Abu Dhabi, UAE.
RESTRAINT OF PRZEWALSKI’S HORSES (*Equus ferus przewalskii*) FOR REPRODUCTIVE STUDIES AT THE NATIONAL ZOO’S CONSERVATION & RESEARCH CENTER (NZP-CRC) AT FRONT ROYAL, VIRGINIA

Mark MacNamara1* and Linwood R. Williamson2

1Fauna Research, Inc., Red Hook, NY 12571 USA; 2Center for Species Survival, Smithsonian’s National Zoological Park, Conservation & Research Center, Front Royal, VA 22630 USA

Abstract

A description of the National Zoo’s Conservation & Research Center Przewalski’s horse facility is presented and illustrates a successful layout of pens, alleys, stalls and a hydraulic restraint device (Tamer®, Fauna Research, Inc., Red Hook, NY 12571 USA; faunaresearch@yahoo.com). The facility provides good animal flow, safety for keepers and horses and allows for low stress, repeat handling and the ability to perform a wide array of veterinary procedures. The importance of training and conditioning of the horses to the facility and the restraint equipment is emphasized. The hydraulic Tamer® allows zoo personnel to handle the horses on a regular basis without the use of chemical immobilization, making it possible to conduct long-term reproductive studies that often require repeat handling for rectal palpations, ultrasound exams, hormone injections and monitoring ovarian activity.
POST-MORTEM NUTRITIONAL EVALUATION OF BONE MINERAL CONCENTRATIONS IN THE HORSE, COW, AND DOG AND ITS APPLICATION TO EXOTIC SPECIES

Samantha M. Middleton, BA,1* Thomas H. Herdt, DVM, MS, Dipl ACVIM, Dipl ACVN,1,2 Justin Zyskowski, BS,2 and Dalen W. Agnew, DVM, PhD, Dipl ACVP1,2

1Michigan State University College of Veterinary Medicine, Lansing, MI 48910 USA; 2Michigan State University Diagnostic Center for Population and Animal Health, Michigan State University, College of Veterinary Medicine, Lansing, MI 48910 USA

Abstract

The analysis of the skeleton as an index of mineral status has been well-established. Calcium and phosphorus represent the majority of the mineral basis of bone in the form of hydroxylapatite \([\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2]\). Other elements such as sodium, magnesium, copper, and zinc have not been investigated as thoroughly. In this study, bone density and mineral concentration were used to evaluate equine, bovine, and canine specimens. Once baseline values for bone mineral density and mineral concentration in cows, horses, and dogs were determined, exotic specimens were examined to evaluate the ability to extrapolate from domestic to zoo animals. Initial analyses show comparable values between the domestic and exotic species examined thus far. For instance, the average bone ash percentage for bovine (n=8) and equine (n=9) species was, respectively, 64.95 ± 7.024 and 62.28 ± 3.131 with an average phosphorus content of 12.24% and 10.74%. Specimens from exotic hoofstock such as a reticulated giraffe (Giraffa camelopardalis reticulata) and a Bactrian camel (Camelus bactrianus) had bone ash percentages of 63.60 and 65.10, respectively. Bone phosphorus content of the giraffe was 11.79% and the camel was 12.25%.

This work provides the first index of normal elemental concentrations and normal bone densities in domestic or exotic species. In addition, these data have provided unique insights on the microenvironment of the bone surface, suggesting further avenues of continued research.
CUTANEOUS LYMPHOSARCOMA IN AN EGYPTIAN FRUIT BAT (*Rosettus aegyptiacus*)

June E. Olds, DVM, 1* Aaron D. Lehmkuhl, DVM, 2,3 and Amanda J. Fales-Williams, DVM, PhD, Dipl ACVP 3

1 Blank Park Zoo, Des Moines, IA 50315 USA; 2 USDA APHIS NVSL-PL, Ames, IA 50010 USA; 3 Iowa State University College of Veterinary Medicine, Department of Pathology, Ames, IA 50010 USA

Abstract

An 11-yr-old male Egyptian fruit bat (*Rousettus aegyptiacus*) was found on the floor of the bat exhibit, unable to fly. The animal was presented with superficial bite injuries to the dorsal and ventral thorax and unilateral swelling of the skin, muscles and appendages on the right side of the body. Culture yielded heavy mixed growth of multiple bacterial isolates. Cytologic examination of wound exudate was non-diagnostic. The wounds failed to heal with empirical antibiotic therapy, thus biopsy samples were obtained. Biopsies confirmed cutaneous lymphosarcoma present within the dermis and skeletal muscle. The animal was humanely euthanatized and submitted for necropsy.

Necropsy revealed that the neoplasm extended on the right side of the body from the ear to the pubis bone, both ventrally and dorsally. Histopathology revealed a densely cellular, poorly demarcated, and unencapsulated mass expanding and infiltrating the dermis, subcutis and skeletal muscle. Cells were arranged in sheets and exhibited moderate pleomorphism. In addition, the neoplasm infiltrated the salivary glands and cervical lymph nodes on the right side, and expanded the lamina propria of large airways in the lung.

Immunohistochemical staining (IHC) was performed multiple times, with canine- and feline-specific antibodies in an attempt to further characterize the cell type of origin as either T (CD3+) or B (CD79+) lymphocytes. Unfortunately, IHC was unrewarding. Species differences likely explain the inability to further characterize the cell type of origin.

Neoplasia is uncommon in chiropterans. 2 To the authors’ knowledge, this report documents the first case of cutaneous lymphosarcoma in the *Rousettus* species. 1,3,4

LITERATURE CITED

UNUSUAL SUBCUTANEOUS TUMORS IN THREE CALIFORNIA KINGSNAKES
(Lampropeltis getula californiae, BLAINVILLE, 1835)

Drury R. Reavill, DVM, Dipl ABVP (avian practice), Dipl ACVP,1* Taylor Chance, DVM, Dipl ACVP,2 Richard J. Montali, DVM, Dipl ACVP, Dipl ACZM,3 Robert Nordhausen, MA,4 Jeremy Goodman, DVM,5 and Robert E. Schmidt, DVM, PhD, Dipl ACVP1*

1Zoo/Exotic Pathology Service, West Sacramento, CA 95605 USA; 2Armed Forces Institute of Pathology, Washington, D.C. 20306 USA; 3Johns Hopkins University, Baltimore, MD 21205 USA; 4California Animal Health and Food Safety Laboratory System (CAHFS), Davis, CA 95617 USA; 5Turtle Back Zoo, West Orange, NJ 07052 USA

Abstract

An unusual subcutaneous tumor was identified in three unrelated California kingsnakes (Lampropeltis getula californiae (Blainville, 1835)). Multiple tumors were located within the subcutis along the body of the snakes. All three snakes survived surgical tumor removal and were alive at follow-up examinations.

The tumors were well-circumscribed discrete, multi-lobulated, and composed of large densely packed cells with a pale eosinophilic fibrillar cytoplasm in hematoxylin and eosin (HE) sections. In two cases, cytoplasmic amphophilic globular inclusion bodies were noted. The mitotic index was low in all three cases at <1 per 10 high-power fields. A spindle cell sarcoma of neural origin was the tentative histologic diagnosis, based on HE examination and immunohistochemistry performed.

Two cases were submitted for transmission electron microscopy. The results of the first case found intracytoplasmic globular inclusions consisting of two types. One inclusion type was highly variable in size with the appearance of cell debris. The other inclusion type had variably sized patches of uniform hexagonal particles that, in areas, appeared paracrystalline. The cytoplasm of the cells in some areas was scant but did have an abundance of filaments. In the second case without evidence of cytoplasmic inclusions on HE sections, there were numerous neurosecretory granules within the cytoplasm; however, the granules contained fragmented electron-dense bodies, with the appearance of secondary lysosomes.

Although the exact classification of these unique neoplasms is still uncertain, a neural origin is suspected. The tumors do exhibit a benign growth behavior and multiple tumor development is common.
NEOSPOROSIS IN AN ABORTED SOUTHERN WHITE RHINOCEROS (*Ceratotherium simum simum*) FETUS

Cheryl Sangster, DVM, MVSc, Dipl ACVP,1* Benn Bryant, BVSc, MVS,2 and Michelle Campbell, BSc, BVSc, DZooMed (Mammalian), MRCVS2

1Taronga Zoo, Mosman, NSW, Australia, 2088;  2Taronga Western Plains Zoo, Dubbo, NSW, Australia, 2830

Abstract

Although only first recognized as a disease entity in the 1980’s, neosporosis is now considered a major cause of abortion in cattle across the globe.1 In other species, abortion or stillbirth has been associated with natural infection of *Neospora* sp. in goats, horses, a deer (*Cervus eldi siamensis*) and two twin antelope (*Tragelaphus imberberis*).1

In December 2008, a Southern white rhinoceros (*Ceratotherium simum simum*) aborted a 7-mo gestation, male fetus. The dam was estimated to be between 7 and 9 yr of age when wild caught in South Africa in 2002. In 2003 she was transferred to an open range zoological facility in Australia. Her previous calf born at the zoo was healthy. On gross post-mortem examination, the liver of the aborted fetus appeared enlarged and rounded, and a small segment of intestine was herniated through the umbilical opening. On hematoxylin and eosin stained sections, foci of necrosis were noted in the hepatic parenchyma associated with low numbers of lymphocytes, plasma cells and neutrophils in addition to basophilic, granular material (mineral). Protozoal zoites, confirmed as *Neospora* sp. by immunohistochemistry, were identified within the hepatic lesions and within the cerebellum, but with little to no inflammatory reaction in the latter site. Based on the presence of *Neospora* sp. zoites within necrotic hepatic lesions, the abortion was attributed to the protozoal infection. Literature searches reveal only one report of neosporosis in a white rhino calf and no prior cases of *Neospora* related abortion in this taxa.2

LITERATURE CITED

THE OPOSSUM’S TALE: ALOPECIA AND PURITUS IN A VIRGINIA OPOSSUM
(\textit{Didelphis virginiana})

Shangzhe Xie, BSc/BVMS\textsuperscript{1}\textsuperscript{*} and Karl Hill, DVM\textsuperscript{2}

\textsuperscript{1}Veterinary Dentistry, Rabbit and Exotic Medicine, Perth, Western Australia; \textsuperscript{2}Santa Barbara Zoo, Santa Barbara, CA 93103 USA

Abstract

A 14-mo-old male neutered Virginia opossum (\textit{Didelphis virginiana}) was presented in May 2008 with scabs and hair thinning around the right shoulder area. He was treated with a gentamycin/bethamethasone topical spray (Butler Animal Health Supply LLC., Dublin, OH 43017 USA), and appeared to improve for about 1 mo; however, he presented again in July 2008 with similar scabs and hyperemia of the skin on the shoulder. Physical examination revealed the presence of fleas, prompting treatment with imidacloprid (Advantage 10, Bayer Animal Health, Bayer Healthcare LLC, Shawnee Mission, KS 66201 USA). He was rechecked 3 wk later and found to be free of fleas. However, the scabs and skin hyperemia were still present. Allergy or contact dermatitis was suspected at this stage, and it was suggested that the cedar mulch, which was used for bedding, be removed.

One week later, treatment with prednisone (Butler Animal Health Supply LLC., Dublin, OH 43017 USA; 1 mg/kg p.o. s.i.d. for 7 days) was initiated, as removal of the cedar mulch had not helped his condition. He improved after the course of prednisone, with the skin hyperemia completely resolved and only a few small scabs remaining. However, this improvement only lasted for 3 wk. Skin and hair samples were sent for fungal culture, and he was bathed in an emollient oatmeal shampoo (Epi-Soothe, Virbac Animal Health, Virbac Corporation, Forth Worth, TX 76137 USA) and dipped in lime sulfur. He was also treated with prednisone (1 mg/kg p.o. s.i.d. for 14 days) again. The culture results indicated that a few colonies of \textit{Cladosporidium} sp. were grown from the samples submitted, and a miconazole nitrate/chlorhexidine gluconate spray (Malaseb, DVM Pharmaceuticals, Teva Animal Health Inc., Saint Joseph, MO 64503 USA) was prescribed for twice a day application to the affected area for 14 days.

His condition worsened after 1 wk, and he was anesthetized for a full diagnostic work-up. The hair loss was bilaterally symmetric, with flaky skin and exudative dermatitis over the shoulders, hips and base of the tail. Skin scrapes were collected for microscopic examination and culture, and skin biopsies were collected for histopathology. The skin scrapes were negative for ectoparasites under microscopic examination, and the bacterial culture yielded no growth. The skin biopsy revealed multifocal marked chronic ulcerative dermatitis with a mild neutrophilic infiltrate. Blood was also collected for a complete blood count, serum biochemistry analysis, endocrine and thyroid panels, as well as allergy testing (serum IgE). The endocrine and thyroid panels are summarized in Table 1 and allergy panel results in Table 2. Complete survey radiographs were taken and revealed possible narrowing of the spinal canal at T9, near the region of hair loss. The opossum was treated with another course prednisone (1 mg/kg p.o. s.i.d. for 14
days), together with cefpodoxime proxetil (Simplicef®, Pfizer Animal Health, Pfizer, Inc., New York, NY 10017 USA; 15 mg/kg p.o. s.i.d. for 14 days). He improved dramatically on this course of medications, and the oral prednisone was continued for a further 14 days, and then weaned off over a period of seven days.

The significance of the endocrine panel results are unknown because there are no normal opossum reference values available for comparison, but the results may be useful for similar cases in the future. The total thyroxine results were within normal limits (range = 0.1–2.5 µg/dl).¹ The rest of the thyroid panel was hard to interpret due to lack of normal reference ranges, but the free thyroxine and total triiodothyronine values were at roughly the same levels as previous tests conducted on the same opossum. The allergen panel revealed significant titers to milk, and possibly liver and fleas (the test was conducted while the opossum was on prednisone, making interpretation more complicated). At this point in time, it is known for sure that the pruritis/alopecia was responsive to prednisone, indicating that pruritis was the primary problem. There remains the possibility that the prednisone relieved the pain and swelling associated with the possible spinal lesion at T9. An elimination diet will be the next diagnostic step to investigate the significance of the high IgE titer to milk and liver.

This case reveals the gaps in knowledge of disease processes in opossums, even though they have been extensively used as laboratory animals in the past. Hopefully, this case report will spark a wave of reports regarding diseases in opossums and renew interest in the only marsupial species in North America.

ACKNOWLEDGMENTS

I would like to acknowledge the staff of Santa Barbara Zoo for their involvement in this case, as well as Greer Labs for performing the allergy panel.

LITERATURE CITED

Table 1. Endocrine and thyroid test results for a Virginia opossum (Didelphis virginiana) with alopecia and pruritus.

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free thyroxine (ng/dl)</td>
<td>0.5</td>
</tr>
<tr>
<td>Total thyroxine (µg/dl)</td>
<td>2.09</td>
</tr>
<tr>
<td>Total triiodothyronine (ng/dl)</td>
<td>28</td>
</tr>
<tr>
<td>Estradiol (pg/ml)</td>
<td>130</td>
</tr>
<tr>
<td>17-OH-progesterone (nmol/L)</td>
<td>5.99</td>
</tr>
<tr>
<td>Androstenedione (nmol/L)</td>
<td>18.1</td>
</tr>
</tbody>
</table>

Table 2. Allergen test results (food panel) for a Virginia opossum (Didelphis virginiana) with alopecia and pruritus.

<table>
<thead>
<tr>
<th>Food</th>
<th>MAU^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>53</td>
</tr>
<tr>
<td>Liver</td>
<td>36^b</td>
</tr>
<tr>
<td>Kangaroo</td>
<td>10^b</td>
</tr>
<tr>
<td>Rice</td>
<td>5^b</td>
</tr>
<tr>
<td>Egg</td>
<td>2^b</td>
</tr>
<tr>
<td>Pork</td>
<td>2^b</td>
</tr>
<tr>
<td>Flea</td>
<td>23^b</td>
</tr>
</tbody>
</table>

^aModified Absorbance Units (the level of allergen specific Ig detected)

^bScores ranging 0-39 indicate that no circulating allergen specific IgE was detected for the allergens tested.
AVIAN MYCOBACTERIOSIS IN TWO FREE-RANGING STYGIAN OWLS (Asio stygius)

Diego Soler, MS, DVM,1,3* Claudia Brieva, MS, DVM,1,3 and Wellman Ribón, MS2

1Faculty of Veterinary Medicine and Animal Husbandry, Universidad Nacional de Colombia, Bogota, Colombia; 2Group of Mycobacteria, Instituto Nacional de Salud, Bogota, Colombia; 3Research Department, Asociación de Veterinarios de Vida Silvestre, Bogota, Colombia

Abstract

Mycobacterium avium complex and Mycobacterium genavense are generally responsible for mycobacteriosis in birds, especially when they are immunosuppressed.2,4,10 Avian mycobacteriosis has been reported in several bird species with varying clinical signs.2,4-8 Diagnosis comprises clinical examination, conventional microbiology and molecular methods that are not always available.1,10,11 There is a growing concern about this infectious disease given its increase among immunocompromised people and its impact on bird species. We report two mycobacteriosis cases in stygian owls (Asio stygius) caused by M. avium, a mycobacteria species not reported before for this avian species in Neotropical conditions.3

Two free-ranging stygian owls were found at the Universidad Nacional de Colombia (elevation: 2640 meters) in Bogota, Colombia, but died after several days of treatment. Clinical examination, necropsy, and sampling of liver tissue for hematoxylin-eosin histologic staining, Ziehl-Neelsen staining, hsp65 gene molecular analysis and sequencing of 16S rRNA gene were conducted. No isolate was obtained in cultures. The necropsy revealed yellowish nodules adhered to the costal surface of the thoracic portion of coelom, in the liver, and in the lungs. Hematoxylin-eosin stained liver tissues showed chronic granulomatous lesions, and Ziehl-Neelsen staining revealed alcohol-acid resistant bacilli. No characteristic restriction patterns were obtained through molecular methods, but by sequencing the bacilli were identified as M. avium, a mycobacteria species not reported before in this avian species in Neotropical conditions. Molecular methods enable microorganism species identification when microbiologic confirmation is not possible.1,11 Avian mycobacteriosis cases should be reported to adopt measures aimed at preserving wildlife and human health.2,9

ACKNOWLEDGMENTS

Acknowledgments to Claudia Castro, Martha Moreno y Derly Fierro for their support at mycobacteria, pathology and microbiology laboratory, respectively. To the Instituto Nacional de Salud (INS) de Colombia, Universidad Nacional de Colombia y Asociación de Veterinarios de Vida Silvestre (VVS) for funding.

LITERATURE CITED


ASSESSMENT OF COMBINATION DRUG PROPHYLAXIS FOR PREVENTION OF VERTICAL TOXOPLASMA TRANSMISSION IN PALLAS’ CATS (Otocolobus manul)

William F. Swanson, DVM, PhD, 1,* Greg Levens, DVM, 1 Karen A. Terio, DVM, PhD, Dipl ACVP, 2 Michael R. Lappin, DVM, PhD, Dipl ACVIM, 3 Mitch Bush, DVM, Dipl ACZM, 4 Helen Bateman, MSc, 1 Jackie Newsom, 1 Dawn Strasser, 1 Pat Callahan, 1 and Mark Campbell, DVM 1

1 Center for Conservation and Research of Endangered Wildlife, Cincinnati Zoo & Botanical Garden, Cincinnati, OH 45220 USA; 2 College of Veterinary Medicine, University of Illinois, Maywood, IL 60153 USA; 3 College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Ft. Collins, CO 80523 USA; 4 Conservation and Research Center, Smithsonian National Zoological Park, Front Royal, VA 22630 USA

Abstract

The Pallas’ cat (Otocolobus manul) is unique among the world’s 36 felid species in exhibiting an extreme susceptibility to toxoplasmosis. 1-5 Female Pallas’ cats with chronic immunoglobulin titers to Toxoplasma frequently experience recurrent vertical transmission to developing fetuses or neonates with pronounced mortality. 1,5 The objective of this study was to assess the efficacy and safety of a combination drug regimen (i.e., diclazuril and clindamycin) for preventing Toxoplasma transmission during pregnancy in seropositive Pallas’ cats. Two female Pallas’ cats with persistent Toxoplasma serotiters were paired with males during several breeding seasons, resulting in five term pregnancies and the birth of 19 kittens. Drug treatment during pregnancy consisted of either 1) diclazuril (Vecoxan®, Janssen Animal Health, High Wycombe, Buckinghamshire HP144HJ UK; 1 mg/kg p.o.) once per wk (pregnancy #1; 3 kittens), 2) diclazuril (1 mg/kg p.o) twice per wk (pregnancy #2; 5 kittens) or 3) diclazuril (1 mg/kg p.o) once per wk followed by clindamycin (Clintabs®, Virbac Animal Health, Inc., Fort Worth, TX 76137 USA; 16 mg/kg p.o. b.i.d.) for the last 3 wk of pregnancy (pregnancies #3-5; 5, 3 and 3 kittens, respectively). Kittens were removed 1-3 days after birth for hand-raising or fostering to a domestic queen, and treated either with diclazuril (1 mg/kg p.o) once or twice per wk for 12 wk (pregnancy #2) or injectible clindamycin (Hospira Inc., Lake Forest, IL 60045 USA; 10 mg/kg i.m. b.i.d.) for five days followed by a single dose of diclazuril (1 mg/kg p.o.) 2 days later (pregnancies #3-5). Kittens subsequently showing clinical signs suggestive of toxoplasmosis were treated with several antibiotics including ceftriaxone sodium (Rocephin®, Roche Pharmaceuticals, Nutley, NJ 07110 USA), trimethoprim-sulfamethoxazole (Bactrim®, Roche), atovaquone (Mepron®, GlaxoSmithKline, Research Triangle Park, NC 27709 USA) and/or clindamycin at varying dosages. Blood samples collected from Pallas’ cat dams on the day after parturition and kittens older than 12 wk of age were assessed by ELISA for Toxoplasma serotiters (IgM and IgG), and milk and whole blood from Pallas’ cat dams were tested via PCR for Toxoplasma DNA. All deceased kittens were evaluated for gross and histologic evidence of toxoplasmosis.
For the two pregnancies treated with diclazuril alone, only one of eight kittens (12.5%) survived to adulthood and toxoplasmosis was diagnosed histologically in at least one deceased kitten in each litter, suggesting Toxoplasma transmission from the dam. The one surviving kitten developed Toxoplasma titers indicative of exposure. For the three pregnancies treated with a combination of diclazuril and clindamycin, six of eleven (55%) kittens survived to adulthood and no evidence of toxoplasmosis was observed in any deceased kitten. The day after parturition, these Pallas’ cat dams had moderate Toxoplasma IgG titers, but milk and blood samples tested negative for Toxoplasma DNA. All six surviving kittens were seronegative for Toxoplasma exposure after 12 wk of age.

Our results suggest that diclazuril alone is ineffective in preventing Toxoplasma transmission in utero, but that a combination regimen of diclazuril and clindamycin used sequentially in pregnant females and their neonatal kittens may have some efficacy. However, it is unknown if this drug regimen had any effect on neonatal mortality unrelated to toxoplasmosis and further studies addressing drug safety may be warranted.

ACKNOWLEDGMENTS

The assistance of the veterinary and animal care staff at the Cincinnati Zoo and Botanical Garden is gratefully acknowledged.

LITERATURE CITED

SEARCHING FOR Cryptosporidium IN THE AVIARIES OF THE ANTWERP ZOO

Francis Vercammen, DVM,1* Bruno Levecke, DVM,2 Redgi De Deken, DVM, PhD,3 and Jef Brandt, DVM, PhD1

1Royal Zoological Society of Antwerp, K. Astridplein 26, B-2018 Antwerp, Belgium; 2Laboratory of Parasitology, Faculty of Veterinary Medicine, Ghent University, Salisburylaan 133, B-9820 Merelbeke, Belgium; 3Animal Health, Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerp, Belgium

Abstract

Following mortalities of confiscated turacos (Corythaeola cristate) in our quarantine section due to Cryptosporidium baileyi and a recent international report of lethal infections in mixed-bred falcons (Falco rusticolus x Falco cherrug), every individual aviary in the Antwerp Zoo was examined for this parasite. Pooled fecal samples were analyzed by modified Ziehl-Neelsen, rapid immunomigration, immunofluorescence and PCR. Only by PCR, one sample was found positive, suggestive for the low presence of Cryptosporidium in our captive bird population. Additionally, samples of trachea, lung and small intestine were taken at necropsies, but so far no evidence for Cryptosporidium spp. was found.

Material and Methods

From August 2008 until March 2009 pooled fecal samples and individual organs were analyzed for Cryptosporidium spp. Feces were collected in all 94 aviaries of the Antwerp Zoo, comprising 686 birds, in total 86 species and 22 orders. A modified Ziehl-Neelsen (mZN), an immunofluorescent assay (MeriFluor® Cryptosporidium/Giardia immunofluorescence assay, Meridian Diagnostics Inc., Cincinnati, OH 45244 USA), and an immunomigration dipstick assay (Crypto-Strip, Coris BioConcept, Belgium) were used for all fecal samples, and a PCR4 targeting the 18S rRNA was used for 50 samples. Since this parasite has been found in the respiratory and intestinal tract,5 trachea, lungs and small intestines of 16 birds were sampled at necropsy.

Discussion and Conclusion

Although avian cryptosporidiosis has been reported worldwide1 in more than 30 avian species,5 data on its prevalence in zoos are lacking. In one Japanese zoo, all 173 samples of 46 avian species belonging to 11 orders were negative;2 yet a nucleic acid recognition method was not used. The detection limit of mZN is reported to stand at 10^6 oocysts per ml unconcentrated fecal smears, whereas PCR is reported to be more sensitive than conventional and immunologic assays.3 The immunologic assays have each a similar level of sensitivity, but whether these assays are performing better than staining methods remains a matter of discussion.3 The rapid immunomigration assay for copro-antigen can be useful when the oocysts are lacking in the feces.3
Our results indicate a low presence of Cryptosporidium in our collection and a higher sensitivity for PCR than mZN or immunoassays, but warrants a continuous search for this protozoan.

LITERATURE CITED

SOLAR HYDROGEN BIO-MIMETIC ENERGETICS (sHe-BioME), A NEW AND EMERGING SUB-DISCIPLINE OF ZOOLOGICAL MEDICINE AND THE WILDLIFE BIOLOGICAL SCIENCES

Carl J. Lange, BSME, MSME, PE, CPEI,1 Khan Sakeeb, BS, CE,2 Zarina Anika,2 Estuardo Rodas,2 Todd Losey, BS,3 Daniel Grey,4 Kam Chun Chan,6 Kelin Chen,5 Fouad Issa,2 Mahmoud Abdel-Dayem,2 Viktor Roytman,4 Alvin Zhang,7 and Horace E. Walcott, DVM, MSPH, MSc3*

1Lange Technical Services LTD, Deer Park, NY 11729 USA; 2Department of Chemical and Biological Engineering, Polytechnic Institute of New York University, Brooklyn, NY 11201 USA; 3Brooklyn Technical High School, Brooklyn, NY 11217 USA; 4Columbia University, New York, NY 10027 USA; 5School of Engineering, and Applied Sciences, Princeton University, Princeton, NJ 08544-5263 USA; 6Massachusetts Institute of Technology, Cambridge, MA 02139-4307; 7Cooper Union, New York, NY 10003-7120 USA

Abstract

We have been developing equations on the bioenergetics of aquatic and air borne species for hypothesis testing by experimentation. Along with morphologic data and fluid dynamics data, we are combining data on the chemistry of hydrogen combustion to develop drone crafts for use in wild life investigations. We are also designing a novel robotic tranquilizing gun, which does not require charges or pressurized carbon dioxide. Major design features of the gun have been derived from ethno-botanical and aerodynamics data on the blow pipe.

Introduction

The post World War II evolution of Scientific Medicine from Techno-Medicine to Info-Medicine, has not been in synchrony with the need to advance ecologically sound approaches in biomedicine and engineering.7,18,20 The practice of medicine can be hampered due to the current energy crisis and environmental tipping points.4 One unexplored area is the confluence of zoological medicine, comparative animal bio-mechanics, the fluid dynamics of avian and aquatic animals, mechantronics and the electrochemical thermo-dynamics of hydrogen combustion.17,19

We have been testing hypotheses in the above-indicated area defined as solar hydrogen electric bio-mimetic energetics (sHe-BioME). Our studies have focused on the development of autonomous aircrafts, boats and submarines, which in terms of structure and energetics mimic specific aquatic and avian animals.3,19,22,23,25 germane to the developed hypotheses are allometric equations on the power of the drone vehicles relative to hydrogen combustion and the application of anatomic and bio-physical data.21

In addition, we have also conducted ethno-botanical and aerodynamics studies on the blow pipe. The data from the blow-pipe studies are being used to develop a robotically controlled dart gun, which does not require charges or pressurized carbon dioxide.8,9
Materials and Methods

Aerodynamic studies were conducted by Fedotov, Yee and Walcott, to explore hypotheses: that the propulsion of darts are governed by the Gas Laws, Poisuillies Equation and the Bernouli Equation. \(1,5,8,9,11\) Data from the ethno-botanical studies of the blow pipe have been used in the design of a pneumatic dart gun. \(10\) The dart gun will be robotically controlled and will be part of the payload of a solar hydrogen electric autonomous air sampling vehicle (sHe\(^{-}\) - AAV). \(20\)

Allometric equations developed by Mc Neill to summarize the propulsive power of animals in fluids were modified and used for the development of a drone submarine, the drone aircraft, a drone water sampling boat and a buoyant micro-power plant. \(17,19\) In our thermodynamic studies, we are examining the relationship of Gibbs Free Energy from hydrogen combustion, and the mechanical power components used for the propulsion of the drone crafts. Three varieties of robotic fish (Hammacher Schlemmer, www.hammacher.com) are used as external standards for thermodynamic comparisons with the three drone crafts, which use water as a fuel. Morphologic data of avian and aquatic species, electrochemical thermodynamic data and mechanotronics are used in the construction of the drone crafts. \(17\)

Results

The investigations of Fedotov et. al, have demonstrated that the forced expiratory volume used for the propulsion of darts in a blow pipe is governed by the gas laws, Poisuilli’s Equation and Bernouli’s Equation (Equations 1-4). \(8,9,11,13\) The ethno-botanical studies have indicated a similarity in structure of the blow pipe due to among different nations in the Amazon. Two models of dart rifles are undergoing development. The barrels replicate the hand crafted blow pipes of the Amazon and a non-polluting chemical reaction is used for the propulsion of the dart. (Figures 1 and 2). \(1,10\)

Our thermodynamic data suggest an equivalence between the rate of Gibbs Free energy expenditure or generation and the sub-components of Mc Neill’s allometric equations (Equations 5-7). Fluid dynamic studies on a wind turbine and water turbine have demonstrated the production of electrical energy, which splits distilled water into hydrogen and oxygen in 3V and 12 V proton exchange membranes of fuel cells (Equations 8 and 9). \(5,20\)

Equation 1 (Poisuille’s Equation for the blow pipe and dart rifle)
\[
V = \frac{\Delta P \pi r^4}{8 \eta l}
\]
\(\Delta P = \text{Pressure Change at the two ends of the firing chamber of the blow pipe}; \ r = \text{radius of blow pipe}; \ \eta = \text{air viscosity}; \ l = \text{length of blow pipe firing chamber}\)

Equation 2 (Bernouli’s Equation for the blow pipe and dart rifle)
\[
\rho v^2 + \text{Ps} = \text{Pt}
\]
\(v = \text{velocity of the fluid}; \ \rho = \text{fluid density}; \ Pt = \text{total pressure and Ps = Static pressure}\)

Equation 3
Power (P or \(\Delta G_{H_2O}/\Delta t\)) of Flight of a fixed wing aircraft (sHe\(^{-}\) AAV)
P_{total} \equiv \Delta G_{H+O}/\Delta t = \text{Profile Power} + \text{Induced Power}

P_{total} = [(\rho \nu^3 C_o A/2) + (2\kappa M_h g^2/\pi \rho \nu \alpha)]

\rho = \text{air density}; \nu = \text{speed of air}; M_h = \text{mass of the sHe -AAV}; \kappa = \text{Induced drag factor}; g = \text{gravitational acceleration}; \alpha = \text{wing span/chord}

Equation 4
\Delta G_{H+O}/\Delta t = [(\rho \nu^3 C_o A/2) + (2\kappa M_h g^2/\pi \rho \nu \alpha)]

Equation 5
For the sHe - AUV:
\Delta G_{H+O}/\Delta t = \text{Parasite Power} = 0.5 \rho A \nu^3 C_D
A = \text{Total Surface area of the craft and } C_D = \text{Drag coefficient based on total area}

Equation 6 (Wind Turbine, wind hydrogen electric bio-mimetic energetics, wHe - Bio-ME)
\Delta G_{H+O}/\Delta t = I \text{ (current)} \times V \text{ (voltage)} = 0.5 \rho \pi r^2 \nu^3
\rho = \text{air density}, \nu = \text{mean wind velocity}

Equation 7 (Water Turbine, hydromechanical hydrogen electric bio-mimetic energetics, hymkHe- BioME)
\Delta G_{H+O}/\Delta t = I \text{ (current)} \times V \text{ (voltage)} = 0.5 \rho \pi r^2 \nu^3
\rho = \text{water density}, \nu = \text{mean water current velocity}

Discussion

The dart rifles will use an electro-pneumatic firing mechanism. The data from studies on the bio-mechanics of the tentacles of the Portuguese man-o-war (Physalia physalis) will be used for the design of a more energy efficient winch for the submarine probe of the drone water sampling boat.\textsuperscript{17,22} Some unexplored areas of sHe - BioME include nano-chemical studies to develop more efficient PEMs, the quantum mechanics of photosynthesis and flexible ultra-thin solar panels.\textsuperscript{14-16} In the future we will conduct bio-mechanical studies on insects to develop autonomous micro-aerial vehicles (MAVs), capable of injecting therapeutic agents into free ranging animals and collecting fluid samples.\textsuperscript{2,3,6,12,22,24,25}

Conclusion

Allometric equations, which summarize the bio-mimetic energetics of hydrogen electric power can be used in combination with comparative anatomy and the fluid dynamics of avian and aquatic species to design drone crafts applicable to zoological medicine.\textsuperscript{17} A novel dart gun is undergoing development. The applied anatomy of air borne and aquatic animals have the potential to contribute to the significant greening of veterinary medicine.\textsuperscript{19}

ACKNOWLEDGMENTS

This research was supported by grants from the Brooklyn Tech Alumni Research Foundation. Dr. Haldane Rogers of Brooklyn Tech was a consultant on the aerodynamics studies of the blow pipe. The microscopic examination of the dart tips was conducted in the laboratory of John Cunningham at Brooklyn Tech. Without the technical
guidance of Ms. Jessica Dolan, Assistant Curator of Harvard University Herbaria, the many plant specimens and artifacts could not have been identified and examined. Dr. Gustavo Romero of Harvard University Department of Economic Botany, with his vast field experiences, provided useful insights into the ethnobotany and ethnotoxicology of curare and the blow pipe. The members of the library staff of the Harvard University Herbaria were generous in their assistance in the location of rare documents on economic botany.

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20. Roytman, V. 2008. The development and testing of a solar hydrogen electric aeronautical air sampling vehicle (sHeAAV). Provisional Patent Filed Feb 27, 2009, USPO.


**Figure 1.** The proximal segment of the barrel of a blow pipe with the hour glass shaped mouth piece. The dart has a fletch made from wound Ceiba cotton wool and the tip end is coated with dark resin like curare syrup. In the insert are two views of the piercing tip profile, laterally and in cross section. The firing chamber is the segment of the barrel anterior to the mouth piece.

**Figure 2.** The Green Dart Rifle: Lange Rifle, which is electro-pneumatic.
GUN SHOT TRAUMA IN A TRUMPETER SWAN (*Cygnus buccinator*)

*Horace E. Walcott, DVM, MSPH, MSc*

*Brooklyn Technical High School, Brooklyn, NY 11217 USA*

**Abstract**

A 12.5-kg adult male trumpeter swan (*Cygnus buccinator*) was presented for necropsy examination in good nutritional status. On the lateral aspect of the right thoraco-abdominal region was an ellipsoidal area of subcutaneous hemorrhage surrounded by a central perforation (gun-shot wound). Two pellets were found in the abdominal blood clots. Toxicology testing indicated 1.5 ppm of lead in the liver. Macroscopic lesions were consistent with type III gun trauma. Microscopic examination of tissue samples demonstrated disseminated intravascular coagulopathy.

**Introduction**

In the mid-western region of the United States, several trumpeter swans (*Cygnus buccinator*) have been deliberately or accidentally shot during the autumnal migration of Canadian geese (*Branta canadensis*). Between 1993 and 1994, gunshot contributed to 31% of the mortalities of immature canvasbacks (*Aythya valisineria*) in inland Louisiana. From 1986 to 1992, in the northwestern region of Washington state, illegal shooting and other traumatic factors contributed to 11% and 12% of the total swan mortality, respectively. In 1935 excessive hunting and other factors resulted in an Illinois population of less than 100 swans. Since then reintroductions from Alaska have replenished the diminishing population. In the cases of accidental shootings, the swans were incorrectly identified as geese. In the autumn of 1994, one swan undergoing intensive care at the Wild Life Ward of the College of Veterinary Medicine, University of Illinois died of complications associated with gun-shot trauma. The swan was necropsied for macroscopic and microscopic pathologic evaluation. The gross description is reported and the pathologic findings and diagnoses described. Based on human forensic studies, shot gun wounds are classified as type I, type II and type III. Type I injuries are sustained at a long range (greater than 7 m) and result in subcutaneous or deep fascia location of pellets. Type II injuries are sustained at a close range of 3 to 7 m and result in the perforation of structures beneath the deep fascia. Type III trauma occurs at point-blank range (less than 3 m). The bullets from a shot gun are usually low velocity. However at a distance of less than 3 m, there is a rapid deceleration of the pellet from an approximate muzzle velocity of 450 m/s. Due to the unfavorable ballistic characteristics of a spheroid pellet, the injury to a bird will be severe. In comparison and contrast with terrestrial mammals, the pathophysiology of multiple trauma due to gun-shots in the aquatic avian species has many similarities and differences, respectively. The sequela of shock is significant in the pathophysiology of gun-shot trauma in this case and that of avian species in general (Figure 1).
Materials and Methods

A complete necropsy examination was conducted and tissue samples collected and stored in phosphate buffered formalin. The tissue samples were then processed for histopathology and mounted on slides prior to staining with hemotoxylin and eosin. The stained sections of tissue were microscopically examined.

Results

Gross Description

An adult male trumpeter swan weighing 12.5 kg is presented in good nutritional status. At the distal end of the right ulna and radius, 5-8 cm from the radiocarpal-metacarpal joint, a dark red featherless area (10 x 4 cm) is present. On the ventral wing surface close to the right proximal phalanx, there is another featherless dark reddened area (4 x 2 cm). On the lateral aspect of the right thoraco-abdominal region is a 29 x 13 cm, ellipsoidal area of subcutaneous hemorrhage surrounded by a central perforation (gun-shot wound). The hemorrhagic region extends from the distal sternum to the proximal pelvis on the right side. The segment of the wing with the subcutaneous hemorrhage in the radiocarpal-metacarpal area is slightly mobile and crepitant. Multiple gas bubbles are located on the surface of the abdominal and pectoral muscles with the ellipsoidal area of hemorrhage. Dark red fluid (5-10 ml) is present on the sternal and rib surfaces below the damaged muscles. The proximal and distal segments of the last ribs on the right side are separated from each other 6-8 cm from the sternum. A 4-10 cm diameter circumscribed area is dark red and contains the two fractures. In the right ventro-lateral abdominal region approximately 200 ml of clotted blood extends to the pelvic canal and covers the abdominal viscera. An ovoid, 3 x 2 cm perforation of 3-4 cm depth is present 5 cm from the greater curvature of the gizzard. Liquid material extends from the proventriculus to the small intestine. Two pellets are found in the abdominal blood clots.

Micromorphologic and Macromorphologic Diagnoses

1. Acute, multiple fractures of the right radius and ulna and two ribs on the right side.
2. Acute, moderate fibrinous thrombosis; systemic vasculature.
3. Acute, multifocal renal infarction.
4. Acute, locally extensive, subscapular hepatic necrosis.
5. Acute, locally extensive, muscle hemorrhage and necrosis; pectoral and abdominal muscles.
6. Focal ulceration; right ventral wing.
7. Mild to moderate, subacute pericholangitis.

Conclusion

The cause of death was most likely due to shock and disseminated intravascular coagulation (DIC) secondary to trauma from gun shots. The contribution of bacteria isolated from the pectoral muscle wound is insignificant.3-6
Discussion

The lesions in the swan are consistent with thoracic and abdominal trauma due to gun shots.\textsuperscript{9,10,12} The multiple fractures and radiologic data demonstrating the presence of radio-opaque pellets in the thorax and abdomen corroborated the toxicologic data, which indicated lead in liver tissue. The micro-pathologic findings are consistent with DIC.

ACKNOWLEDGMENTS

The histopathology was performed by Dr. Wanda Haschek-Hock of the Department of Pathology, University of Illinois, College of Veterinary Medicine. My fellowship in Toxicological Pathology was funded by a grant from the Pfizer Pharmaceutical Corporation.

LITERATURE CITED

### Table 1. Summary of macromorphologic diagnoses.

<table>
<thead>
<tr>
<th>Organ System</th>
<th>Diagnoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdomen</td>
<td>Acute, moderate hemoperitoneum.</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>Acute, locally-extensive, necrohemorrhagic myositis of the pectoral and abdominal muscles (gun shot).</td>
</tr>
<tr>
<td></td>
<td>Acute, multiple compound fractures of the radius and ulna and the last two right ribs (gun shot).</td>
</tr>
</tbody>
</table>

### Table 2. Summary of microscopic lesions.

<table>
<thead>
<tr>
<th>Organ System</th>
<th>Lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rostral and Mid-cerebrum</td>
<td>Fibrin thrombi in the intra-cerebral and leptomeningeal vessels.</td>
</tr>
<tr>
<td>Lung</td>
<td>Locally extensive area of hemorrhage, edema, and mild congestion.</td>
</tr>
<tr>
<td>Liver</td>
<td>Coalescing subcapsular areas of necrosis with adjacent areas of bile ductular proliferation with moderate infiltrates of mononuclear cells and heterophils. Hemosiderophages are present in the areas of necrosis and fibrosis present in the portal triads. Attached to the overlaying serosal surface is an eosinophilic material containing erythrocytes. Toxicology Findings. Liver 1.5 ppm lead. The lead level is higher than background concentration and not suggestive of lead toxicosis.</td>
</tr>
<tr>
<td>Kidney</td>
<td>Linear areas of tubular degeneration and congestion extending from the subcapsular area into the cortex. Fibrin thrombi are present in some associated vessels.</td>
</tr>
<tr>
<td>Skin</td>
<td>Segmental loss of the epidermis with a thick layer of eosinophilic material mixed with inflammatory cells and bacterial colonies. In the subjacent area there is hemorrhage and edema and an arteriole containing a thrombus.</td>
</tr>
</tbody>
</table>
Figure 1. Proposed shock pathway in the swan - pathophysiology pathway.
PHARMACOKINETICS OF MELOXICAM (METACAM\textsuperscript{TM}) AFTER INTRAVENOUS, INTRAMUSCULAR AND ORAL ADMINISTRATION TO RED-EARED SLIDER TURTLES (\textit{Trachemys scripta elegans})

Carlos Rojo-Solís,\textsuperscript{1}*, José María Ros-Rodríguez, PhD, DVM,\textsuperscript{1} Mónica Valls, DVM,\textsuperscript{2} Teresa Alvaro, DVM,\textsuperscript{2} Juan Antonio Gilabert, PhD,\textsuperscript{1} Teresa Encinas, PhD, DVM,\textsuperscript{1} and Daniel García-Párraga, DVM\textsuperscript{2}

\textsuperscript{1}Toxicology and Pharmacology Department, Veterinary Faculty, Complutense University, Madrid, Spain; \textsuperscript{2}Veterinary and Laboratory Department, L'Oceanogràfic, Parques Reunidos Group, Ciutat de les Arts i de les Ciències, Valencia, Spain

Abstract

Meloxicam is a non-steroidal anti-inflammatory drug (NSAID) widely used in veterinary medicine that has shown preferential inhibition of cyclo-oxygenase-2 and a potent analgesic and anti-inflammatory activity. In the present study, sodium meloxicam (Metacam\textsuperscript{®}, injectable solution, 5 mg/ml, Boehringer Ingelheim España, S.A., Sant Cugat del Vallès, Barcelona, Spain) was administered to healthy adult red-eared slider turtles (\textit{Trachemys scripta elegans}; \textit{n}=12) by intravenous (0.22 mg/kg), intramuscular (0.5 mg/kg) and oral routes (0.5 mg/kg) in order to investigate the basic clinical pharmacokinetics of the drug. After administration, blood samples were collected serially from the dorsal cervical, subcarapacial sinus (vein), and meloxicam concentrations were determined by high performance liquid chromatography. After intravenous injection plasma meloxicam levels decreased rapidly; the elimination half-life was 7.57 hr and clearance resulted in 19 ml/hr/kg. The volume of distribution at steady state (180 ml/kg) was small, similar to values obtained in other animal species and for other nonsteroidal anti-inflammatory drugs. The drug was quickly absorbed after both intramuscular and oral routes (absorption half-lives: 17.18 and 25.93 min, respectively), but bioavailability and maximum concentrations were higher after intramuscular (85.38%; 3.19 μg/ml) than after oral dosing (36.81%; 0.31 μg/ml). Moreover, after oral dose the meloxicam plasma levels presented secondary peaks and a remarkable individual variability, resulting in larger elimination half-life and mean residence time values than after intramuscular administration. These results indicate that meloxicam presents better and more predictable clinical pharmacokinetic behaviour in red-eared slider turtle after intramuscular than after oral route.
A SURVEY OF BITE PROTOCOLS AND RABIES PREVALENCE IN CAPTIVE MAMMALS AMONG ZOOS NATIONWIDE

Jacqueline Zelepsky, DVM1,* and Tara Harrison, DVM, MPVM, Dipl ACZM1,2

1College of Veterinary Medicine, Michigan State University, East Lansing, MI 48823 USA; 2Potter Park Zoo, Lansing, MI 48912-1646 USA

Abstract

A national survey questionnaire was conducted in 32 zoos throughout 17 states between February and May 2008. This survey questionnaire consisted of six questions that evaluated the details surrounding captive mammalian bites amongst zoo visitors and personnel. The survey was completed by zoo veterinarians after reviewing the most recent bite incident reports. The information collected documented mammalian bites occur commonly. An average of 9.1 bite incidents per zoo involving zoo visitors were reported in the last 5 yr compared to an average of 7.5 bite incidents per zoo involving personnel within the last 5 yr. Zoo personnel had bites documented with a larger variety of mammals and of greater severity (average rating 3.83/5; scale defined at numeric intervals with 0 meaning bite did not break skin and 5 indicating life-threatening injuries). While victim profile and severity of attack differed between visitor and personnel bites, the majority were not reported to the local health department. This lack of reporting is speculated to be due to low rabies risk, fear of media involvement, and an unknown conclusion for the offending animal. Of the animals involved in the listed attacks, average quarantine was 47.5 days when dealing with a zoo visitor bite versus an average quarantine of 18 days when involving a personnel bite incident. These results demonstrate the need for a standardized protocol following a bite incident and cooperation with the local health department as necessary.
INDEX

[A]

Acinonyx, 97
African elephant, 20, 22, 39, 54, 59, 132, 133, 200
African foam-nesting frogs, 112
African hunting dogs, 28
Agalychnis, 111, 114
Ailurus, 131
Amazona, 106
American flamingo, 187
American kestrels, 190
Amur tiger, 56, 184
Andean spectacled bears, 47, 48
Andros iguana, 84
Anesthesia, 56, 94, 95, 97, 99, 107
Animal care, 47, 173
Animal welfare, 171, 176, 178
Anteater, 183
Aonyx, 129
Aortic dissection, 158
Aquila, 34, 193
Ara, 34, 102
Asian elephant, 20, 21, 40, 53, 61, 62, 63, 80, 132
Asian small-clawed otter, 129
Asio, 212
Atelerix, 188
Atelopus, 113
Atlantic sharpnose, 196
Avian mycobacteriosis, 212

[B]

Batrachochytrium, 82, 111
Bilateral ureteral stent, 129
Bile, 46
Buteo, 197

[C]

Calcium, 19, 22, 204
California ground squirrels, 182
California kingsnakes, 207
Callimico, 156, 157
Caracal, 42
Carcharhinus, 163
Ceratotherium, 185, 208
Cheetahs, 97
Chiromantis, 112
Clover traps, 93
Colombia, 12, 108, 212
Conservation, 2, 4, 5, 6, 9, 10, 13, 28, 39, 43, 47, 49, 76, 77, 78, 79, 80, 81, 82, 84, 86, 87, 88, 89, 91, 111, 123, 124, 125, 133, 137, 159, 162, 189, 200, 202, 203, 214
Cow, 204
Crotalinae, 117
Cryptobranchus, 82
Cryptosporidium, 216, 217
Cyclura, 76, 77, 78, 84
Cygnus, 223, 225

[D]

Damaliscus, 26, 121
Dasyatis, 170
Dendrobatis, 111
Dental disease, 51, 180
Diarrhea, 183
Diceros, 185
Didelphis, 209, 211
Disaster, 140, 147
Dromaius, 94
Dystocia, 21

[E]

Eastern hellbender, 82
Egyptian fruit bat, 205, 206
Electrocution, 193
Electrolytes, 102
Elephants, 3, 40, 60, 81, 100
Elephas, 20, 21, 40, 53, 61, 80
Elodontomas, 33
Emus, 94
Equus, 43, 98, 99, 203
Equus ferus, 98, 203
Eugenol, 170
Eye, 41, 44, 167

[F]
Falco, 105, 190, 216, 217
Florida panthers, 87
Fractures, 136
Franciscana dolphin, 165

[G]
Galapagos tortoise, 191
Gastrointestinal parasites, 121
Gavia, 89, 90
Geochelone, 191
Giant anteater, 17
Giraffa, 19, 55, 121, 204
Giraffe, 19
Gorilla, 5, 6, 126, 127, 153, 158
Green buildings, 70
Grevy’s zebra, 43

[H]
Health assessment, 77, 82
Helarctos, 195
Horse, 204

[I]
Intraocular lens, 43
Ionized calcium, 62, 102
Iron deficiency anemia, 25
Isoeugenol, 170

[J]
Jugular vein, 98, 109

[K]
Kite string injuries, 136

[L]
Lampropeltis, 207
Largus, 101
Loxodonta, 22, 39, 59, 100, 132, 133, 200
Lycaon, 28, 29, 79

[M]
Macropus, 41, 122
Macrossclididae, 30
Malayan sun bear, 195
Malayan tapir calves, 25
Malayan tapirs, 25, 51, 52
Mammary gland, 195
Meloxicam, 228
Mustela, 83
Mycobacterium, 3, 4, 26, 27, 212, 213
Myocardial disease, 32
Myrmecophaga, 17, 18, 23, 58, 183

[N]
Neoplasia, 118, 205
Neosporosis, 208
Nepal, 3, 4, 12

[O]
O-desmethyltramadol, 109
Odocoileus, 27, 93
Okapi, 189
Oreophasis, 34
Osteopilus, 114
Otocolobus, 214, 215

[P]
Pallas’ cat, 214, 215
Pan, 6, 160
Panamanian golden frogs, 113
<table>
<thead>
<tr>
<th>A</th>
<th>Panthera, 6, 44, 46, 56, 119</th>
<th>Sumatran elephant, 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Parasitic diseases, 217</td>
<td>Suricata, 32</td>
</tr>
<tr>
<td>C</td>
<td>Pavi, 109</td>
<td>[T]</td>
</tr>
<tr>
<td>D</td>
<td>Phoenicopterus, 187</td>
<td>Tamers®, 202</td>
</tr>
<tr>
<td>E</td>
<td>Pigeons, 108, 197</td>
<td>Tapirus, 25, 51</td>
</tr>
<tr>
<td>F</td>
<td>Pinnipeds, 169</td>
<td>Taurine, 18, 23</td>
</tr>
<tr>
<td>G</td>
<td>Pododermatitis, 197</td>
<td>Tetratrichomonas, 183</td>
</tr>
<tr>
<td>H</td>
<td>Pontoporia, 165</td>
<td>Thiafentanil, 94</td>
</tr>
<tr>
<td>I</td>
<td>Pregnancy, 58</td>
<td>Tiger, 120</td>
</tr>
<tr>
<td>J</td>
<td>Primate, 124, 151, 154</td>
<td>Toxoplasma, 182, 214, 215</td>
</tr>
<tr>
<td>K</td>
<td>Procyon, 130</td>
<td>Trachemys, 115, 228</td>
</tr>
<tr>
<td>L</td>
<td>Przewalski's horses, 98</td>
<td>Transabdominal ultrasound, 189</td>
</tr>
<tr>
<td>M</td>
<td>Pseudomonas, 34</td>
<td>Transthoracic echocardiography, 153</td>
</tr>
<tr>
<td>N</td>
<td>Puma, 86, 87</td>
<td>Tremarctos, 47</td>
</tr>
<tr>
<td>O</td>
<td>Panthera, 6, 44, 46, 56, 119</td>
<td>Tricaine methanesulfonate, 170</td>
</tr>
<tr>
<td>P</td>
<td>Pigeons, 108, 197</td>
<td>Tuberculosis, 3, 4, 212</td>
</tr>
<tr>
<td>Q</td>
<td>Pinnipeds, 169</td>
<td>Tumors, 195</td>
</tr>
<tr>
<td>R</td>
<td>Pododermatitis, 197</td>
<td>Tupaiidae, 30</td>
</tr>
<tr>
<td>S</td>
<td>Pontoporia, 165</td>
<td>[Q]</td>
</tr>
<tr>
<td>T</td>
<td>Pregnancy, 58</td>
<td>Quarantine, 4, 64-68, 111, 135, 145, 166, 216, 229</td>
</tr>
<tr>
<td>U</td>
<td>Primate, 124, 151, 154</td>
<td>[R]</td>
</tr>
<tr>
<td>V</td>
<td>Procyon, 130</td>
<td>Raccoons, 130</td>
</tr>
<tr>
<td>W</td>
<td>Przewalski's horses, 98</td>
<td>Rattlesnakes, 117</td>
</tr>
<tr>
<td>X</td>
<td>Pseudomonas, 34</td>
<td>Red-backed voles, 33</td>
</tr>
<tr>
<td>Y</td>
<td>Puma, 86, 87</td>
<td>Rehabilitation, 87</td>
</tr>
<tr>
<td>Z</td>
<td>[Q]</td>
<td>Respiratory illness, 115, 116</td>
</tr>
</tbody>
</table>

**[U]**

| A | Raccoons, 130 | Urinary bile acids, 46 |
| B | Rattlesnakes, 117 | Ursus, 96, 180 |
| C | Red-backed voles, 33 | [V] |
| D | Rehabilitation, 87 | Venezuela, 48, 91, 199 |
| E | Respiratory illness, 115, 116 | [W] |
| F | Restraint, 221 | Wastewater, 101 |
| G | Rhizoprionodon, 196 | Water management 10,11, 65, 70-75 |
| H | Ricardo's iguana, 76, 77, 78 | [X] |
| I | Rossettus, 205 | Xylazine, 98 |
| J | [S] | [Y] |
| K | S-100 protein, 165 | Yersinia, 83, 182 |
| L | Saguinus, 159 | [Z] |
| M | Salmonella typhimurium, 35, 38 | Zoonotic disease, 5 |
| N | Seahorse, 166 | [Z] |
| O | Serologic titers, 119 | Sumatran elephant, 80 |
| P | Skin conditions, 48 | Suricata, 32 |
| Q | Southern black rhinoceros, 185 | [T] |
| R | Southern white rhinoceros, 185, 208 | Tamers®, 202 |
| S | Spermophilus, 182 | Tapirus, 25, 51 |
| T | Sphyrna, 196 | Taurine, 18, 23 |
| U | [S] | Tetratrichomonas, 183 |
| V | [S] | Thiafentanil, 94 |
| W | [S] | Tiger, 120 |
| X | [S] | Toxoplasma, 182, 214, 215 |
| Y | [S] | Trachemys, 115, 228 |
| Z | [S] | Transabdominal ultrasound, 189 |
| [A] | [S] | Transthoracic echocardiography, 153 |
| [B] | [S] | Tremarctos, 47 |
| [C] | [S] | Tricaine methanesulfonate, 170 |
| [D] | [S] | Tuberculosis, 3, 4, 212 |
| [E] | [S] | Tumors, 195 |
| [F] | [S] | Tupaiidae, 30 |
| [G] | [S] | [Q] |
| [H] | [S] | Quarantine, 4, 64-68, 111, 135, 145, 166, 216, 229 |
| [I] | [S] | [R] |
| [J] | [S] | Raccoons, 130 |
| [K] | [S] | Rattlesnakes, 117 |
| [L] | [S] | Red-backed voles, 33 |
| [M] | [S] | Rehabilitation, 87 |
| [N] | [S] | Respiratory illness, 115, 116 |
| [O] | [S] | Restraint, 221 |
| [P] | [S] | Rhizoprionodon, 196 |
| [Q] | [S] | Ricardo's iguana, 76, 77, 78 |
| [R] | [S] | Rossettus, 205 |
| [S] | [S] | S-100 protein, 165 |
| [T] | [S] | Saguinus, 159 |
| [U] | [S] | Salmonella typhimurium, 35, 38 |
| [V] | [S] | Seahorse, 166 |
| [W] | [S] | Serologic titers, 119 |
| [X] | [S] | Skin conditions, 48 |
| [Y] | [S] | Southern black rhinoceros, 185 |
| [Z] | [S] | Southern white rhinoceros, 185, 208 |
| [A] | [S] | Spermophilus, 182 |
| [B] | [S] | Sphyrna, 196 |
NOTES