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Dear Friends and Colleagues,

Welcome to our first-ever virtual AAZV Annual Conference!

My deepest thanks to the AAZV Scientific Program Committee (SPC) and our other standing Committees for the work they have done to bring us to this point. AAZV is truly a volunteer organization. Members, just like you, continually step up to support the broader membership and organization. These members have worked consistently and diligently throughout the past year to keep AAZV moving forward, particularly impressive over the last 6 months as the COVID-19 pandemic took hold. A special “shout out” to the SPC. These incredible AAZV members planned our regular conference and then rapidly pivoted and did it all again as they moved the meeting to a virtual platform.

Additional thanks to the Executive Director’s office for their tireless work and guidance as the Executive Committee grappled with the broader implications of the pandemic for the organization and supported the move to a virtual conference.

The impacts of this pandemic continue to unfold. As a group, zoological and wildlife veterinarians are likely better positioned than most others to intellectually understand the scientific aspects of an emerging infectious disease, and a pandemic. That knowledge can be a source of strength and hope, it can allow our voices to help shape response, policy, and protocol at a variety of levels. And yet, it may only go so far in mitigating some of the negative personal impacts that have been reverberating for so many around the globe. We are experts, we have passion, and we do amazing work. And we are only human. We each can only do and be so much. And that is okay too.

At its core, AAZV is about helping our members help animals. The organization’s mission is to empower our members to advance our profession and enhance wild animal health, welfare, and conservation. This continuing education conference opportunity – and the associated formal and informal learning and networking opportunities – remains an important component of that work. Even in the virtual space. And even in a time like this.

I personally continue to believe in our work…. helping animals, advancing conservation… and feel it is as important as ever. Perhaps even more important. Spending a little time focusing on this work, celebrating the accomplishments of others, learning new things, commiserating about challenges – that all continues to have meaning for me. And I hope for you.

Thank you all for being here, for being part of this community.

*Leigh*

Leigh Clayton  
President, American Association of Zoo Veterinarians
Dear Colleagues,

Welcome to our 52nd AAZV Annual Conference and first-ever Virtual Conference! These are certainly challenging times. As much as we love our face-to-face conference and social interactions, our current crisis dictates we explore a new direction. We want to ensure that as veterinarians working on the frontlines of zoological animal medicine, we have the opportunity to share and learn from the outstanding work of our friends and colleagues. Our virtual conference will provide an excellent venue to share that knowledge and we are looking forward to seeing your faces on our screens. On behalf of the Scientific Program Committee, we are delighted to share this year’s thoughtfully crafted program with you. Your hard-working SPC members responsible for the 2020 conference program and workshops are Sam Sander, Alicia Hahn, Kurt Sladky, and Matt Kinney. We are also grateful to Heather Robertson and Margarita Woc Colburn from the Nashville Zoo who worked hard at the early stages of planning in hopes of meeting in Nashville. We are looking forward to meeting them there in the not-too-distant future.

There are seventeen scientific sessions of varying length scheduled over four days. Some sessions are taxon-specific (Aquatics, Avian, Carnivores, Elephants, Primates, Megavertebrates, Mammals, and Herptile) and others are organized by topic (Conservation, Diagnostics, Wildlife Rehabilitation, Mycology, Cardiology, Anesthesia, Animal Welfare, and Leadership and Training). We will have two masterclasses: Successful Management of an Animal Health Crisis at a Zoological Institution and Aquatic Medicine. We are fortunate to have Dr. Jen Brandt from the American Veterinary Medical Association to open our conference with a keynote talk entitled: Mission Possible: Creating a Culture of Wellbeing. There will also be a variety of posters to enhance our educational experience. The 36 session chairs chose 95 submissions for oral presentations and 24 for posters. The 22.25 hours of continuing education credits are once again being sponsored by the American College of Zoological Medicine. Up to 6.5 additional hours are available through the workshops. Workshop topics include Hospital Design, Animal Welfare, ZIMS, and the 27th Annual Zoo & Wildlife Pathology Workshop.

Our virtual conference platform will allow us to have the Opening Icebreaker on Sunday evening and the student reception on Monday evening. During the breaks on Monday we will have the opportunity to visit posters. Tuesday through Thursday breaks can be used to visit the exhibitors. The platform will be open before and after the scheduled sessions to allow more socializing. We are sure this will be an unforgettable conference!

The SPC would like to gratefully acknowledge the tireless efforts of Rob Hilsenroth, AAZV Executive Director, and Adine Nicholson, AAZV Director of Development, for their constant support and assistance in making this conference a success. We are also grateful to the AAZV Executive Committee for their input and support. Welcome to our virtual conference and we truly hope you enjoy the conference and our virtual time together.

Kind regards,

Sam Rivera
AAZV Scientific Program Committee Chair
Senior Director of Animal Health, Zoo Atlanta
American Association of Zoo Veterinarians
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MISSION POSSIBLE: CREATING A CULTURE OF WELLBEING

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Abstract

Do you work in an environment where you and your colleagues leave at the end of the day feeling a sense of accomplishment? Do you believe that your efforts are valued? Do you know how to create conditions that allow you and your colleagues to thrive?

Creating a healthy workplace is an all-hands-on deck effort where every member of the team can choose to play an essential role. This dynamic presentation focuses on five real-world premises that contribute to a culture of workplace wellbeing. During this presentation, attendees will learn to:

• compare and contrast wellness and wellbeing,
• define person-in-environment theory,
• describe the role of belonging and inclusion in creating cultures of wellbeing, and
• list five premises for creating a culture of wellbeing.

Key words: Wellbeing, wellness
UNDERSTANDING THE SORROWS AND JOYS OF CARING FOR ANIMALS IN THE ZOO VETERINARY PROFESSION

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Abstract

Providing care for wild animals in zoological institutions, as well as wildlife centres and sanctuaries, brings many joys and positive experiences, but can also leave someone emotionally drained or numb by negative experiences. Animal caregivers, curators, veterinarians, researchers, and other animal welfare staff (henceforth zoo professionals), often have high levels of compassion, empathy, and drive to care for others and effect change. Caring for and serving others gives a sense of joy and achievement, creating compassion satisfaction. Recruitment of and access to social support, working in an effective team, supervising and directing positive outcomes, gaining professional experience, and using self-care strategies promote compassion satisfaction. Yet, these positive experiences often are combined with painful ethical dilemmas, where optimal solutions are not feasible, and decisions must be from among a variety of sub-optimal alternatives; this creates moral stress. Repeated exposure to distressing events such as neglect, inaction, and animal euthanasia, can leave zoo professionals at risk of compassion fatigue or burnout. Common symptoms of compassion fatigue can include feeling mentally and physically tired, sadness and apathy, bottled-up emotions, and an inability to get pleasure from activities that previously were enjoyable, as well as a lack of self-care. These serious problems have been well documented among workers in settings such as veterinary practices,1-3 laboratory animal care facilities, and animal shelters, but there have not been any publications specifically for veterinary professionals that work in zoo environments. Recent surveys of veterinary wellbeing have found that awareness has improved of conditions such as compassion fatigue and burn out but that more action is still required.4 Organizations and initiatives have started to emerge for veterinary professionals to provide advice and support for mental health issues in the work place which are also important in a zoo, wildlife sanctuary and wildlife center setting.5,6 Based on survey data, this paper will provide specific examples of challenging circumstances facing wildlife veterinary professionals. A brief overview of strategies for preventing and addressing compassion fatigue and enhancing compassion satisfaction will be presented, drawing on current experiences and research literature. It will also outline various approaches and frameworks and conclude with future directions and recommendations to further the study and practice of wildlife veterinary professional wellbeing.

Key words: Compassion, fatigue, resilience, veterinary, wellbeing, zoo

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LITERATURE CITED


PATHOLOGY TRAINING FOR ELEPHANT VETERINARIANS, MANAGERS, AND FOREST POLICE IN MYANMAR

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Abstract

Emerging diseases and novel poaching methods are a threat to elephant populations in Asian elephant range countries. In Myanmar, captive and wild elephants forage in the forest at night increasing the risk of disease transmission and poaching. Guns, poisons, and a variety of brutal methods are used to kill elephants. In addition, elephants can die of infectious diseases carried by humans, livestock, or other elephants. Unless a comprehensive examination (including appropriate laboratory tests) is performed, the cause of death may not be known, making it difficult to counter such losses. Yet post-mortem examinations, if they are performed at all, often include only a gross inspection; samples for histopathology, culture, toxicology, and other tests necessary to establish a definitive diagnosis are not routinely collected. This problem is not limited to Myanmar, but is also common in other Asian elephant range countries. To address this, workshops were provided for elephant veterinarians and managers, as well as a separate workshop for forest police, who are often the first to find poached elephant carcasses. A backpack containing all the tools needed for a diagnostic elephant necropsy was also provided to workshop participants. In addition, connections with public and private diagnostic services were established (for histopathology, toxicology, and microbiology within and outside Myanmar). These workshops provided Myanmar wildlife veterinarians with the skills and materials needed to conduct thorough post-mortem examinations and an appreciation that pathology has a vital role in elephant conservation. Importantly, these workshops are models for the development of parallel training in other countries.

Key words: Elephants, Myanmar, pathology, toxicology, training

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STRATEGIC APPROACHES TO COMMUNITY-BASED CONSERVATION IN NORTHERN KENYA

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Abstract

Community-based conservation promotes the idea that long-term wildlife conservation success requires engaging with and providing benefits to local communities. It promotes coexistence – people, and their livestock, living with wildlife. For coexistence to work, communities directly interacting with wildlife need to understand and appreciate the value of conserving wildlife.

San Diego Zoo Global (SDZG) has been supporting community conservancies in northern Kenya for more than 15 yr. This support was initially limited to core funding for infrastructure and other needs as determined by community leadership. After many years of relationship building, requests for additional types of support such as scientific and animal management expertise become more frequent. As our program grew, we began to frame our work around priority species, develop key messages, and tell our story to engage additional stakeholders and donors. Internally, we determined scope of work and project goals in order to maximize conservation impact and avoid mission creep. We developed conceptual models, results chains, and work plans to test our assumptions and hold ourselves accountable. The mission for our work in northern Kenya closely aligns with those of our partners and is to support communities and wildlife conservation through multidisciplinary capacity enhancement and shared tools to further conservation in multi-use landscapes. Our vision is to safeguard thriving wildlife populations and resilient ecosystems for future generations by the cooperative efforts of pastoralist communities, wildlife conservancies, nongovernmental organizations (NGOs), and government agencies in Kenya.

Projects that SDZG team members are involved with are at the expressed request of local pastoralist community leaders and NGOs and in cooperation with the Kenya Wildlife Service. While many projects are species specific, they all fall within the following strategic themes: 1) Community conservancy support: SDZG supports community and wildlife conservancies in their work in the arenas of governance, peace building, bursaries, security, conservation research, and livestock and rangelands management. SDZG collaborates with pastoralist communities in deciding the most effective way to direct resources and provides funding based on priorities for infrastructure and community development. SDZG does not support the purchase of arms or ammunition. 2) Capacity enhancement: SDZG enhances available tools, training, and facilities and integrates local knowledge to ensure conservation success. 3) Science based recommendations: SDZG believes that a science-based understanding of wildlife conservation, livestock ecology, and health at the wildlife-livestock interface advances wildlife protection. 4) Youth and adult engagement and education: Wildlife conservation is first about people. SDZG works with community leadership to support pastoralist community members in valuing wildlife, fostering sustainable coexistence, and supporting education.
**Key words:** Capacity enhancement, community-based conservation, conservation research, Kenya, wildlife conservancy, wildlife health

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VALUE OF TELEMEDICINE AND ZOOS IN THE VETERINARY CARE OF GRAUER’S GORILLAS (Gorilla beringei graueri) IN THE EASTERN DEMOCRATIC REPUBLIC OF CONGO

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Abstract

Grauer’s gorillas are a critically endangered gorilla subspecies that is endemic to eastern Democratic Republic of Congo (DRC) in Central Africa. The Gorilla Rehabilitation and Conservation Education (GRACE) Center (www.gracegorillas.org) is the only sanctuary for this species. Because Association of Zoos and Aquariums (AZA) institutions have expertise in caring for gorillas, GRACE partnered with zoos to set up its animal care program when it was established in 2009. Two advisory groups (Veterinary and Animal Care & Welfare) were key to the success of this program. The advisors were experts from four partner zoos and other institutions who provided intensive in situ training, typically twice per year when possible, for GRACE’s all-Congolese team and have consulted remotely on a monthly and on-call basis for assistance with husbandry needs, diagnostics, preventive medicine, and emergency and maintenance treatments. This became challenging when travel became difficult and our teams have relied heavily on telemedicine techniques. This model has fostered strong partnerships between GRACE and zoos as well as innovative solutions for gorilla health management (e.g., remotely conducted cytopathology, farmed gorilla vegetation, locally produced gorilla nutritional biscuits and natural dental care). Additionally, GRACE successfully utilizes advanced operant conditioning used by zoos for gorilla health management and is now training other great ape sanctuaries in these techniques. Most recently with the Ebola crisis, a rapid and effective response to the disease allowed for the efficient protection of staff and animals. This partnership has resulted in an award-winning program that provides high-level care in one of the most remote and logistically challenging locations in Africa.

Key words: Africa, gorilla

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LITERATURE CITED


USE OF COMPUTED TOMOGRAPHY TO DETERMINE THE SENSITIVITY OF CLINICAL SIGNS AS A DIAGNOSTIC TOOL FOR RESPIRATORY DISEASE IN REHABILITANT BORNEAN ORANGUTANS (Pongo pygmaeus)

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Abstract

Orangutans are unique among great apes in their predilection for chronic, insidious, and, ultimately, fatal respiratory disease. Termed Orangutan Respiratory Disease Syndrome (ORDS), this cystic fibrosis-like disease is characterized by co-morbid conditions of sinusitis, mastoiditis, airsacculitis, bronchiectasis, and recurrent pneumonia1. The aim of this retrospective study was to determine the sensitivity of clinical signs in the diagnosis of ORDS in Bornean orangutans (Pongo pygmaeus) in range country rescue centers compared to the gold standard of diagnosis of bronchiectasis via computed tomography (CT). Ultimately our hope was that these results would aid rescue centers and zoos without access to advanced imaging with their ability to diagnose ORDS. We retrospectively compared observed clinical signs to CT imaging in a population of clinically affected animals at an orangutan rescue center in southeastern Borneo who had documented disease. Between August 2017 and August 2019, this center housed 21 animals affected with ORDS. Twenty of the affected orangutans underwent CT imaging to determine which of the areas of the respiratory tract were affected by disease. We reviewed clinical signs recorded in medical records and keeper observation notes for each individual for the period of 2 yr prior to the date of the CT scan. A chi-square test of association was used to assess whether the observed clinical signs could predict the results of CT imaging; sensitivity of clinical signs to predict ORDS was also assessed at various timepoints prior to CT imaging. Results show that clinical signs may not be sensitive indicators in predicting ORDS pathology on CT imaging, although a prospective study with a larger sample size is warranted to further investigate our hypothesis. The findings of this study suggest the need for advanced imaging to properly diagnose and manage the most common health issue of captive orangutans2. Institutions that house orangutans are encouraged to consider partnership with local human and veterinary diagnostic imaging specialists. Future research should include a prospective study using a standardized data dictionary and regular observations collected by specifically trained keepers and veterinary staff.

Key words: Bornean orangutan, clinical signs, orangutan respiratory disease syndrome, Pongo pygmaeus
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LITERATURE CITED


A NOVEL Babesia SPECIES IN THE VIRGINIA OPOSSUM (Didelphis virginiana)

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Abstract

Over 100 species of Babesia have been reported across the animal kingdom, including a number in wildlife, and the role of wildlife as a reservoir for zoonotic disease continues to evolve.5,9 Virginia opossums are ubiquitous in North America and common patients at wildlife rehabilitation centers. They have adapted to living in close proximity to humans and domesticated animals in urban and suburban settings. Although Babesia spp. have been described in monodelphid opossums in Brazil and in several species of Australian marsupials, there are no reports of the parasite in Virginia opossums to date.1,2,4,6-8 Post-mortem diagnostic testing of an opossum with unresolving anemia revealed Babesia spp. in peripheral blood films and bone marrow cytology. Standard PCR with sequencing confirmed it was a novel Babesia species.3 Subsequently, blood and/or spleen samples were collected from nine additional opossums presented to the wildlife center and sent for blood smear analysis and PCR; of these nine two were positive for the same novel Babesia. All three patients were symptomatic, two with severe anemia and the other with icterus and hematuria; none survived. The morbidity and mortality of this novel Babesia sp. appears significant, as subclinical infection is thought to be common in wildlife. We continue to examine the phylogenetic associations of this novel Babesia in order to further characterize it taxonomically and to determine its clinical and epidemiologic implications for Virginia opossums, as well as its potential for zoonotic impact.

Key words: Babesia, Didelphis virginiana, PCR, phylogenetic analysis, tick-borne disease, Virginia opossum

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LITERATURE CITED


PLASMA ALPHA-TOCOPHEROL AND THIOBARBITURIC ACID REACTIVE SUBSTANCES IN COLD-STUNNED KEMP’S RIDLEY SEA TURTLES (Lepidochelys kempii) WITH MULTIFOCAL STEATITIS

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Abstract

Steatitis has been documented in many species, including diet-associated vitamin E deficiencies in kittens, Nile crocodiles, and olive ridley sea turtles in managed care, and a free-ranging loggerhead sea turtle with high adipose tissue concentrations of polychlorinated biphenyls.¹⁻⁵,⁷⁻⁹ This condition infrequently occurs in cold-stunned Kemp’s ridley sea turtles (Lepidochelys kempii; KRT), but the etiology is undetermined.⁶ The objective of this study was to compare plasma concentrations of alpha-tocopherol (vitamin E) and thiobarbituric acid reactive substances (TBARS; a measure of lipid peroxidation), and the TBARS to alpha-tocopherol (T/E) ratio (an assessment of oxidative stress), between cold-stunned KRT with steatitis (n = 10; as diagnosed by palpation, cytology, and/or surgical biopsy,) and control KRT (n = 9). None of the animals had detectable steatitis at admission, and the median number of days to diagnosis of steatitis was 77 (45-469 days). Data was compared between KRT with steatitis and control KRT using the Wilcoxon Rank Sum test. All 10 KRT had lower alpha-tocopherol concentrations (min below detection limit in n = 7, max 43 nmol/g) than control animals (85-305 nmol/g, P < 0.01). Seven of 10 cold-stunned KRT had lower TBARS concentrations (1.3-3.2 nmol/g), compared to control animals (1.8-3.9 nmol/g, P = 0.03). In addition, all 10 cold-stunned KRT had higher T/E ratios (0.04-0.9), compared to control animals (0.01-0.03, P < 0.01). These results suggest that increased oxidative stress associated with low plasma alpha-tocopherol may play a role in the development of steatitis in cold-stunned KRT, which has implications for optimization of supportive care.

Key words: Alpha-tocopherol, cold-stunning, Kemp’s ridley sea turtle, Lepidochelys kempii, oxidative damage

ACKNOWLEDGMENTS

The authors thank animal care professionals of the NEAQ for the medical care provided to the cold-stunned turtles in this report, and for their technical assistance.
LITERATURE CITED


PREVALENCE AND ANTIMICROBIAL RESISTANCE PATTERNS OF *Salmonella* spp. IN TWO FREE-RANGING POPULATIONS OF EASTERN BOX TURTLES (*Terrapene carolina carolina*)

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**Abstract**

Salmonellosis is an important zoonotic infection and exposure to pet reptiles has been implicated in several human outbreaks. Although several studies report a low salmonellae prevalence in free-ranging chelonians, they may serve as a reservoir for human-pathogenic strains. In spring and summer of 2013 and 2019, free-ranging eastern box turtles (*Terrapene carolina carolina*) from populations in Illinois (rural) and Tennessee (urban) were collected through canine and visual search. Cloacal swab samples were collected from each turtle, selectively enriched with tetrathionate broth, then plated on selective and differential media to isolate *Salmonella* spp. Genus was confirmed via MALDI-TOF and antibiotic sensitivities were performed. Isolates were serotyped by the National Veterinary Services Laboratory. Of the 341 turtles sampled, *Salmonella* spp. were detected in nine individuals (2.64%; 95% CI: 1.2–5.0%). The isolates included five different serovars: Anatum (*n* = 2), Newport (*n* = 2), Thompson (*n* = 1), Bareilly (*n* = 2), and Hartford (*n* = 2), each resistant to two antimicrobials. There was no significant difference in prevalence between state (*P* = 0.115), Illinois locations (*P* = 0.224), season (*P* = 0.525), year (*P* = 0.297), sex (*P* = 0.435), or age class (*P* = 0.549). The health of *Salmonella*-positive and -negative turtles was not significantly different, as assessed through hematology and plasma biochemistry (*P* > 0.05), indicating asymptomatic carrier status. The low detected prevalence implies that free-ranging eastern box turtles play a minimal role in the spread of salmonellae, unlike their pet counterparts; however, the identified serotypes are potentially human and animal-pathogenic, so there is some concern for public and animal health.

**Key words:** Antimicrobial resistance, eastern box turtle, epidemiology, *Salmonella enterica*, *Terrapene carolina carolina*, zoonotic disease

**ACKNOWLEDGMENTS**

We thank Drs. Cari Rasmussen and Terri Lloyd for the field assistance and diagnostic testing of the 2013 samples. Many thanks to all members of the Wildlife Epidemiology Lab, John Rucker with his turtle dogs, Marwa Adawe, Kristin Ellis, and the remainder of the University of Illinois Veterinary Diagnostic Laboratory Microbiology staff. Student support was provided by National Institutes of Health, T35 OD011145.
RETROSPECTIVE EVALUATION OF THE CLINICAL PRESENTATION OF A NOVEL FILARIOID NEMATODE IN MANAGED AND WILD GRASSHOPPER SPARROWS (Ammodramus savannarum)

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Abstract

Grasshopper sparrows (Ammodramus savannarum) are a species of ground-dwelling bird with twelve different subspecies.² The Florida subspecies (Ammodramus savannarum floridanus) is classified as federally endangered due to habitat loss, nest predation, and flooding.²,³ A managed breeding program was established at White Oak Conservation Center (WOCC) in 2015 using eastern grasshopper sparrows (Ammodramus savannarum pratensis) as a model for breeding Florida grasshopper sparrows as part of a population support effort. A novel filarioid parasite (Aproctella sp.) was discovered on blood smear and postmortem evaluation of both subspecies housed at WOCC. Filarioid worms have been seen in a variety of avian species, however few have been shown to be pathogenic.¹ Records from 157 eastern and Florida grasshopper sparrows were analyzed and correlations between presence of filariosis and subspecies, sex, body condition score, and presence of squamous metaplasia, coelomitis, and air sacculitis at necropsy were investigated. Of the 157 total, 29 (18.5%) were positive for filariosis either via blood smear, postmortem analysis, or both. Statistical analyses showed that presence of filariosis was significantly associated with squamous metaplasia, coelomitis, and air sacculitis at postmortem evaluation. There was no significant correlation between presence of filariosis with subspecies, sex, or body condition score. Further studies are needed to investigate Aproctella sp. pathogenesis and transmission in grasshopper sparrows.

Key words: Ammodramus savannarum, Aproctella, filariosis, grasshopper sparrow

ACKNOWLEDGMENTS

The authors would like to thank the University of Florida College of Veterinary Medicine and the White Oak Conservation Center Avian Department for their assistance in this project.

LITERATURE CITED


COMPARISON OF FECAL CYTOLOGY AND PRESENCE OF Clostridium perfringens ENTEROTOXIN IN CAPTIVE BLACK-FOOTED FERRETS (Mustela nigripes) BASED ON DIET AND STOOL QUALITY

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Abstract

Gastroenteritis is a documented cause of morbidity and mortality in managed black-footed ferrets (Mustela nigripes), particularly due to infectious agents.¹ Fecal cytology is an inexpensive and rapid test that can help guide clinical management strategies for animals with enteritis; however, normal parameters have not been established in this species. The objective of this study was to characterize fecal cytological findings of 50 fecal samples from 18 black-footed ferrets that received two diet types (ground meat-based versus whole-prey), and that were visibly judged to be normal or abnormal. This study also tested for the presence of Clostridium perfringens enterotoxin via enzyme-linked immunosorbent assay (ELISA) in all abnormal and a subset of normal stool samples. Significantly higher spore-forming bacteria and yeast counts were present in normal samples from individuals following the meat-based diet as compared to whole-prey. Samples from individuals with abnormal stool had significantly more spore-forming bacteria than normal stool samples, regardless of diet. Normal samples had higher diplococci and spore-forming bacteria as compared to domestic canine and feline standards. A single abnormal sample was positive for enterotoxin and was from the only animal requiring treatment. This study describes cytological findings in black-footed ferrets receiving a commercial ground meat versus whole-prey diet, and with normal or abnormal stool. Results indicate that low numbers of spore-forming bacteria can be found in fecal samples from black-footed ferrets with visibly normal stools. Fecal cytology shows significantly increased spore-formers in both visibly normal and abnormal stools in ferrets following a ground meat-based diet.

Key words: Black-footed ferret, Clostridium perfringens, cytology, enterotoxin, Mustela nigripes, yeast

ACKNOWLEDGMENTS

The authors thank the Phoenix Zoo’s Conservation Science team for their commitment to sample collection for this project and dedicated care for the study subjects. The authors also acknowledge the Phoenix Zoo’s Pet Memorial Fund for funding this project.

LITERATURE CITED

USE OF PERCUTANEOUS LIVER BIOPSY TO BEST ASSESS MINERAL LEVELS IN NON-DOMESTIC BOVIDS

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Abstract

Mineral imbalances in non-domestic bovids are challenging to detect and manage. Secondary copper (Cu) deficiency has been tracked at the San Diego Zoo Safari Park (SDZSP) using antemortem seruma and postmortem liver concentrationsb with population-wide interventions. Deficiencies in iron (Fe) and zinc (Zn) have also been documented at SDZSP based on serum, both in apparently healthy animals and in parasitized and anemic animals. To establish true mineral status, paired liver and serum concentrations for Cu, Fe, and Zn were compared (n = 49, Table 1). Liver biopsies were performed percutaneously on apparently healthy anesthetized individuals from 15 bovid species from Oct 2018 – Feb 2020, often in a field setting without ultrasound. Protocol was based on domestic bovid models using a 14 or 16 ga semi-automatic soft tissue biopsy needlec between the 10th and 11th right ribs. Liver status (Table 2) of Cu was accurately predicted by serum status (Table 3) in only 53% of samples, with similar findings for Fe and Zn (both 57%). Low serum Cu concentrations (n = 7) were frequently inaccurate measures of adequate or above liver levels (57%), while adequate serum concentrations (n = 40) often failed to identify a low or marginal liver concentration (38%). Alternatively, of the 18 cases where low or marginal liver Cu concentrations were diagnosed via biopsy, only three (17%) were accurately predicted by serum. Similar findings were seen for Fe and Zn (Table 4). These discrepancies highlight the importance of integrating antemortem liver biopsies for mineral level measurement into the complete diagnostic and management practices for non-domestic bovids.

Key words: Bovids, copper deficiency, liver biopsy, mineral levels, trace elements

ACKNOWLEDGMENTS

This work would not be possible without the decades of tracking initiated by Dr. Nadine Lamberski and Disease Investigations and the SDZG clinical lab. This current project is done with the support of current SDZSP clinical veterinarians, the clinical lab, the Collection Husbandry Sciences department, and the expertise and support of the registered veterinary technicians at SDZSP.

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aTrace element screen, Nutrition/Trace Element-8105, California Animal Health & Food Safety Laboratory System, Davis, CA 95616 USA

bMineral analysis of tissue samples, Minerals, Tissue-50254, MSU Veterinary Diagnostic Laboratory, Lansing, MI 48909 USA

cMila Soft Tissue Biopsy Needle, MILA International, Inc., Florence, KY 41042 USA

Key words: Bovids, copper deficiency, liver biopsy, mineral levels, trace elements
### Table 1. Median ± standard deviation concentrations of copper, iron and zinc found in 49 samples from 15 bovid species at SDZSP in serum and liver.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Serum</th>
<th>Liver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (Cu)</td>
<td>1.10 ± 0.36</td>
<td>127.59 ± 521.40</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>1.35 ± 0.71</td>
<td>430.08 ± 269.22</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>0.67 ± 0.29</td>
<td>113.12 ± 196.54</td>
</tr>
</tbody>
</table>

### Table 2. Concentrations used to classify liver status (ppm, dry weight basis) of copper, iron, and zinc, as categorized as low, marginal (Cu only), adequate, or above adequate based on SDZSP historic ranges and diagnostic lab ranges.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Low</th>
<th>Marginal</th>
<th>Adequate</th>
<th>Above Adequate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (Cu)</td>
<td>≤ 30.00</td>
<td>30.01-79.99</td>
<td>80.00-329.99</td>
<td>≥ 330.00</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>≤ 170.00</td>
<td>170.01-749.99</td>
<td>≥ 750.00</td>
<td></td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>≤ 90.00</td>
<td>90.01-499.99</td>
<td>≥ 500.00</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3. Concentrations used to classify serum status (ppm) of copper, iron, and zinc, as categorized as low, adequate, or above adequate based on SDZSP historic ranges and diagnostic lab ranges.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Low</th>
<th>Adequate</th>
<th>Above Adequate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (Cu)</td>
<td>&lt; 0.8</td>
<td>0.8-2.0</td>
<td>&gt; 2.0</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>&lt; 1.0</td>
<td>1.0-2.5</td>
<td>&gt; 2.5</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>&lt; 0.6</td>
<td>0.6-2.0</td>
<td>&gt; 2.0</td>
</tr>
</tbody>
</table>

### Table 4. Evaluation of serum mineral concentration as a diagnostic test to evaluate liver mineral concentration for copper, iron, and zinc in non-domestic bovids at SDZSP as measured by sensitivity, positive predictive value, specificity, and negative predictive value.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Sensitivity of serum to diagnose low or marginal liver levels; % (95% CI)</th>
<th>Positive predictive value of low serum values to diagnose low liver values; % (95% CI)</th>
<th>Specificity of adequate or above serum levels to diagnose adequate or above liver values; % (95% CI)</th>
<th>Negative predictive value of not-low (adequate or above adequate) serum values to indicate adequate or above liver levels; % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (Cu)</td>
<td>16.7 (3.6-41.4)</td>
<td>42.9 (15.9-74.9)</td>
<td>87.1 (70.2-96.4)</td>
<td>64.3 (58.4-69.7)</td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>0 (ND)</td>
<td>0 (ND)</td>
<td>67.4 (52.5-80.1)</td>
<td>100 (ND)</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>55.6 (21.2-86.3)</td>
<td>26.3 (14.8-42.4)</td>
<td>65.0 (48.3-79.4)</td>
<td>86.7 (75.2-93.3)</td>
</tr>
</tbody>
</table>
MEASURING EFFECTIVENESS OF STRECK CELL PRESERVATIVE ON STABILIZING ASIAN ELEPHANT (*Elephas maximus*) WHOLE BLOOD FOR COMPLETE BLOOD COUNT TESTING

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Abstract

Health assessments of Asian elephants (*Elephas maximus*) in remote areas may be hindered by lack of access to equipment required for blood testing and may result in delayed complete blood counts (CBCs). Streck Cell Preservative is a proprietary liquid stabilization agent that may be used to extend the integrity of whole blood to allow for delayed diagnostic CBC testing. This study aimed to determine the efficacy of Streck Cell Preservative as a stabilization agent for EDTA-treated whole blood from Asian elephants. Seven healthy Asian elephants had blood drawn opportunistically once or twice, yielding a total sample size of n = 12. EDTA-treated whole blood from each elephant was separated into three sets consisting of two aliquots: a control aliquot and an aliquot with Streck Cell Preservative at a 1:1 ratio. Each set was placed either in a refrigerator, an indoor laboratory benchtop, or outside in ambient conditions out of direct sunlight. Complete blood counts were performed on days 0, 1, 4, 7, and 10 post-collection. Over the data collection period, sample quality deteriorated rapidly by day 4 for the control and treated samples in the refrigerator and lab conditions. The control sample in outside conditions deteriorated by day 1, while the treated sample deteriorated by day 4. Therefore, Streck Cell Preservative may be used to stabilize Asian elephant whole blood for delayed CBC testing for a short period if kept refrigerated or in indoor laboratory conditions and may be suitable for delayed processing in outdoor field conditions.

Streck, Inc., La Vista, Nebraska 68128, USA

Key words: Asian elephant, complete blood count, *Elephas maximus*, Streck Cell Preservative

ACKNOWLEDGMENTS

Support for this study was provided by the Houston Zoo, Johnathan Ishee and Emily Downing-Ishee, and Dr. and Mrs. William W. Ishee Jr. The authors would also like to thank Mr. Daryl Hoffman, Mr. Rob Bernardy, the Houston Zoo Veterinary Clinic Staff, and the Houston Zoo Elephant Keeper Team. The authors also thank the EEHV Advisory Group for providing a letter of support for this research.
ON-SITE TESTING OF ELEPHANT BLOOD FOR VIREMIA WITH ELEPHANT ENDOTHELIOTROPIC HERPESVIRUS 1 IN ASIAN ELEPHANTS (Elephas maximus)

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Abstract

Elephant hemorrhagic disease (EHD) is a frequently lethal disease of young elephants due to infection with various types of elephant endotheliotropic herpesvirus (EEHV). Monitoring of young elephants for viremia with EEHV may be vital for timely and educated initiation of antiviral therapy.1 The present gold standard for this purpose relies on quantitative Taqman PCR assays, which are highly sensitive but time-consuming (24-48 hr) due to the need for specialized laboratories and expensive equipment.2,3 We considered that on-site testing of blood samples might substantially shorten the time from sample collection to obtaining a dependable result. Therefore, we developed an isothermal recombinase polymerase amplification (RPA) assay for the on-site detection of EEHV1 DNA in Asian elephant (Elephas maximus) blood samples within 30 min using portable equipment. With a detection limit of approximately 60 template copies per assay, the novel RPA assay was slightly less sensitive than Taqman PCR. Yet, it detected both high levels (EHD cases) and low levels (transient, low-level viremia) of EEHV1 DNA in elephant blood. False-positive cases were not observed except on one occasion, when expired test constituents were used. Moreover, a time-to-reaction value provides an estimate of the actual EEHV1 DNA template numbers in the sample. Accordingly, the novel test may contribute to rapid decision-making for animals at EHD-risk. We emphasize, however, that this test cannot stand alone and should always include a back-up strategy, which involves the experience of a professional diagnostic laboratory with technical possibilities beyond RPA.

Key words: Asian elephant, EEHV monitoring, elephant endotheliotropic herpesvirus (EEHV), Elephas maximus, on-site testing, recombinase polymerase amplification (RPA)

LITERATURE CITED


WHITE BLOOD CELL DIFFERENTIAL COUNTS AND PLATELET ESTIMATES: BLOOD FILM REVIEW IS ESSENTIAL IN ELEPHANT HEMATOLOGY

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Abstract

Two unique features of elephant hematology are known challenges in analytical methodology: two types of monocytes typical for members of the Order Afrotheria, and platelet counts of the comparatively small elephant platelet.1,2 The objective of this study was to investigate white blood cell (WBC) differential and platelet data generated by the Hemavet 1700FS, an impedance-based hematology analyzer without availability of validated species-specific software for recognition of elephant WBCs and platelets, compared to manual blood film review of 50 elephants (n = 35 Elephas maximus and n = 15 Loxodonta africana). All hematological variables, including absolute numbers of heterophils, lymphocytes, monocytes, eosinophils, basophils, and platelets were significantly different (P < 0.0001) between the two methods of analysis, and there was no agreement using Altman-Bland bias plots for method comparison. Manual blood film review consistently produced higher heterophil and monocyte counts as well as platelet estimates, while lymphocyte, eosinophil, and basophil counts were higher in the analyses performed by the automated analyzer. Thus, the hematology analyzer did not properly differentiate elephant lymphocytes and monocytes, and did not accurately count elephant platelets. These findings emphasize the importance of manual blood film review as part of the elephant CBC in both clinical and research settings and as a basis for the development of hematological reference intervals. Blood film review in elephants should include a 200 WBC differential and platelet estimate per routine laboratory practices.3 Further studies are needed on the validation of species-specific software and the evaluation of hematology analyzers using other analytical methods.

Drew Scientific Inc., Miami Lakes, FL 33014 USA

Key words: African elephant, Asian elephant, complete blood count, Elephas maximus, hematology, Loxodonta africana

ACKNOWLEDGMENTS

The authors thank the University of Miami’s Avian and Wildlife Laboratory team for technical assistance with this study.
LITERATURE CITED


ANTIFUNGAL SUSCEPTIBILITY PATTERNS OF Nannizziopsis guarroi AND THE SINGLE-DOSE PHARMACOKINETICS OF ORALLY ADMINISTERED TERBINAFINE IN THE BEARDED DRAGON (Pogona vitticeps)

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Abstract

Nannizziopsis guarroi (NG) is a common pathogen of bearded dragons (BD, Pogona vitticeps) causing cutaneous lesions ranging from mild scale discoloration and dysecydsis to ulcerative lesions, invasive mycosis and death.1 Despite its recognition as an emerging disease, a safe and effective treatment modality has yet to be elucidated.2,3 Four molecularly confirmed isolates of NG from clinical cases in two BD and two green iguanas (Iguana iguana) were tested through a commercial laboratory for antifungal susceptibility. A compounded oral solution of terbinafine (25 mg/ml; 20 mg/kg) was administered to nine BD through gavage directly to the stomach.4 Blood (0.2 ml) was drawn from the ventral tail vein at times 0, 0.5, 1, 2, 4, 8, 12, 24, 36, 48, 60, 72, 84 and 96 hr. Plasma terbinafine levels were measured using high-performance liquid chromatography. The ranges of antifungal minimum inhibitory concentrations for the isolates obtained from clinical cases were: nystatin 2-4 µg/ml, fluconazole 4-64 µg/ml, itraconazole 0.125-2 µg/ml, posaconazole 0.125-1 µg/ml, voriconazole 0.06-0.25 µg/ml, ketoconazole 0.125-2 µg/ml, and terbinafine 0.015-0.03 µg/ml. Peak plasma terbinafine concentration (Cmax) was 243.3 ± 63.6 ng/ml. Time to peak plasma concentration (Tmax) was 9.3 ± 2.3 hr with an average elimination half-life (T1/2) of 15.9 ± 5.1 hr. The research presented here indicates terbinafine, at a dose of 20 mg/kg would exceed the minimum inhibitory concentrations for NG for at least 48 hr and may be a treatment option for BD infected with NG in the future.

Key words: Bearded dragon, mycosis, Nannizziopsis guarroi, pharmacokinetics, Pogona vitticeps, terbinafine

LITERATURE CITED


DIAGNOSIS AND TREATMENT OF A Paranannizziopsis australasiensis (Onygenales) OUTBREAK IN AFRICAN BUSH VIPERS (Atheris squamigera)

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1Houston Zoo, Inc, Houston, TX 77030 USA; 2Texas A&M Veterinary Medical Diagnostic Laboratory, College Station, TX 77843 USA; 3Department of Veterinary Pathobiology, College of Veterinary Medicine and Biomedical Sciences, Texas A&M University, College Station, TX 77843 USA

Abstract

The fungal genus Paranannizziopsis (Onygenales) comprises emerging pathogens of reptiles; however, medical and pathologic knowledge of Paranannizziopsis infections are limited. The disease is primarily described in Australasia. An outbreak of Paranannizziopsis australasiensis occurred in a group of juvenile African bush vipers (Atheris squamigera). Ten African bush vipers ranging between 69 to 149 days (average: 113 days) were found deceased without previous clinical signs. On gross evaluation, snakes had multifocal, raised, white to grey to dark brown discolored cutaneous patches. Microscopically, all the snakes had integumentary lesions that ranged from vesicles to epidermal pustules to extensive necroheterophilic and ulcerative plaques with fibrin, hemorrhage, numerous superficial and intraepidermal fungal hyphae and conidia, and mixed gram-negative and gram-positive bacteria. Panfungal polymerase chain reaction targeting the internal transcribed spacer 2 region identified P. australasiensis with 100% identity in three cases. Eleven cohorts were treated prophylactically with nebulized terbinafine for a minimum of 30 days; two of these died before the completion of treatment. This is the first report of P. australasiensis in the United States and the first record of Paranannizziopsis infection in African bush vipers. Rapid detection and treatment allowed for reduction of mortality. P. australasiensis should be considered in the differential diagnosis for cutaneous dermatomycosis in snakes and a potential threat for reptile ex situ conservation programs.

Key words: African bush viper, Atheris squamigera, fungal dermatitis, Paranannizziopsis australasiensis

ACKNOWLEDGMENTS

The authors thank the dedicated staff at the Houston Zoo for their remarkable care for these animals and the histology technicians at TVMDL for their professionalism and commitment.

LITERATURE CITED


DEVELOPMENT OF A GENOTYPING ASSAY FOR *Ophiomyces ophiodiicola*, A Fungal Pathogen Infecting Free-Ranging and Managed Snake Populations

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Abstract

Ophidiomycosis (snake fungal disease) is an emerging infectious disease caused by the fungus *Ophiomyces ophiodiicola*. All snake species appear to be susceptible and significant variation has been observed in clinical presentation, progression of disease, and response to treatment, which may be due to genetic variation in the causative agent. The objective of this project was to design a genotyping assay for *O. ophiodiicola* that would determine the clade to which a given isolate belongs, thus informing treatment decisions for snakes with ophidiomycosis. We hypothesized that a set of specific primer-probe sets could be created that would distinguish between clades based on the amplification pattern of the *O. ophiodiicola* isolate using qPCR. Six full genome sequences of *O. ophiodiicola* representing different fungal clades were aligned to identify 29 genomic areas shared between subsets of the isolates with 100% sequence similarity. Specific primer-probe sets were designed to amplify these areas and were tested for specificity *in silico*, confirming that the target sequences were only found in a subset of the isolates and that the primers would not bind other microbes commonly isolated from snake skin. Eleven primer-probe sets were selected that produce unique amplification patterns for each isolate, each with a limit of detection of 10 or fewer fungal copies and an amplification efficiency of 90-110%. This genotyping assay can be applied to *O. ophiodiicola* isolates using multiplex qPCR and will allow us to further understand the epidemiology of this important emerging disease and to more effectively manage individual clinical cases.

**Key words:** Genetic diversity, *Ophiomyces ophiodiicola*, ophidiomycosis

ACKNOWLEDGMENTS

The authors thank the USGS National Wildlife Health Center for sharing the full-genome sequences of the fungal isolates. We also thank the American Association of Zoo Veterinarians for funding this project through a grant from the Wild Animal Health Fund.
DISSEMINATED PHAEOHYPHOMYCOSIS IN A SUMATRAN TIGER (Panthera tigris sumatrae)

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Abstract

Phaeohyphomycosis is an infection by pigmented fungi in the family Dematiaceae.¹ It is recognized as a rare but emerging opportunistic pathogen.⁶ The condition has been documented in a wide range of species including ectotherms, birds, ruminants, horses, dogs, and cats.¹-⁶ Disease is mostly associated with immune compromise.⁴ A 16-yr-old female Sumatran tiger (Panthera tigris sumatrae) was evaluated for hyporexia. The patient had a history of oral eosinophilic granulomas and a chronic keratopathy, requiring occasional treatment with glucocorticoids and episcleral cyclosporine implants.⁴ Examination revealed a large subcutaneous left axillary mass with draining tracts. Serosanguinous to purulent discharge containing numerous small black grains was expressed, consistent with a mycetoma. Complete blood count and serum biochemistry revealed azotemia, hypercalcemia, and nonregenerative anemia. Treatment including intravenous fluid therapy, anti-emetics, and a long-lasting antibiotic injection were administered. Histopathology from an incisional biopsy confirmed mats of fungal hyphae and oral itraconazole was started. Due to poor appetite and medication compliance, intravenous liposomal amphotericin B and supportive care were administered twice weekly. Persistent hyporexia and subcutaneous lesions, as well as progressive cachexia and azotemia occurred despite treatment and euthanasia was elected. Necropsy revealed disseminated phaeohyphomycosis affecting multiple lymph nodes, the nasal cavity, and kidneys. Fungal culture isolated Curvularia species. This is the first report of phaeohyphomycosis in an exotic carnivore. Aggressive systemic antifungal treatment was unsuccessful, likely complicated by delay in diagnosis and concurrent chronic kidney disease.

⁴Cyclosporine 12mg silicone-matrix implant, North Carolina State University, Raleigh, NC 27607 USA
⁵Itraconazole 105mg, Pet Health Pharmacy, Youngtown, AZ 85363 USA
⁶Amphotericin B USP 50mg, X-Gen Pharmaceuticals DJB, Horseheads, NY 14845 USA

Key words: Curvularia, eumycetoma, Panthera tigris sumatrae, phaeohyphomycosis, Sumatran tiger

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The authors thank the Phoenix Zoo animal care team for their dedicated care to this patient.
LITERATURE CITED


SYSTEMIC MYCOTIC DISEASE AND SUBSEQUENT ITRACONAZOLE TESTING IN THE SOUTHERN BLACK RHINOCEROS (*Diceros bicornis minor*)

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Abstract

A 16-yr-old male southern black rhinoceros (*Diceros bicornis minor*) developed raised lesions of the dermis concurrent with a severe and sudden drop in body condition. Over several weeks, lesions progressed to large, open, cavitated sores and new lesions developed, typically one every few days. Within 1 mo of the initial lesion, three other black rhinoceroses also began to develop grossly similar lesions with loss of condition. Skin biopsies were consistent with mycotic dermatitis, and due to the deep vascular and perivascular presence of fungal organisms, suggestive of hematogenous spread. Molecular diagnostics confirmed Curvularia, a hypomycete facultative pathogen, in several samples. Due to the high cost and high dose volume of brand name itraconazole, the animals were treated with compounded itraconazole for 3-6 mo until on resolution of signs. All four animals improved while on itraconazole treatment and the lesions resolved. Blood samples and skin biopsies were evaluated by ultra-performance liquid chromatography with tandem mass spectrometry for itraconazole and its active metabolite, hydroxyitraconazole, concentrations were not detected (< 0.002 μg/ml). Drug concentrations in the compounded formulation were 85% of what was expected based on pharmacy labeling, indicating lack of drug absorption rather than poor formulation strength. This is the first report of a Curvularia species causing disease in rhinoceros. It is also the first report to confirm that compounded itraconazole dosed at published equine dosages (5 mg/kg q24hr) does not reach measurable levels in plasma or skin in black rhinoceroses.

**Key words:** Curvularia, *Diceros bicornis minor*, fungal dermatitis, itraconazole, southern black rhinoceros, systemic fungal mycosis

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The authors thank the staff at Fossil Rim Wildlife Center for their dedication to the animals in their care. They would also like to thank the laboratory staff of Dr. Jennifer Davis for their assistance with itraconazole testing.
INVESTIGATION OF A NOVEL ASPERGILLOSIS PROPHYLAXIS VACCINE IN INCA TERNS (Larosterna inca)

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Abstract

Aspergillosis is a leading cause of death in Inca terns (Larosterna inca) at the Wildlife Conservation Society Bronx Zoo. Historically, the youngest birds, especially fledglings, were most at risk for death from Aspergillus sp. infections. A novel vaccine to prevent aspergillosis was investigated as a means of mitigating these deaths within the flock. Under development as an antifungal vaccine to improve survival of human cancer patients that receive hematopoietic cell transplants, the Asp f3 vaccine was protective in mice1 and chickens against experimentally induced aspergillosis. To investigate efficacy of this vaccine in Inca terns, chicks received a series of three Asp f3 vaccines administered at 2, 4, and 6 wk of age. Plasma collected at the time of vaccination indicated development of Asp f3-specific IgY titers following the first and second immunizations. While the mechanism of vaccine protection involves vaccine-primed CD4+ T cells in mice,1 development of IgY titers in Inca terns was recorded as a quantifiable surrogate immune response. The efficacy of this vaccine in the Inca terns was evaluated based on changes in aspergillosis-associated death rate in the population. Among the 54 Inca terns vaccinated during 2017-2019, only one bird succumbed to aspergillosis. This individual had only received two out of three vaccines at the time of death. Following implementation of AspF3 vaccination, the incidence rate of aspergillosis-associated death among birds 3 yr of age or less decreased from 7.48% to 1.85%. Further study is warranted to investigate efficacy of the Asp f3 vaccination in preventing Aspergillus sp. infection in other avian taxa.

Key words: Asp f3 vaccine, aspergillosis, Aspergillus fumigatus, Inca tern, Larosterna inca

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LITERATURE CITED


STUDY OF FUNGAL CONTAMINATION IN THE NESTS OF A CAPTIVE HUMBOLDT PENGUIN (Spheniscus humboldti) COLONY

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Abstract

Aspergillus fumigatus is an environmental mold with opportunistic pathogenicity. Similarly to reports in other captive colonies,1 the Humboldt penguin (Spheniscus humboldti) population at ZooParc de Beauval (France) is endemically affected by aspergillosis, which was estimated to account for 42.9% of penguin deaths. This study aimed to assess fungal contamination in penguin nests and identify azole resistances in Aspergillus fumigatus isolates.

Three sets of environmental samples were collected (April 2018, December 2018, and September 2019) by swabbing the artificial nests of the enclosure. Samples were inoculated onto malt extract agar at 35°C. Fungal colonies were counted and phenotypic and molecular identification were performed. DNA of all the Aspergillus fumigatus isolates was systematically sequenced to look for azole resistance mutations in the CYP51 gene.

Results revealed that 83%, 100% and 100% of the nests were contaminated with at least one fungal species, while mean fungal colony-forming units per nest were 0.8, 2.6 and 45.7 in April 2018, December 2018 and September 2019, respectively. Moreover, Aspergillus Fumigati section was isolated in 67%, 75% and 100% of the nests, respectively. DNA sequencing of the β-TUB gene identified all but one isolate (Aspergillus nishimurae) as Aspergillus fumigatus stricto sensu. Only one resistance mutation for azole drugs was detected in the CYP51 gene (G138A).

Despite the geographical location of the zoo in a rural environment, surrounding intensive agricultural practices did not seem to select resistant strains. However, penguin nests were heavily contaminated, which warrants cautious monitoring of fungal populations, and disease surveillance in the colony.

Key words: Aspergillus fumigatus, contamination, fungal, Humboldt penguin, resistance, Spheniscus humboldti

LITERATURE CITED

FISH MEDICINE REVIEW

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Abstract

Fish medicine is gaining attention, with growing focus on both individual animal and population health issues. Veterinary care expectations are impacted by professional standards and available technology. This is seen most clearly with elasmobranch medicine.

More veterinarians are interested in fish medicine and incorporating fish into their practice, across a variety of settings – from pet/hobbyist, to public display, to aquaculture, to conservation. Fish caregivers are seeking veterinary input into case management more than ever before. Fish are being identified and managed as individuals more frequently and for both groups and individuals clearer goals for longevity, welfare, and survival are being discussed and advanced. Welfare standards and welfare assessments are being applied to fish. Overall, there is a trend to move away from allowing fish to be managed as a ‘commodity’. In the author’s opinion, this appears driven by internal pressure within the profession as well as external factors, such as reduced ability to obtain fish and growing societal pressure around animals in captivity.

Technological advances have made it easier to provide advanced medical care as well. Examples include portable imaging (e.g., portable/water resistant ultrasound, wireless direct radiology), small volume blood analysis (e.g., chemistries, vitamins), and molecular diagnostic tools for both disease identification and environmental evaluation (e.g., emerging infectious diseases, microbiomes). Expanded diagnostics and intervention modalities allow veterinarians to routinely practice high-level medicine. Additionally, the application of behavior analysis technology is used to predictably train animals. Fish respond readily to positive reinforcement training, which can be used to advance husbandry behaviors.

Overall, there is growing ability to accomplish high-level veterinary medicine on fish patients, as well as support for doing so.
CLINICAL AND MICROBIOLOGIC CHARACTERIZATION OF LYMPH NODE ABSCESSATION IN CALIFORNIA SEA LIONS (Zalophus californianus) STRANDED FROM 2015-2019

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Abstract

Severe, focal to multifocal abscessation of the axillary and inguinal lymph nodes is a frequent cause of morbidity and mortality in stranded juvenile California sea lions (Zalophus californianus; CSL). Similar abscesses are documented in rehabilitation and managed care. A retrospective case review was conducted of all juvenile CSL with at least one axillary and/or inguinal lymph node abscess admitted to The Marine Mammal Center (TMMC; Sausalito, CA) from January 2015 through December 2019 (n = 162). Clinical data and cultured isolates were evaluated to: 1) characterize the clinical syndrome, 2) investigate factors associated with clinical outcome (survival to release versus death), and 3) report cultured pathogens. Hematology and serum chemistry parameters at the time of abscess diagnosis were within reference intervals, except 33% of cases were leukopenic (TMMC, unpubl. data). Radiographs were available for 45 cases; findings associated with abscesses included soft tissue swelling (n = 40), intralesional gas (n = 19) and osteomyelitis (n = 3). Overall mortality among these cases was 63%; however, the incidence was lower in patients with one abscess, that underwent surgical treatment, and that received multimodal antimicrobial therapy. A total of 90 isolates were recovered from aerobic (n = 48) and anaerobic cultures (n = 17), 56% of which were gram-negative. The most common gram-negative isolates were Escherichia coli (n = 15), Proteus spp. (n = 8) and Enterococcus spp. (n = 6), and the most common gram-positive isolates were Streptococcus phocae (n = 10) and Staphylococcus spp. (n = 9).

Key words: Abscess, California sea lion, Escherichia coli, lymph node, Streptococcus phocae, Zalophus californianus

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The authors thank past and present volunteers and staff of The Marine Mammal Center for sustaining its mission to advance global ocean conservation through marine mammal rescue and rehabilitation, scientific research and education.
COMPARISON OF CARDIOPULMONARY EFFECTS OF CONTROLLED MECHANICAL VENTILATION AND APNEUSTIC ANESTHESIA VENTILATION IN BOTTLENOSE DOLPHINS (Tursiops truncatus) AND CALIFORNIA SEA LIONS (Zalophus californianus)

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Abstract

Anesthesia of large, breath-holding marine mammals has presented many logistical and physiological challenges. Among these challenges is the ability to provide adequate ventilation secondary to anesthetic induced respiratory depression. Anesthesia may lead to ventilation-perfusion inequality, hypercarbia, and right-to-left intrapulmonary shunting with resultant hypoxemia. Although many modes of mechanical ventilation are described in human medicine, controlled mechanical ventilation (CMV) is the most commonly employed mode in veterinary anesthesia. Apneustic anesthesia ventilation (AAV), which closely resembles the normal, conscious respiratory pattern of marine mammals, may optimize ventilation to overcome these cardiopulmonary challenges. Based on completed domestic terrestrial animal trials in pigs and horses, we believe AAV may have translational applications for marine mammals, and possibly other large exotic terrestrial mammals. We provide preliminary evaluation of the cardiopulmonary effects of a newly developed anesthesia ventilator (DolVent™), capable of delivering both the AAV and CMV modes of ventilation, in anesthetized bottlenose dolphins (Tursiops truncatus) and California sea lions (Zalophus californianus) undergoing clinical procedures. Using a cross-over study design, each patient was randomly assigned to a starting ventilation mode, maintained on that mode for 30 min, then switched to the alternate mode of ventilation for an additional period of 30 min. Ventilation-perfusion inequality, alveolar dead space ventilation, oxygen extraction ratio, cardiac output, systemic vascular resistance, minute ventilation, and rate of elimination of carbon dioxide were calculated during each ventilation mode. Results suggest in large anesthetized marine mammals, the lung protective strategy of AAV may improve gas exchange, reduce ventilator related harm, and improve anesthetic outcomes.

Key words: Apneustic anesthesia ventilation, cardiopulmonary, marine mammals

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LITERATURE CITED


PHARMACOKINETICS OF A SINGLE DOSE OF INTRAMUSCULAR AND ORAL MELOXICAM IN YELLOW STINGRAYS (*Urobatis jamaicensis*)

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Abstract

Elasmobranchs are popular display animals in public aquarium and zoos, but medical management gaps remain in the understanding of the pharmacokinetics of analgesics and pain management in these species.¹,² Meloxicam is a nonsteroidal anti-inflammatory drug that has been evaluated intravenously and intramuscularly in teleosts,³ but has yet to be studied in any elasmobranch species. The pharmacokinetics of meloxicam were determined in seventeen yellow stingrays (*Urobatis jamaicensis*). All stingrays were determined to be healthy from complete physical examinations and baseline bloodwork performed prior to study inclusion. A single dose of meloxicam (1 mg/kg IM) was administered to all rays followed by a 2 mg/kg oral dose after a 4-wk wash-out period. Blood samples were collected from the mesopterygial vein⁴ at baseline and nine time points up to 96 hr after administration of meloxicam. Plasma concentrations were determined using reversed-phase high performance liquid chromatography. Pharmacokinetic analysis was performed using a noncompartmental technique. The mean peak plasma concentrations for intramuscular and oral meloxicam was 1.1 µg/ml and 1.5 µg/ml, respectively. The mean terminal half-life of meloxicam after intramuscular and oral administration was 1.48 and 16.8 hr, respectively. Based on these findings, the recommended meloxicam dosage and frequency for yellow stingrays is 2 mg/kg orally once daily. Due to rapid elimination with the intramuscular administration, maintaining clinically relevant plasma concentrations may be difficult using this route. Further studies are needed to determine multi-dose pharmacokinetics of meloxicam in yellow stingrays, as well as single-dose and multi-dose pharmacokinetics in other elasmobranch species.

Key words: Elasmobranch, meloxicam, mesopterygial vein, pharmacokinetics, *Urobatis jamaicensis*, yellow ray

LITERATURE CITED


HISTOLOGIC EVIDENCE OF RENAL DISEASE IN BROWN PELICANS (*Pelicanus occidentalis*) AFTER TREATMENT WITH MELOXICAM

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Abstract

The incidence of renal disease in free-living brown pelicans (*Pelicanus occidentalis*) is unknown. Visceral gout is a fairly common sequela to renal disease in birds, although not reported in the brown pelican.³⁻⁵,¹¹,¹³ Causes of visceral gout include nutritional (usually iatrogenic), severe dehydration or sodium toxicity, ingestion of toxins such as heavy metals or mycotoxins, viral or bacterial infections, and exposure to nephrotoxic drugs.³,⁵

The acute deaths of brown pelicans undergoing treatment for a variety of conditions at the South Florida Wildlife Center in 2014 were investigated. Within a 6-mo period, eight pelicans presented for necropsy with histologic or gross evidence of renal disease. Seven of the eight had evidence of urate tophi in or on the surface of various organs (visceral gout). All eight pelicans had received varying doses of meloxicam (0.5-1.0 mg/kg q12-24 hr) for 3-13 days prior to death.

Meloxicam is a widely used NSAID in avian species that is generally considered safe. Pharmacokinetic analysis and limited safety studies have been performed in multiple avian species;¹⁻¹⁰,¹²,¹⁴ however, it is difficult to extrapolate these results to the diversity of species treated in a wildlife rehabilitation setting. A recent pharmacokinetic study, concluded the half-life of a single dose of meloxicam in brown pelicans is the longest reported in any avian species.⁴ We suspect the visceral gout lesions in these reported cases were due to the use of meloxicam. The authors recommend cautious use of meloxicam in brown pelicans until further pharmacokinetic, safety, and efficacy data is available.

Key words: Brown pelican (*Pelicanus occidentalis*), meloxicam, renal disease, visceral gout

LITERATURE CITED


RETROSPECTIVE ANALYSIS OF MORTALITY IN CAPTIVE-BRED POPULATIONS OF PELECANIFORMES SPECIES FROM A SINGLE INSTITUTION OVER A 20-YEAR PERIOD

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Abstract

No retrospective analysis of mortality in multiple Pelecaniformes species is available. The primary objective of this retrospective study was to identify common and significant causes of mortality in Pelecaniformes species held in a French zoo. Post-mortem reports were analyzed over a 20-yr period, including 165 individuals representing 12 species.

The most common causes of death or euthanasia were musculoskeletal (including trauma; 26%), digestive (16%), respiratory (15%), urinary (10%), and cardiovascular disorders (9%). Genital (2%), neurological (2%), and ocular (1%) diseases were of a lesser significance. Seventeen African sacred ibises (Threskiornis aethiopicus) died of aspergillosis or itraconazole toxicity following complications of endoscope-guided laser sterilization. These 17 individuals were not included in further statistical analyses.

Young animals were particularly represented, especially scarlet ibises (Eudocimus ruber) for which most deaths (70%) occurred during the first year of life, highlighting the need for sustained health monitoring in fledglings. African sacred ibises under 5 yr of age were significantly more affected by musculoskeletal issues than other birds, and metabolic bone disease only occurred in males from this species (n = 6/53).

With regard to digestive conditions, African sacred ibises aged 2.5-3.6 yr were significantly more affected by hemorrhagic enteritis than birds from other species, often in association with Clostridium perfringens infections (n = 4/7). Respiratory diseases were significantly more prevalent in white pelicans (n = 7/26), particularly in males under 1 yr of age (n = 5/7). Aspergillosis led to eosinophilic and necrotizing pneumonia in ibises, while pyogranulomatous infections were observed in white pelicans. Pneumonia was mainly caused by aspiration in white pelicans and scarlet ibises, whereas primary bacterial origin was most common in African sacred ibises and hamerkops (Scopus umbretta). Cardiovascular conditions were particularly prevalent in scarlet ibises (18%), which is consistent with previous reports.2 Cardiomyopathies, both dilated (33%) or hypertrophic (22%), were the most common diseases in scarlet ibises. While previously reported as highly prevalent in scarlet ibises,1 myocarditis, pericarditis, and atherosclerosis were only seen in one individual of this species. Myocarditis was diagnosed in one female white pelican and one female boat-billed heron (Cochlearius cochlearius), while pericarditis was observed in a 22-yr-old female white pelican.

Inflammatory conditions were particularly prevalent (n = 30/165) and associated with mainly
digestive disorders (enteritis, hepatitis, 45%), followed by cardiovascular (myocarditis, pericarditis, epicarditis, 15%) and urinary diseases (interstitial nephritis, ureteritis, tubulonephritis, 15%), generalized infections (coelomitis, mycobacteriosis, 15%), and respiratory conditions (aerosacculitis, rhinitis, 5%). All inflammatory conditions were diagnosed before 5 yr of age within Threskiornithidae species, regardless of sex, but they were diagnosed at any age in white pelicans (Pelecanus onocrotalus).

This is the first retrospective study of mortality causes in multiple Pelecaniformes species, highlighting the prevalence of inflammatory processes, as well as specific conditions that need to be further investigated to improve management of some species under professional care.

**Key words:** Inflammatory conditions, mortality, Pelecaniformes, retrospective study, Threskiornithidae

**LITERATURE CITED**


RETROSPECTIVE REVIEW OF CHRONIC GASTROINTESTINAL DISEASE IN THE MANED WOLF (Chrysocyon brachyurus) AT THE SMITHSONIAN NATIONAL ZOOLOGICAL PARK AND CONSERVATION BIOLOGY INSTITUTE (2002-2019)

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Abstract

Chronic gastrointestinal disease is a serious, well-documented problem in captive maned wolf (Chrysocyon brachyurus) populations that can result in debilitating health problems, especially when protein is lost to the intestine.3,4 Inflammatory bowel disease (IBD) and lymphangiectasia are the two most common forms of protein-losing enteropathies in dogs, but the complex etiologies of these diseases makes diagnosis difficult.1-3 Medical records of 66 wolves from the Smithsonian National Zoological Park and Smithsonian Conservation Biology Institute between 2002 and 2019 were evaluated for evidence of chronic enteropathy. Twenty-six animals (39%) were identified, 21 of which had histopathology of the gastrointestinal tract available for review. Sixteen (76%) had histopathologic evidence of lymphangiectasia. Animals with postmortem diagnosis of lymphangiectasia had a significantly lower albumin (P < 0.0001, CI = -1.353 to -0.733), red blood cell count (P = 0.0368, CI = -1.5130 to -0.0523), total protein (P = 0.0004, CI = -2.681 to -0.899), and higher white blood cell count (P = 0.015, CI = 1.1609 to 9.7491) at the time of clinical presentation and were more likely to experience anorexia (P = 0.0265) and ascites (P = 0.0076) compared to animals without lymphangiectasia. Twenty-five wolves were refractory to treatment despite a variety of treatment protocols; only one wolf was diagnosed antemortem with lymphangiectasia through laparoscopic-assisted full thickness surgical biopsies of the intestinal tract and is currently responding to treatment with a low-fat diet and prednisone. Full thickness surgical biopsies may provide an advantage in diagnosing and guiding treatment of gastrointestinal pathology in maned wolves.

Key words: Chrysocyon brachyurus, histopathology, inflammatory bowel disease, lymphangiectasia, maned wolf

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LITERATURE CITED


ONE HEALTH IMPACT AFTER DETECTION OF EASTERN EQUINE ENCEPHALITIS VIRUS IN TWO MEXICAN WOLF (Canis lupus baileyi) PUPS AT BINDER PARK ZOO

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Abstract

In the fall of 2019, south-central Michigan experienced the highest incidence of eastern equine encephalitis (EEE) virus cases in the state, in humans and other species, including wild deer and domestic horses. In the midst of the outbreak, EEE was diagnosed in two deceased Mexican wolf (Canis lupus baileyi) pups at Binder Park Zoo (BPZ). Diagnosis of EEE, a state reportable disease, prompted immediate reporting to local and state agencies. Follow-up required communication and collaborations between BPZ, Michigan State University, and local and state public health agencies. Surveillance was conducted by trapping, species identification, and disease testing of mosquitos on property. The zoo initiated both internal and external messaging to ensure transparency of the event and provided educational material and complimentary mosquito spray for staff and spray stations for zoo patrons. Public health agencies recommended cancelation of all overnight camping safaris. In addition, the diagnosis of EEE prompted many school group cancellations. After risk assessment, in conjunction with local and state agencies, mosquito management was implemented on property, including barrier sprays and state-conducted aerial mosquito adulticide. This event serves as an important example of how diagnosis of a zoonotic disease can require a substantial amount of time and resources and may have affects beyond the zoo’s animal health program, including public perception and zoo attendance. Zoos can act as regional sentinels for disease and communication is vital to maintain positive public perception.

Key words: Canis lupus baileyi, eastern equine encephalitis virus, encephalitis, Mexican wolf, mosquito, One Health

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LITERATURE CITED


PROTEIN-LOSING ENTEROPATHY DUE TO LYMPHANGIECTASIA AS A CAUSE OF MORBIDITY AND MORTALITY IN RED WOLVES (Canis rufus)

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Abstract

Protein-losing enteropathy (PLE) is an uncommon gastrointestinal syndrome in which mucosal damage results in malabsorption, diarrhea, and weight loss. PLE is typically diagnosed in middle-aged domestic canids, may be associated with inflammatory bowel disease (IBD), neoplasia, and lymphangiectasia, and warrants a guarded to poor prognosis.1,3 Lymphangiectasia is the dilation and obstruction of the lymphatic vessels with lymph fluid, which causes protein malabsorption and loss through the gastrointestinal tract; lymphopenia, hypoalbuminemia, hyperglobulinemia, and hypocholesterolemia are variably present. In a retrospective study of red wolves (Canis rufus) housed or necropsied at the North Carolina Zoo (NCZ), lymphangiectasia was identified as a cause of PLE in nine individuals aged 4-16 yr; eight of the wolves had been housed at the NCZ and the remaining case was from a managed free-range population in coastal NC. In two wolves, severe muscle atrophy was directly attributed to lymphangiectasia, while the remaining wolves had concurrent lesions including lymphosarcoma, histiocytic sarcoma, thyroid carcinoma and interstitial nephritis. In all cases, PLE was most severe in the duodenum, proximal jejunum, and ileum with grossly evident mucosal thickening, dilated lacteals and prominent serosal lymphatics. Histologically, lesions ranged from minimal to severe, with lacteal dilation and rupture, lipogranulomas and variable submucosal edema, crypt hyperplasia and lymphoplasmacytic enteritis. Pulmonary fibrin thrombi and hypoproteinemia/hyperglobulinemia were also documented. While enteritis has been previously described in red wolves,2 this study describes PLE due to lymphangiectasia as a potential cause of morbidity and mortality in both captive and free ranging red wolves.

Key words: Canis rufus, lymphangiectasia, protein losing enteropathy, red wolves

LITERATURE CITED


UROLITHIASIS AND CRYSTALLURIA IN FOXES

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Abstract

A 5-yr-old intact male fennec fox (Vulpes zerda) presented with hematuria and a urinary tract infection that was unresponsive to antibiotic therapy. Re-check examination revealed a radiolucent filling defect via double contrast cystogram. A pure cystine urolith was removed during cystotomy. One year later, a second cystotomy was performed due to recurrent urolith formation. Subsequent urolithiasis and crystalluria were not prevented with medical and nutritional management commonly used for domestic dogs, thus castration was elected due to testosterone involvement in cystine crystal formation.\(^1\) Castration, combined with the Mazuri Maned Wolf Diet\(^a\) resulted in continued medical resolution, confirmed by quarterly urinalysis and ultrasound. Two additional male fennec foxes presented with crystalluria at the same institution, so data from the Minnesota Urolith Center were analyzed to determine population prevalence of urolithiasis in foxes. From 1981-2017, 41 uroliths were submitted from foxes, 75% of which were from intact males. 63% of cases were composed of struvite and 17% were cystine composition. The remainder of the uroliths were calcium phosphate or oxalate, compound, or mixed materials. Of the 41 cases, fennec foxes were over-represented with 11 case submissions and 45% were cystine uroliths. Uroliths, specifically cystinuria, have been reported and managed in maned wolves (Chrysocyon brachyurus) but have not been previously noted in foxes.\(^2\) Urolithiasis in foxes may be more prevalent than previously recognized and clinicians should consider routine urinalysis as part of the preventive medicine program for foxes.

\(^a\)Mazuri Maned Wolf Diet 5MD9, PMI Nutrition Intl., LLC, Brentwood, MO 63144 USA

Key words: Crystalluria, cystine, fennec fox, urolithiasis, Vulpes zerda

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LITERATURE CITED


TWENTY-YEAR RETROSPECTIVE MORTALITY REVIEW FOR THE ASSOCIATION OF ZOOS AND AQUARIUMS NORTH AMERICAN SNOW LEOPARD (Panthera uncia) POPULATION

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Abstract

Snow leopards (SL) (Panthera uncia) are included in many collections at North American (NA) zoos. The objective of this 20-yr retrospective study was to review and summarize morbidity and mortality for the NA AZA SL population to better inform caretakers and veterinary staff of medical issues, which can affect the long-term success of the captive population. This study focused on pathology reports from 241 SLs at NA AZA institutions that died or were euthanized between January 1, 1999 and December 31, 2019. Data were reviewed, and causes of death (COD) and concurrent diseases were summarized by organ system, disease process and age group. Overall, non-infectious disease was the most common COD (74.7%). Chronic renal disease (CRD) and malignant neoplasia (73 (38.8%) and 37 (19.7%) [including oral squamous cell carcinoma = 12 (6.4%)]) of 188, respectively) were a common COD in adult and geriatric SL; maternal neglect/trauma and congenital diseases (including coloboma 5/32 (15.6%)) were common COD or euthanasia in juveniles and neonates. Concurrent diseases in association with CRD included veno-occlusive disease, cardiac fibrosis, enteritis, and urolithiasis. CRD⁵, ocular coloboma¹,², veno-occlusive disease⁴ and oral and cutaneous papillomas and squamous cell carcinoma³,⁶ are of recognized concern and have been previously described in SLs. Neoplasms not previously reported in SLs or that are generally uncommon in the veterinary literature included transitional cell carcinoma of the urinary bladder (n = 7) and mesothelioma (n = 1).

Key words: Association of Zoos and Aquariums (AZA), mortality review, Panthera uncia, retrospective, snow leopard, Species Survival Program (SSP).

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Breeze Zoo, Greater Baton Rouge Zoo, Houston Zoo, Idaho Falls Zoo at Tautphaus Park, Jackson Zoo, John Ball Zoological Gardens, Kansas City Zoo, Lake Superior Zoo, Lee Richardson Zoo, Lincoln Park Zoological Gardens, Los Angeles Zoo, Louisville Zoological Gardens, Manitowoc Lincoln Park, Maryland Zoo in Baltimore, Memphis Zoological Gardens and Aquarium, Mesker Park Zoo and Botanical Garden, Micke Grove Zoo, Mill Mountain Zoo, Miller Park Zoo, Milwaukee County Zoological Gardens, NEW Zoo and Adventure Park, Nashville Zoo, Niabi Zoo, Oklahoma City Zoo and Botanical Garden, Omaha’s Henry Doorly Zoo and Aquarium, Oregon Zoo, Philadelphia Zoo, Pittsburgh Zoo and PPG Aquarium, Potawatomi Zoo, Potter Park Zoological Garden, Racine Zoo, Rio Grande Zoo, Roger Williams Park Zoo, Rolling Hills Zoo, Roosevelt Park Zoo, Rosamond Gifford Zoo at Burnet Park, Ross Park Zoo, Sacramento Zoo, San Antonio Zoo, San Diego Zoo Global, San Francisco Zoological Gardens, Seneca Park Zoo, St. Louis Zoo, Sunset Zoological Park, Tanganyika Wildlife Park, Tiger Haven, Toledo Zoological Gardens, Toronto Zoo, Tulsa Zoo, Utah’s Hogle Zoo, Utica Zoo, Wildlife Conservation Society – Bronx and Central Park Zoos, Woodland Park Zoo, Zoo Boise, Zoo de Granby, Zoo Knoxville, Zoo Leon.

LITERATURE CITED


NEOPLASIA AND CATS: AN EVALUATION OF RISK FACTORS FROM PUBLISHED AND RETROSPECTIVE CASES OF NON-DOMESTIC FELID CANCER

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Abstract

This study sought to combine all published case reports of non-domestic felids affected with neoplasia, as well as to include retrospective cases collected into the Exotic Species Cancer Research Alliance (ESCRA) neoplasia database (www.escra.org). The compiled data were evaluated for prevalence, treatment and survival time of animals with neoplasia. Literature cases consisted of confirmed, individually identifiable cases collected from three different databases for scientific literature (PubMed, CAB Abstracts, and Web of Science Zoological Record, n = 233). Retrospective cases were collected from participating zoological institutions. In total, there were 451 felids, representing 21 different species of felids from 1932-2018. There was a total of 239 females, 172 males and 40 cases of unknown sex. There was a total of 115 types of neoplasia. The most frequently confirmed types of neoplasia were mammary carcinoma, mammary adenocarcinoma, leiomyoma, squamous cell carcinomas and lymphoma. Only 104 felids reportedly received treatment. Thirteen animals received supportive care only in the form of antibiotics, fluids, or NSAIDs administered for post-operative pain. Of cases with specifically indicated treatments, surgery was the most common (98). Other treatments included chemotherapy (24) with 17 of these animals receiving chemotherapy alone and seven combined with surgery. Radiation was employed in three felids in combination with surgery. Overall, treatment was significantly associated with survival (P < 0.05). The evaluation of published cases as well as the expansion of research regarding neoplasia in animals will not only promote survival and treatment for those affected with neoplasia, but will also offer a unique opportunity to compare oncology mechanisms across all species.

Key words: Cancer, felid, non-domestic, survival, treatment

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The authors thank our ESCRA and ACE students involved in helping compile and log these cases, and Cathy Minogue of Northwest ZooPath for data retrieval. We would also like to thank Dr. Dalen Agnew, and Michigan State University’s Veterinary Diagnostic Lab for their involvement in this project. Funding for this project was provided by National Cancer Institute, NIH (NCI CSBC/PS-ON) and NIH U54 CA 217376.
TISSUE HARVESTING TECHNIQUES AND CREATION OF A GLOBAL BIOBANK IN ZOO AND WILD ANIMALS

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Abstract

Adult stem cell therapy in animals has been documented in over 100 peer-reviewed publications. In order to provide therapeutic stem cells, tissues must be harvested and processed to yield a dose of quality tested cells. The cell yield from such a harvest may be impacted by many factors including species, harvest tissue type and location, and method of harvest. Once tissue is harvested, the method of transport and laboratory cell isolation, expansion and cryobanking will also impact the yield and quality of the stem cells. Surgical and non-surgical methods of tissue procurement have been developed in collaboration with many clinical veterinarians and include open surgical (Figure 1), lipoaspiration (Figure 2), laparoscopic (Figure 3), and post-partum collection of umbilical cord tissues. The primary tissue utilized by these authors has been adipose tissue due to ease of collection, abundance, ability to collect from alive and recently deceased animals, ease of transport, and ability to culture expand the cells with traditional methods. Umbilical cord collection is non-invasive, but the terrestrial animal tissues are often highly environmentally contaminated and difficult to extract. Based on domestic animal data, adipose tissue is the most common source of tissues for stem cell isolation in veterinary medicine. Intraabdominal adipose sources include falciform ligament, omental and mesenteric adipose. This adipose may be harvested by open surgical technique or by laparoscopy. Peri-gonadal adipose at spay/neuter is also a readily available source of stem cells. Subcutaneous adipose tissue is harvested by either open surgical lipectomy or by liposuction with locations including lateral thoracic wall, tailhead/rump, and inguinal areas. In general, the location of collection does not make large differences in regenerative cell yield. In dolphins and whales, the most accessible adipose depot was determined to be the nuchal fat pad (via lipoaspiration) since subcutaneous blubber did not contain an adequate concentration of stem cells. These various techniques have been utilized by these authors and collaborators to successfully harvest tissue and extract stem cells in over 30 different animal species including marine mammals (e.g., dolphin,orca,pilot whale, walrus, sea lion), mega-vertebrates (e.g., giraffe, rhinoceros, elephant), large cats (e.g., lion, tiger, cheetah, mountain lion), bears, primates (lowland gorilla), ungulates, sea turtles, sharks and penguin species.

Adipose tissue amounts are typically between 5-100 grams. Transport is generally at 2-8 °C in a validated shipping system (Figure 4). These authors have collaboratively developed a simple collection and transportation system that can utilize chemical cooling lid that eliminates the need for ice packs. Once received in the processing laboratory, the adipose tissue can be cryo-banked (liquid nitrogen) or further processed by collagenase digestion and washing/centrifugation steps. The post-processing stromal vascular fraction cells can be either utilized therapeutically, cryo-banked, or further processed by cell culture expansion. Quality-assurance steps may include
microbial sterility testing, endotoxin testing, cell number and viability, flow cytometry for cell identity markers, and differentiation assays such as PCR. The goal has been to provide a simple collection system to allow remote tissue collection and shipping to a central laboratory where cells can be isolated and utilized therapeutically, utilized in research, or provided for treatment of patients in the future. An added benefit of building such a global cell bank is the long-term preservation of the DNA and stem cells of rare and endangered species.

**Key words:** Adipose stem cell, biobank, endangered species, laparoscopy, liposuction

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**LITERATURE CITED**


Figure 1. Surgical harvest of falciform ligament adipose.

Figure 2. Lipoaspiration of dolphin nuchal fat pad.

Figure 3. Laparoscopic collection of intraabdominal adipose.

Figure 4. Adipose collection system.
PATHOGEN TRANSMISSION AT THE DOMESTIC ANIMAL-WILDLIFE INTERFACE

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Abstract

As evidenced by recent spillover events, the domestic animal-wildlife interface continues to shrink. The contact between wild birds and backyard chickens exemplifies this concept. Backyard chicken flocks continue to rise in popularity, and pathogen spillover events, such as the ongoing outbreak of virulent Newcastle disease virus (vNDV) in Southern California are becoming more common, resulting in significant economic loss and impacting animal welfare. To understand the movement of pathogens between backyard chickens and wild songbirds, we performed three studies in Athens, Georgia, to measure the prevalence, transmissibility and host competence of passerines to lentogenic Newcastle disease viruses (NDV). To determine wild-type NDV prevalence and confirm that they were not infected with NDV prior to experiments, we surveyed seven sites in Athens from 2016-2017, collecting oropharyngeal and cloacal swabs from ~245 birds representing 55 species. All individuals tested negative by virus isolation and/or real-time RT-PCR, while 50 serum samples tested negative by HI. We performed an experimental infection trial to determine the susceptibility of songbirds to lentogenic NDV LaSota at the U.S. National Poultry Research Center by directly inoculating five groups of wild-caught northern cardinals (Cardinalis cardinalis), brown-headed cowbirds (Molothrus ater), American goldfinches (Spinus tristis) and house finches (Haemorhous mexicanus) with 0.1 ml (10^6.7 EID50/ml) of the LaSota vaccine and collecting serum and swabs up to 14 dpi. To quantify transmission, adult SPF chickens were inoculated similarly, and co-housed in separate isolators with two to five wild songbirds of the aforementioned species. Cardinals demonstrated the greatest susceptibility to direct inoculation by shedding up to 10^3.9 EID50/ml of virus, with a shedding duration of 11 dpi. Of the 27 songbirds co-housed with infectious chickens over 14 dpi, one goldfinch and one house finch tested positive for LaSota by VI or RT-PCR, respectively. We then tested the transmission of the LaSota vaccine in the field, on two inoculated backyard chicken flocks. HI and RT-PCR results confirmed chickens seroconverted and shed after LaSota vaccination. Forty-one birds (13 species) seroconverted and four were positive on RT-PCR, supporting transmission of the vaccine strain virus between chickens and wild birds. Lastly, as host behavior is predictive of infection risk, we performed behavioral observations at the farms to identify the passerines most likely to enter chicken pens to consume chicken feed. We captured 30% more wild birds and observed greater wild bird activity near the enclosed flock in contrast to the free-range flock. Our preliminary data suggests that members of the Emberizidae, such as chipping and white-throated sparrows (Spizella passerine and Zonotrichia albicollis respectively) were more likely to consume supplemental feed...
and enter coops based upon season and/or habitat as opposed to chicken management style. On the other hand, resident feeder birds such as tufted titmice \((Baeolophus bicolor)\), northern cardinals and Carolina chickadees \((Poecile carolinensis)\) were more likely to forage on supplemental feed regardless of whether chickens maintained a consistent presence nearby. Our results indicate that songbirds are susceptible and have both the ecological opportunity for exposure and susceptibility of infection with paramyxoviruses, but also underscore that infection and movement of pathogens by wild birds from backyard chicken flocks can be significant to their populations, to commercial operations, or to zoological institutions.

**Key words:** Backyard chickens, domestic animal-wildlife interface, Newcastle disease, *Paramyxovirus*, songbirds

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This work was funded by the USDA-ARS, the Ford Fellowship Foundation, the Georgia Ornithological Society, the University of Georgia College of Veterinary Medicine, the AAUW, the Oconee Rivers Audubon Society, and the Poultry Respiratory Disease Coordinated Agricultural Project. We thank numerous undergraduate students who were involved in the collection of the field data.
Salmonella DYNAMICS OF RACCOONS (Procyon lotor)

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Abstract

The genus Salmonella is one of the most common causes of diarrheal diseases of people and animals. Salmonella infections are a significant public health threat, responsible for over 93 million annual illnesses worldwide and in the United States alone, >1 million cases of salmonellosis and 600 deaths are reported annually. The approach to understanding salmonellosis, its prevention, and control lends itself well to a One Health approach because it can infect such a wide variety of hosts with a wide variety of clinical outcomes, and because common environmental sources for both people and animals have been identified. Although foodborne salmonellosis in people has declined, disease caused by environmental strains, including after direct/indirect contact with animals, is on the rise. We conducted various cross-sectional studies to understand the pathogen dynamics of Salmonella in a common, abundant and general mesomammal with ample opportunity to come in contact with pets, livestock or people. We performed repeated cross-sectional studies involving 110 raccoons to: 1) compare Salmonella prevalence and serotype diversity in raccoons from several sites representing three biomes in Georgia; 2) assess the impact of season, habitat characteristics, and demographic factors on the occurrence of Salmonella in raccoon feces or on their paws; and 3) to specifically compare the impact of supplemental feeding on the Salmonella prevalence, we compared raccoons fed at feral cat Trap-Neuter-Return colonies, with those that were not supplemented in a similar habitat absent of feral cats. We found an overall prevalence of ~50% (57/114 samples), representing 73 serotypes, with no significant differences in prevalence among seasons, age, or sites - although we did find that raccoons trapped at TNR feeding stations shed Salmonella at a higher prevalence. Model selection indicated that both raccoon weight (a proxy for age) and presence of livestock were predictive of Salmonella prevalence. In addition, we isolated Salmonella from 35% of paw samples in our study, indicating that direct exposure to raccoon feces are not needed for transmission to other animals or surfaces. For serotypes recovered from all sites, Anatum, Bareilly, Braenderup, Montevideo, Muenchen, Newport and Saintpaul are among the top 20 serotypes in human cases in the United States. Due to their behavior and infection rate, raccoons are excellent reservoirs and transporters of Salmonella, relevant to people, domestic animals, and zoological institutions.

Key words: Feces, Procyon lotor, raccoons, Salmonella, zoonosis

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This work was funded by an NIH R15 grant and funds from the Food and Drug Administration. We would like to thank numerous students who were involved in the collection of the field data.
COMPARING DROMEDARY CAMEL (Camelus dromedarius) SEROPREVALENCE TO Coxiella burnetii WITH C. burnetii DNA IN Ticks COLLECTED FROM CAMELS IN LAIKIPIA COUNTY, KENYA

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Abstract

Query (Q) fever is a globally pervasive, neglected zoonotic disease of conservation and public health importance, caused by the bacterium Coxiella burnetii.8 Coxiella burnetii causes reproductive pathology in numerous zoological hoofstock species and normally causes subclinical infections in livestock.1,6,7,10,11 Dromedary camels (Camelus dromedarius) are an increasingly important livestock species in semi-arid landscapes.2,3 Ticks have been shown to be naturally infected with C. burnetii worldwide.8 This study was designed to contribute to knowledge of Q fever epidemiology in Laikipia County, Kenya, and hypothesized that there would be a positive association between camel seropositivity and carrying a tick that tested positive for C. burnetii. For this study we tested camel sera (n = 251) collected from three herds using the CHE-KIT Q fever by IDEXX C. burnetii antibody test kit (IDEXX Europe B.V., Scorpius 60 Building F, Hoofddorp 2132 LR, The Netherlands) and found 52% seroprevalence. Age and total solids were the only assessed factors significantly associated with seropositivity. Ticks from camels (n = 4,776) were divided into pools (n = 425) and tested for C. burnetii using RT-PCR to identify insertion sequence IS1111. Preliminary tick results revealed 40% positive, 25% suspect, 35% negative, and 1% inconclusive. Ticks of the genera Rhipicephalus, Hyalomma, and Amblyomma accounted for 94% (25% positive), 4% (63% positive), and 2% (73% positive) of the total tick collection, respectively. Preliminary results showed no association between camel seropositivity and carrying a positive tick. Subsequent testing using Melt-MAMA SNPs will be performed to discern C. burnetii DNA from that of non-pathogenic Coxiella-like endosymbiotic organisms before final conclusions are made regarding the association between seroprevalence and tick positivity.4,5,9

Key words: Camels, One Health, Q fever, ticks, wildlife-livestock interface, zoonoses
ACKNOWLEDGMENTS

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LITERATURE CITED


HEALTH ASSESSMENT OF BLANDING’S TURTLE (*Emydoidea blandingii*)
POPPULATIONS IN KANE COUNTY, ILLINOIS, USA

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Abstract

The state-endangered Blanding’s turtle (*Emydoidea blandingii*) is progressively declining throughout its North American range due to urban development, habitat destruction, road mortality, and predation. Characterizing the health status of Blanding’s turtle populations is critical for implementing informed management strategies, especially for small populations of particular conservation concern. For this purpose, a population level health assessment was performed in Kane County, Illinois in summer 2019. Thirty-seven unique individuals at four study sites were trapped, sampled, and evaluated. Physical examination, complete blood cell counts, biochemistry profiles, and qPCR multipathogen surveillance (four ranaviruses, three *Mycoplasma* spp., three herpesviruses, two *Salmonella* spp., *Emydomyces testavorans*, and intranuclear coccidiosis) were performed. *Emydoidea herpesvirus 1* (EBHV1) was the only pathogen detected and was found exclusively in adults in May and early June. Herpesvirus positive animals had poorer body condition (*P* = 0.001) and lower heterophil counts (*P* = 0.01) than negative animals. Ectoparasites and hemoparasites were present at all sites in most adults, with a higher ectoparasite prevalence in July (*P* = 0.001) but were not associated with signs of clinical disease. At one study site, higher prevalence of ectoparasites, lower packed cell volume, total solids, and albumin, and smaller clutch sizes may indicate a poorer plane of health when compared to the other study sites, and further investigation is planned. This study establishes a baseline health assessment in these populations, allowing for more targeted evaluation of health parameters in future studies, and potentially enabling immediate conservation actions to support health at sites of concern.

**Key words:** Blanding’s turtle, chelonian, conservation, *Emydoidea blandingii*, epidemiology, health assessment

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EPIDEMIOLOGY AND PATHOGENESIS OF Serratia marcescens IN THE LORD HOWE ISLAND STICK INSECT (Dryococelus australis)

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Abstract

The Lord Howe Island stick insect (Dryococelus australis) is endemic to the Lord Howe Island group in the southwestern Pacific. It is critically endangered, confirmed as occurring at only one site, an off-shore rock stack known as Ball’s Pyramid. The insect is extinct on Lord Howe Island following the introduction of the Black rat (Rattus rattus) in the late 1800s. A captive-breeding program by Melbourne Zoo and a rodent eradication program on Lord Howe Island have allowed reintroduction plans to proceed. A significant challenge, however, facing both the captive breeding programme and the future plans for re-introduction to Lord Howe Island is the occurrence of significant mortality events associated with the bacterium, Serratia marcescens. Our studies to characterise the S. marcescens isolated from multiple mortality events between 2014 and 2019 demonstrate that very closely related strains predominate. Thus far, we have not been able to detect an environmental source of bacteria with the same restriction endonuclease pattern as those that have been associated with these disease outbreaks and so have identified a predominant ‘outbreak’ strain (AM923). We have obtained whole genomic sequence data via both Illumina MiSeq and Nanopore long read sequences from a representative of the AM923 S. marcescens strain. Analysis of the genome to compare this sequence to other fully assembled S. marcescens genomes and short read sequences in the GenBank database show that this strain is closely related to other entomopathogenic strains. We have found that AM923 is linked to a select group of Serratia spp. that is distinct from strains associated with human disease. We have also established that these strains are pathogenic via model infection control studies in Apis mellifera, the European honeybee. We have designed and tested in preliminary conditions a multiplex qPCR assay for the specific and rapid detection of this potential pathogen in insects and the environment. We aim to optimise this qPCR to further elucidate the disease epidemiology of S. marcescens in Lord Howe Island stick insects to inform the likelihood of success of re-establishment of this species in the wild following the release of captive-bred individuals.

Key words: Epidemiology, genomic, insect, reintroduction, sequencing, Serratia marcescens

ACKNOWLEDGMENTS

The authors thank the staff of Melbourne Zoo’s Ectotherm and Veterinary departments for their assistance with this research.
ECHOCARDIOGRAPHIC EVALUATION OF GIANT TORTOISES

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Abstract

Despite the common presence of giant tortoises in captivity, there is surprisingly little published information regarding their causes of illness and death. The application of echocardiography has only recently been studied for evaluating cardiac health in chelonians. Studies have included loggerhead sea turtles (Caretta caretta), red-eared terrapins (Trachemys scripta elegans), Hermann’s tortoises (Testudo hermanni), and Russian tortoises (Agrionemys horsfieldii).2-4 This study aimed to establish a safe and effective imaging technique for echocardiography in non-anesthetized giant tortoises. Normal echocardiographic reference values were defined for 17 healthy Galapagos tortoises (Chelonoidis spp.) and compared them to previously published values, as well as those of 27 healthy Aldabra tortoises (Aldabrachelys gigantea).1 Tortoises were either placed in ventral recumbency on an elevated surface or allowed to stand in a natural position using a behavioral or food restraint. The ultrasound probe was applied in the left or right cervical brachial window for examination and was positioned in two basilar views to highlight the three chambers of the heart and the associated great vessels, the appearance of pericardial effusion, the atrioventricular inflow velocities, and pulmonic and aortic outflow velocities. Color, continuous wave, and pulsed-wave Doppler were used to assess directionality and velocity profiles of blood flow. The Simpson method was used to assess the area, volume, and ejection fraction of the single ventricle. The heart rate was 28 ± 12 (median ± SD) beats per minute (bpm) and the ejection fraction was 60.5 ± 10%. Thirty four of 44 tortoises had identifiable pericardial fluid. In conclusion, this study describes a feasible method to assess a giant tortoise’s cardiac structure and function without chemical restraint. The echocardiographic values outlined in this study represent a population of apparently healthy giant tortoises with normal cardiac structure and function. These values are being used in a further ongoing study to identify and evaluate treatment of giant tortoises with cardiomyopathy.

Key words: Aldabra tortoise, Aldabrachelys gigantea, Chelonoidis spp., echocardiogram, Galapagos tortoise, ultrasound

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The authors thank the animal care staff of Santa Fe College Teaching Zoo, St. Augustine Alligator Farm Zoological Park, Beni Family Giant Tortoise Preserve, as well as the nurses of the UF Zoo Medicine and Cardiology Services.
LITERATURE CITED


EFFECT OF BODY POSITION ON ECHOCARDIOGRAPHIC PARAMETERS IN PRAIRIE RATTLERNAKES (*Crotalus viridis*)

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Abstract

Although echocardiography is a non-invasive diagnostic tool that can provide instantaneous information about cardiac function, it is uncommonly used by veterinarians to assess reptilian patients.1-3 Echocardiograms were on 14 clinically healthy, adult prairie rattlesnakes (*Crotalus viridis*) by a board-certified veterinary cardiologist. Cardiac measurements were taken with each snake in a horizontal and vertical position to assess changes that may occur when a snake is climbing. Cardiac parameters including ventricular volume in systole and diastole as well as the diameter of the left atrium, pulmonary artery, and paired left and right aortic arches were obtained. The percentage of ventricular volume change during the cardiac cycle and the ventricular area were noted to be significantly different in snakes in the vertical position when compared to snakes in the horizontal position. No evidence of cardiac disease was noted in any of the study animals. This study is the first to obtain echocardiographic measurements in North American vipers and adds to the understanding of techniques used to evaluate the cardiac function of these species.

Key words: *Crotalus viridis*, echocardiography, prairie rattlesnake

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LITERATURE CITED


CHARACTERIZATION OF ATHEROSCLEROSIS AND ATTEMPTED TREATMENT IN ZOO-HOUSED SHOEBILLS (Balaeniceps rex)

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Abstract

Atherosclerosis is a type of arteriosclerosis characterized by intimal and medial deposition of cholesterol clefts, lipid-laden macrophages, and collagen.3 Amazon and grey parrots (Amazona spp. and Psittacus erithacus) are among the most common avian species reported with atherosclerotic lesions, but the disease has been reported in most avian orders at varying prevalence.1,2,4,5 This case series reports clinical, hematologic, imaging, and pathologic findings associated with atherosclerosis in multiple shoebills (Balaeniceps rex) in a zoologic institution. Atherosclerotic lesions were documented on post-mortem exams in six of 11 adult shoebills over a 32-yr period, and were suspected in one other. Most (n = 5) had a large focal lesion in the descending aorta at the level of the celiac and cranial mesenteric arteries documented on necropsy or by imaging. Other sites included the ascending aorta and subclavian arteries. Additional systemic degenerative arterial changes were present in six of seven birds. Common presenting clinical signs included weight loss, regurgitation, weakness, and a unilateral wing droop. Two birds were found dead without premonitory signs. The atherosclerotic lesions were diagnosed antemortem in four shoebills by radiography and computed tomography. Treatment was attempted with atorvastatin and pentoxifylline in three of these shoebills. The survival time from antemortem diagnosis in these three birds was 18, 21, and 50 days. Due to comorbidities identified on postmortem examination, the significance of the atherosclerosis in some cases was difficult to determine; however, the high prevalence of arterial disease in this species may have implications for other shoebills under managed care.

Key words: Atherosclerosis, Balaeniceps rex, descending aorta, regurgitation, shoebill

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The authors thank Drs. Patricia Gaffney, Arely Rosas Rosas, and Devinn Sinnott as well as the Disease Investigations team at San Diego Zoo Global for necropsy and histology support in these cases.

LITERATURE CITED


CHANGES IN SERUM CARDIAC TROTONIN I IN ASIAN ELEPHANTS (Elephas maximus) WITH ELEPHANT ENDOTHELIOTROPIC HERPESVIRUS INFECTION

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Abstract

Elephant endothealiotropic herpesvirus (EEHV) is one of the most significant causes of mortality in Asian elephants (Elephas maximus).4,5,8 The unusual tropism for endothelial cells of capillaries can lead to catastrophic vascular dysfunction, hemorrhage, edema, and often death.7 Being able to distinguish when viremia may lead to clinical disease, versus benign primary infection, is critical for timely intervention.1 Cardiac troponin I (cTnI), an intracellular protein of cardiomyocytes, is only present in serum when there is destruction of cardiomyocytes, and the level of cTnI is directly correlated to the severity of cardiac damage.2,3,6 The goal of this study is to identify and correlate changes in cTnI in Asian elephants with different levels of EEHV viremia. Forty-one frozen blood samples from 27 captive Asian elephants were evaluated for EEHV viremia using quantitative polymerase chain reaction on whole blood; corresponding serum was analyzed for cTnI using a high sensitivity assay.9 Viremia was categorized as none (18/41), low (<20,000 vge/ml, 11/41) and high (≥20,000 vge/ml, 12/41). Four of the non-viremic samples had detectable cTnI. Nine low viremia samples were positive for EEHV1 (1A and 1B combined) and did not have detectable troponin. Ten high viremia samples were positive for EEHV1 and had detectable cTnI (mean = 1.36, SD = 2.78). Three out of 23 viremic samples had EEHV5 viremia and no detectable cTnI. The relationship between EEHV1 viremia level and cTnI was statistically significant (n = 21, P = 0.033), suggesting that a positive EEHV1 viremia level combined with detectable cTnI might be used as an indication for initiation of treatment for EEHV1.

Key words: Asian elephant, cardiac troponin, cTnI, EEHV, Elephas maximus, endothealiotropic elephant herpesvirus

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LITERATURE CITED


SUCCESSFUL MANAGEMENT OF AN ANIMAL HEALTH CRISIS AT A ZOOLOGICAL INSTITUTION

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Abstract

An animal health crisis of viral origin caused multiple deaths including an African elephant (Loxodonta africana), three mandrills (Mandrillus sphinx), a babirusa (Babyrousa celebensis), and a lion-tailed macaque (Macaca silenus) over a 24-day period at a zoological institution. The causative agent, encephalomyocarditis virus (EMCV), was rapidly identified and multiple actions were immediately taken to manage the outbreak of disease, including reservoir host control, animal translocations, vaccination, and staff communication. These were the first cases of EMCV for this zoological institution. The emotional and workload toll on staff was managed with leadership-coordinated support for teams, an employee assistance program, and the use of decompression spaces and companion animals. Epidemiological investigation and scientific discovery of the EMCV and its reservoir host, as well as learnings on collaboration, communication, and staff support resulted in successful management of the crisis.

Key words: EMCV, reservoir host, staff wellbeing, vaccination, zoo

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SUCCESSFUL MANAGEMENT OF AN ANIMAL HEALTH CRISIS AT A ZOOLOGICAL INSTITUTION: THE POWER OF TRANSPARENCY THROUGH EFFECTIVE COMMUNICATION AND COLLABORATION

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Abstract

During an animal disease outbreak, it can be easy to focus only on health-directed efforts within the zoological institution. Equally important is having communication plans for both within the institution and with outside colleagues and professional associations. Trusting over 400 zoological professionals at multiple institutions and associations with critical information allowed us to effectively manage the crisis while maintaining a strategic level of confidentiality. Being transparent through sharing of information allowed for powerful collaborations resulting in a rapid response to the crisis. As part of the transparency focus and in accordance with AZA accreditation standards, an AZA incident report was submitted.

Key words: Collaboration, communication, transparency, zoo
SUCCESSFUL MANAGEMENT OF AN ANIMAL HEALTH CRISIS AT A ZOOLOGICAL INSTITUTION: IDENTIFYING THE ETIOLOGIC AGENT OF DISEASE AND THE SOURCE OF INFECTION

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Abstract

The rapid identification of a developing outbreak of disease and the identification of the suspect etiological agent by an in-house pathology program was critical to the management of an animal health crisis. The suspect agent was identified tentatively as EMCV on the initial day of the outbreak based on the gross lesions and confirmed within 1 wk by virus isolation and RT-PCR. There were two distinct patterns to the gross lesions; however, in all cases the lesions were confined to the heart. In non-primate cases, gross lesions consisted of broad petechial hemorrhages throughout the epicardium and ventricular myocardium, accompanied by streak-like areas of pallor throughout the ventricular myocardium. In primate cases, the gross cardiac lesions lacked the acute epicardial and myocardial hemorrhages and the areas of myocardial pallor were broader and more extensive across the ventricular myocardium. Histologic changes were characterized by peracute to acute non-suppurative myocardial necrosis. Virus isolation from heart tissue confirmed the etiology as EMCV and sequencing revealed the same strain in all six zoo animal cases, indicating they were derived from the same source. Virus testing of the reservoir hosts on the property through a surveillance program indicated that the same strain found in the fatal zoo animal cases was harbored in the reservoir host population, implicating them as the likely source of the outbreak. At the time of the outbreak, the prevalence of the virus in the trapped reservoir host population was 33%.

Key words: EMCV, reservoir host, virus isolation, zoo

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We acknowledge Victoria Sikorski for her logistical and administrative support and Dr. Phillip Gauger at Iowa State University Veterinary Diagnostic Laboratory for his assistance in EMCV qRT-PCR testing for our ongoing reservoir host surveillance program.
SUCCESSFUL MANAGEMENT OF AN ANIMAL HEALTH CRISIS AT A ZOOLOGICAL INSTITUTION: RESERVOIR HOST CONTROL AND MAPPING, ANIMAL TRANSLOCATIONS, AND VACCINATION ADMINISTRATION WITH SERUM NEUTRALIZATION MONITORING

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Abstract

Early response to an EMCV outbreak at a zoological institution focused on reservoir host control, translocating susceptible animals to reservoir host-free locations, serologic surveillance, and vaccination. Partnership with many lines of business altered the whole zoo operation to ensure a reduction in reservoir host harborage and available food sources, resulting in a rapid decrease in the reservoir host population and a reduction in the prevalence of the virus in the trapped reservoir host population (from 33% during the outbreak [April] to 11% weekly average for the 6 mo [May-October] following reservoir host mitigation). Interestingly there was an increase in reservoir host virus prevalence without an increase in reservoir host population during the historic Florida EMCV outbreak season1 (31% weekly average for November-March). A robust animal behavioral training program proved invaluable for translocating and sampling susceptible animals. The initial vaccination series of susceptible animals was performed with another AZA-accredited zoo’s manufactured killed vaccine; this gained us a 12-14 wk advantage while a vaccine was being manufactured from our viral isolate. Cross protection of the other zoo’s and our EMCV vaccines was later confirmed by antigenic comparison and plaque reduction neutralization testing. Where possible in vaccinated animals, plaque reduction neutralization titers were monitored and a four-fold increase used as a guide for possible protection. Subsequent epidemiological investigation has driven strategies for sustained reservoir host control (including weekly mapping that drives targeted mitigation efforts) and a vaccination program to reduce risk of EMCV exposure and susceptibility.

Key words: EMCV, reservoir host, serum neutralization, vaccination, zoo

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LITERATURE CITED

SUCCESSFUL MANAGEMENT OF AN ANIMAL HEALTH CRISIS AT A ZOOLOGICAL INSTITUTION: STAFF SUPPORT AND WELLBEING

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Abstract

During an animal disease outbreak at a zoological institution, multiple unexpected and sporadic deaths significantly impacted animal care teams physically, emotionally, and mentally. Massive increase in workload, grief with animal loss, fear of additional animal loss, and the initial uncertainty of staff around human health concerns resulted in both physical and emotional fatigue. Rapid engagement of the Human Resources and Human Health Services teams, as well as the Employee Assistance Program, provided staff with much needed guidance and help. Animal Care leadership efforts for day to day support was extremely well received by staff. Providing decompression spaces for Animal Care staff to take a break, get a change of scenery, and grab a snack was an important component of support. Use of emotional support animals (domestic dogs and the zoo’s animal ambassadors) to visit individuals and teams was one of the most beneficial therapies for staff.

Key words: Crisis, employee assistance program, fatigue, support animals, wellbeing, zoo

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We acknowledge Dr. Michael Hankins, Gail Brown, the Employee Assistance Program for Walt Disney World, Gina Woods and the Disney ASE Cast Experience team, as well as our dedicated cast with their emotional assistance dogs and animal ambassadors.
CAN YOU HEAR ME NOW? THE ASIAN ELEPHANT (*Elephas maximus*) EAR CANAL: A DIVERSE ENVIRONMENT

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Abstract

The ear canal of elephants is not well described and the unique anatomy of the elephant ear canal can provide challenges to examination. Long-term treatment of a female Asian elephant (*Elephas maximus*) exhibiting recurrent otitis externa was not resolving. Because of the ongoing infection during 18 mo of treatment, the question raised was, whether foreign material found in the external ear canal was normal. A study to determine the normal internal appearance of the Asian elephant ear canal was initiated utilizing a 1.4M pediatric (7.8 mm) endoscope (Karl Storz Veterinary Endoscopy-America, Goleta, CA, USA). Five additional female Asian elephants with no ear canal issues noted in their histories were examined. Most elephants had some debris (ear wax) in the external ear canal; however, one of the normal elephants contained free-living colonies of saprophytic nematodes (*Rhabditida panagrolaimus* sp.) in both ear canals. The adults were ~3 mm in length and males and females were detected. Subsequent topical treatment with 3 ml of 1% ivermectin (Norbrook Inc. Overland Park, KS USA) was infused into the ear canal via the working channel of the pediatric endoscope. Then aliquots of ~ 60 ml of warm water was infused a few minutes later to suspend the nematodes for removal through the working channel. Following removal of as many nematodes as possible, an additional 3 ml of 1% ivermectin was infused through the working channel. Endoscopic examination of both ear canals 2 mo and 1 yr after treatment, revealed normal ear canals with no nematodes.

**Key words:** Asian elephant, ear canal, *Elephas maximus*, otitis externa, parasites
ELEPHANT ENDOTHELIOTROPIC HERPESVIRUS HEMORRHAGIC DISEASE TREATMENTS AND SURVIVORSHIP IN AN ASIAN ELEPHANT CALF (Elephas maximus)

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Abstract

Prior to the onset of clinical signs, a 21-mo-old female Asian elephant (Elephas maximus) calf was diagnosed with elephant endotheliotropic herpesvirus (EEHV) 1A viremia on routine qPCR screening of whole blood. Hematologic changes included anemia, leukopenia, monocytopenia, thrombocytopenia, and marked inflammation. Immediate rectal fluid and famciclovir therapy was initiated, followed by intensive treatments performed under eight standing sedations over 9 days. The calf developed mild signs of EEHV Hemorrhagic Disease (EEHV-HD) within 12 hr and severe signs within 48 hr of diagnosis consisting of petechial hemorrhage of the tongue and vulva, edema of the head, anorexia, and weakness. Conventional therapies including crystalloid fluids, synthetic colloid fluids, plasma, whole blood, antibiotics, gastroprotectants, non-steroidal anti-inflammatories, and vitamins were administered. In addition to these, relatively novel treatments including aminocaproic acid, a famciclovir fortified fresh plasma, and allogenic stem cells were also administered. Aminocaproic acid has been evaluated in elephant plasma in vitro, but this case represents the first administration of aminocaproic acid to a calf with EEHV-HD. This treatment was clinically monitored with thromboelastography. During recovery, the calf showed improving clinical signs, rebounding CBC values, and a declining whole blood viral load. In the post-recovery period, venipuncture compliance waned and detomidine hydrochloride gel b was given transmucosally either orally or rectally to facilitate blood collection. This case highlights diagnostic and therapeutic strategies that may be applied in cases of EEHV-HD.

Key words: Aminocaproic acid, Asian elephant, EEHV, elephant endotheliotropic herpesvirus, Elephas maximus, thromboelastography

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PHARMACOKINETICS OF SINGLE-DOSE FIROCOXIB IN AFRICAN ELEPHANTS (Loxodonta africana)

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Abstract

Musculoskeletal problems requiring medical therapy occur frequently in captive elephants in North America.1,3,4 Firocoxib is one of the most commonly administered COX-2 inhibiting NSAIDs to elephants.2 The purpose of this study was to develop a dosing regimen based on the pharmacokinetics of two doses (0.01 and 0.1 mg/kg) using commercially available firocoxib tabletsa or paste.b Six adult female African elephants participated in the study. Samples were analyzed via HPLC with pharmacokinetic data subjected to non-compartmental analysis using Phoenix WinNonLin®. Serum levels of firocoxib were too low for pharmacokinetic analysis after a single oral dose of 0.01 mg/kg. At a 0.1 mg/kg dose for tablets (n = 4), mean ± SD values for key parameters were: area under the curve (AUC) 1588 ± 362 hr*ng/ml, maximum plasma concentration (Cmax) 31 ± 6.6 ng/ml at 6.4 ± 1.8 hr, and half-life (T1/2) 66 ± 59 hr. The clearance rate (CL/F) was 88.1 ± 2.17 ml/min/kg, and the apparent volume of distribution (Vz/F) was 10.93 ± 7.25 L/kg. For the paste, low numbers of participants (n = 2) prevented determination of some parameters. Key pharmacokinetic parameter averages included: AUC of 814 hr*ng/ml, Cmax of 44 ng/ml, Tmax of 7.0 hr, T1/2 of 36.4 hr, and a kd of 0.019 1/hr. The CL/F was 132 ml/min/kg and the Vz/F was 6.9 L/kg. Based on mean AUC, the relative bioavailability of paste compared to tablet formulations was 50%. While study numbers were low, these data support a dose of 0.1 mg/kg PO q24 hr for African elephants.

aPrevicox® chewable tablets, Merial Limited, Duluth, GA 30096-4640, USA
bEquioxx®, oral paste, Merial Limited, Duluth, GA 30096-4640, USA

Key words: Equioxx®, firocoxib, Loxodonta africana, pain, pharmacokinetics, Previcox®

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The authors are grateful to the keepers, veterinarians, and staff at the facilities who participated in this study, including the Maryland Zoo in Baltimore, the Caldwell Zoo, and the Cleveland Metroparks Zoo. The authors also would like to thank the staff of the Clinical Pharmacology Laboratory at Auburn University for their perseverance with sample analysis. The Morris Animal Foundation provided support for this research (D15ZO-007).

LITERATURE CITED


SINGLE-DOSE, MULTIPLE-DOSE, AND THERAPEUTIC DRUG MONITORING PHARMACOKINETICS OF FIROCOXIB IN ASIAN ELEPHANTS (Elephas maximus)

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Abstract

Musculoskeletal problems requiring medical therapy occur frequently in captive elephants in North America.1-3 The purpose of these studies was to evaluate cyclooxygenase (COX) inhibition and determine appropriate dosing based on the pharmacokinetics of two doses (0.01 and 0.1 mg/kg) of firocoxib. Twenty-one Asian elephants participated in these studies. Single oral dosing of a commercially available tableta (n = 7) or pasteb (n = 4) determined a preferred dose, which was evaluated further via single IV dosec (n = 3), consecutive oral doses of both formulations (n = 6 tablets, n = 5 paste), and finally therapeutic monitoring of clinical patients (n = 5). Sample analysis was via HPLC with pharmacokinetic data subjected to non-compartmental analysis. Serum levels of firocoxib were too low for pharmacokinetic analysis after a single oral dose of 0.01 mg/kg. Key parameters for the single oral dose of 0.1 mg/kg included Cmax (49 ± 3.27 ng/ml for tablets; 62 ± 14.8 ng/ml for paste), AUC (1332 ± 878 hr*mg/ml for tablets; 1455 ± 634 hr*mg/ml for paste), and T½ (34.3 ± 30.3 hr for tablets; 19.9 ± 12.8 hr for paste). After consecutive daily oral doses (0.1 mg/kg), the time to steady state was 5 days, and after 8 days of dosing, parameters included AUC (6341± 3003 hr*mg/ml for tablets; 5613 ± 2262 hr*mg/ml for paste), and T½ (84.4 ± 32.2 hr for tablets; 62.9 ± 2.25 hr for paste). Firocoxib preferentially inhibited COX-2, and no elephants experienced any adverse effects. Firocoxib should be administered to Asian elephants at a dose of 0.1 mg/kg PO q24 hr.

aPrevicox® chewable tablets, Merial Limited, Duluth, GA 30096-4640, USA
bEquioxx®, oral paste, Merial Limited, Duluth, GA 30096-4640, USA
cEquioxx® injection, Merial Limited, Duluth, GA 30096-4640, USA

Key words: Elephas maximus, Equioxx®, firocoxib, pain, pharmacokinetics, Previcox®

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The authors are grateful to the keepers, veterinarians, and staff at the facilities who participated in this study including the Center for Elephant Conservation, the Santa Barbara Zoo, the Tulsa Zoo, Fresno Chaffee Zoo, and African Lion Safari. The authors also would like to thank the staff of the Clinical Pharmacology Laboratory at Auburn University for their perseverance with sample analysis. The Morris Animal Foundation provided support for this research (D15ZO-007).
LITERATURE CITED


NOVEL DIAGNOSTIC EVALUATION OF FATAL *Balamuthia mandrillaris* MENINGOENCEPHALITIS IN A CAPTIVE BORNEAN ORANGUTAN (*Pongo pygmaeus*) WITH IDENTIFICATION OF POTENTIAL ENVIRONMENTAL SOURCE AND EVIDENCE OF CHRONIC EXPOSURE

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¹Phoenix Zoo Arizona Center for Nature Conservation, Phoenix, AZ 85008 USA; ²Midwestern University College of Veterinary Medicine, Glendale, AZ 85308 USA; ³Centers for Disease Control and Prevention (CDC), Atlanta, GA 30333 USA

**Abstract**

In 2017, an 11.5-yr-old female Bornean orangutan (*Pongo pygmaeus*) was examined for lethargy and facial grimacing. Within 72 hr, left-sided hemiparesis developed that worsened over the next week. An MRI revealed a focal right-sided cerebral mass suspected to be a neoplasm. Ten days after onset of clinical signs, the orangutan was deceased.

On postmortem exam, the medial right parietal lobe was replaced by a focus of neuromalacia and hemorrhage (7 cm × 4 cm × 3.5 cm) that displaced the lateral ventricle and abutted the corpus callosum. Histopathology of the cerebral lesion revealed pyogranulomatous meningoencephalitis with intratissui amoeba trophozoites and rare cysts. Fresh parietal lobe was submitted to the Center of Disease Control (CDC) for multiplex free-living amoebae real-time PCR and detected *Balamuthia mandrillaris* DNA at a high burden. Mitochondrial DNA was sequenced and a 760-bp locus 19443F/20251R was compared to several human infections of *B. mandrillaris* and shown to be identical to the isolates from four human cases of encephalitis. Indirect immunofluorescent antibody testing of stored serum samples indicated this orangutan had exposure to *B. mandrillaris* for at least 2.5 yr prior to death. Within 1 wk of the orangutan’s death, water from the exhibit was analyzed and identified the presence of *B. mandrillaris*. *Balamuthia mandrillaris* is considered a rare emerging infectious disease in humans with 109 cases identified by the CDC since 1974.¹ This is the first non-human report of *B. mandrillaris* to include antemortem imaging, retrospective antemortem serum antibody evaluation, and successful environmental identification of the amoeba.

**Key words:** *Balamuthia mandrillaris*, Bornean orangutan, indirect immunofluorescence antibody (IFA) assay, magnetic resonance imaging, *Pongo pygmaeus*

**LITERATURE CITED**

CLINICAL MANAGEMENT OF DENTAL DISEASE IN PYGMY SLOW LORISES (Nycticebus pygmaeus) IN HUMAN CARE

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Abstract

Dental disease is a common finding in pygmy slow lorises (Nycticebus pygmaeus) under human care, but etiology is not fully understood. The limited size of the oral cavity can make dental disease difficult to fully appreciate. A retrospective study evaluated medical records, diet, and husbandry protocols from 18 of 22 holding institutions with the objective to describe the clinical signs, most commonly affected areas, diagnostics, and treatment protocols used, to help guide care for dental disease. The total study population was 42 animals ranging from 2-15.25 yr old, 19 males (44.2%), 20 females (46.5%), and three with no documented sex (9.3%). Multiple cases (n = 26) did not present any indication of dental disease prior to the examination. Evidence of periodontal disease, such as gingivitis, began on average at 7.66 yr in males and at 9.06 yr in females. Skull radiographs were the most frequently reported diagnostic tool (n = 13 cases), but many were inconclusive for tooth root resorption (n = 8; 61.5%), while all of the cases imaged with computed tomography (CT) (n = 4) were able to highlight it. Molars were the most frequently extracted teeth (n = 20). Diets with high fruit content and low gum exudate have been associated with dental disease in this species, but not all animals on the same diet developed it. Routine dental examinations and change of diet could minimize development of dental disease, while CT provides a superior imaging modality to diagnose it earlier in this species.

Key words: Dental disease, diet, Nycticebus pygmaeus, periodontal disease, pygmy slow loris

ACKNOWLEDGMENTS

The authors thank the following institutions for their participation and providing information for this study: Akron Zoo, Albuquerque Biopark, Brookfield Zoo, Busch Gardens, Capron Park Zoo, Cincinatti Zoo, Columbus Zoo & Aquarium, Duke Lemur Center, El Paso Zoo, Lee Richardson Zoo, Lincoln Park Zoo, Little Rock Zoo, Mesker Park Zoo, Omaha’s Henry Doorly Zoo and Aquarium, The Philadelphia Zoo, Pueblo Zoo, Trevor Zoo, and Wildlife Conservation Society-Bronx Zoo. Authors also thank the slow loris Species Survival Plan (SSP) and Taxonomic Advisory Group (TAG) committees for their support in this study.

LITERATURE CITED


REPRODUCTIVE HEALTH EVALUATION AND CONTRACEPTIVE USE IN SANCTUARY CHIMPANZEEES (Pan troglodytes verus) IN SIERRA LEONE

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Abstract

The bushmeat and pet-trade result in unimaginable numbers of primates needing care at in-country sanctuaries. 1 Natural social structure was ranked the most important attribute for welfare in chimpanzees under human care, 2 but reproduction control is necessary to manage sanctuary populations. 3 This study evaluated the reproductive health of sanctuary chimpanzees managed with long-term contraception. Females > 7 yr and consistent full sexual swellings > 6mo were started on oral contraceptives, followed by implant placement at their next exam, and replaced at recommended intervals (Table 1).

Eighty-eight chimpanzees (Pan troglodytes verus; 36 males; 52 females; 1-36 yr) underwent preventive medicine evaluation and contraception updates. Mean duration of contraception in females was 7.8 yr (0-15.3 yr). Five unintended pregnancies occurred: due to a lapse in contraception (n = 2), during active 3-yr implants (Zarin®) use (n = 3); the latter possibly suggesting that these implants have a shorter efficacy in some chimpanzees. Two pregnant females were implanted, parturition was normal. Females on progestin implants experienced folliculogenesis and estrus; 58% (31/53) of females showed: follicles (on ultrasound), sexual swellings, sperm on vaginal cytology, and / or mating. Sexual activity is an important part of chimpanzee social life, and long-term progestin contraception does not appear to interfere with this social interaction. Overall, few reproductive lesions were found via ultrasound examination: uterine leiomyomas (n = 3), testicular mineralization (n = 5), epididymal dilation (n = 1, vasectomy); and peri-testicular fluid (n = 8). Progestin implants in females seem to effectively balance social needs, reproductive control and reproductive health in great apes, thereby maintaining positive social welfare.

Key words: Chimpanzee, contraception, Pan troglodytes, reproductive health, sanctuary, welfare

ACKNOWLEDGMENTS

We thank Dr. Carmen Vidal and Dr. Alejandra Romero-Forero, Mori, Pastor, Sinneh and Sheriff and the Tacugama Chimpanzee Sanctuary animal care staff and volunteers for their work in support. The authors would like to thank the Barcelona Zoo Foundation (Becas PRIC, Fundació Barcelona Zoo) for financial support for the project.
LITERATURE CITED


Table 1. Number of contraception bouts (n = 128) used at Tacugama Chimpanzee Sanctuary (2008-2020) in 37 females.

<table>
<thead>
<tr>
<th>Contraception Implants</th>
<th>Inter-dose interval</th>
<th>Bouts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etonogestrel 68 mg (Implanon NXT®)</td>
<td>2-2.5 yr</td>
<td>73</td>
</tr>
<tr>
<td>Etonogestrel 68 mg (Nexplanon®)</td>
<td>2-2.5 yr</td>
<td>3</td>
</tr>
<tr>
<td>Levonorgestrel 150 mg (Jadelle®)</td>
<td>2-2.5 yr</td>
<td>22</td>
</tr>
<tr>
<td>Levonorgestrel 150 mg (Zarin®)</td>
<td>3 yr</td>
<td>18</td>
</tr>
<tr>
<td>Oral combination pill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levonorgestrel + ethinylestradiol (Microgynon®)</td>
<td>24 hr</td>
<td>2</td>
</tr>
<tr>
<td>Gestoden + ethinylestradiol (Harmonet®)</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Levonorgestrel + ethinylestradiol (Lydia®)</td>
<td>24 hr</td>
<td>3</td>
</tr>
<tr>
<td>Levonorgestrel + ethinylestradiol (Femicept®)</td>
<td>24 hr</td>
<td>1</td>
</tr>
</tbody>
</table>

aN.V. Organon, Oss, The Netherlands, a subsidiary of Merck & Co., Inc.
bN.V. Organon, Oss, The Netherlands, a subsidiary of Merck & Co., Inc.
cBayer AG, Leverkusen, Germany.
dShanghai Dahua Pharmaceutical Co. Ltd, Shanghai, China.
eBayer AG, Leverkusen, Germany.
fPfizer Ireland Pharmaceuticals, Co. Kildare, Ireland.
gMylan Laboratories Limited, Mumbai, India.
hAccord Healthcare Ltd, Harrow, United Kingdom.
CONGENITAL SOFT PALATE DEFECT AND CORRECTIVE PALATOPLASTY IN A PYGMY HIPPOPOTAMUS (Choeropsis liberiensis)

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Abstract

Several days after birth, a male pygmy hippopotamus (Choeropsis liberiensis) calf was noted to have intermittent respiratory stertor; the animal was otherwise healthy, nursing, and gaining weight appropriately. At approximately 1 mo of age, the calf began exhibiting a behavior similar to a reverse sneeze, especially after nursing. Occasionally white fluid was expelled from the nostrils. Two months later, the calf developed intermittent bilateral mucopurulent nasal discharge. A culture was performed and targeted antibiotic therapy was instituted. The nasal discharge subsequently improved; however, the stertorous breathing and reverse sneeze-type activity continued, especially after eating. At 6 mo of age the calf was anesthetized for further diagnostics. Computed tomography (CT) of the head showed a congenital defect of the soft palate with failure of midline closure. This defect resulted in communication of the nasopharynx and oropharynx with accompanying bilateral otitis media and rhinitis. Rhinoscopy and laryngoscopy confirmed mucus and food material in the nasal passages bilaterally. At 9 mo of age, the calf underwent a palatoplasty to correct the defect between the nasopharynx and oropharynx. Repeat CT scan and intra-oral examination 1 mo later indicated that, although the soft palate was longer than prior to surgery, a defect was still present. The animal continues to expel food material from the nasal passages shortly after eating and its weight is slightly below the expected growth curve, but it is otherwise normal. This is the first reported case of a soft palate defect in this species.

Key words: Choeropsis liberiensis, cleft palate, computed tomography, palatoplasty, pygmy hippopotamus, rhinoscopy

ACKNOWLEDGMENTS

We thank Drs. Raul Cortes, Briana Danielson, and Miguel Medina for their assistance with this case. We also thank the keepers at Zoo Miami for their dedicated care of this patient.
RETROSPECTIVE SURVEY OF NEOPLASIA IN MANAGED GIRAFFES (Giraffa camelopardalis)

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Abstract

While giraffes (Giraffa camelopardalis) are commonly managed in zoos and conservation programs worldwide, the current understanding of the prevalence and progression of neoplastic disease in giraffes is limited by the scarcity of published reports.1-4 This study collated documented cases of neoplasia based on gross and histologic evaluation of ante- and postmortem samples. In total, 30 giraffes from 22 institutions across the United States were included. While subspecies was not reported in all cases, those identified included Masai, Rothschild’s, and reticulated subspecies. Thirteen animals died natural deaths, 15 were euthanized, and two were alive at the time of this report. A total of 38 tumors were reported and classified as eighteen (18) different diagnoses, including leiomyoma (7), adenoma (4), luteoma (4), lymphoma (4), pheochromocytoma (3), squamous cell carcinoma (3), adenocarcinoma (2), ameloblastic fibroma (1), carcinomatosis of undetermined cell lineage (1), cavernous hemangioma (1), cystic granulosa cell tumor (1), dysgerminoma (1), fibrosarcoma (1), leukemia (1), lipoma (1), pituitary nerve sheath tumor (1), rhabdomyosarcoma (1), and teratoma (1). Multiple concurrent neoplastic lesions were documented in six cases. Mesenchymal tumors (18) comprised the majority of neoplasms. The most prevalent location, regardless of tumor type, was the female reproductive tract (14). Twenty-four neoplastic lesions were incidental findings at necropsy, whereas eight neoplasms were considered to be the primary cause of death. The findings reported here characterize multiple neoplastic lesions in giraffes and could provide insight to the future management of this species.

Key words: Cancer, Giraffa camelopardalis, giraffe, neoplasia, tumor, zoological institution

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The authors thank the many AZA-accredited institutions that generously provided cases for inclusion in this report. The authors are also grateful to Cathy Minogue of Northwest ZooPath for data retrieval.

LITERATURE CITED


GIRAFFE SKIN DISEASE: THE CLINICOPATHOLOGIC CHARACTERIZATION OF CUTANEOUS FILARIASIS IN THE CRITICALLY ENDANGERED NUBIAN GIRAFFE (Giraffa camelopardalis camelopardalis)

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Abstract

Giraffe skin disease (GSD) is an emerging disease recognized in the last 25 yr. 2 Nubian giraffe (Giraffa camelopardalis camelopardalis) are critically endangered,4 and identifying the etiology of GSD and understanding its impact on health is a priority in supporting the population. Sixty-four Nubian giraffe were immobilized in Murchison Falls National Park, Uganda, from 2017-2019. GSD lesions were examined, biopsied, and overall health assessed by visual exam and bloodwork. Fifty-five captured giraffe had GSD (86%) affecting the neck, axilla, shoulders, chest, and cranial trunk, with no lesions on the hips, limbs, dorsum, or head. Emerging lesions were characterized as 1-3 cm ulcerated papules with eosinophilic-pyogranulomatous dermatitis and fibrosis. Chronic-active lesions were 2-23 cm ulcerated plaques with granulation tissue, hyperkeratosis, and severe eosinophilic and pyogranulomatous dermatitis. Inactive lesions were 2-16 cm contracted scars with hyperkeratosis and residual inflammation. Emerging and chronic-active lesions included granulomas within hair follicles containing adult Spirurid nematodes with myriad superficial encysted microfilaria and burrowing stage III larvae. Microanatomy of the nematode was consistent with Stephanofilaria sp., a parasite transmitted by biting flies and described in skin lesions of livestock and wildlife worldwide, including rhinoceros (Rhinoceros sp.).1,3,5 Lesions were most actively parasitized during heavy fly seasons. 25% of giraffe were treated with experimental dosages of 1% ivermectin (200 µg / kg SC, Durvet, MO, USA) or 5% eprinomectin (1 mg/kg SC, Boehringer Ingelheim, GA, USA) and translocated to new ranges within Uganda. Long-term monitoring of the lesions and response to treatment are an ongoing project to help conserve the Nubian giraffe.

Key words: Filariasis, Giraffa camelopardalis camelopardalis, giraffe skin disease, Nubian giraffe, parasitic dermatitis, Spirurid nematode, Stephanofilaria, Uganda

ACKNOWLEDGMENTS

The authors sincerely thank the many supporters of Operation Twiga II, III & IV, in particular the Metzger Foundation. Ivan Carter Wildlife Conservation Alliance, Cheyenne Mountain Zoo, World Giraffe Day 2018, Cleveland Metroparks Zoo and others, and for the generous support of the AZA Conservation Grant Fund/Disney
Conservation Fund 2018, Mrs. Rae Memorial Fund, and Columbus Zoo and Aquarium. The samples were collected under a research permit of the Giraffe Conservation Foundation and their agreement with the Uganda Wildlife Authority and were imported into the USA with the appropriate permits through USDA.

LITERATURE CITED


ALLERGEN TESTING IN TWO RELATED ONE-HORNED RHINOCEROSES
(Rhinoceros unicornis) WITH SEASONAL DERMATITIS

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Colleen M. McCann, PhD,2 Kenneth J. Conley, DVM, DACVP,1 Denise McAloose, VMD,
DACVP,1 Andrew Rosenberg, DVM, Dipl ACVD,3 and John M. Sykes IV, DVM, Dipl ACZM1

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Abstract

Skin diseases of rhinoceroses are common but descriptions are primarily limited to diseases of
black and white rhinoceroses (Diceros bicornis and Ceratotherium simum).1,3-5 Allergic dermatitis
was diagnosed in a 25-yr-old female Rhinoceros unicornis and her 6-yr-old female offspring by
skin biopsy, intradermal skin (IDST) and allergen specific serum IgE testing. Dam and offspring
presented with seasonal, ulcerative dermatitis affecting the face, legs and trunk starting at 6 and 2
yr of age, respectively. Symptomatic treatment included systemic (oral antibiotics, antihistamines,
steroids, pentoxifylline) and topical (steroid and antibiotic ointments and antiseptic shampoos and
sprays) therapies, but the condition worsened over time. Specific allergen testing was then pursued
during a single standing sedation using transmucosal or injectable detomidine. IDST was
performed just caudal to the pinnal base using controls (sterile saline and histamine phosphate)
and 61 regionally specific allergens. This anatomic location produced adequate visualization and
skin thickness to immediately evaluate for intensity of reaction (wheal size, erythema, turgidity).
Specific serum allergen responses were detected in each animal using Heska’s Equine
ALLERCEPT® Allergen Panel. Histopathology of the affected skin was consistent with an
allergic etiology: chronic eosinophilic dermatitis. Based on protocols developed in horses,4
injectable allergen-specific immunotherapy has been initiated in these animals. This is the first
reported use of IDST and serological allergen testing in rhinoceroses, detailing feasibility for
future studies to aide in the diagnosis and treatment of allergic dermatopathies.

Key words: Allergic dermatitis, biopsy, Heska equine allergen panel, intradermal skin
testing, rhinoceros, Rhinoceros unicornis

ACKNOWLEDGMENTS

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in the Mammal Department for their assistance in the success of this process.

LITERATURE CITED

1. Miller MA, Buss PE. Rhinoceridae (Rhinoveroses). In: Miller RE, Fowler ME (eds.). Fowler’s zoo and wild


INTRAVENOUS BUTORPHANOL IMPROVES MIXED VENOUS OXYGEN CONTENT IN ETORPHINE-IMMOBILIZED WHITE RHINOCEROS (*Ceratotherium simum*) PRIMARILY BY DECREASING TISSUE OXYGEN CONSUMPTION RATHER THAN BY INCREASING TISSUE OXYGEN DELIVERY

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Abstract

Butorphanol increases arterial oxygen partial pressure (PaO₂) in etorphine-immobilized white rhinoceros (*Ceratotherium simum*), hence the hypothesis it would increase oxygen delivery to tissues (DO₂).1 Six sub-adult, male, white rhinoceros were administered each of two treatments in random order, 2 wk apart: etorphine-saline and etorphine-butorphanol. Rhinoceros were darted intramuscularly with etorphinea (2.6 ± 0.1 µg/kg) (mean ± SD), intubated nasally in sternal recumbency (time = 0 minutes [t = 0]), positioned in lateral recumbency, and connected to a breathing system with pneumotachometer.b Peripheral arterial and balloon-tipped thermodilution pulmonary arterial catheters were inserted.c Baseline data were collected at t = 30, butorphanold (0.026 ± 0.001 mg/kg) or saline was administered intravenously at t = 37, and data were collected at t = 40 and 50. A linear mixed effect model was used to determine differences between treatments. At t = 40 and 50, PaO₂ and arterial oxygen content (CaO₂) were greater after butorphanol than after saline (each P < 0.0001). Cardiac output (Qt) was lower after butorphanol at both times (each P < 0.0001). There was no difference in DO₂ between treatments. However, at both times, oxygen consumption (VO₂) was lower (P = 0.0009 and 0.0029, respectively) after butorphanol than after saline. Mixed venous oxygen partial pressure and content (PvO₂ and CvO₂, respectively) were greater after butorphanol at both times (each P < 0.0001). Despite the increased CaO₂ after butorphanol, DO₂ did not increase because Qt decreased; however, the simultaneous decrease in VO₂ increased PvO₂ and CvO₂, indicating improved oxygen supply-and-demand balance.

aVoluplex, Mnandi, Centurion 0157 South Africa
bADInstruments Pty Ltd, Bella Vista, New South Wales 2153 Australia
cGaeltec Devices Ltd, Dunvegan, Isle of Skye, IV55 8GU, Scotland
dWildlife Pharmaceuticals Pty Ltd, White River, Mpumalanga 1240 South Africa
**Key words:** Butorphanol, *Ceratotherium simum*, etorphine, hypoxemia, oxygen delivery, white rhinoceros

**ACKNOWLEDGMENTS**

The authors thank the John T. and Jane A. Wiederhold Foundation, the South African Veterinary Association Wildlife Group, the South African National Research Foundation, Veterinary Wildlife Services, South African National Parks, Leana Rossouw, Guy Haussler, Thembeka Mtetwa, Penelope Miya, and Gaeltec Devices.

**LITERATURE CITED**

PLASMA CONCENTRATIONS AND CLINICAL EFFECTS OF BUTORPHANOL-
AZAPERONE FOR STANDING SEDATION OF SOUTHERN WHITE RHINOCEROS
(Ceratotherium simum simum)

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Abstract

Despite the risks associated with immobilization of rhinoceroses, there are no published pharmacokinetic studies on chemical immobilizing agents in any rhinoceros species. Standing sedation in rhinoceros is necessary for various clinical procedures, such as artificial insemination and other reproductive techniques. Butorphanol and azaperone have been described for sedation in rhinoceros species, but administration has resulted in varying degrees of sedation, including recumbency.1,2 This study evaluated the plasma concentrations, pharmacokinetics, and clinical sedative effects of butorphanol and azaperone in southern white rhinoceroses (Ceratotherium simum simum). Standing sedation (n = 8) was performed in southern white rhinoceroses (n = 3) using a combination of butorphanol (mean 25.3 µg/kg; range 22-30 µg/kg) and azaperone (mean 25.9 µg/kg; range 20-30 µg/kg) injected intramuscularly with blood collection at opportunistic time points approximately every 10 min. Standing sedation was achieved for 73.5 min (mean) (range 58-99 min). Plasma concentration of butorphanol ranged from 0.62 to 3.96 ng/ml, and azaperone ranged from 0.69 ng/ml to 28.29 ng/ml. Video evaluated by two reviewers using a novel quantitative scoring system was used to assess sedation level and correlate with plasma concentrations. Preliminary pharmacokinetic parameters, including peak plasma concentration and time to peak plasma concentration, for each drug were evaluated. The findings of this study will help guide standing sedation of southern white rhinoceroses, as well as provide novel pharmacokinetic and pharmacodynamic data on chemical immobilizing agents.

Key words: Azaperone, butorphanol, Ceratotherium simum simum, southern white rhinoceros

ACKNOWLEDGMENTS

The authors thank the Sacramento Zoo Conservation Fund and San Diego Zoo Northern White Rhinoceros Initiative for funding.

LITERATURE CITED

COMPARISON OF A SINGLE VERSUS TWO-DART ANESTHESIA INDUCTION PROTOCOL IN PRZEWALSKI’S HORSES (Equus ferus przewalski)

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Abstract

Anesthesia is often needed to perform veterinary procedures in Przewalski’s horses (Equus ferus przewalski).1,2 Behavioral and physiologic parameters were prospectively compared in 14 horses (six males, eight females, 3-18 yr) after a single versus two-dart induction with intramuscular medetomidine (0.06 mg/kg), butorphanol (0.05 mg/kg), thiafentanil (0.02 mg/kg) and ketamine (1 mg/kg). Horses were randomly assigned to receive all drugs in a single dart or receive medetomidine and butorphanol 10 min prior to thiafentanil and ketamine in a second dart. Induction and recovery quality were scored on a scale from 1-5 (worst to best) and video recordings assessed for frequency of specific behaviors. Need for supplemental propofol was recorded. Median values for scores were compared using the Mann-Whitney U test. Frequency of selected behaviors and propofol use were compared using Fisher’s exact test. P ≤ 0.05 considered significant. Median induction score was better (P = 0.01) with two darts (4/5) compared to a single dart (3/5). Degree of muscle fasciculation was less (P = 0.006) with the two-dart protocol. Though not statistically significant, 14% versus 71% of horses transitioned to recumbency headfirst (undesirable) after two darts versus one dart respectively (P = 0.07), and supplemental propofol was administered in 43% of horses after two darts versus 100% of horses after one dart (P = 0.10). Physiologic and recovery parameters did not differ significantly between groups. Improved induction quality was observed using a two versus one-dart induction protocol and should be considered when anesthetizing Przewalski’s horses in zoological institutions.

Key words: Anesthesia, Equus ferus przewalski, Przewalski’s horse, thiafentanil

ACKNOWLEDGMENTS

The authors thank Drs. Jack Allen, Jeff Zuba, and James Oosterhuis for facilitating data collection, and the Harter hospital staff, mammal curators, animal managers and keepers at the San Diego Zoo Safari Park for their invaluable assistance during the procedures. Similarly, the authors thank Drs. Miranda Sadar, Matthew Johnston, Melinda Frye and Mark Stetter at Colorado State University for their support of this collaborative effort.

LITERATURE CITED

RETROSPECTIVE COMPARISON OF CHEMICAL IMMOBILIZATION PROTOCOLS FOR CAPTIVE SABLE ANTELOPE (Hippotragus niger)

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Abstract

Large dangerous hoofstock, sable antelope (Hippotragus niger), often are managed in captivity via chemical immobilization.1 Despite several recorded protocols, limited objective or subjective data has been reported for chemical immobilization of this species. Immobilization records of 161 sable antelope without major health issues were reviewed. Subjective ratings and objective measurements during anesthesia for combinations of thiafentanil and xylazine (TX), butorphanol and azaperone and medetomidine (BAM), carfentanil and xylazine (CX), carfentanil and acepromazine (CA), and etorphine and xylazine (EX) were compiled and statistically analyzed with significance determined at $P < 0.05^a$ (Table 1). TX had better induction ratings than CA, EX and CX, but not BAM. Both BAM and TX resulted in the best muscle relaxation, followed by CX. Overall anesthetic ratings were best in TX and EX compared to CA and CX. Complications were 2.56 times more likely with CX compared to other drug combinations. Time to recumbency was longest in BAM, EX, and CA compared to CX, and shortest in TX. Time from reversal to standing was longest with CX compared to TX, CA, and EX. Initial heart rate was highest in CA and lowest in BAM compared to all other combinations. Initial respiratory rate was not significantly affected by drug combination. Initial body temperature was lower for BAM and TX compared to CA and EX. While all drug combinations evaluated can be used to successfully immobilize H. niger, certain combinations may be situationally preferred based on desired muscle relaxation, expected induction or recovery times, anticipated procedure length, or ambient temperature at time of immobilization.

aWildlife Pharmaceuticals, Inc., Windsor, Colorado, 80550, USA

Key words: Chemical immobilization, Hippotragus niger, opioid, sable antelope, thiafentanil, xylazine

ACKNOWLEDGMENTS

The authors thank the Veterinary Medical Science Research and Training Program at Texas A&M University and the Animal Care Staff at Fossil Rim Wildlife Center for their support.

LITERATURE CITED

Table 1. Estimated dosage of drugs based on combinations utilized in the immobilization of sable antelope at Fossil Rim Wildlife Center.

<table>
<thead>
<tr>
<th>Immobilizing combination</th>
<th>Immobilizing drug</th>
<th>Dosage (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carfentanil, xylazine</td>
<td>Carfentanil</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>Xylazine</td>
<td>0.14</td>
</tr>
<tr>
<td>Etorphine, xylazine</td>
<td>Etorphine</td>
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<tr>
<td></td>
<td>Xylazine</td>
<td>0.10</td>
</tr>
<tr>
<td>Thiafentanil, xylazine</td>
<td>Thiafentanil</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>Xylazine</td>
<td>0.12</td>
</tr>
<tr>
<td>Carfentanil, acepromazine</td>
<td>Carfentanil</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>Acepromazine</td>
<td>0.04</td>
</tr>
<tr>
<td>Butorphanol, azaperone, medetomidine</td>
<td>Butorphanol</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>Azaperone</td>
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</tr>
<tr>
<td></td>
<td>Medetomidine</td>
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</table>
EVALUATION OF AGREEMENT BETWEEN OSCILLOMETRIC AND DIRECT BLOOD PRESSURE MEASUREMENT TECHNIQUES IN ANESTHETIZED CAPTIVE CHIMPANZEEES (Pan troglodytes)

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Abstract

Chimpanzees in captivity commonly develop cardiomyopathies, and since vascular disease is a potential coexisting factor,1,2 accurate blood pressure measurement is essential in diagnosing and managing these disease processes. No study has evaluated the level of agreement between invasive blood pressure measurement, which is the gold standard, and more frequently used oscillometric techniques. This is important because measurement of blood pressure non-invasively, if reliable, would make monitoring these disease processes more feasible through operant conditioning in captive animals without immobilization. The objective was to evaluate the level of agreement between direct and both finger and brachial oscillometric blood pressure measurement techniques in anesthetized chimpanzees. Data was recorded every 5 min from eight chimpanzees anesthetized with ketamine, dexmedetomidine, midazolam and isoflurane.

Agreement between direct, brachial and finger measurements for systolic, diastolic and mean (MAP) arterial pressure was assessed by Bland-Altman plot. The mean difference between two measurement methods and 95% upper and lower limits of agreement (LOA) were calculated. Sensitivity and specificity were determined to identify the oscillometric techniques’ ability to detect hypotension.

For MAP, the bias between finger and direct and brachial and direct was 1.2 mmHg (LOA ± 35) and 0.8 mmHg (LOA ± 30), respectively. The sensitivity and specificity for MAP measured by finger were 65.6% and 94.1% while brachial was 78.4% and 94.6%. Brachial MAP was within ≤ 20 mmHg of direct 87% of the time. Oscillometric blood pressure measurement via a cuff placed on the brachium provided reasonable agreement with the gold standard while the finger cuff displayed less agreement.

Key words: Chimpanzee, direct blood pressure, oscillometric, Pan troglodytes

ACKNOWLEDGMENTS

The authors thank the animal care staff of both Zoo Knoxville and Chattanooga Zoo.

LITERATURE CITED

VARIATIONS IN BLOOD PRESSURE DURING ANESTHETIC EVENTS IN CHIMPANZEES (Pan troglodytes)

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Abstract

Blood pressure can vary during anesthetic events, particularly with administration of vasoactive anesthetic drugs, and should be monitored as an indicator of anesthetic depth and tissue perfusion. Previous reports of indirect blood pressure monitoring in chimpanzees (Pan troglodytes) and gorillas (Gorilla gorilla) anesthetized with ketamine, medetomidine and isoflurane, documented initial hypertension, followed by normotension. Antagonism of medetomidine led to a hypotensive state.

Direct blood pressure monitoring is the gold standard, but is often not performed due to technical limitations or lack of available equipment. In this study, arterial catheters were placed in the medial tibial artery and direct blood pressure was monitored in eight chimpanzees during anesthesia with ketamine, dexmedetomidine and midazolam (Phase 1). Four animals required isoflurane to achieve an adequate plane of anesthesia. Blood pressure was recorded every 5 min for 30 min. Atipamezole was administered to antagonize dexmedetomidine, and isoflurane was then used in all animals to maintain anesthesia (Phase 2). Blood pressure readings were recorded for a further 30 min. Arterial blood pressure decreased over time, and showed significant decreases in mean, diastolic and systolic arterial pressure between phases 1 and 2 (P < 0.01), and with the use of isoflurane in phase 1 (P < 0.01). All chimpanzees entered a hypotensive state (mean arterial pressure < 60 mmHg) and four were profoundly hypotensive (mean arterial pressure < 40 mmHg) during phase 2. Caution is recommended with the antagonism of alpha-2 drugs and continued use of isoflurane during anesthesia with respect to effects on blood pressure.

Key words: Alpha 2 agonist, anesthesia, blood pressure, chimpanzee, Pan troglodytes

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The authors thank the animal care staff of both Zoo Knoxville and Chattanooga Zoo, in addition to Masimo Corporation for the loan of their equipment

LITERATURE CITED

EFFECTS OF MIDAZOLAM ON CORTICOSTERONE PRODUCTION AND BLOOD GASES IN SPECTACLED EIDERS (Somateria fischeri) CAPTURED FOR SURGICAL IMPLANTATION OF TRANSMITTERS

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Abstract

Spectacled eiders (Somateria fischeri) are a threatened species under the Endangered Species Act and researchers desire to minimize potential negative effects associated with research methods. A previous study showed that low pH, primarily metabolic acidosis, was an important variable in models predicting mortality after surgical satellite transmitter placement.¹ We hypothesized that administration of midazolam, a benzodiazepine sedative, would reduce stress and physical exertion in eiders as compared to a saline control as measured by sedation scores, and blood parameters identified a priori as biomarkers of stress (corticosterone) and physical exertion (lactate, pH).³,⁵ We hypothesized that midazolam-treated eiders would have lower corticosterone and lactate levels compared to saline-treated eiders and would maintain normal blood pH. Spectacled eiders (n = 41) were captured for transmitter implantation during spring of 2018 in western Alaska. Midazolam⁶ (5 mg/ml, average dose 2.2 mg/kg IM; n = 20) or saline⁷ (0.7 ml IM; n = 21) was administered at the time of capture and sedation scores and blood samples were collected upon arrival to the tent used for field surgeries and again at anesthetic induction. Midazolam treatment reduced mean values of corticosterone and lactate, and median levels of pH compared to controls. All responses changed in association with time elapsed from dosing in patterns consistent with abatement of the midazolam treatment effect. Respiratory acidosis was an unexpected finding in midazolam treated eiders and attributed to sedative-induced respiratory depression.¹,² Intubation and mechanical ventilation are recommended for eiders anesthetized after sedation with midazolam.

¹Midazolam Injection, USP, Akorn, Lake Forest, Illinois 60045 USA
²0.9% Sodium Chloride Inj., Hospira, Lake Forest, Illinois 60045 USA

Key words: Blood gas, corticosterone, lactate, midazolam, Somateria fischeri, spectacled eider

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The authors thank the USFWS Cooperative, Recovery Initiative, Busch Gardens, and Zoo Miami for funding. We acknowledge N. Stellrecht for project oversight, D. Ayuluk, Hermens Helicopters, Yukon Delta NWR staff, V. Casey, UAF Shared Services, S. Lambert and D. Webb for logistical support. We thank the field crew: L. Carlson, C. Deane, E. Ford, R. Friendly, N. LaShomb, M. Miller, C. Montgomery.
LITERATURE CITED


EVIDENCE FOR HYPOADRENOCORTICISM AS AN UNDERLYING CAUSE OF PERACUTE MORTALITY SYNDROME IN RED PANDA (Ailurus fulgens)

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Abstract

Red pandas (Ailurus fulgens), native to India, China, Nepal, Bhutan, and Myanmar, are endangered with extinction due to deforestation and habitat fragmentation.1 Kidney, liver, and gastrointestinal disease are causes of death in the red panda population under human care;2 however, a new mortality syndrome emerging in the North American Species Survival Population, red panda peracute mortality syndrome, is threatening population survival. Since 2016, multiple red pandas have died with no clear cause of death. This case series describes the ante-mortem and post-mortem findings of five red pandas at Brookfield Zoo that died or are currently being medically managed for underlying abnormal adrenal function. The majority of red pandas were found deceased immediately after or in close proximity to an anesthetic event with major post-mortem finding of severe diffuse adrenal cortical atrophy. Antemortem clinical signs consisted of thin body condition, vomiting, intermittent diarrhea, neck ventroflexion, and ataxia. Most presented in the spring or fall with an association with warmer weather. Initial evidence suggests mortality is due to abnormal adrenal function resulting in fatal electrolyte disturbances, most noticeably hypokalemia.3 Results from ACTH stimulation tests suggest an inappropriate response to adrenocorticotropic hormone with persistently low cortisol and aldosterone levels after cosyntropin administration (Cortrosyn®, Amphastar Pharmaceuticals, Inc., Rancho Cucamonga, CA 91730, USA). Clinical improvement was seen when red pandas were started on prednisolone therapy (Hi-Tech Pharmacal Co., Inc. Amityville, NY 11701 USA). If the cause of red panda peracute mortality syndrome is adrenal dysfunction, then treatment may be lifesaving.

Key words: Ailurus fulgens, hypoadrenocorticism, mortality, red panda

LITERATURE CITED


HYPERLIPIDEMIA AND XANTHOMATOSIS IN CAPTIVE YELLOW-FOOTED ROCK WALLABIES (Petrogale xanthopus)

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1University of California Davis School of Veterinary Medicine, Davis, CA 95616 USA; 2Sacramento Zoo, Sacramento, CA 95822 USA

Abstract

Xanthomas are localized lipid deposits in organs with associated granulomatous inflammation. Xanthomatosis is a rare condition often associated with inherited or acquired dyslipidemias in humans.1 Three yellow-footed rock wallabies (Petrogale xanthopus) were diagnosed with xanthomas secondary to hyperlipidemia and hypercholesterolemia at a single institution. All cases presented with cutaneous masses at the haired skin and paw pad junctions of the extremities, or mucocutaneous junctions. Biopsy and histopathology of these masses were consistent with xanthoma. The three clinically affected individuals were overconditioned and had lipemic serum, elevated cholesterol and triglycerides, and reversed high- and low-density lipoprotein fractions. Six other individuals were present in the collection and had identical husbandry, but were of more appropriate body condition, normolipidemic, and had no xanthomas. One of the clinical cases was also diagnosed with hepatic lipidosis via liver biopsy. This wallaby was eventually euthanized due to declining quality of life associated with its condition. Necropsy revealed xanthomas affecting the haired/non-haired skin junctions of all four limbs and muzzle, as well as the trachea. Genetic predisposition, obesity and metabolic derangement, and endocrine diseases such as hypothyroidism are considered as causes of hyperlipidemia. The three clinically affected individuals had the same sire, which may suggest a genetic predisposition. Since the diagnosis of xanthomatosis in this collection, dietary modifications have been made to encourage weight loss and prevent development of obesity and hypercholesterolemia. Husbandry and medical management for this species should consider that some individuals may be predisposed to hyperlipidemia and subsequent xanthoma formation.

Key words: Cholesterol, Petrogale xanthopus, triglyceride, xanthoma, yellow-footed rock wallaby

ACKNOWLEDGMENTS

The authors thank Dr. Cora Singleton and Dr. Janna Wynne for their assistance obtaining broader captive population information, and Dr. Patricia Pesavento for expertise and guidance with the pathology of these cases. The authors would also like to recognize the Sacramento Zoo animal care staff for their dedicated care of these macropods.

LITERATURE CITED

LAPAROSCOPIC OVARIECTOMY IN NON-DOMESTIC HOOFSTOCK: INDICATIONS AND TECHNIQUES TO INCREASE SURGICAL SUCCESS

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Abstract

Contraception of non-domestic hoofstock is performed to prevent pregnancy of animals with low genetic value, high relatedness to the herd, or a medical condition that might be exacerbated by the physiologic and metabolic demands of pregnancy, parturition, and lactation. In large mixed species field exhibits, selectively feeding an individual animal or repeated darting for administration of a contraceptive or porcine zona pellucida (PZP) vaccine booster is challenging. The authors have performed minimally invasive laparoscopic ovariectomies in a number of non-domestic hoofstock species of diverse size and taxonomy that offer reliable, permanent sterilization. Laparoscopic ovariectomy has been performed in adult waterbuck (Kobus sp., n = 3), addra gazelle (Nanger dama, n = 1), and red-fronted gazelle (Eudorcas rufifrons, n = 1) with no peri-operative or post-operative complications. Significant modifications from single incision laparoscopic ovariectomy procedure described in domestic dogs (Canis lupus familiaris) were needed to facilitate laparoscopic surgical success in non-domestic hoofstock including; caudal abdominal port placement, intra-abdominal pressure adjustments, pronounced initial Trendelenburg positioning, and anticipation of physiologic anesthetic complications. The presence of a rumen, caudally positioned reproductive tract, and mobile ovarian pedicles resulted in the need for adaption of the traditional technique described in the domestic dog and cat. These laparoscopic surgical techniques, refined over multiple procedures, have resulted in rapid recovery and hospital discharge with no morbidity or mortality. Single port laparoscopic ovariectomy should be considered in non-domestic hoofstock as a feasible option for permanent sterilization when indicated. This procedure is permanent, minimally invasive, and allows for rapid return of the patient to the herd.

Key words: Contraception, laparoscopy, non-domestic hoofstock, ovariectomy, sterilization
DETECTION OF A *Mycobacterium avium* SUBSP *avium* IN A PUDU AND MUNTJAC IN THE UNITED STATES

Nicole Aulik, PhD,1,2* Jennifer Godhardt-Cooper, MSc,1 Adrian Mutlow, MA, VetMB, MSc,3 Kenneth J. Conley, DVM, DACVP,4 Chungyi Hansen, MSc,2 and Adel Taalat, MVSc, PhD2

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Abstract

Recently, a Southern pudu (*Pudu puda*) and a Reeves’ muntjac (*Muntiacus reevesi*) were identified as having a disease similar to Johne’s disease in clinical presentation (diarrhea, wasting) and postmortem findings (granulomatous typhloenteritis and lymphadenitis with intralesional acid-fast rods). In the pudu, an antemortem fecal sample tested positive by a commercially available, ISMAP02 target-based real-time PCR for the causative agent of Johne’s disease, *Mycobacterium avium* subspecies *paratuberculosis* (MAP). The positive result and continued wasting prompted euthanasia and submission of tissues, serum, and feces for further diagnostics. The tissues and feces were analyzed using different MAP-specific PCR targets (multiplex assay: IS900, 251, F57), which yielded no further positive results; however, three MAP antibody ELISAs demonstrated a positive result for Johne’s disease. Liquid culture was performed on the tissues and feces and revealed acid-fast rods. Multiplex PCR analysis of the liquid culture did not result in positive MAP PCR. The muntjac died with minimal acute clinical signs, and tissues and feces were submitted for PCR and culture based on necropsy findings. Multiplex PCR on fresh tissue did not yield any positive results for MAP infection but were positive when *M. avium* primers were used. Consistently, the same liquid cultures showed acid-fast bacilli. To identify the acid-fast bacilli cultured, isolates from both animals were subjected to whole-genome sequence (WGS) analysis using Illumina platform. Phylogenetic analysis based on WGS of the two isolates indicated they are closely related to *Mycobacterium avium* subspecies *avium* (MAA). A large number of single nucleotide differences (SNPs) were found when each genome was compared to the reference MAA strain, suggestive for continuous adaptation of the new isolates to their host (pudu and muntjac) following infection. These data also indicate that it is imperative that surveillance for Johne’s Disease in exotic species must include the use of a multiplex PCR that utilizes more than one target. If a disease similar to Johne’s disease is suspected in an exotic species, culture and WGS may be necessary to identify the causative agent.

**Key words:** Johne’s, muntjac, *Mycobacterium avium* subsp. *paratuberculosis*, PCR, pudu, whole-genome sequencing

ACKNOWLEDGMENTS

The authors acknowledge the Section of Microbiology Molecular, Serology and Bacteriology at the Wisconsin Veterinary Diagnostic Laboratory at the University of Wisconsin-Madison for helping to test the samples/isolates. We also thank Dr. Talaats laboratory at the Department of Pathobiological Sciences, University of Wisconsin-Madison for assistance with sequencing and analysis.
**Yersinia pseudotuberculosis** EPIZOOTIC IN NON-DOMESTIC RUMINANTS AT A ZOOLOGICAL INSTITUTION: CLINICAL PRESENTATIONS, DIAGNOSIS, POSTMORTEM FINDINGS, AND TREATMENT SUCCESS

**Matt Marinkovich, DVM,1,* Steven V. Kubiski, DVM, PhD, DACVP,2 Matthew E. Kinney, DVM, Dipl ACZM,3 Meredith M. Clancy, DVM, MPH, Dipl ACZM,3 and Lauren Howard, DVM, Dipl ACZM3**

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**Abstract**

**Yersinia pseudotuberculosis** is a gram-negative, facultative anaerobe that has caused morbidity and mortality in both animals and humans. The bacterium and associated disease show an increased prevalence in cold and wet conditions and previous large-scale outbreaks have been documented in ruminants that are free ranging and under managed care.1,2 Between February and April 2019, 27 non-domestic ruminants and five wild birds were diagnosed with **Yersinia pseudotuberculosis** at the San Diego Zoo Safari Park. Fourteen ruminant species were affected including members of Cervidae and five Bovidae subfamilies. The outbreak affected all age groups (ranging 3 mo to 15 yr), both sexes, and was documented in ten different field habitats. Antemortem diagnoses were made with a combination of cold-enriched bacterial culture and PCR of feces and rectal swabs. Gross and histologic lesions were relatively pathognomonic, with segmental, transmurally thickened and reddened intestinal loops, tortuous and prominent serosal lymphatics, and mesenteric lymphadenopathy corresponding to necrotizing enteritis, lymphangitis and lymphadenitis with myriad intralesional gram-negative cocci. Of the 32 affected individuals, 17 were found deceased, six were euthanized, and nine survived (seven with treatment and two without). Sudden death was common, and when present, subtle clinical signs included trailing the herd, having a slightly hunched posture, and having a decreased flight distance. Early identification of these animals, followed by prompt field removal and hospitalization was crucial, and of nine animals treated, seven survived with intensive care that involved intravenous fluid therapy and antibiotics.

**Key words:** Epizootic, intensive care, non-domestic ruminants, **Yersinia pseudotuberculosis**

**LITERATURE CITED**


RETROSPECTIVE ANALYSIS OF EXTENDED COPPER OXIDE WIRE PARTICLE TREATMENTS ON STRONGYLE FECAL EGG COUNTS IN CAPTIVE HIPPOSTRAGINAE

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Abstract

Gastrointestinal nematodes (GIN) have severe clinical implications associated with high morbidity, and even mortality in artiodactyls housed in zoological institutions. The life cycle and ecology of GIN present several challenges in their control including the development of anthelmintic resistance, reinfection in high-density captive herds, the implementation of arrested larval development, and recent shifts in climate producing warmer and wetter conditions. To mitigate these issues and prevent anthelmintic resistance, institutions are implementing alternative forms of GIN control including copper oxide wire particles (COWP) as a bolus or a feed additive. This study investigated the impacts of COWP on fecal egg counts (FEC) to quantify long-term effectiveness of COWP as a treatment for GIN in exotic artiodactyls, specifically gemsbok (*Oryx gazella*) and sable antelope (*Hippotragus niger*) of the hippotraginae subfamily. Two years of FEC data, obtained using a modified McMaster fecal floatation, were analyzed from individuals (n = 47) at Fossil Rim Wildlife Center, treated exclusively with commercially available COWP® in a top-dressing application dosed at 25 mg/kg monthly. COWP decreased FEC in hippotraginae by a FEC reduction ratio of 42%. Mean pre-treatment FEC was 1086 eggs/g, while mean post-treatment FEC was 554 eggs/g, a statistically significant difference (P < 0.05) using a paired t-test. We conclude that COWP administration makes an important addition to parasitic control methods, however they should not serve as the only treatment and should continue to be evaluated in other exotic artiodactyls.

Key words: Copper oxide wire particles, fecal egg count reduction test, gastrointestinal nematodes, hippotraginae, *Hippotragus niger*, *Oryx gazella*

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The authors would like to express a deep gratitude to the Animal Health and Animal Care staff at Fossil Rim Wildlife Center for their expertise and dedication to conservation, as well as for their investment in the training of future professionals.
REVIEW OF HISTOLOGIC LESIONS AND MORTALITY IN RIO CAUCA CAECILIANS (Typhlonectes natans) OVER A TWENTY-TWO-YEAR PERIOD

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Abstract

Rio Cauca caecilians (Typhlonectes natans) are unique, fully aquatic species of amphibian from the order Gymnophiona. They are housed in several zoological institutions and aquaria with limited information available regarding health and disease. This retrospective study evaluates common pathologic findings and mortality of Rio Cauca caecilians from three different institutions over a 22-yr period. Comparisons to previous medical health surveys1,2 were conducted with evaluation based on age class and sex to determine if the primary causes of mortality and common histologic findings have remained similar over time and between institutions. Between March 1997 and December 2019 there were 62 mortalities including male (14/62; 23%), female (27/62; 44%), and undetermined sex (21/62; 33%). The majority of examined individuals were adult (37/62; 60%), followed by juveniles (13/62; 21%), neonates (9/62; 14%), and undetermined age class (3/62; 5%). Thirteen (21%) individuals were euthanized. Adult females (17/62; 27%) represented the largest group. In adults, the most common lesion and contributor to death was renal disease (28/38; 74%) followed by skin disease (16/38; 42%), specifically mycotic dermatitis (8/38; 21%) due to Saprolegnia sp. Other common findings included: gastrointestinal nematodiasis, cutaneous bacterial infection, and adrenal hyperplasia. This retrospective study will provide a useful reference to help guide veterinary care, management decisions, and collection management planning for caecilians under human care.

Key words: Amphibian, caecilian, mycotic dermatitis, nephritis, Saprolegnia, Typhlonectes

LITERATURE CITED


PAIN AND ANALGESIA IN AMPHIBIANS: COMPARISON OF THERMAL AND MECHANICAL NOXIOUS STIMULI TO DETERMINE EFFICACY OF MORPHINE IN WHITE’S TREE FROGS (*Litoria caerulea*) AND NORTHERN LEOPARD FROGS (*Lithobates pipiens*)

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Abstract

Measuring pain and analgesic efficacy in amphibians is difficult and appears to be dependent on experimental models and species utilized. The objectives of this study were two-fold: Experiment 1) we compared two commonly used laboratory pain models; the Hargreaves apparatus, which measures thermal nociception, and the von Frey filament model, which measures mechanical nociception, applied to the hindlimbs of White’s tree frogs (WTF, *Litoria caerulea*) (n = 6) and northern leopard frogs (NLF, *Lithobates pipiens*) (n = 6) after administration of subcutaneous (SC) morphine sulfate (50 mg/kg) or isovolumetric saline as a control; and Experiment 2) we evaluated and compared the antinociceptive efficacy of morphine sulfate (100 mg/kg and 50 mg/kg SC) versus isovolumetric saline as a control in NLF (n = 12) using the von Frey filament model. Both experiments were performed using a complete crossover, observer-blinded, experimental design. In experiment 1, WTF were hypersensitive to the noxious thermal and mechanical stimuli after morphine administration compared with saline, which was completely unexpected. There were no statistically significant differences between morphine and saline in the NLF with either model. In experiment 2, NLF demonstrated a dose-dependent mechanical antinociceptive response to morphine-sulfate. These results indicate the importance of experimental model used when evaluating nociception in different amphibian species. While application of thermal nociceptive stimuli is appropriate in reptiles, nociception in amphibian species may best be evaluated using mechanical nociceptive models. Additionally, species differences should be considered regardless of model and analgesic drug used.

Key words: Antinociception, *Lithobates pipiens*, *Litoria caerulea*, morphine sulfate, northern leopard frog, White’s tree frog

LITERATURE CITED


COMPARATIVE PHARMACOKINETICS OF SUBCUTANEOUS VERSUS TRANSCUTANEOUS CEFTAZIDIME IN LEOPARD FROGS (*Lithobates pipiens*)

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Abstract

Antimicrobial use in amphibians is commonly performed with little or no pharmacokinetic (PK) data to support antibiotic selection, route of administration, or dose frequency, even though anurans are widely used as laboratory animals, housed in zoological institutions, and commonly maintained as pets. Ceftazidime is frequently used in anurans as it has particular efficacy against gram negative bacterial organisms, which are the predominant type isolated in amphibians.1 Dosing for amphibians is typically extrapolated from reptile publications or anecdotal reports, with the most frequently cited ceftazidime dose as 20 mg/kg subcutaneous (SC), intravenous (IV), or intramuscular (IM) q48-72hr.2 This study compared the plasma, renal, and cutaneous concentrations of ceftazidime in leopard frogs when administered as follows: 20 mg/kg SC, 40 mg/kg SC, and 20 mg/kg transcutaneous (TC). Samples were collected at time points 0, 12, 24, 48, 72, and 96 hr. Plasma ceftazidime concentrations were similar regardless of route of administration with the higher dose resulting in higher plasma concentrations. Subcutaneous administration resulted in higher renal ceftazidime concentrations compared to transcutaneous administration. Cutaneous ceftazidime concentrations were significantly higher when transcutaneous administration was used. The results of this study represent progress in our understanding of antimicrobial metabolism in anurans, as there are currently no published studies comparing PK data between transcutaneous and subcutaneous drug administration in amphibians.

Key words: Ceftazidime, leopard frog, Lithobates pipiens, pharmacokinetics

LITERATURE CITED


POPULATION PHARMACOKINETICS OF CEFTAZIDIME AFTER A SINGLE SUBCUTANEOUS INJECTION AND NORMAL ORAL AND CLOACAL BACTERIAL FLORA SURVEY IN EASTERN HELLBENDERS (Cryptobranchus alleganiensis alleganiensis)

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Abstract

Population pharmacokinetics utilizing sparse sampling were used to determine pharmacokinetics in the eastern hellbender (Cryptobranchus alleganiensis alleganiensis) due to their slow growth rate and the limited number of appropriately sized individuals in the zoo-housed population. Twenty-five eastern hellbenders received a single subcutaneous injection of ceftazidime (TAZICEF®, 1g ceftazidime for injection reconstituted to 100 mg/ml, Hospira, Inc. Lake Forest, IL 60045, USA) at 20 mg/kg. Each animal had blood samples collected up to four times between 0 and 192 hr post-injection. Plasma samples were analyzed by high-pressure liquid chromatography (HPLC). A nonlinear mixed-effects model (NLME) was fitted to the data to determine typical values for population parameters, an ideal method due to the sampling limitation of each hellbender. Results indicate an elimination half-life (T½) of 36.63 hr and volume of distribution (Vss) of 0.31 L/kg. Antibiotic concentrations were above a minimum inhibitory concentration (MIC) value of 8 µg/ml for 120 hr. Prior to antibiotic administration, six hellbenders had oral and cloacal swabs taken for aerobic culture. Fifty-five bacterial isolates were obtained (24 cloacal, 31 oral) with 10/12 (83%) of individuals growing three or more different isolates and 11/12 (92%) growing Shewanella putrefaciens. Twelve isolates had susceptibility testing performed and all were susceptible to ceftazidime. These results indicate that ceftazidime is an appropriate choice of antibiotic in hellbenders and when given at a dosage of 20 mg/kg subcutaneously, maintains concentrations above the MIC for up to 5 days.

Key words: Ceftazidime, Cryptobranchus alleganiensis, eastern hellbender, flora, pharmacokinetics, susceptibility

ACKNOWLEDGMENTS

The authors thank the managers and animal care staff of the Ron Goellner Center for Hellbender Conservation and the veterinary technicians at the Saint Louis Zoo for their support and technical assistance with this project. This project was funded by the WildCare Institute’s Saint Louis Zoo Field Research for Conservation Grant.
EVALUATION OF EUTHANASIA METHODS USING INJECTABLE AGENTS IN LEOPARD GECKOS (Eublepharis macularius)

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Abstract

There are very few studies comparing euthanasia techniques in reptile species. The objective of this study was to compare different injectable drug protocols and routes of administration for humane euthanasia of leopard geckos (Eublepharis macularius). Fifty-three asymptomatic adult leopard geckos scheduled for euthanasia due to Cryptosporidium sp. exposure were divided into six groups: intracoelomic pentobarbital 400 mg/kg (ICOP4, n = 9), intracoelomic pentobarbital 800mg/kg (ICOP8, n = 9), and alfaxalone (20 mg/kg IM) followed by either intracardiac pentobarbital 800 mg/kg (ICAP, n = 9), intracardiac lidocaine 100 mg/kg (ICAL, n = 9), or intracardiac potassium chloride (KCl) 10 mEq/kg (ICAK, n = 9). A control group (AC, n = 8) received alfaxalone 20 mg/kg IM only. Heart rate was measured using a Doppler and time from injection to cardiac arrest was recorded. 8/9 (88.9%) geckos in all groups receiving intracardiac euthanasia agents went into cardiac arrest within 10 sec of injection. Several geckos in the ICAK group had muscle spasms following cardiac arrest. 6/9 (66.7%) ICAL animals had spontaneous return of heartbeat and righting reflex several hours following documentation of cardiac arrest. Of the intracoelomic groups, 7/9 (77.8%) in the ICOP4 group experienced cardiac arrest within 45 min (mean: 34 min). All animals in the ICOP8 group experienced cardiac arrest within 60 min (mean: 33 min). Intracardiac pentobarbital, lidocaine, and KCl resulted in rapid cessation of heartbeat in leopard geckos sedated with alfaxalone, but the latter two protocols were associated with secondary undesirable effects. The intraperitoneal techniques resulted in a prolonged time to cardiac arrest.

Key words: Eublepharis macularius, euthanasia, leopard gecko, lidocaine, pentobarbital, potassium chloride

LITERATURE CITED


COMPARISON OF FRESH AND FROZEN FECAL SAMPLES IN TWO TRANSPORT MEDIA FOR THE DETECTION OF ENTERIC BACTERIA IN ROCK IGUANAS (*Cyclura* spp.)

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**Abstract**

Enteric bacterial growth in paired fecal samples from eleven captive rock iguanas (four *Cyclura lewisi*, five *Cyclura pinguis*, and two *Cyclura collei*) were evaluated to determine effects of transport medium type and freezing on bacterial recovery. Four swabs were inserted and rotated into each fresh fecal sample. Two swabs per sample were placed in 1 ml aliquots of a liquid Cary-Blair (CB) transport medium and two swabs were placed in 1 ml aliquots of a liquid Amies (AM) transport medium. One CB and one AM aliquot were submitted for enteric culture per iguana. The second CB and AM aliquots were stored at -20 °C for 2 wk, then submitted for enteric culture. Eighteen bacterial isolates were detected. *Salmonella* was cultured from 6/11 (54.5%) iguanas in all four sample types. The five *Salmonella* serotypes detected were III 50:k:z, IV_45:g.z51:--, 4,5,12:i:--, III Rough O:k:z, III Rough O:k:--. *Escherichia coli* was found in over half of the iguanas with prevalence of 9/11 (81.8%) in fresh AM, 8/11 (72.7%) in fresh CB, 6/11 (54.5%) in frozen AM, and 7/11 (63.6%) in frozen CB. Lower prevalence was found for other bacterial species with variability between the two media and storage conditions. These results indicate that both media may have utility for performing enteric cultures in field, especially for detection of *Salmonella*, but recovery of certain bacterial species may be affected by sample freezing.

*a*Protocol™ C&S Medium, Fisher Diagnostics, Middletown, Virginia 22645 USA  
*b*BD™ ESwab Transport System; BD Diagnostics, Sparks, Maryland 21152 USA

**Key words:** Bacterial flora, *Cyclura* spp., enteric culture, rock iguana, *Salmonella*

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The author thanks Maggie Castille for participating in this study during her veterinary externship at the Fort Worth Zoo, ectotherms department staff for husbandry care of these iguanas, veterinary technicians for sample processing and submission, and bacteriology staff at Texas Veterinary Medical Diagnostic Laboratory for performing the enteric cultures.
REVIEW OF FEMALE REPRODUCTIVE DISEASE IN MORTALITY OF VARANID SPECIES

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Abstract

Varanid lizards (genus Varanus) are common species managed in zoological collections, with 29 species currently housed in AZA institutions. A systematic literature review (2000-2020) was performed to identify prevalence of reproductive disease in female varanids, using the search methodology described in Table 1. Only five publications were found, and none addressed reproductive issues broadly across species and institutions.1-5

A review of 667 pathology reports of male and female varanids from North American zoos and captive populations (NAZ+) found 67 (10%, representative of 18 species, all female) with evidence of reproductive disease. Prevalence was highest in rough-necked monitors (Varanus rudicollis, 33.3%), Komodo dragons (Varanus komodoensis, 28.9%), and crocodile monitors (Varanus salvadorii, 9.4%). Of the 67 cases, the most common lesions were follicular rupture with coelomitis (55.2%), yolk embolization (32.8%), and oophoritis (22.4%). Of the 37 with follicular rupture and coelomitis, concurrent lesions included metastatic mineralization (27.0%) and amyloid-like deposition disorder (13.5%).

As an iconic collection species an additional 24 pathology reports of female Komodo dragons from European zoos (EUZ) were reviewed, and 11 (45.8%) exhibited reproductive disease. Findings differed in some respects between EUZ and NAZ+ Komodo dragons: follicular rupture with coelomitis (45.8% EUZ, 50.0% NAZ+), oophoritis (16.7% EUZ, 9.1% NAZ+), and yolk embolism (8.3% EUZ, 54.6% NAZ+). Notable concurrent lesions seen with follicular rupture again included metastatic mineralization (27.0%) and amyloid-like material (0% EUZ, 36.4% NAZ+).

Reproductive disease is apparently common in female varanids. Further investigation is needed to identify and mitigate contributory causes.

Key words: Coelomitis, follicular rupture, monitor lizard, reproductive disease, varanid, Varanus
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Table 1. Citation results from literature review of four databases (Web of Science Zoological Record, Web of Science Core Collection, PubMed, and Google Scholar).

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2020 52nd AAZV Annual Conference Proceedings
MYCOPLASMOSIS IN AMERICAN ALLIGATORS (Alligator mississippiensis):
RECRUDESCENCE AFTER A QUARTER OF A CENTURY WITH A NOVEL
CLINICAL MANIFESTATION

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Marley Iredale, DVM,† Emily Brenner, DVM,† Amy B. Alexander, DVM, Dipl ACZM,† James
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Abstract

Mycoplasma alligatoris was first observed to cause disease in captive American alligators
(Alligator mississippiensis) in 1995.1,2 During that index outbreak, affected individuals presented
with nonspecific clinical signs and major necropsy findings included pneumonia, polyserositis,
and arthritis.1 Nearly 25 yr later, a second mortality event in American alligators occurred in a
large communal exhibit consisting of approximately 300 A. mississippiensis at the same facility.
Affected alligators initially presented with unilateral ocular and oral commissure swelling that was
associated with a concurrent spike in mortalities. Initial necropsy findings identified necrotizing
vasculitis, fasciitis, and myositis of the masticatory muscles as the cause of the facial swelling;
however, there was no evidence of systemic polyserositis or arthritis in early cases, and pulmonary
changes were inconsistent. Mycoplasma sp. was isolated from heart blood and muscle swabs of
one affected alligator by routine aerobic and blood culture. PCR and sequencing of the 16S and
16S-23S intergenic spacer of both the cultured bacteria and of lesions of affected animals
confirmed M. alligatoris. Subsequent necropsies identified classical alligator mycoplasmosis
lesions, including pneumonia and polyserositis, though arthritis was infrequent and extremely
mild. Minimum inhibitory and minimum bactericidal concentrations for two clinical isolates were
determined, and alligators were treated with oxytetracycline individually. Over an approximately
10-wk period, 56 alligators died or were euthanized due to clinical signs, for a mortality rate of
~19%. This report details a novel clinical presentation of M. alligatoris disease in captive
American alligators that clinicians should be aware of in establishing differential diagnoses for
crocodilians.

Key words: American alligator, bacteria, crocodilian, Mycoplasma, mycoplasmosis

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The authors thank David C. Drysdale (Owner), John Brueggen (Director), Dr. Kent Vliet (Scientific Advisor) and
the dedicated animal care staff at Saint Augustine Alligator Farm Zoological Park for their commitment and support
of this work, and the Histology Laboratory and Clinical Microbiology Laboratory at University of Florida’s College
of Veterinary Medicine for technical assistance.
LITERATURE CITED


NOVEL SERPENTOVIRUSES AND ASSOCIATED DISEASE IN VIPERIDAE AND ELAPIDAE

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Abstract

Viruses in the subfamily Serpentovirinae (order Nidovirales, family Tobaniviridae) can cause significant morbidity and mortality in captive snakes but infections to date have been limited to members of the Boidae, Colubridae, Homalopsidae and Pythonidae families.1-7 Clinical signs range from non-specific malaise to open-mouth breathing with increased oral or nasal mucus production, oral mucosal hyperemia or acute death.2,3,7 Post-mortem findings include stomatitis, sinusitis, tracheitis, esophagitis and proliferative pneumonia.4 In June 2019, within a collection of approximately 150 confiscated venomous snakes, four novel serpentoviruses were diagnosed in eighty-six snakes of various Viperidae (ten different Trimeresurus spp., Tropidolaemus wagleri, Atheris squamigera, Bothriopsis bilineata, Bitis gabonica) and a single Elapid species (Acanthophis rugosus). Diagnosis was based on reverse transcription polymerase chain reaction and sequencing of ante-mortem oral swabs or post-mortem tissue samples. These viruses cluster in a clade sufficiently distinct to represent a novel genus. Clinical signs included poor-feeding and thin body condition, abnormal behavior or breathing, stomatitis, and acute death. Post-mortem findings included variably severe inflammation, necrosis and/or epithelial proliferation throughout the respiratory and upper gastrointestinal tracts. Opportunistic secondary diseases were also noted. This represents the first report of serpentoviruses in viperid and elapid species. The clinical signs and pathology in a large number of snakes infected with these newly described viruses is described. These findings expand the diversity of snakes for which serpentovirus infection should be considered clinically, and suggests that serpentovirus testing should be incorporated into routine infectious disease screenings of viperid species.

Key words: Elapidae, pathology, Serpentovirus, Viperidae

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The authors thank the veterinary and histology technicians and hospital assistants of the Zoological Health Program and the keepers in the Department of Herpetology for their assistance in the success of this program and animal care.
LITERATURE CITED


A NOVEL SUNSHINE VIRUS IN SIDEWINDERS (Crotalus cerastes) WITH PNEUMONIA: THE FIRST NORTH AMERICAN MEMBER OF THE SUNVIRIDAE

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Abstract

The Sunviridae are a recently discovered virus family in the order Mononegavirales, which also contains several families of significant pathogens including Paramyxoviridae, Rhabdoviridae, Filoviridae, and Bornaviridae. The only previously known sunvirus is Sunshine Coast virus, found in carpet pythons in Australia with neurologic and respiratory disease. Sidewinders (Crotalus cerastes) are rattlesnakes native to the southwestern United States and northeastern Mexico. Two sidewinders in a zoological collection in the southeastern United States died after exhibiting respiratory signs. Histopathology revealed respiratory syncytia and rare intracytoplasmic inclusions as well as lesions consistent with bacterial sepsis. PCR testing was negative for paramyxoviruses and reoviruses but revealed the presence of a novel member of the Sunviridae. A probe-hybridization qPCR assay was designed and found three additional cases, all in sidewinders. Other viperids and colubrids in the same building were negative. Greater copy numbers were seen in tracheal washes than in blood or buffy coats. Illumina sequencing of a tracheal sample with high copy numbers found a 17,210 base pair genome with 167-fold average coverage. This virus had 69.8% nucleotide homology to Sunshine Coast virus. These findings expand the known geographic range of Sunviridae to include North America and the host range to include Viperidae; it is probable that additional diversity remains to be discovered.

Key words: Crotalus cerastes, pneumonia, sidewinder, sidewinder sunshine virus, Sunviridae

ACKNOWLEDGMENTS

The authors thank the dedicated animal care staff for their commitment and support of this work.

LITERATURE CITED


ANTICOAGULANT AND LEUKOCYTE QUANTIFICATION TECHNIQUE HAVE A SIGNIFICANT EFFECT ON THE TOTAL WHITE BLOOD CELL COUNT OF BEARDED DRAGONS (Pogona vitticeps)

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Abstract

Hematology is a common diagnostic tool used to assess the health of bearded dragons (Pogona vitticeps). The effects that white blood cell (WBC) counting techniques and anticoagulants have on estimated total WBC count in this species have not been reported.¹ This study was completed to evaluate these effects. Blood was collected from the ventral coccygeal vein of ten (four male, six female) captive bearded dragons. Smears were made immediately from whole blood and the remainder of the blood was evenly distributed into ethylenediaminetetraacetic acid (EDTA) and lithium heparin (HEP) microtainers. Estimated total WBC counts resulting from phloxine and Natt and Herrick’s solution staining techniques and standard manual blood smear methods were performed for each anticoagulant in duplicate and then averaged. While total WBC counts estimated from fresh whole blood smears (mean: 3136 cells/µl) were not significantly different than those from EDTA blood smears (mean: 3938 cells/µl, P = 0.094), they were significantly higher than those from HEP blood smears (mean: 1970 cells/µl; P = 0.007). Regardless of technique, total WBC counts estimated from all methods in EDTA samples were significantly higher than those estimated from all methods in HEP samples (P < 0.0001). Total WBC counts estimated from the phloxine solution staining technique were lower than those from both the blood smears and the Natt and Herrick’s solution 10- and 60-min staining techniques. For EDTA, Natt and Herrick’s solution 60-min staining technique improved leukocyte discrimination from red blood cells and thrombocytes. Anticoagulant and counting technique significantly impact estimated total WBC counts and should be considered clinically.

Key words: Bearded dragon, complete blood count, EDTA, hematology, heparin, Pogona vitticeps

ACKNOWLEDGMENTS

The authors thank Ivana Levy for her dedication and expertise in bearded dragon handling and the veterinary student husbandry technicians who cared for the bearded dragons during the completion of this study.

LITERATURE CITED

COMPARISON OF BIOCHEMISTRY VALUES FROM BLOOD AND LYMPH IN KREFFT’S RIVER TURTLES (*Emydura macquarii krefftii*)

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Abstract

Lymph contamination of peripheral blood samples is common in reptile clinical practice due to a close association of the lymphatic and vascular systems. Grossly lymph-contaminated samples are generally discarded due to potential dilution effects on hematologic and biochemistry parameters. Differences in biochemistry values from different sample sites in chelonians are often attributed to lymph contamination.\(^2\)\(^3\) Previous studies have evaluated blood-lymph mixtures but provide limited information since the proportion of lymph is unknown.\(^1\) Differences in biochemistry values of pure lymph compared to plasma are unknown in chelonian species. Paired plasma samples collected from the jugular vein and lymph samples collected from the dorsal lymphatic ring adjacent to the subcarapacial sinus were collected from 11 (six females, five males) Krefft’s river turtles (*Emydura macquarii krefftii*) for comparison of biochemistry analytes. No significant differences were found between lymph and plasma samples for chloride, glucose, alanine transaminase, aspartate transaminase, creatinine kinase, urea nitrogen, and total bilirubin. Statistically significant (P < 0.05) differences were found between lymph and plasma samples for gamma glutamyl transferase, total protein, globulin, and uric acid. Sex and sample differences were statistically significant for sodium, potassium, calcium, phosphorous, magnesium, lactate dehydrogenase, albumin, and triglycerides, while significant sex differences only were found for alkaline phosphatase, cholesterol, and iron. For most sex differences, values for females were greater than for males. For most sample differences, values for plasma were greater than for lymph, therefore lymph contamination of plasma samples may affect clinical diagnostic interpretation.

Key words: Biochemistry, *Emydura macquarii krefftii*, Krefft’s river turtle, lymph, plasma

ACKNOWLEDGMENTS

The authors thank Dr. Kyle Donnelly and the Department of Animal Programs at Brevard Zoo for their help with this study.

LITERATURE CITED


CLINICAL USE OF ERYTHROCYTE SEDIMENTATION RATE IN FREE-RANGING BLANDING’S TURTLES (Emydoidea blandingii)

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Abstract

Understanding health is vital to the conservation of many chelonians, including the Blanding’s turtle (Emydoidea blandingii); however, many clinical pathology tests may not reliably detect differences in health status in this species. Erythrocyte sedimentation rate (ESR) measures inflammation and has been used to differentiate healthy and unhealthy chelonians, primates, and cetaceans. The purpose of this study was to evaluate ESR in free-ranging Blanding’s turtles as part of a comprehensive health assessment program. Our objective was to describe the biological variation in ESR and create reference intervals. Sixty-one Blanding’s turtles were captured at two sites in Illinois. Turtles received a complete physical exam, CBC, chemistry, and ESR was performed using both microhematocrit tubes (MHT) and commercial kits (Winpette). Method agreement was assessed with Passing-Bablok regression and reference intervals were generated. Associations between ESR and demographic, environmental, and health factors were determined using multivariable general linear modeling. The MHT method proportionately overestimated ESR compared to the Winpette. Using both methods, ESR was significantly different between study sites, higher in adult Blanding’s turtles, and higher in gravid turtles compared to non-laying females (P < 0.05). ESR was negatively associated with PCV (P < 0.05). Reference intervals include 3-10 mm/hr (Winpette) and 3.3-11.5 mm/hr (MHT). ESR values in Blanding’s turtles are comparable to other reptiles, and while MHT and Winpette results are not interchangeable, their associations with biological predictors are similar. This study provides useful baseline information to aid the clinical application and interpretation of ESR in chelonians.

Key words: Blanding’s turtle, Emydoidea blandingii, erythrocyte sedimentation rate, inflammatory markers

ACKNOWLEDGMENTS

The authors thank the turtle technicians who aided in the collection of all turtles used in this study.

LITERATURE CITED


AN OUTBREAK OF Cryptosporidium avium IN ATTWATER’S PRAIRIE CHICKENS (Tympanuchus cupido attwateri)

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Abstract

Cryptosporidium avium (formerly Cryptosporidium avian genotype V) belongs to the non-gastric Cryptosporidium clade, and has been associated with disease in birds and squamates, often primarily centered on the cloaca and urinary tract.1 From May-August 2019, an outbreak of C. avium occurred in hand-reared Attwater’s prairie chicken (Tympanuchus cupido attwateri) hatchlings at a single institution. Three individual cases are described, with chicks presenting with swollen cloaca, inanition, and lethargy in two cases, and oral-nasal discharge, sinus swelling, and upper respiratory crackles in the third. Chicks were treated with a myriad of therapies including paromomycin a 100 mg/kg PO q12hr, NaCl 0.9% b at 3% body weight SC q12-24hr, and meloxicam c 1 mg/kg PO q24hr with poor success.2 These three individuals all died or were euthanized. Definitive diagnosis was made postmortem via PCR and sequencing from bursa of Fabricius or sinus tissue.3 Necropsy findings included reddened cecal tips, enlarged bursa of Fabricius, and in the individual with respiratory signs, mucus in the sinuses and wet lungs. Histologic findings identified severe lymphoplasmacytic inflammation and mucosal proliferation or ulceration associated with cryptosporidia along the apical aspects of epithelial cells in the bursa of Fabricius, intestine, cecum, colon, cloaca, conjunctiva and nasal mucosa. 160/254 of the chicks hatched within the season developed clinical signs consistent with cryptosporidiosis, with a 42.5% mortality rate in infected chicks. This report extends the known host range of C. avium, and demonstrates broader tissue tropism; further investigation to determine its population effects on Tympanuchus sp. is indicated.

a100 mg/ml, Diamondback Drugs, Scottsdale, Arizona 85251, USA
bSodium Chloride 0.9%, Hosperia, Lake Forest, IL 60045, USA
cMetacam®, 1.5 mg/ml, Boehringer Ingelheim Vetmedica, Inc. St. Joseph, MO 64506, USA

Key words: Attwater’s prairie chicken, bursa of Fabricius, cryptosporidiosis, Cryptosporidium avium, grouse, Tympanuchus cupido attwateri

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Thank you to all Fossil Rim Wildlife Center veterinary technician, Allyssa Roberts, and animal care specialists for their time and resources in management of this case.
LITERATURE CITED


EXAMINING NECROTIZING ENTERITIS IN LORIKEETS

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Abstract

Enteritis is a common cause of morbidity and mortality in lorikeets.1-3 In an informal survey, 11 of 12 zoos reported a history of enteritis in their lorikeet flocks; 50% reported recurrent enteritis outbreaks (Unpublished). In this study, we examine the microbiota in two lorikeet flocks with a history of enteritis (Columbus Zoo and Aquarium – CZA; Denver Zoo). Since 2012, the CZA flock has experienced repeated outbreaks of enteritis despite extensive diet and husbandry modifications. In 2018, both zoos observed a spike in enteritis. We employed 16S rRNA sequencing to characterize the cloacal microbiota in healthy lorikeets (n = 51), lorikeets with enteritis (n = 16), and lorikeets susceptible to enteritis (n = 15), with susceptible defined as birds with a history of enteritis or birds that subsequently developed enteritis after being identified and sampled as a healthy during a flock survey. Based on 16S sequencing, culture of intestinal contents from three lorikeets on TSA with 5% sheep blood, and genotyping of the isolates, we identified Type A Clostridium perfringens with CPB2 toxin as the likely agent in these outbreaks. We observed significantly greater abundances of C. perfringens in lorikeets with enteritis and lorikeets susceptible to enteritis as compared to healthy. Isolates were susceptible to clindamycin. Additionally, we examined histopathologic changes in lorikeets with and without enteritis and observed necrotizing intestinal lesions with intralesimal gram-positive rods in lorikeets with enteritis. Our results identify lorikeets at high risk for Clostridial infection, potentially enabling new ways to manage and target therapeutic applications to prevent enteritis and improve lorikeet health.

Key words: Clostridium perfringens, enteritis, lorikeet, microbiota

ACKNOWLEDGMENTS

The authors thank the veterinary teams, animal care staff, and administrators at the Columbus Zoo and Aquarium and the Denver Zoo for their participation in and support of this project. We further acknowledge funding from: Columbus Zoo and Aquarium / Ohio State University Collaborative Research Fund, National Institutes of Health Training Grant (T35).
LITERATURE CITED


SYSTEMIC INFECTION WITH A NOVEL *Eimeria* SPECIES IN ZOO-HOUSED LESSER FLAMINGOS (*Phoeniconaias minor*)

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Abstract

Systemic protozoal infection due to *Eimeria* sp. is uncommon and has not been previously reported in flamingos. Infection in birds is most often limited to the intestine.† A flock of over 100 lesser flamingos (*Phoeniconaias minor*) has been housed at Fort Worth Zoo for almost 20 yr and is the primary *P. minor* captive breeding population worldwide. In 2017, two hand-reared juveniles were found dead with no prior signs of illness. Histologic examination revealed disseminated protozoal infection with organisms in the spleen and intestine in both flamingos and liver of one flamingo. Pan-coccidial polymerase chain reaction (PCR) and sequencing of spleen from one flamingo identified a novel *Eimeria* species with 96% homology to *Eimeria reichenowi*. In 2019, a hand-reared juvenile presented with non-specific signs of illness and was later euthanized due to declining condition despite treatment efforts. Disseminated protozoal infection was confirmed histologically with organisms in the spleen, liver, lung, and intestine. PCR and sequencing of spleen was positive for an *Eimeria* genetically identical to the 2017 isolate. The histologic findings in these cases are similar to disseminated visceral coccidiosis in cranes due to *Eimeria reichenowi*.‡ Hand-rearing may have been a factor in disease progression. Preventive measures and individual treatments are challenging with a large flock, and this species is sensitive to capture and restraint. Development of a specific qPCR for this organism to aid in investigation is ongoing.

**Key words:** Coccidia, *Eimeria*, lesser flamingo, mortality, *Phoeniconaias minor*

ACKNOWLEDGMENTS

The authors thank the Fort Worth Zoo’s bird department staff for their daily husbandry work with the flamingos and veterinary technicians for their efforts in administering flamingo treatments and processing laboratory samples; the support staff at the Zoological Pathology Program and Northwest ZooPath for sample processing; and April Childress for processing samples for molecular diagnostics.

LITERATURE CITED


IN VITRO MODELING OF CLINICAL DOSING REGIMENS OF ADEQUAN® IN CHILEAN FLAMINGOES (Phoenicopterus chilensis) FOR ASSESSMENT OF POTENTIAL ANTICOAGULANT EFFECT

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Abstract

Polysulfated glycosaminoglycans (PSGAG) are synthetic products administered for orthopedic conditions to stimulate collagen synthesis, inhibit collagen breakdown, and decrease joint pain and inflammation. 3 Adequan® is the only parenteral PSGAG that is FDA-approved for degenerative joint disease management in dogs and horses. Its chemical structure is an analogue of heparin, potentially conferring anticoagulant properties. 1 While used extra-label for many species, case reports have described hemorrhagic diathesis and cardiovascular shock in treated birds. 2,4

For this in vitro study, citrated plasma samples were opportunistically collected from 42 (23 male and 19 females) Chilean flamingoes (Phoenicopterus chilensis) during their annual preventive health examinations. Each sample had baseline coagulation assessed by thrombin clotting time (TCT) and fibrinogen assays. Repeated TCT determinations were performed on spiked plasma aliquots from each bird containing the maximum plasma concentration expected to be achieved from one of three Adequan® doses (1 mg/kg; 5 mg/kg; 10 mg/kg). These respective doses were chosen as the dose at this institution considered clinically effective for avian species; 1 the label canine dose; 4 and the dose associated with published cases of hemorrhagic diathesis in avian species. 2 Due to inherent variability in baseline TCT and fibrinogen among individuals, each bird’s spike-in TCT samples were compared with its own baseline TCT to detect a heparin-like effect of Adequan®. 4 These in vitro data support clinical observations that Adequan® at 1 mg/kg does not have an anticoagulant effect in Chilean flamingoes.

Adequan® Elanco, Luitpold Animal Health, Greenfield, IN 46410 USA; Adequan® Canine, 100 mg/ml

Key words: Adequan®, Chilean flamingo, coagulation, Phoenicopterus chilensis, polysulfated glycosaminoglycan (PSGAG), thrombin clotting time (TCT)

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LITERATURE CITED


RETROSPECTIVE ANALYSIS OF NEOPLASIA IN CAPTIVE CRANES, 1993-2018

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Abstract

A retrospective review of necropsy and histopathology reports from 446 cranes representing 14 species during 1993-2018 were evaluated for neoplasia. Cases were obtained from the International Crane Foundation (ICF), Northwest ZooPath (NWZP) and six other zoological institutions in the United States. Reports from ICF and NWZP were the only cases included in prevalence calculations. Overall prevalence of neoplasia was 8.0% (35/435) with a metastasis rate of 37% (13/35). The average age at diagnosis was 30.8 ± 13 yr. Gastrointestinal system was the most common organ system involved (n = 12, 28%), followed by urinary (n = 7, 16%), integument (n = 6, 14%), and reproductive (n = 4, 9%). Of the gastrointestinal neoplasms, liver was the most commonly affected (11/12, 92%). Kidney was the only organ in the urogenital tract where neoplasia was found. Multiple neoplasms were observed in only one crane. Of the cases with metastasis, hematopoietic and respiratory cases had 100% metastasis (2/2 each) whereas integument, nervous system, and musculoskeletal systems had no evidence of metastasis (0/7, 0/3, and 0/1, respectively). Eurasian cranes (Grus grus) had the highest rate of neoplasia by specie (40%, 2/5), followed by demoiselle (Anthropoides virgo, 21%, 6/28), wattled (Bugeranus carunculatus, 18%, 4/22) and whooping cranes (Grus americana, 18%, 7/39). This is the first study to evaluate neoplasia in cranes on a large scale. Currently, only sporadic case reports of neoplasia exist with previous crane mortality reports finding no evidence of neoplasia.1-6 Based on this study, neoplasia is an important differential for disease in these long-lived and commonly displayed birds.

Key words: Crane, Gruiformes, neoplasia

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LITERATURE CITED


USE OF A COMMERCIALY AVAILABLE EQUINE WEST NILE VIRUS VACCINE FAILS TO ELICIT AN ANTIBODY RESPONSE IN A ZOO-BASED CONSERVATION BREEDING POPULATION OF ENDANGERED GREATER SAGE-GROUSE (Centrocercus urophasianus)

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Abstract

Greater sage-grouse (Centrocercus urophasianus) are an endangered species in Canada and have been extirpated from five states in the United States.1,3,4 While habitat loss and low chick survival rate contribute to continued population declines, infectious diseases also pose a challenge to conservation efforts.1,3 The greater sage-grouse is known to be susceptible to West Nile virus (WNV).3,5 This study measured the humoral response to a commercially available WNV vaccinea in a conservation breeding program of endangered greater sage-grouse. Since the initiation of this breeding for release program at the Calgary Zoo in 2014, all sage-grouse have been vaccinated against WNV. Juveniles received a series of three vaccines (0.5 ml SC, 1.0 ml SC, and 1.0 ml IM), every 3-4 wk starting around 2 wk of age; adults were boostered annually (1.0 ml IM). Antibody titres using either serum neutralization or plaque-reduction neutralization were measured on 60 serum samples collected in 2018 from 36 juveniles and 18 adults. No detectable antibody response was noted in juveniles after their second (n = 17) or third booster vaccinations (n = 23). Of the 20 samples collected from adults only 35% had positive titres. There have been only two cases of adverse vaccine reaction noted in this species, with over 900 doses being administered from 2014-2019. Despite a lack of antibody response in juveniles and most adults, there have been no WNV associated deaths in this population, suggesting that cell-mediated immunity may be of greater importance for protection against WNV infections in this species, as suggested in previous research.2,4

aWest Nile Innovator®, Zoetis Inc., Kalamazoo, Michigan, 49007, USA

Key words: Centrocercus urophasianus, greater sage-grouse, immune response, vaccine, West Nile virus.

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LITERATURE CITED


COMPUTED TOMOGRAPHY AND PATHOLOGY FINDINGS IN THE FEET OF ZOO GIRAFFE (Giraffa camelopardalis reticulata)

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Abstract

Hoof overgrowth and associated lameness are health concerns for giraffe at multiple zoos.1 To better describe giraffe foot anatomy and pathology contributing to lameness, the distal limbs of 10 adult reticulated giraffe (Giraffa camelopardalis reticulata) from five zoos were evaluated postmortem by computed tomography (CT) and histopathology. All giraffe had hoof overgrowth of at least one front foot and nine of 10 giraffe had a history of lameness. In total, 19 front feet and 14 hind feet were studied. Common lesions identified by CT included pedal osteitis (10/10 giraffe, 33/33 feet), distal phalangeal bone fractures (P3 fractures; 4/10 giraffe, 7/33 feet), subchondral bone degeneration (10/10 giraffe, 30/33 feet), navicular disease (8/10 giraffe, 20/33 feet), osteoarthrosis (10/10 giraffe, 33/33 feet), proximal sesamoid osteitis/osteonecrosis (7/10 giraffe, 15/33 feet), and laminitis (5/10 giraffe, 17/33 feet). Concurrent soft tissue tendinopathy and desmopathy of the distal limb were identified, including the deep digital flexor tendon (6/10 giraffe, 10/33 feet), superficial digital flexor tendon (6/10 giraffe, 12/33 feet), suspensory ligament (6/10 giraffe, 11/33 feet), interdigital ligament (2/10 giraffe, 5/33 feet), intersesamoidean ligament (8/10 giraffe, 22/33 feet), and collateral ligaments (10/10 giraffe, 28/33 feet). Distal limb dissections and histopathology were performed to verify results. This study demonstrates that zoo giraffe with hoof overgrowth can develop profound chronic osseous degeneration and soft tissue injury of their feet. Further research is warranted to identify effective prevention and management strategies and the potential impact of proactive routine hoof care for zoo giraffe.

Key words: Computed tomography, foot anatomy, Giraffa camelopardalis reticulata, giraffe, histopathology, lameness

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LITERATURE CITED

HIGH PREVALENCE OF LESIONS OF SYSTEMIC HYPERTENSION AND ASSOCIATED RENAL DISEASE IN BILE-EXTRACTED ASIATIC BLACK BEARS (Ursus thibetanus)

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Abstract

Despite proven alternatives to bear bile, approximately 17,000 bears undergo bile extraction on bile-farms across Asia to supply traditional medicinal markets. Farmed bears are confined to small cages to facilitate bile extraction via needle aspiration, surgically implanted catheters, or transabdominal fistulas. Rescued bile-extracted bears exhibit severe, concurrent behavioral and physical issues including extreme aggression, emaciation, dental fractures, cholecystitis, abdominal hernias and abscesses, and hepatic neoplasia. Cardiovascular disease, predominantly aortic aneurysm rupture/dissection, is the third leading cause of death in rescued Asiatic black bears (Ursus thibetanus). A high prevalence of aortic dilation (>50%) was reported in bile-extracted bears, consistent with systemic hypertension. Renal disease commonly precipitates systemic hypertension in other species and recently evidence of chronic renal disease was identified in bile-extracted bears. We hypothesized a positive correlation between renal disease and lesions of systemic hypertension in bile-extracted bears. Archived samples from 180 rescued bears were analyzed. Validated correlates of systemic hypertension were used, including hypertensive retinopathies, left ventricular hypertrophy, and aortic dilation. The majority of bile-
extracted bears, 76.1% (137/180), exhibited at least one lesion of systemic hypertension, and 62.8% (86/137) two or more concurrent lesions. Left ventricular hypertrophy was most common, present in 74.4% of bears, followed by aortic dilation/aneurysm in 69.3% of bears. Lesions of systemic hypertension were positively correlated to serum creatinine and renal histopathology score. Due to significant sequelae of chronic, uncontrolled systemic hypertension, including aortic aneurysm rupture/dissection, further elucidating the etiology of systemic hypertension is crucial as increasing numbers of bears are rescued from bile farms.

**Key words:** Aortic aneurysm, Asiatic black bear, bile farming, renal disease, systemic hypertension, *Ursus thibetanus*

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**LITERATURE CITED**


PHYSICAL THERAPY IMPROVES FUNCTION AND MOBILITY IN TWO GERIATRIC GALAPAGOS TORTOISES (*Chelonoidis nigra*)

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Abstract

An approximately 90-yr-old, 220-kg, male Galapagos tortoise (*Chelonoidis nigra*) housed at a zoological institution presented with a 2-mo history of isolating, rear limb dragging, and decreased activity. Radiographs showed multifocal degenerative joint disease (DJD). The tortoise had a brief period of improvement after non-steroidal anti-inflammatory therapy, but mobility declined again within 3 wk. Physical therapy was instituted using the Wolfe Kinetic Technique™ (WKT), a gentle manual method which has been used effectively in many species to improve function and mobility and reduce pain and stiffness. The WKT method focuses on movement of the spine, ribs, and pelvis in order to distribute the workload throughout the body and promote functional movement patterns. Gentle manipulations of the shell were performed to increase space within the shoulder and hip joints, approximate movement of the spine and ribs in multiple planes, and provide proper proprioceptive input to the nervous system. A marked improvement in activity and speed of movement was noted after two treatments. After 6 wk (seven treatments), the tortoise was moving normally, socially integrated, and observed copulating with a female. A second, approximately 100-yr-old, male Galapagos tortoise presented with a 3-wk history lameness and hyperesthesia. A similar WKT program was initiated. The hyperesthesia resolved and return to normal function and activity were observed after 3 weekly treatments. DJD is a common finding in geriatric reptiles and physical therapy should be considered as part of a multimodal approach to treatment of this disease.

Key words: *Chelonoidis nigra*, degenerative joint disease, Galapagos tortoise, geriatric, physical therapy, Wolfe Kinetic Technique

LITERATURE CITED


ANIMAL WELFARE ACT: KEY ROLE OF THE ATTENDING VETERINARIAN

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Abstract

The U.S. Department of Agriculture (USDA) Animal Plant Health Inspection Service (APHIS) Animal Care is the division of USDA that provides leadership for determining standards of humane care and treatment of animals. APHIS achieves compliance through inspection, education, cooperative efforts and enforcement. The Animal Act (AWA) is a statute enacted by Congress in 1966. The enabling regulations and standards are found in 9CFR, Chapter 1, Subchapter A – Animal Welfare (AWAR).

The AWAR is divided into four parts; Part 1 Definitions; Part 2 Regulations; Part 3 Standards; Part 4 Rules of Practice. The AWA covers only warm-blooded animals used in regulated activities, excepting farm animals used for agricultural purposes, birds, rats or mice bred for use in research, and horses unless they are used for biomedical research or teaching. For the most part, the AWA covers animals kept in captivity, not living naturally in the wild. This paper focuses on the parts of the AWA that most frequently apply to zoo and captive-wildlife facilities and their attending veterinarians.

The AWAR, Part 2-Regulations is divided into Subparts A – J. Subpart D; Attending Veterinarians and Adequate Veterinary Care, and Subpart I; Miscellaneous - § 2.131 Handling of Animals are worthy of extra attention.

The AWAR, Part 3-Standards is divided into Subparts A – F, with each section focusing on specific species. The standards define the facilities and operating standards such as structural strength, heating, ventilation, shelter, and primary enclosures; defines the animal husbandry and health standards, such as feeding and watering; and defines the standards of transportation. The species are partitioned as follows: Subpart A - Dogs and Cats, Subpart B - Guinea Pigs and Hamsters, Subpart C – Rabbits, Subpart D - Nonhuman Primates, Subpart E - Marine Mammals, and Subpart F - All other covered species. The standards applicable to most zoo, wildlife, and marine mammal facilities are found in Subparts D, E, and F, with Subpart F covering most types of zoo and wildlife species.

Attending veterinarians support the humane treatment of animals and help to contribute to the success of regulated facilities. They ensure the provision of adequate veterinary care and oversee the adequacy of other aspects of animal care and use. This may include working with the facility to develop a program that covers all health-related aspects of care, such as disease monitoring and prevention, husbandry, employee knowledge, and after-hours care as well as providing prevention, monitoring and treatment programs to achieve individual and herd health.

The attending veterinarian (AV) is key to ensuring good welfare for the animals living at zoos and wildlife facilities. Regulated facilities must have a formal arrangement with an AV, either as a full-
time employee or as a part-time consultant. In the case of a part-time attending veterinarian, the formal arrangement must include a written Program of Veterinary Care (PVC) and regularly scheduled visits. The regulated facility must assure the AV has appropriate authority to ensure the provision of adequate veterinary care, and oversee the adequacy of other aspects of animal care and use, such as cleaning and disinfection, rodent control, reproduction and more. Regulated facilities are expected to follow the Program of Veterinary Care developed by and in collaboration with the part-time attending veterinarian and also follow all treatment instructions. Full-time AVs are free to develop a PVC as well, although it is not required. A recently published final rule amended the requirements for a PVC for dogs. At this time, a written and AV-signed PVC for dogs is required for all facilities with dogs.

An adequate program of veterinary care must include the daily observation of all animals to assess health and wellbeing, both physical and behavioral. There must be a mechanism of communication between onsite caregivers and the AV to ensure animal health, behavior and wellbeing problems are communicated routinely and in a timely and accurate manner to the AV. There must be appropriate methods for prevention, control, diagnosis, and treatment of diseases and injuries. The licensee must also provide appropriate facilities, personnel, equipment and services to manage the animal collection and facilitate adequate veterinary care. Adequate veterinary care must also include pre and post-procedural care in accordance with established veterinary medical and nursing procedures.

USDA APHIS Animal Care supports the AV’s authority to ensure the provision of adequate veterinary care for animals at an AWA licensed or registered facility. The USDA inspector will call the AV if there is a question about an animal’s veterinary care or treatment or to confirm the animal is receiving adequate care. Non-compliance issues of adequate veterinary care can often arise from the failure of the licensee to contact or to follow instructions from the AV. Regulated facilities may be subject to penalties and other sanctions for failing to comply with the AWA and/or AWAR.

The AWAR also contains specific requirements for the AV, including:

§3.8: approving exercise program for dogs, and exempting certain dogs from exercise requirements
§3.100: supporting a request for variance for space requirements for marine mammals
§3.105: providing written exception feeding schedules not including daily offerings for marine mammals
§3.110 & 3.111: performing, overseeing, and evaluating necropsies of marine mammals; performing scheduled physical examinations at least yearly for cetaceans and manatees; maintaining individual medical records for marine mammals (§3.111 is not currently enforced)
§3.131: requiring the sanitation of pens with a gravel/dirt/sand substrate when needed
§3.13 (dogs & cats), §3.35 (GP & hamsters), §3.61 (rabbits), §3.86 (primates), 3.112 (marine mammals), §3.136 (subpart F): certifying that animals are acclimated to temperatures outside the established regulatory ranges
§3.77: determine and implement acceptable humidity levels for primates
§3.81: directing the environment enhancement program for nonhuman primates if outside currently accepted professional standards, and ensuring the compatibility, special considerations, and exemption of primates from all or part of the program

The role of the AV is integral to the provision of adequate veterinary care and the wellbeing and welfare of the regulated animals.

**Key words:** Compliance, adequate veterinary care, Animal Welfare Act, attending veterinarian, USDA AWA regulations
COMPREHENSIVE HEALTH ASSESSMENT INCLUDING MULTI-PATHOGEN SURVEILLANCE IN THE FEDERALLY THREATENED EASTERN MASSASAUGA RATTLESNAKE (*Sistrurus catenatus*) IN ILLINOIS, USA

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Abstract

The eastern massasauga rattlesnake (EMR; *Sistrurus catenatus*) is federally threatened due to severe habitat loss and human persecution. Disease also represents an emerging and potentially significant threat to the persistence of isolated EMR populations, including those in Illinois.⁶ EMR pathogen surveillance has historically focused on ophidiomycosis, which has been detected in snakes from Illinois at a prevalence of 14-22% since at least 2000.²-⁴ Ophidiomycosis can cause significant morbidity and mortality in EMR; however, the importance of other diseases for EMR survival and fitness is uncharacterized.¹,⁵ The purpose of our study was to conduct health assessments, including multi-pathogen surveillance, in the last viable population of EMR in Illinois. Thirty-five free-living EMR were examined in spring 2019. Cloacal swabs and whole blood were assayed for herpesviruses, adenoviruses, and ranaviruses, whereas skin swabs (whole body and lesions) were tested for *Ophidiomyces ophiodiicola* using PCR. Erythrocyte counts (400 cells) were performed to quantify parasitemia and pathogen presence was modeled using logistic regression. Overall, 26% of EMR tested positive for *O. ophiodiicola* and 88% of these had skin lesions. Low levels of hemogregarine parasitemia were observed (<5%), but no other pathogens were detected. Agreement between body and lesion swabs for detecting *O. ophiodiicola* was moderate (kappa = 0.48), and detection of *O. ophiodiicola* was maximized when body and lesion swabs were tested in parallel. Our study clarifies aspects of diagnostic testing in EMR and demonstrates that co-pathogens appear rare in a population from Illinois with historic and ongoing *Ophidiomyces* infection.

**Key words:** Adenovirus, eastern massasauga rattlesnake, herpesvirus, *Ophidiomyces ophiodiicola*, ranavirus, *Sistrurus catenatus*

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LITERATURE CITED


A NOVEL MORTALITY-ASSOCIATED Helicobacter SPECIES IN GOPHER TORMTOISES (Gopherus polyphemus): qPCR TEST DEVELOPMENT AND VALIDATION, AND AN EPIDEMIOLOGIC SURVEY

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Abstract

The genus Helicobacter comprise spiral-shaped bacteria in the phylum Proteobacteria, order Campylobacteriales which have been associated with disease in animals, including reptiles. Three wild gopher tortoises (Gopherus polyphemus) presented between 2012 and 2019 with nasal discharge, lethargy, and poor body condition. Cytologic examination of nasal discharge identified heterophilic rhinitis and a predominance of spiral-shaped bacteria. PCR and sequencing of the 16S rRNA gene revealed this to be a novel Helicobacter species. Two tortoises died despite treatment, the third was euthanized without treatment. Histologic examination of the nasal mucosa showed granulocytic to lymphocytic rhinitis with variable mucusal hyperplasia, erosion, and ulceration; Warthin-Starry staining highlighted the presence of spiral bacteria in the untreated tortoise. Genus-specific primers were designed, and the gyrA and groEL genes were amplified by PCR and sequenced. Phylogenetic analysis shows that this organism and other previously characterized Helicobacter from tortoises form a clade. Development and cross-validation of two qPCR diagnostic assays for the gyrA and groEL genes showed significant correlation of the results of two assays (P < 0.0001, Wilcoxon rank sum test). These assays were used to survey nasal wash samples from a collection of 37 gopher tortoises. Sex, medication, nasal discharge score, blood data (CBC and chemistry), and other clinical data were compared with qPCR results for this bacteria. Mortality of tortoises was significantly correlated to higher Helicobacter loads detected by qPCR (P = 0.0128, Wilcoxon rank sum test). Upper respiratory disease in tortoises appears to involve complex microbial ecology. Factors beyond Mycoplasmopsis (Mycoplasma) agassizii should be taken into account.

Key words: Gopher tortoise, Gopherus polyphemus, Helicobacter, mortality, quantitative PCR

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LITERATURE CITED


INVESTIGATING THE IMPACT OF CAPTURE METHODS ON THE TRANSFER OF Ophiidiomyces ophiodiicola DNA IN FREE-RANGING LAKE ERIE WATERSNAKES (Nerodia sipedon insularum)

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Abstract

Ophiidiomycosis (commonly known as snake fungal disease) is caused by the fungus Ophiidiomyces ophiodiicola1 and poses a threat to the health of snakes worldwide. Although O. ophiodiicola transmission is not entirely understood, physical contact between infected individuals likely plays a role.3 Lake Erie watersnakes (Nerodia sipedon insularum, LEWS) were listed as a federally endangered and threatened species from 1999 to 20112 and have been affected by ophiidiomycosis since 2009.3 During annual LEWS population health surveillance, up to 20 snakes of unknown disease status are transported together in the same pillowcase. The purpose of this project was to evaluate biosecurity practices during this capture and assessment process. It was hypothesized that snakes kept in group pillowcases would show an increase in the quantity of O. ophiodiicola DNA on their skin, compared to snakes kept in individual pillowcases. Eighty-nine free-ranging LEWS were individually hand captured using clean nitrile gloves, visually examined for skin lesions, swabbed for qPCR, and assigned to either an individual or group pillowcase. Snakes were re-swabbed after spending at least 1 hr in their respective pillowcases. Overall, 67% were initially qPCR positive for O. ophiodiicola. Fourteen individuals (16%) converted from negative to positive for O. ophiodiicola after pillowcase transport, including six that were transported individually. The results of this study indicate that using group pillowcases to transport LEWS does not significantly increase transmission of O. ophiodiicola; however, biosecurity is important when working with infectious diseases and future studies are needed to better understand the transmission of ophiidiomycosis.

Key words: Biosecurity, fungal disease transmission, Lake Erie watersnake, Nerodia sipedon insularum, Ophiidiomyces ophidiicola, ophiidiomycosis

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LITERATURE CITED


2. Lorch JM, Knowles S, Lankton JS, Michell K, Edwards JL, Kapfer JM, Staffen RA, Wild ER, Schmidt KZ,

DEVELOPMENT AND VALIDATION OF A QUANTITATIVE PCR ASSAY FOR DETECTION OF TERRAPENE HERPESVIRUS 2 IN EASTERN BOX TURTLES (Terrapene carolina carolina)

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Abstract

Herpesviruses are associated with disease in multiple chelonian species and can result in clinical signs such as respiratory tract infections, stomatitis, conjunctivitis, hepatitis, and papillomatosis. Herpesvirus-associated fibropapillomas cause significant morbidity and mortality in marine turtles and have recently been identified in an eastern box turtle (Terrapene carolina carolina) infected with Terrapene herpesvirus 2 (TerHV2). Further investigation is necessary to understand the impact of carcinogenic herpesviruses on chelonian health, however, reliable and specific methods for detection and quantification of herpesviral load are lacking. The purpose of this study was to develop and validate a quantitative real-time PCR assay for detection of TerHV2 in box turtles. TaqMan primer-probes were developed targeting the DNA polymerase gene. Inter and intra-assay variability, linear range of detection, limit of detection, and specificity were assessed. The assay was highly specific for TerHV2 as it failed to amplify seven other closely-related chelonian herpesviruses. It performed with high efficiency (slope = -3.52, R2 = 1, efficiency = 92.29%), low intra-assay variability, and low inter-assay variability (coefficient of variation ≤ 1.25% at all standard dilutions). Reaction efficiency was not impacted in the presence of box turtle DNA from combined oral/cloacal swabs or whole blood. This assay has a linear range of detection from 10^7 to 10^1 viral copies per reaction, with occasional detection of as few as 1 viral copy per reaction. This qPCR assay will be a valuable tool in the surveillance and characterization of TerHV2 in box turtles.

Key words: Chelonian, eastern box turtle, epidemiology, qPCR, Terrapene carolina, Terrapene herpesvirus 2
PAINTED TURTLE (*Chrysemys picta*) POPULATION HEALTH ASSESSMENT IN KANE COUNTY, ILLINOIS, USA

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Abstract

Painted turtles (*Chrysemys picta*) represent a clinically relevant species in wildlife ecosystems, conservation and education institutions, and private veterinary clinics. Free-living populations frequently co-occur in ecosystems with species of conservation concern, such as the Illinois state-endangered Blanding’s turtle (*Emydoidea blandingii*).1 In Kane County, Illinois, painted turtles are considerably more numerous than Blanding’s turtles and may represent a valuable sentinel for population health in rare chelonian species. However, the health of painted turtle populations is understudied. This study characterized population health in free-ranging painted turtles from four habitat locations within Kane County. In summer 2019, 97 painted turtles were trapped, sampled, and examined. Complete blood counts, plasma biochemistries, and protein electrophoresis were performed. Combined oral/cloacal swab samples were collected for multi-pathogen testing (four ranaviruses, three *Mycoplasma* spp., three herpesviruses, two *Salmonella* spp., *Emydomyces testavorans*, and intranuclear coccidiosis) using qPCR. Adults had a higher prevalence of ectoparasites and hemoparasites (Chi-square test: \(P = 0.001\) and \(P = 0.015\), respectively), and higher total solids (t-test: \(P = 0.0019\)) than juveniles. Females had higher packed cell volume (t-test: \(P = 0.0019\)) and total solids (t-test: \(P < 0.0001\)) than males. Emydid herpesvirus 1 (*EmyHV-1*) was detected in eight turtles and a *Mycoplasma* sp. recently described in Blanding’s turtles was identified in one individual. No clinical signs were associated with either pathogen. This study provides baseline data on hematology, plasma biochemistries, protein electrophoresis, and pathogen DNA detection that may inform future studies in chelonian conservation and clinical medicine.

Key words: Chelonian, *Chrysemys picta*, clinical pathology, conservation, health assessment, painted turtle

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LITERATURE CITED

PRESUMPTIVE HETEROPHIL EXTRACELLULAR TRAPS RECOGNIZED CYTOLOGICALLY IN REPTILE PATIENTS WITH INFLAMMATORY CONDITIONS

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Abstract

Neutrophil extracellular traps (NETs) represent a novel cellular mechanism of neutrophil antimicrobial defense activity. Intravascular neutrophils produce extracellular web-like structures composed of chromatin, histones, and cytoplasmic granule proteins to attack and kill microbes. They may impact both pathogen and host; NETs correlate strongly with disseminated intravascular coagulation and mortality in critically ill humans, providing prognostic information.1 The mechanism was first discovered in human neutrophils in 2004 and fish neutrophils in 2007.2,4 A similar process was then documented in heterophils in chicken in vitro.3 Presumptive heterophil extracellular traps (HETs) were first described in blood films of a gopher tortoise (Gopherus polyphemus) with systemic inflammation.5 While prior reports are limited to blood film review and in vitro studies, this case series highlights the cytological identification of presumptive HETs in eight reptile patients with various inflammatory conditions, including bacterial and viral infections. Subjects included five gopher tortoises, one blood python (Python curtus), one Burmese python (Python bivittatus), and one desert king snake (Lampropeltis getula splendida). Cytology samples with identified HETs included tissue imprints (n = 4), nasal discharge (n = 2), oral swab (n = 1), and skin lesion fine needle aspirate (n = 1). All five gopher tortoises suffered from upper respiratory disease with bacterial etiology, and snakes had upper respiratory tract infection (n = 2) or bacterial dermatitis (n = 1). To the authors’ knowledge, this is the first report of presumptive HETs recognized in reptile cytology specimens, suggesting an active cellular process in vivo in response to systemic inflammation in non-avian reptiles and contributing to further understanding of extracellular traps in these species.

Key words: Cytology, extracellular traps, heterophil, inflammation, reptile

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LITERATURE CITED


ASSESSING OCULAR HEALTH OF EASTERN AND ORNATE BOX TURTLES
(Terrapene carolina carolina, Terrapene ornata ornata) BASED ON INTRAOCULAR PRESSURE AND TEAR PRODUCTION

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Abstract

Intraocular pressure (IOP) and tear production (TP) are standard tests for ocular health in veterinary patients. Ophthalmic abnormalities such as blepharoedema, conjunctivitis, and ocular discharge are common in North American box turtles (Terrapene spp.); however, there are no published studies quantifying IOP and TP in box turtles despite their popularity. The purpose of this study was to assess ocular health in apparently healthy free-ranging eastern box turtle (n = 113, EBTs, Terrapene carolina) and ornate box turtles (n = 113, OBTs, Terrapene ornata) by measuring IOP and TP, establishing reference ranges, and determining associations with demographic, seasonal, and health factors. Turtles from Illinois and Tennessee were sampled in the field as part of a larger ongoing comprehensive health assessment study. IOPs were significantly higher in EBTs compared to OBTs (P < 0.0001). In both species, IOPs were higher and TP was lower in juveniles than adults (P < 0.05). EBTs and OBTs with a bright attitude had significantly higher IOPs than EBT who were quiet (P < 0.05). In EBTs and OBTs, TP was significantly higher in the spring than summer, in turtles from Illinois vs. those from Tennessee, and in EBTs with aural abscesses (P < 0.05). Understanding reference ranges, and biological variables affecting baseline values, is necessary when diagnosing and treating ophthalmic diseases in both wild and captive species. Ocular disease in free-ranging box turtles could alert clinicians and researchers to changes in the systemic health of these sentinel species and thus improve management of individuals and populations.

Key words: Eastern box turtle, intraocular pressure, ornate box turtle, tear production, Terrapene carolina carolina, Terrapene ornata ornata

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OLIGOCHAETOSIS IN ANURAN AMPHIBIANS

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Abstract

Oligochaetes are free-living annelid worms found in most aquatic and terrestrial environments; however, members of the genus Dero (Allodero) have been documented to reside routinely in the urinary tract of wild Cuban tree frogs (Osteopilus septentrionalis) and rarely in captive poison dart frogs (Oophaga histrionica) and other species of anurans. This case series details the pathological findings associated with these parasites in anurans and characterizes the unique features of oligochaetes. Parasites that were morphologically consistent with oligochaetes were identified histologically in the Wolffian ducts and urinary bladder in dendrobatids submitted for histologic evaluation after death without clinical signs or death following short, non-specific clinical illness. Water samples collected from bromeliad axils of one affected population of poison dart frogs contained very high numbers of oligochaetes. The parasites were characterized morphologically by scanning electron microscopy and by PCR and sequencing of the 16S gene. In the wild, oligochaetes are most often commensal organisms of unknown clinical significance. In cases of heavy parasite burden in captivity, high numbers of oligochaetes can result in severe localized and systemic disease, such as bacterial septicemia due to rupture of the urinary tract. Moreover, the presence of these parasites in bromeliad axils has significant implications for exposure of frog species that utilize these water sources as part of their life cycles. Many dendrobatids maintained in captivity return to the same bromeliad axils frequently, increasing their risk of exposure. Therefore the potential for clinical disease in the captive setting is essential information for clinicians.

Key words: Anurans, Dero (Allodero), oligochaetes, urinary tract

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LITERATURE CITED


COMPARING EFFECTS OF LITHIUM HEPARIN AND DIPOTASSIUM ETHYLENEDIAMINETETRAACETIC ACID ON HEMATOLOGIC VALUES IN EASTERN BOX TURTLES (Terrapene carolina carolina)

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Abstract

Anticoagulants are employed to prevent clotting and preserve cellular morphology for clinical pathology tests. Lithium heparin is the most frequently used anticoagulant in chelonians; however, dipotassium ethylenediaminetetraacetic acid may be superior in some species. While eastern box turtles’ (Terrapene carolina carolina) hematologic parameters are well studied, the effects of different anticoagulants on hematology in this species are unknown. This study evaluated the effects of lithium heparin (LH) and dipotassium ethylenediaminetetraacetic acid (K₂EDTA) on hematologic values in free-living eastern box turtles (n = 59). Blood samples were collected from eastern box turtles in Illinois, immediately divided between LH and K₂EDTA microtainers, and complete blood counts were performed on each sample. Grossly, plasma from K₂EDTA blood samples was frequently and significantly hemolyzed. Blood mixed with LH had higher packed cell volume (PCV) (P = 0.04), white blood cell count (WBC) determined by leukopet (P < 0.0001), WBC determined by blood film estimate (P < 0.0001), absolute heterophils (P = 0.007), and lymphocytes (P < 0.0001), and lower total solids (P < 0.0001) and monocytes (P = 0.0001) than blood mixed with K₂EDTA. K₂EDTA apparently lysed erythrocytes in turtles in this study making it difficult to accurately count white blood cells and artificially lowering PCV. Our findings demonstrate that K₂EDTA should not be used in eastern box turtles.

Key words: Anticoagulants, dipotassium ethylenediaminetetraacetic acid, eastern box turtle, hematology, lithium heparin, Terrapene carolina carolina

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LITERATURE CITED


A NOVEL HERPESVIRUS DETECTED IN THREE DIFFERENT SPECIES OF CHELONIANS

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Abstract

Herpesviruses are significant pathogens in both wild and captive chelonian populations due to their association with morbidity and mortality. Currently, all chelonian herpesviruses have been identified as closely related alphaherpesviruses within a clade of their own. In the present report, we detected a novel herpesvirus related to other alphaherpesviruses in three species of the Emydidae family: a captive leopard tortoise (Stigmochelys pardalis) in West Texas, a Russian tortoise (Testudo horsfieldii) found near Fort Irwin in California, and two free-ranging, three-toed box turtles (Terrapene mexicana triunguis) found in Forest Park, St. Louis, Missouri. The leopard tortoise was also co-infected with the tortoise intranuclear coccidian and displayed clinical signs of severe mucoid/diphtheric stomatitis, rhinitis, glossitis, and conjunctivitis. The Russian tortoise was ELISA-positive for exposure to Mycoplasma agassizii and exhibited mucopurulent nasal discharge. One of the three-toed box turtles displayed no clinical signs at the time of detection, whereas the other free-living turtle was found dead after a chronic course of severe blepharedema, open lacerations near her cloaca, lethargy, dehydration, and edema of the neck and both tympanic membranes. Based on phylogenetic analysis, we suggest the name Terrapene herpesvirus-3 (TerHV-3) for the novel herpesvirus. The branching order of the turtle herpesviruses mirror the divergence patterns of their hosts, consistent with codivergence. This virus appears to have the ability to host-jump and potentially be associated with significant morbidity in aberrant hosts. Future screening for this herpesvirus may be useful in determining its role in chelonian upper respiratory tract disease.

Key words: Herpesvirus, Stigmochelys pardalis, Terrapene herpesvirus-3, Terrapene mexicana triunguis, Testudo horsfieldii

LITERATURE CITED


COMPARISON OF BLOOD LEPTIN, ADIPONECTIN, VITAMIN E, AND BLOOD AND ADIPOSE FATTY ACID COMPOSITIONS IN WILD AND CAPTIVE POPULATIONS OF CRITICALLY ENDANGERED VANCOUVER ISLAND MARMOTS (Marmota vancouverensis)

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Abstract

Vancouver Island marmots are endemic to Vancouver Island, British Columbia, Canada. Due to a restricted geographic distribution and low numbers, the species has been listed as critically endangered since 1978. Population decline is thought to have occurred due to clear-cut logging and the associated increased predation. Conservation efforts include establishment of a captive-breeding program in 1997 with release of captive-bred marmots in their natural habitats since 2003. Field studies have shown that captive-born released marmots have a significantly lower annual survival rate compared to wild-born counterparts. Overwinter survival has been reported as a significant factor limiting release success in these captive-bred marmots. The captive diet and other captive parameters could negatively alter white adipose tissue composition and lipid metabolism, translating into a reduced survival rate for captive-born marmots during their first wild hibernation. The objective of this prospective study was to investigate differences in lipid metabolism between wild and captive marmots during the active season. Comparison of blood adipokines (leptin, adiponectin), and vitamin E, as well as blood and adipose fatty acid composition were performed using Luminex xMAP® assays, high performance liquid chromatography, and gas chromatography, respectively. Fifty-two captive and 40 wild marmots were sampled. Total and most individual fatty acids were increased in plasma and adipose tissue in captive compared to wild marmots. The ratio n6/n3 increased in captivity by more than twofold in plasma and adipose tissue. These results identified alterations of lipid metabolism in captive marmots, and will help formulate diet recommendation for the captive-release program.

Key words: Adipokines, hibernation, lipid metabolism, Marmota vancouverensis, Vancouver Island marmot

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LITERATURE CITED


PREVALENCE OF VECTOR-BORNE PATHOGENS IN NONDOMESTIC FELIDS FROM A SANCTUARY IN TENNESSEE, USA

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Abstract

Vector-borne diseases (VBDs) are frequently diagnosed in domestic felids, however their occurrence in captive nondomestic felids is largely unknown with the exception of cytauxzoonosis. Fatal Cytauxzoon felis infection has been reported in captive tigers and lions, although apparently healthy tigers can harbor the pathogen asymptomatically.1-4 Whole blood samples from 30 adult tigers (Panthera tigris) and eight adult lions (Panthera leo) from a sanctuary in eastern Tennessee were analyzed for Cytauxzoon felis, Bartonella spp., Mycoplasma spp., Rickettsia spp., Anaplasma spp., Ehrlichia spp., Babesia spp., and Hepatozoon spp. DNA by PCR amplification. Sample size was determined by power analysis based on preliminary data to estimate VBD prevalence. The estimated prevalence of VBDs found were Cytauxzoon felis (13%), Candidatus Mycoplasma haemominutum (3%), and Ehrlichia ewingii (3%). During the study, two animals had evidence of fulminant disease secondary to Cytauxzoon felis. One animal was treated successfully with atovaquone and azithromycin. The other animal died 24 hr after presenting for lethargy and anorexia; necropsy revealed schizont-laden macrophages within pulmonary vessels, marked pulmonary hemorrhage, and erythrophagocytosis in the tracheobronchial lymph nodes and spleen, consistent with acute cytauxzoonosis. This study demonstrated a moderate prevalence of VBDs in this population and identified the presence of two novel agents (Candidatus Mycoplasma haemominutum and Ehrlichia ewingii) in tigers. The identification of these VBDs suggests that nondomestic felids become infected and may serve as reservoir hosts. Future research is necessary to better understand the clinical significance of these diseases, as well as nondomestic felids’ role in enzootic and peridomestic pathogen transmission.

Key words: Candidatus Mycoplasma haemominutum, Cytauxzoon felis, Ehrlichia ewingii, Panthera leo, Panthera tigris, vector-borne disease

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LITERATURE CITED


ACANTHOCEPHALANS IN CAPTIVE MANED WOLVES (Chrysocyon brachyurus)

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Abstract

Acanthocephalans, intestinal parasites of vertebrates, require invertebrates as intermediate hosts. Severe disease is common in New World primates, sea otters (Enhydra lutris) and Channel Island foxes (Urocyon littoralis). They have been identified in wild maned wolves (Chrysocyon brachyurus). This is the first report of acanthocephalans in captive maned wolves and of associated disease in the species. An 8.5-yr-old male maned wolf with a history of suspected inflammatory bowel disease (IBD) and confirmed intestinal lymphoma was euthanized. Intestinal worms seen grossly were assumed to be tapeworms; however, histologic examination revealed chronic, severe enterocolitis attributed to acanthocephalans embedded within the mucosa. A second 8.5-yr-old male with confirmed IBD was euthanized due to uncontrollable weight loss and diarrhea. Free intestinal worms and worms attached to the jejunal mucosa were found, and full thickness serosal lesions were located at worm attachments. Histologic examination confirmed lymphoplasmacytic/eosinophilic enteritis with intralesional acanthocephalans. Grossly similar worms were found in the feces of four other maned wolves housed in adjacent enclosures, one with confirmed IBD. Acanthocephalan eggs are intermittently recovered on direct and formalin-ethyl acetate sedimentation fecal exam. The acanthocephalans have been identified as Pachysentis canicola, and molecular analysis is pending. This species naturally infects gray fox (Urocyon cinereoargenteus), skunks, coyotes (Canis latrans) and rattlesnakes (Crotalus atrox), which serve as paratenic hosts in Texas. P. canicola has been recovered from a striped skunk trapped in the maned wolf enclosure; however, the intermediate host is unknown. Treatment success for acanthocephalan infection is variable depending on species and host, and is currently being attempted with ivermectin.

Key words: Acanthocephalan, Chrysocyon brachyurus, inflammatory bowel disease, maned wolf, Pachysentis canicola, spiny-headed worm

ACKNOWLEDGMENTS

The authors thank Allyssa Roberts, LVT, and the carnivore animal care specialists at Fossil Rim Wildlife Center.
USE OF OCLACITINIB MALEATE (APOQUEL®) TO TREAT SUSPECTED ALLERGIC HYPERSENSITIVE DERMATITIS IN A MALE NYALA (*Tragelaphus angasii*) AND GOAT (*Capra hircus*) AT A ZOOLOGICAL INSTITUTION

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Abstract

Two adult ruminants including an approximately 150-kg male nyala (*Tragelaphus angasii*) and 64.4-kg, male goat (*Capra hircus*), presented with alopecia and pruritis of varying degrees of chronicity and severity. These animals were housed in separate areas of the institution and none of the other animals housed with them exhibited any similar clinical signs or dermatologic lesions. The nyala exhibited alopecia that slowly progressed over 2 mo with no other dermatologic lesions while the goat presented with a chronic history of moist dermatitis under the dewclaws of all four feet secondary to continuous chewing at the skin. The goat exhibited intermittent waxing and waning of the moist dermatitis unassociated with temperature, but overall no improvement was noted. Hematologic and serum biochemical results were unremarkable. Skin biopsies collected from the nyala revealed evidence associated with moderate chronic hyperplastic dermatitis that was suggestive to be secondary to an allergic stimulus. Due to the inability to administer series of injections for either animal, oclacitinib maleate was prescribed (Apoquel®, Zoetis, Parsippany-Troy Hills, New Jersey 07054 USA, 0.43 to 0.49 mg/kg PO q12hr.) to alleviate the clinical signs, and then tapered to maintenance regimen. Both animals exhibited minimal to no evidence of pruritis after receiving the loading dose of oclacitinib and continued to improve with the maintenance dose. Three months after it was prescribed, both animals showed improvement with hair coat coverage and no signs of pruritis. No adverse effects were observed. This is the first documentation of using oclacitinib maleate in ruminants.

**Key words:** Allergic dermatitis, *Capra hircus*, goat, nyala, oclacitinib maleate, *Tragelaphus angasii*

ACKNOWLEDGMENTS

The authors thank the ZooTampa’s animal care staff for their dedication towards excellent animal care and the animal technicians, Michelle Devlin, Ryan O’Shea, and Stacey Brandes for their assistance in the procedure and process of diagnostic samples. The authors also thank Dr. Amanda J. Dennis for evaluating the skin biopsies.
RADIOGRAPHIC EVALUATION OF THE THORAX OF SOUTHERN TAMANDUAS (Tamandua tetractyla) AND GIANT ANTEATERS (Myrmecophaga tridactyla)

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Abstract

The basis for radiographic interpretation is anatomical knowledge. It is necessary to know what is normal, and its variations, in order to recognize any pathological change.¹ According to a survey carried through 40 yr in the archives of Fundação Parque Zoológico de São Paulo, Brazil, the percentage ratio of causes of deaths in anteaters and tamanduas with pneumonia and cardiorespiratory diseases reached almost 25% of the total deaths.² The same author recommends that the first steps for the correct maintenance of anteaters and tamanduas in captivity are an adequate preventive management and a rigorous quarantine program for newcomers. One of the main complementary exams indicated by the author is thoracic radiograph, mainly for cardiological evaluation. The goal of this study was to learn about the anatomical structures of the thoracic cavity of giant anteaters (Myrmecophaga tridactyla) and southern tamanduas (Tamandua tetractyla) through radiographic images of the thorax in four different projections. A total of 20 specimens of giant anteater and 15 specimens of southern tamandua were evaluated. The animals were kept in captivity in three different institutions within the state of São Paulo: Fundação Parque Zoológico de São Paulo, Parque Zoológico Municipal Quinzinho de Barros, and Zoológico Municipal de Bauru. All animals used in this study received prior clinical evaluation. The animals were weighed and first evaluated at a distance to observe their behavior and possible clinical changes. To achieve a less stressful and safer procedure, the animals were anesthetized (ketamine 3.0 mg/kg IM; midazolam 0.3 mg/kg; butorphanol 0.3 mg/kg and 0.5% isoflurane by face mask). After the induction, they received a complete physical examination and blood samples were taken for complete blood work. Radiographic examinations were performed at the animal's institution of origin, using a portable digital device (model Sound Eklin Mark 1210c), which allows the evaluation of the radiographic image through a monitor right after the image acquisition. The animals were positioned by the same operators, and a “foam bed” was used for ventrodorsal incidence. All radiographs were taken on inspiration and were evaluated by the authors. In this study, the cardiac silhouette in both lateral views of the animals evaluated presents some differences compared to most domestic dogs, such as narrower apex in relation to the cardiac base or cranial margin. Furthermore, being a more tapered and relatively larger heart, it presents a more oblique position and there is less contact with the sternum. In ventrodorsal and dorsoventral views, the cardiac silhouette is located almost completely in the left hemithorax, which is not seen in dogs or cats. This finding, seen in 100% of the animals studied, could be wrongly interpreted as a pathological displacement, secondary to some pulmonary or mediastinal mass or by pneumothorax; however, it is concluded that this is the usual positioning of the cardiac silhouette of healthy animals. The assessment of the cardiac silhouette was performed subjectively and by calculating the vertebral heart size (VHS), described for dogs by Buchanan and Bücheler.³ For the giant anteater, VHS mean value in lateral projections was 8.32 ± 0.55 vertebrae (mean ± standard
The short axis ranged from 7.6 to 11.74 cm, and the long axis ranged from 9.67 to 14.03 cm. In the southern tamanduas, VHS mean value in lateral projections was 7.87 ± 0.73 vertebrae (mean ± standard deviation). The short axis ranged from 3.63 to 5.90 cm, and the long axis ranged from 4.3 to 7.7 cm. It is also noted, the pulmonary parenchyma of the giant anteaters and southern tamanduas can be seen with evident interstitial marking that remains uniform in both hemithorax. Despite being a common finding, one should consider the fact the animals were anesthetized and in a decubitus position, which may cause some effect on the pulmonary pattern. Prolonged lateral recumbency results in hypostatic congestion of the dependent lung, and it can occur almost immediately after the animal is placed under anesthesia. It was also possible to notice a slight increase in radiopacity of the bronchial wall in all animals, regardless of age and especially in the region close to the main bronchial bifurcation. None of the evaluated animals had any clinical symptoms of lung diseases or any respiratory and hormonal disorders, which could lead to the formation of such images. As for the trachea of the anteaters studied, we can perceive discreet to moderate mineralization of tracheal rings, regardless of the animal's age. It is therefore concluded that such findings are common in giant anteaters and southern tamanduas without clinical significance, regardless of age. Despite its wide distribution and its ecological importance, data on giant anteaters and southern tamanduas radiographic anatomy are rarely reported in the known literature. Studies aiming at the evaluation of the thoracic region in anteaters of the species *Myrmecophaga tridactyla* and *Tamandua tetradactyla* are scarce. The data obtained in this study can be used as a way of diagnosing the actual incidence of pneumopathies, pleuropathies, and cardiopathies in these species, contributing to the advancement of medicine in wildlife clinics and, most of all, to the conservation of these species.

**Key words:** Giant anteater, *Myrmecophaga tridactyla*, radiology, southern tamandua, *Tamandua tetradactyla*, thoracic radiographs

**LITERATURE CITED**


VALIDATION OF CHEMILUMINESCENT ASSAY FOR CANINE THYROID STIMULATING HORMONE IN RED PANDAS (Ailurus fulgens fulgens)

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Abstract

Thyroid abnormalities have been anecdotally reported in red pandas (Ailurus fulgens fulgens), however definitive diagnosis is hampered by a lack of established reference ranges and validated diagnostic tests. Serum thyroid stimulating hormone (TSH) is the major modulator of thyroid hormones and a vital diagnostic for evaluation of thyroid function.3,4,6,7,10 Chemiluminescent assays are commonly used to measure serum TSH and are species-specific, however several assays have been validated in non-target species.4,7-9 A chemiluminescent assay validated for canine thyroid stimulating hormone (cTSH) has been validated in domestic canids and felids.3,7,9-11 This study validated the use of this cTSH assay for measurement of TSH in red pandas. Banked serum samples (n = 15) were submitted for analysis using the cTSH assay.8 Validation was determined by percent estimated recovery, and inter- and intra-assay coefficient of variability. Serial dilutions of serum with TSH concentrations within the normal canine range and with elevated TSH concentration yielded high estimated recoveries, indicating the assay was able to accurately measure TSH concentration in red panda serum. The inter- and intra-assay evaluations yielded low coefficients of variability, indicating the assay was able to consistently measure TSH concentrations in red panda serum. Based on the samples used in this study and the resultant data, the cTSH assay appears valid for measurement of TSH in red pandas. Validation of the cTSH assay in red pandas has several important clinical implications. A validated test to detect thyroid dysfunction will increase the ability for clinicians to accurately diagnose, monitor, and treat red pandas with thyroid disease.1,5-7

Key words: Ailurus fulgens fulgens, chemiluminescent, red panda, thyroid stimulating hormone, validation

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Funding provided by Boehringer Ingelheim and the Michigan State University Graduate Office Fellowship Funds. The authors acknowledge the Michigan State University Veterinary Diagnostic Laboratory endocrinology department for performing the sample cTSH testing and aiding in the evaluation of data as well as the veterinary staff at Potter Park Zoo and Binder Park Zoo for providing samples.

LITERATURE CITED


TOTAL EAR CANAL ABLATION AND LATERAL BULLA OSTEOTOMY IN ATLANTIC HARBOR SEALS (Phoca vitulina concolor) FOR SUCCESSFUL SURGICAL MANAGEMENT OF OTITIS MEDIA

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Abstract

Surgical intervention in the form of a total ear canal ablation and lateral bulla osteotomy (TECA-LBO) was performed in four Atlantic harbor seals (Phoca vitulina concolor) with chronic, severe otitis media. All seals presented with unilateral purulent otic discharge refractory to prolonged topical and systemic medical management, including targeted sensitivity-based antimicrobial therapy. Managing otitis media in these seals accompanied challenges due to unique otic anatomy, a semi-aquatic environment, multi-drug resistant organisms and drug administration limitations. Clinical diagnosis of otitis media was achieved via computed tomography (3/4) and positive contrast ear canalography (1/4). Surgical intervention required careful consideration of anatomy unique to phocids, namely neurovascular structures. TECA-LBO was successful in achieving complete clinical resolution of otitis in all cases. Post-operative complications were minor and included temporary unilateral paralysis of the left nare (2/4) and a transient left ptosis (1/4). Partial to complete surgical site dehiscence occurred in all cases, however, complete healing via second intention was documented in 60 days or less. All stranded animals met criteria for release, and one rehabilitated seal was fitted with a satellite tag which confirmed normal swimming and diving patterns post-release. This case series describes the novel application of TECA-LBO to otitis media in harbor seals and details the unique anatomic considerations for this surgical approach. In harbor seals, TECA-LBO can be performed safely to treat persistent cases of otitis media and should be considered in cases of chronic otitis that are not responsive to medical management.

Key words: Harbor seal, lateral bulla osteotomy, otitis media, Phoca vitulina, total ear canal ablation

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The authors thank Molly E. Bryant for creating medical illustrations of the harbor seal skull and neurovascular anatomy relevant to total ear canal ablation and lateral bulla osteotomy. The authors also thank Drs. James Bailey and Louisa Rahilly for their outstanding anesthesia support, Dr. Allison Tuttle for her guidance and mentorship, and the past and present husbandry staff and volunteers at Mystic Aquarium and National Marine Life Center.
COMPARISON OF AGAROSE GEL ELECTROPHORESIS AND CAPILLARY ZONE ELECTROPHORESIS IN THE BOTTLENOSE DOLPHIN (Tursiops truncatus)

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Abstract

Protein electrophoresis has been demonstrated to be a useful adjunct test in routine and diagnostic bloodwork in many animal species.1 In the dolphin, it has been used in health assessments of free ranging animals and in evaluation of animals under human care.2,3 Reference intervals (RI) for protein fractions have been published using the traditional methodology of agarose gel electrophoresis (AGE).4 Recently, a new method of capillary zone electrophoresis (CZE) has become more available in veterinary laboratories. The goals of the current study were to produce RI (by ASVCP guidelines) and to complete a method comparison. RI were determined using banked samples from 45 healthy adult free ranging dolphins. As has been reported in humans and limited animal species, the CZE method provided a lower coefficient of variation in fraction quantitation and also resolved additional fractions including beta-1 and beta-2 globulin fractions.5,6 Significant Spearman’s correlations between methods were observed for all protein fractions except for the beta globulin fraction where the AGE quantitated a lower level (r = 0.03, P = 0.81). The level of albumin quantitated by CZE was also lower with a median of 49.1% in AGE versus 41.6%. The A/G ratio in CZE (median 0.76) was also significantly lower (P < 0.0001) than in AGE (median 1.07). These data reinforce that method specific RI are important when using protein electrophoresis in research studies or as a clinical tool. The automation of CZE is attractive as is the resolution of globulin fractions. Future studies will evaluate the utility of this new method in marine mammals.

Key words: Agarose gel electrophoresis, capillary zone electrophoresis, dolphin, protein electrophoresis, Tursiops truncatus

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LITERATURE CITED


VENOUS BLOOD GAS ANALYSIS PARAMETERS IN HEALTHY, AWAKE GIRAFFE 
(Giraffa camelopardalis)

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Abstract

Due to their unique anatomy and physiology, giraffe (Giraffa camelopardalis) immobilizations are known to be difficult.¹⁻⁶,¹¹⁻¹² Blood gas analysis may give a veterinary team accurate information regarding acid-base, respiratory, and metabolic status during the procedure and can enable interventions that improve the likelihood of a positive outcome for the patient.⁸,¹⁰ Blood gas analyses previously have been performed for giraffe under anesthesia, however reference intervals for awake, healthy giraffe have yet to be established.² Thanks to operant training practices at zoos, staff may safely carry out a number of noninvasive procedures on giraffe without the need for physical or chemical restraint.⁷ Using an i-STAT portable clinical analyzer with CG4+ cartridges (Abbott Point of Care Inc., Princeton, NJ 08540 USA), venous blood gas analyses were performed on 24 awake and apparently healthy giraffe at two zoological institutions (Cheyenne Mountain Zoo; Columbus Zoo and Aquarium) in order to establish reference intervals for pH, PCO2, venous PO2, BE, HCO3, TCO2, and lactate. This is the first report on venous blood gas analysis parameters for awake giraffe, which will provide a helpful reference for clinical use of these values in this species.

Key words: Acid-base, blood gas analysis, Giraffa camelopardalis, giraffe, lactate, reference interval

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The authors thank the veterinary technicians and animal care staff at both Cheyenne Mountain Zoo and Columbus Zoo and Aquarium for performing the procedures associated with this study.

LITERATURE CITED


FATAL HEPATIC FASCIOLIASIS IN TWO GIRAFFES (Giraffa camelopardalis) ATTRIBUTED TO Fascioloides magna WITH A POSSIBLE WHITE-TAILED DEER (Odocoileus virginianus) RESERVOIR HOST

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Abstract

At a southeastern conservation center in the United States, two giraffes (Giraffa camelopardalis), a 1.5-yr-old male and 7-yr-old female, were being managed for chronic poor body condition, inappetence and weakness. Despite treatment, both animals died. Gross findings in both animals included serous atrophy of cavitary fat, serosanguinous abdominal effusion with blood clots in the male, and intraabdominal fibrinous serosal adhesions in the female. In both animals, the liver had prominent bile ducts that contained black inpsissated or congealed material. Histologically, the liver had anastomosing fibrous tracts that contained brown extracellular pigmented material (regurgitated debris) and contained trematode eggs. Larvae inside the eggs were viable. Tracts sometimes also contained abscesses or granulomas oriented around necrotic cellular debris and pigment. Some of the sections had mild to moderate biliary dilatation and fibrosis. A single large necrotic trematode was present in hepatic sections from each animal. Two wild white-tailed deer (Odocoileus virginianus) from the same property also had hepatic fascioliasis. Fascioloides magna was identified by PCR and sequencing of the ITS2 rRNA in both giraffes and in the free-ranging deer. White-tailed deer are considered a potential reservoir host for Fascioloides magna. This is the first report of Fascioloides magna in giraffes in the United States, and only the second report of hepatic fascioliasis in giraffe.1

Key words: Fascioloides magna, Giraffa camelopardalis, giraffe, Odocoileus virginianus, trematodiasis, white-tailed deer

LITERATURE CITED

VENOUS BLOOD GAS AND LACTATE MONITORING OF NUBIAN GIRAFFE (Giraffa camelopardalis camelopardalis) FOLLOWING FIELD IMMOBILIZATION IN UGANDA

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Abstract

Fifty free-ranging Nubian giraffe (Giraffa camelopardalis camelopardalis) estimated to be between 1-6 yr old were immobilized for translocation within Uganda in January 2016 (n = 23) and August 2017 (n = 27). Giraffe were darted with 7-8 mg etorphine hydrochloridea and 40 mg of azaperone tartrate.8 Following recencyency and restraint, immobilization drugs were immediately reversed with 18-24 mg diprenorphine hydrochlorideb IV, dependent upon dose of etorphine. Additionally, 20/50 (40%) giraffe were given 40 mg doxapram hydrochloridec IV, 20/50 (40%) received 100 mg doxapram hydrochloride IV, and 1/50 (2%) received 200 mg doxapram hydrochloride IV. Venous pH, P,CO2, HCO3, and BE were analyzed from 33/50 (66%) giraffe and venous lactate concentrations were analyzed from 34/50 (68%) within 3 min of reversal. Results showed that all animals had increased P,CO2, acidemia, and hyperlactatemia. Parameters were evaluated 10 min later on 24/34 (71% of those initially sampled) and showed significant decrease in P,CO2 from baseline, but no change in acidemia or lactate. Bicarbonate levels were significantly lower, though the change was not deemed clinically relevant. No giraffe died during immobilization. Three females died within 12 hr of suspected capture myopathy. Two of these three mortality cases had blood samples collected, and both had hyperlactatemia above 12 mmol/L, though this finding was not unique to these individuals. During field immobilization of free-ranging Nubian giraffe using this protocol, acidemia and increased P,CO2 and blood lactate should be expected. Our results also indicated that the increased P,CO2 resolved within 10 min, though acidemia and hyperlactatemia persisted.

aCaptivon®, 98, 9.8 mg/ml, Wildlife Pharmaceuticals Pty Ltd, South Africa, Africa
bAzaperone, 100 mg/ml, Kyron Laboratories Pty Ltd, South Africa, Africa
cActivon®, 12 mg/ml, Wildlife Pharmaceuticals Pty Ltd, South Africa, Africa

Key words: Blood gas, etorphine, Giraffa camelopardalis camelopardalis, immobilization, lactate, Nubian giraffe

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RETROSPECTIVE STUDY OF FEMORAL FRACTURES IN WILD RAPTORS: 119 CASES

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Abstract

A retrospective study was conducted out of the database of the Bird of Prey Clinic at the Université de Montréal to describe treatments, complications, and outcomes associated with femoral fractures in free-ranging birds of prey. Medical records of raptors admitted with femoral fractures from 1986 to 2018 were reviewed. In total, 119 individuals from 24 species were included in the study. Twenty-seven birds were dead upon arrival. Nine birds were presented with fractures that had already healed. Surgical repair was attempted on 34 femoral fractures from 33 birds. Fracture healing rate was 54% (15/28) for intramedullary pinning alone, and 67% (4/6) for external skeletal fixator-intramedullary pin tie-in fixator. In addition to these fixators, cerclage fixation was used in 41% (14/34) of cases. For comminuted fractures surgically treated (18/34 cases), healing rate was 56% (10/18). Overall, 42% of surgically treated birds (14/33) were released. Surgical complications occurred in 10 cases (including seven cases of migration and loosening of the pin, and one case of osteomyelitis), leading to euthanasia of four cases. Out of the 29 birds that were either released (28) or kept in captivity (1), 15 had received a conservative treatment. Half the birds that were released had at least one other fractured bone. The vast majority of deaths and euthanasia occurred within 2 wk after admission (55/63). Only 13 birds were euthanized because of the femoral fractures, 11 of them within this 2-wk period. Most other birds (n = 50) succumbed to conditions unrelated to the femoral fracture.

Key words: Avian, femur, fracture, orthopedics, raptor, surgery

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