INTRACYTOPLASMIC INCLUSIONS IN CIRCULATING LEUKOCYTES FROM AN EASTERN BOX TURTLE (*Terrapene carolina carolina*) WITH IRIDO VIRAL INFECTION

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Abstract

A free-ranging adult female eastern box turtle (*Terrapene carolina carolina*) was presented to the University of Tennessee in October 2003 because of suspected trauma and blindness. Physical examination revealed lethargy, clear ocular and nasal discharges, and white oral and laryngeal plaques. Intracytoplasmic inclusions within heterophils and large mononuclear leukocytes were observed on routine blood smear examination. Postmortem findings included necrosis of epithelial and parenchymal cells with intracytoplasmic inclusions. Ultrastructurally, the leukocyte inclusions consisted of variably electron-dense granular material and viral particles consistent with the Iridoviridae family of viruses. The virus shares 100% sequence identity to a 420 base pair sequence of frog virus 3 (FV3) (family Iridoviridae, genus *Ranavirus*) as determined by polymerase chain reaction and gene sequencing targeting a portion of the *Ranavirus* major capsid protein gene.
INTESTINAL, PERICOLOACAL, AND RENAL ADENOCARCINOMAS IN TWO MARINE TOADS (Bufo marinus)

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Abstract

Neoplasia has been reported worldwide in amphibians, although there are few reports of intestinal and renal neoplasms, with the exception of the northern leopard frog (Rana pipiens) in which Rana herpesvirus-1-induced Lucké renal adenocarcinomas have been well described.1-3

Within a 3-mo period, two marine toads (Bufo marinus) presented with prominent swellings in their pelvic areas. The first toad was diagnosed with a soft tissue mass within the pelvic inlet that was compressing the distal colon. Ultrasound revealed the mass to be well vascularized and intimately associated with the intestine. The mass was surgically resected, however the toad was euthanatized 2 days later due to a severe colonic prolapse. Histopathology of the mass revealed a moderately well differentiated transmural adenocarcinoma of the intestine, with no evidence of intranuclear inclusions. The second toad presented with a marked circumferentially swollen cloaca. Ultrasonography revealed a highly vascular soft tissue mass with scattered small cystic areas and intermingled wisps of hyperechogenic densities. Despite supportive therapy, the toad continued to lose weight and died approximately 2 wk post presentation. On necropsy, in addition to the pericoelacal mass, there were hemorrhagic foci noted in the kidneys. Histologically, multicentric adenocarcinoma of the kidneys and pericoelacal tissue was diagnosed. Amphophilic to eosinophilic intranuclear inclusions were noted within the neoplastic renal parenchyma. The temporal spacing of the two cases, coupled with the intranuclear inclusions within the renal adenocarcinoma in the second toad, was suggestive of a viral etiology. Further testing, including electron microscopy, is underway to further define the nature of these neoplasms.

LITERATURE CITED


SKIN FLAP RESTORATION OF A TRAUMATIC WOUND IN A CUBAN IGUANA (Cyclura nubila nubila)

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Abstract

A 5-yr-old female Cuban iguana (Cyclura nubila nubila) was presented to the Busch Gardens Tampa Bay Zoo Hospital after receiving a degloving injury to the left forearm from a male of the same species. A full-thickness, 3-cm portion of skin was removed extending from the carpus proximally to just below the elbow. The iguana was anesthetized with isoflurane via mask (IsoSol®, VEDCO, Inc., St. Joseph, Missouri 64507 USA), then intubated for assessment and treatment. Radiographs confirmed no fractures of the area and no other injuries. Because of the fresh nature of the wound a skin graft approach was considered to heal this wound primarily. The arm and the left lateral thorax were prepared in routine fashion for surgery. A flap of skin 2 cm wide by 3 cm tall was created on the left lateral thorax just caudal to the axilla. This flap was deep enough that the panniculus muscle layer was included. The flap was created in a similar fashion as described for a surgical treatment of a hygroma of the elbow in dogs. The flap was created to encompass the entire wound. The arm was then extended and adducted to the body wall with the newly created flap wrapping around the defect. The surgical incision edges were sutured to the traumatic wound edges using simple interrupted sutures of 3-0 polydioxanone. A small roll of gauze was used to close the dead space where the limb met the body wall to lessen seroma formation. The limb was then wrapped in place to the body. Injectable enrofloxacin (Baytril 100®, Bayer Corp., Agriculture Division, Animal Health, Shawnee Mission, KS 66201 USA) was initiated at 5 mg/kg i.m. every 24 hr for 7 days. The bandage was changed periodically for 4 wk and the surgical site assessed, but little care was needed. At 4 wk post surgery, the site was surgically prepared and the flap was then excised from the body wall and wrapped around the limb. The flap was about 5 mm short of encompassing the entire circumference of the arm. This defect was managed with a biosynthetic absorbent wound dressing (BioDres®, DVM Pharmaceuticals, Inc., Miami, FL 33169 USA) and granulated well in the next 4 wk. The defect on the lateral thorax wall could not be entirely closed primarily and again was managed with the same bandaging materials. Four weeks after the second surgery the iguana had the bandages removed and it was released from the hospital. The surgical site has continued to look well over the past 2 yr.

The skin of reptiles is similar to that of other animals in that it consists of an epidermis and a dermis. A major difference from mammals is that the epidermis has a keratin layer that can be thickened into scales. Information of the cutaneous circulation in reptiles is scarce and relates primarily to thermoregulation. Because of this, the surgeon must assume that the distribution of vessels is generally the same in quadrupeds. Ensuring that the panniculus layer is incorporated into the graft will ensure a reasonable blood supply to the graft. Immobilization of the graft was thought to be essential in the management of this wound and the location of the wound facilitated...
this. Avoiding dead space and seroma formation is also a must for a graft to take to a new location. The complication in this case was minimal and directly related to not accurately sizing the wound and allowing any margin of error in the initial graft. Careful planning is needed before any skin grafting is attempted.

Traumatic injuries are not uncommon in zoological collections. If fresh, they are good candidates for primary healing with grafting techniques. Infected wounds must be aggressively treated first and a healthy granulation bed produced before any attempts can be made. Following basic principles of skin grafting will provide a reasonable guide to surgical repair of wounds in iguanids and perhaps other reptiles with similar skin types.

LITERATURE CITED

REFERENCE HEMATOLOGY AND SERUM CHEMISTRY VALUES FOR THE DIAMONDBACK TERRAPIN (Malaclemys terrapin)

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Abstract

The diamondback terrapin (Malaclemys terrapin) is an inhabitant of the coastal marshlands of the eastern and southern United States. This unique turtle spends its life in tidewater creeks and ponds. Pressure from hunting, coastal construction, vehicle traffic, oil spills, and predation has prompted conservation efforts to protect the diamondback. Health assessment is a vital aspect of species management and conservation but can be quite difficult if reference blood values are not available.

Prior to collecting blood samples, a small study was done to determine the optimal collection site in the diamondback. The femoral vein proved to be the best vessel for obtaining blood that was not diluted by lymph, so it was used throughout this study. Sampling of 103 terrapins was performed in two locations – Stone Harbor, NJ and Wellfleet, MA. The complete blood count and serum biochemistry panel was performed at Antech Diagnostics (1111 Marcus Ave., Lake Success, NY 11042). The white blood cell count (WBC) was estimated from a peripheral blood smear, and biochemical testing was performed using an Olympus Automated Chemistry Analyzer. Hemoglobin concentration was determined by the author.

Hematocrit, hemoglobin, and white blood cell counts are shown in Table 1. They are similar to those published for other turtle species. Serum chemistries (Table 2) on the other hand showed quite a lot of variation and were often dissimilar to values reported for other species. There were significant differences (P<0.05) between males and females for WBC counts, calcium, phosphorous, chloride, total protein (TP), and albumin (Table 3).

Many of the biochemical parameters, including glucose, uric acid, AST, and CPK showed wide variability among individuals. Such variability has also been noted for a number of other chelonian species, and it is possible that these parameters lack sensitivity and specificity for diagnosis of disease in this group of reptiles. Further studies are needed to investigate the correlation of changes in serum chemistry values, systemic illness, and organ-specific pathology of chelonians. The higher total protein elevation in females was probably due to an increase in albumin and vitellin (a plasma protein that is high during egg laying). The higher calcium and phosphorous results for females were also likely due to the process of ovulation. The chloride increase in females may have been the result of dehydration as they migrated on land to nesting sites.
Blood testing of additional diamondback terrapin populations and obviously ill individuals will be necessary to provide more information on the diagnostic value of the various parameters examined in this study.

**LITERATURE CITED**


<table>
<thead>
<tr>
<th>Table 1. RBC and WBC values for <em>Malaclemys terrapin</em>.</th>
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<td><strong>Mean</strong></td>
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<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Hematocrit (%)</td>
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<tr>
<td>Hemoglobin (g/dl)</td>
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<tr>
<td>WBC (10^3 μl)</td>
</tr>
<tr>
<td>Heterophils (%)</td>
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<tr>
<td>Lymphocytes (%)</td>
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<tr>
<td>Monocytes (%)</td>
</tr>
<tr>
<td>Eosinophils (%)</td>
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<tr>
<td>Basophils (%)</td>
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<td>Azurophils (%)</td>
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Table 2. Serum chemistry values for *Malaclemys terrapin*.

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<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
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<td>Glucose (mg/dl)</td>
<td>100.9</td>
<td>69.0</td>
<td>10-267</td>
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<td>SUN (mg/dl)</td>
<td>104.7</td>
<td>54.0</td>
<td>27-258</td>
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<td>Uric acid (mg/dl)</td>
<td>1.3</td>
<td>0.9</td>
<td>0.3-5.3</td>
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<tr>
<td>TP (g/dl)</td>
<td>4.1</td>
<td>0.8</td>
<td>1.8-5.7</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>1.3</td>
<td>0.3</td>
<td>0.4-2</td>
</tr>
<tr>
<td>Globulin (g/dl)</td>
<td>2.8</td>
<td>0.6</td>
<td>1.4-3.9</td>
</tr>
<tr>
<td>Calcium (mg/dl)</td>
<td>13.0</td>
<td>5.0</td>
<td>6.6-30</td>
</tr>
<tr>
<td>Phosphorus (mg/dl)</td>
<td>5.3</td>
<td>1.7</td>
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<td>Sodium (mEq/L)</td>
<td>148.7</td>
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<td>Chloride (mEq/L)</td>
<td>106.9</td>
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<td>AST (U/L)</td>
<td>218.1</td>
<td>130.1</td>
<td>5-681</td>
</tr>
<tr>
<td>CPK (U/L)</td>
<td>4194.1</td>
<td>3849.4</td>
<td>261-21570</td>
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Table 3. Blood and chemistry values significantly different between male and females *Malaclemys terrapin* (*P*<0.05).

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
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<tr>
<td></td>
<td>Mean</td>
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</tr>
<tr>
<td>WBC (10^3/µl)</td>
<td>13.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Calcium (mg/dl)</td>
<td>9.2</td>
<td>1.3</td>
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<tr>
<td>Phosphorus (mg/dl)</td>
<td>4.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Chloride (mEq/L)</td>
<td>99.7</td>
<td>11.2</td>
</tr>
<tr>
<td>Total protein (g/dl)</td>
<td>3.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>1.0</td>
<td>0.3</td>
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NESTED PCR AMPLIFICATION AND SEQUENCING OF DIVERSE REPTILE REOVIRUSES

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Abstract

Reoviruses have been shown to cause fatal pneumonia and subacute tracheitis in reptiles.1 Diagnosis is challenging, as there are no inclusions, and histologic lesions resemble paramyxoviral disease. Serologic diagnosis has been limited to virus neutralization, which is labor intensive and may not cross-react between strains.2 As reptile reoviruses do not hemagglutinate, hemagglutination inhibition is not an option. RNA-dependent RNA polymerase sequences from mammalian orthoreoviruses and piscine aquareoviruses were aligned. Degenerate primers were designed targeting conserved regions. These primers were used in a nested PCR to amplify sequences from eleven reovirus isolates from snake and chelonian species. Nucleotide sequencing of the PCR products showed that the reoviral sequences from these reptiles were novel and represented seven distinct strains. Comparative sequence analysis shows that these viruses are probable members of the genus Orthoreovirus. These primers may be of use for obtaining initial sequence data from novel reoviruses. Further understanding and identification of reoviral types and species will provide useful diagnostic, prognostic, and epidemiologic information for the clinician.

LITERATURE CITED

MINIMUM ALVEOLAR CONCENTRATION: ITS MEANING AND APPLICATION ACROSS THE AMNIOTA

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Abstract

The term “minimum anesthetic response” (MAR) was coined by Merkel and Eger with the intent of providing a means of comparing two anesthetic agents.6 The concept of MAR was developed in reference to the gas anesthetic concentration required to prevent gross purposeful movement in dogs following a noxious stimulus. It became known as the “minimum alveolar concentration” (MAC). The MAC 1.0 is defined as the “minimal anesthetic concentration in the alveolus required to prevent gross purposeful movement in response to a painful stimulus.”2 However, the term “minimum alveolar concentration” is mammal-oriented. Mammals have alveoli while birds and reptiles do not. The term “minimum anesthetic dose” was proposed by Ludders et al. to try to be inclusive of mammals, birds, and reptiles.4 Minimum anesthetic concentration (MAC) also has been suggested and is used in the poultry literature.5,8 These terms all denote the same basic idea but some are anatomically correct, some are anatomically indistinct, and some are anatomically incorrect. Another problem with MAC is that it denotes the plane of anesthesia which in turn impacts cardiopulmonary parameters. Some species, like dogs and horses, have MAC without a large deviation between individuals within a species. Some reptile species appear to have a similar MAC distribution across individuals while others have a range within members of a single species.3,6,7 For the collection of cardiopulmonary parameters, the ideal for reptiles would be to predetermine the MAC of a specific inhalant anesthetic for each animal at the temperature in which an experiment is to occur.9

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LITERATURE CITED

COMPARATIVE CARDIOVASCULAR ANATOMY ACROSS THE AMNIOTA: MAJOR DEFINING FEATURES AND THEIR RELEVANCE TO ANESTHESIA RESEARCH

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Abstract

In birds, reptiles and mammals, the atria are completely divided. With respect to the ventricles, categorization is not as straightforward. The order Crocodylia has a complete ventricular septum, as do the classes Aves and Mammalia. The remaining orders of the class Reptilia possess an incomplete ventricular septum. The conus arteriosus is completely divided into three trunks in the class Reptilia and is divided into two trunks in Aves and Mammalia. In the class Reptilia, the sinus venosus is distinct from the right atrium and in the Aves and Mammalia the sinus venosus has merged into the wall of the right atrium.1 In Amniota, embryos initially have a system of six aortic arches but only arches III, IV, and VI persist, in altered form, into adults. The carotid system (common carotid, the external carotid and the internal carotid arteries) arises from the aortic arch III. The pulmonary artery arises from aortic arch VI (caudal arch). The systemic arch (aorta) varies across vertebrate taxa. In birds, the aorta arises from the right aortic arch IV. In mammals, the aorta arises from the left aortic arch IV. Reptiles retain both the right and left aortic arch IV and thus have two aortas.2,4 The paths of these vessels vary in amniotes so the site of blood sampling will impact blood gas analysis. The intracardiac and extracardiac shunting of blood in Reptilia means that they differ from other amniotes in the way they uptake and distribute inhalant anesthetics.3

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I would like to thank Dr. John Benson, Dr. Peter Constable, and Ms. Ragenia Sarr for their support of my research for my master’s thesis upon which this abstract is based.

LITERATURE CITED

THE CLINICAL UTILITY OF PARTIAL PRESSURE OF END-TIDAL CARBON DIOXIDE AS A SUBSTITUTE FOR PARTIAL PRESSURE OF ARTERIAL CARBON DIOXIDE IN ANESTHETIZED BIRDS OF PREY

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Abstract

We evaluated the relationship between partial pressure of end-tidal CO₂ (ETCO₂) and partial pressure of arterial CO₂ (PaCO₂) in isoflurane-anesthetized raptors. The PaCO₂ were determined in serial arterial samples from isoflurane-anesthetized birds and compared to concomitant ETCO₂ measured with a handheld microstream sidestream capnograph (NPB-75®, Nellcor Puritan Bennett, Pleasanton, CA 94588-2719 USA). Ventilation rates (VR) were modified to reach different levels of ETCO₂. Forty-eight paired samples, taken from 11 birds of prey, weighing 416 - 2062 g, were subjected to linear regression analysis and the Bland-Altman method for assessment of clinical suitability of the two methods (i.e., PaCO₂ and ETCO₂ determinations). Limits of agreement between ETCO₂ and PaCO₂ were also calculated. A strong correlation was observed between the two measurements (r=0.94; P<0.0001). The level of agreement was more variable when the ventilatory rate was lower than the third of the bird’s Theoretical Respiratory Rate (TRR): a1, mean difference between ETCO₂ and PaCO₂ was -6.43 ± 18.64 mm Hg (mean ± 2SD; n=28). When birds were ventilated with a rate above 0.3 TRR, the capnograph accuracy increased and values of ETCO₂ obtained overestimated the concomitantly measured values of PaCO₂ by 5.54 ± 6.10 mm Hg (mean ± 2SD; n=20), which is in agreement with the normal avian respiratory physiology. These results indicate that the ETCO₂ measured by this microstream sidestream capnograph provides a noninvasive, sufficiently accurate estimation of PaCO₂, at least in birds over 400 g receiving manual positive ventilation above the third of the TRR with a Bain system.

a1TRR = BW^{-0.31} × 17.2 (BW = body weight in kg).
VITAMIN E DEFICIENCY IN MULTIPLE SPECIES BEING FED A COMMERCIAL SUPPLEMENT

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Abstract

In spring of 2005 six of 10 brown pelicans (Pelecanus occidentalis) died or were euthanatized within 8 wk of being moved from winter holding onto outdoor lake exhibits. Clinical signs included weakness and inability to stand or hold wings in normal posture. Laboratory analyses included CBC, plasma biochemicals, minerals and zinc concentrations, blood lead, West Nile and chlamydophila serology, plasma vitamin A, D and E concentrations and radiographs.

Necropsies included gross exam, histopathology, virology, toxicology, vitamin determinations, and cultures. Significant findings were severe generalized myopathy. Lesions in striated muscle were mild to moderate atrophy, degeneration and necrosis of up to 90% of the skeletal musculature. No infectious or toxic agents were found. Two other piscivorous birds died with similar signs. A boat-billed heron (Cochlearius cochlearius) had necrotizing steatitis and mild, multifocal, degeneration, necrosis, and mineralization of skeletal muscle; and an adjutant stork (Leptoptilos javanicus) had mild to moderate, multifocal to regionally extensive loss of myocytes with replacement by fibrous connective tissue in the heart.

Food items were analyzed for vitamin E levels. The product (Thiamin E, Stuart Products, Inc., Bedford, TX 76022 USA) that had been used to supplement fish, was found to have been lacking in adequate vitamin E for greater than 9 mo. An error in manufacturing was identified by the producer and measures were taken to immediately correct the problem. Subsequent analyses of two samples, conducted in August, 2005 and March, 2006, at different laboratories confirmed that the concentration of vitamin E in the newly manufactured product met its label guarantee. This experience underscores the importance of periodic review and laboratory analysis of dietary items used in a zoo feeding program.
TRANSCUTANEOUS CARBON DIOXIDE PARTIAL PRESSURE MONITORING IN AVIAN MEDICINE

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¹Division of Zoo Animals, Exotic Pets and Wildlife, ²Division of Anesthesiology, Vetsuisse Faculty, University of Zürich, 8057 Zürich, Switzerland; ³Small Animal Clinic, University of Veterinary Medicine Hannover, Foundation, 30173 Hannover, Germany

Abstract

Growing knowledge in avian medicine has resulted in more sophisticated and challenging surgeries with longer anesthetic time. Simultaneously the requirement and need for better anesthetic monitoring has increased. Currently anesthetic monitoring of critical avian patients include the measurement of standard pulse oximetry (SpO₂) for monitoring arterial hemoglobin oxygen saturation. Especially in longer anesthetics, postoperative recovery and critical care monitoring of ventilation may be as important as the assessment of oxygenation. Blood gas analysis, the gold standard of oxygenation assessment, is generally not available due to small size and blood volume in avian species. Newer investigations in grey parrots (Psittacus erithacus) have shown that end-tidal pressure of carbon dioxide (EtCO₂) would be a reliable indirect measurement of arterial carbon dioxide tension (PaCO₂).² In addition, recent developments in tranncutaneous carbon dioxide (tcPCO₂) monitoring have shown promising results in different mammalian species¹,⁷ and is a well accepted monitoring tool in human intensive care.⁴ The objective of the current study was to determine whether tcPCO₂ measurements will reflect actual CO₂ status in anesthetized avian species and to test a transcutaneous sensor for the first time in an avian species.

Thirty-five healthy Lohmanns selected leghorn chickens (Gallus gallus) were anesthetized with 4% isoflurane (Attane™, Provet AG, 3421 Lyssach, Switzerland) in oxygen delivered by face mask and intubated by endotracheal tubes. Anesthesia was maintained by administration of isoflurane (end-tidal concentration of isoflurane: 1.1-1.3%). Animals were instrumented for endtidal (Cardiacap/5, Datex-Ohmeda, Helsinki, Finnland) and transcutaneous carbon dioxide tension (V-Sign™ Sensor, Sentec AG, Basel, Switzerland) monitoring. Arterial blood for PaCO₂ analysis was collected with preheparinized syringes from arterial puncture of the A. ulnaris or A. tibialis cranialis, gently mixed and tested without delay with a portable clinical analyser (i-STAT, Heska AG, Fribourg, Switzerland).

The analytic performance of the transcutaneous biosensor (tcPCO₂) was compared with EtCO₂ measurement, and arterial PaCO₂. Comparison of tcPCO₂, EtCO₂ and PaCO₂ results were performed according to standard analytic techniques, based on Deming’s regression and Bland-Altman bias representation³,⁵ using a personal computer- based statistics software (GraphPad Prism, version 4.00, GraphPad Software, San Diego, CA 92130 USA). Significance level was set at \( P_{[CLKB1]} = 0.05 \).
The transcutaneous CO₂ sensor produced reliable results in 87.5% (28/32) of investigated animals, while arterial blood collection was possible in 85.7% (30/35) and endtidal CO₂ measurement in 100% (35/35) of investigated animals. Mean and standard deviation (SD) of tcPCO₂ (25.08 mm Hg ± 14.17) were similar to PaCO₂ (24.06 mm Hg ± 6.91), but lower than EtCO₂ (28.91 mm Hg ± 6.36). Results from tcPCO₂ and PaCO₂ (r=0.45, P=0.02), tcPCO₂ and EtCO₂ (r=0.64, P<0.001), and EtCO₂ and PaCO₂ (r=0.56, P<0.001) correlated with each other. Deming’s regression slopes were close to 1.00 and intercepts close to zero for all three parameters. Slopes were significantly different from zero in all three analyses. Overall accuracy was acceptable. Bias of EtCO₂ and tcPCO₂ comparison was smaller than in tcPCO₂ and PaCO₂ and in EtCO₂ and PaCO₂ comparisons. Limit of agreement were fairly wide in all three CO₂ measurement comparisons.

In summary, transcutaneous carbon dioxide measurement is technically easy to perform, non-invasive, and does not increase airway resistance. The tcPCO₂ sensor was reliably tested in humans⁶ and sheep.⁷ The current study expands its application to avian species as an indirect measurement of adequate ventilation. The wider range of tcPCO₂ in comparison to PaCO₂ and EtCO₂ measurements indicates that single results have to be interpreted carefully. In our experience attention has to be paid to carefully depluming the avian skin to improve sensor contact area and to improve adequacy of results. Similar to a previous study,⁷ EtCO₂ overestimated PaCO₂ by approximately 5 mm Hg.

Although Deming’s regression analysis of the different comparisons of CO₂ measurements resulted in significant correlation, results have to be interpreted with caution, because Bland-Altman analysis revealed, besides an acceptable bias, a fairly wide range of differences within the 95% limits of agreement. Since these differences are clinically important, we conclude that the three methods may be used interchangeably only with caution in avian species. Nevertheless, tcPCO₂ measurements offer additional information for monitoring ventilation when EtCO₂ or PaCO₂ measurements are not available or feasible. Further research in critical patients is needed to test its clinical reliability.

ACKNOWLEDGMENTS

The authors thank Sentec AG, Switzerland for providing the V-Sign™ oxygen saturation and transcutaneous carbon dioxide tension device and Sandra Mosimann, Sarah Scharmer, and Ramiro Valero for all their help during the study.

LITERATURE CITED


FATAL HEMOPROTOZOAL INFECTIONS IN MULTIPLE AVIAN SPECIES IN A ZOOLOGICAL COLLECTION

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Abstract

Hemoproteozoal infections in birds are well described and can range from asymptomatic to acutely fatal. The three commonly reported pathogenic avian hemoproteozoa are *Plasmodium* spp., *Haemoproteus* spp., and *Leucocytozoon* spp. Over an approximate 3-yr span, two lesser flamingos (*Phoeniconaias minor*), two green jays (*Cyanocorax yncas glaucescens*), and two Montezuma oropendolas (*Psarocolius montezuma*) died peracutely with no premonitory signs at a zoological collection in the southern USA. At necropsy, the birds were in excellent body condition.Except for one green jay, the coelomic cavities were filled with a dark serosanguineous fluid. Profound splenomegaly and hepatomegaly were present. The livers were tan to purple with numerous, randomly distributed, red to black foci, ranging in size from 1-4 mm. The predominant histopathologic finding, except in one green jay, was large protozoan cysts in the hepatic parenchyma. Frozen tissue samples harvested at necropsy from the six cases were sent to the parasitology division of the Department of Pathobiology at the Texas A&M College of Veterinary Medicine for polymerase chain reaction to amplify the cytochrome B gene of the hemoproteozoa. The amplified gene sequences were compared to reference gene sequences for avian *Plasmodium*, *Haemoproteus*, and *Leucocytozoon* cytochrome B in the GenBank® database. The protozoal parasite within the hepatic parenchyma from the Montezuma oropendolas and the lesser flamingos was identified as *Haemoproteus* spp. Both green jays had *Plasmodium* spp. isolated from the submitted tissue samples. There are no reports in the literature documenting identified fatal hemoproteozoal infections in oropendolas, green jays, or lesser flamingos.
UROPYGIAL GLAND INFLAMMATION, NEOPLASIA AND SURGICAL RESECTION IN SIX NORTHERN CARMINE BEE-EATERS (Merops nubicus nubicus)

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Abstract

A male northern carmine bee-eater (Merops nubicus nubicus), wild caught in Senegal in 1992, developed a large, crusty, ulcerated mass adhered to and protruding from the area of the uropygial gland. The mass was surgically removed and was histologically identified as a carcinoma with squamous and sebaceous differentiation. The bird was euthanatized 10 days post surgery due to deteriorating condition, and on necropsy, neoplastic cells had invaded the vertebral bodies. Evaluation of the remaining 10 bee-eaters in the flock (all wild-caught before 1993) revealed two male and two female birds with similar uropygial gland lesions. Following surgical excision of the masses, these four bee-eaters recovered from surgery without complication. Biopsies revealed squamous metaplasia and chronic active adenitis in all 4 glands, and carcinoma in three glands. Immunohistochemical staining for papillomavirus was performed on one bee-eater biopsy and was negative. Serum vitamin A levels ranged 1.98-3.24 ppm (mean 2.68 ppm), and were similar to values in unaffected bee-eaters, making hypovitaminosis A unlikely. Of the four bee-eaters that survived the immediate 3 wk postoperative period, one bee-eater developed a recurrence of the uropygial mass at 185 days post surgery. The remaining three bee-eaters are still disease-free at 673 - 700 days post surgery. In addition, a new lesion was discovered in a previously unaffected bee-eater 689 days after the initial evaluation of the entire flock. While a definitive etiology was not identified, the lesions may be associated with increasing age. A close evaluation of the uropygial gland should be included in any avian physical examination.
TECHNIQUES AND TRENDS IN THE CHARACTERIZATION OF INFLAMMATORY SKIN DISEASE IN FEATHER PICKING BIRDS

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Abstract

Feather destructive behavior and self mutilation of the skin are common problems in captive birds, particularly psittacines. A number of causes have been identified or suggested, including mycotic, bacterial, viral and parasitic agents, hypersensitivity, hormonal derangements, hepatic or pancreatic disease, and psychogenic disorders. This report summarizes findings of a retrospective study of paired biopsy results from birds with feather loss, feather picking or self-mutilating behavior, or other alterations in the skin recognizable to clinicians.

From 1994 to 2005, 16162 avian biopsies or necropsies were accessioned at Northwest ZooPath. Dermatitis or skin trauma was diagnosed in 1183 of these cases for a incidence of 7.3%. Because skin conditions appear to be a common avian problem, a “paired” biopsy protocol was devised to aid in the understanding of the pathogenesis of dermatitis or other skin lesions, and this study summarizes data collected with this protocol. Briefly, the protocol requested that clearly labeled full thickness biopsies of skin and feather from affected and unaffected sites be obtained and fixed routinely in formalin for histologic examination. Affected sites were clinically abnormal and usually were areas easily reached by the bird’s beak such as the legs or chest. Unaffected sites were areas that appeared clinically normal or were not easily reached by the bird, such as the top of the head or neck. All biopsies were examined at three different levels in the paraffin block.

Criteria used for the diagnosis of inflammatory skin disease included the presence of perivascular to diffuse inflammation in the superficial or deep dermis of clinically affected and unaffected sites. Inflammatory cells typically were lymphocytes with fewer plasma cells, histiocytes, and eosinophilic granulocytes. Varying degrees of edema, epidermal and follicular hyperkeratosis, and perivascular pulpitis were also present in some cases. For most cases, it was necessary to examine all levels of the biopsies to confirm the presence of inflammation. Cases with scarring (suggestive of trauma) in the unaffected site generally were not included in the inflammatory skin disease subset, to avoid confusion regarding the pathogenesis of the inflammation; however, few cases were included in this subset if the scarring was disproportionately mild compared to the severity of the inflammatory process. The primary criterion for the noninflammatory skin disease subset was an absence of inflammation in the unaffected site. Cases with scarring (suggestive of trauma) in the inflammatory skin disease subset were not included in the noninflammatory skin disease subset, to avoid confusion regarding the pathogenesis of the inflammation; however, few cases were included in this subset if the scarring was disproportionate to the severity of the inflammatory process. The primary criterion for the noninflammatory skin disease subset was an absence of inflammation in the unaffected site. These cases sometimes had no inflammation or other lesions in affected sites as well, but usually had some degree of scarring and inflammation in affected sites, and sometimes also had some scarring in the unaffected sites. Any cases that had histologically recognizable infectious agents, neoplasia or follicular dysplasia were excluded from this study.
Results of this study are summarized in Table 1. Using the above criteria the total study population was 412 birds. Inflammatory skin disease was diagnosed in 211 birds for a prevalence of 51%. Noninflammatory skin disease was diagnosed in 201 birds for a prevalence of 49%. Species trends were identified, and included a preponderance of inflammatory skin disease in macaws and Amazon parrots. A preponderance of noninflammatory skin disease or trauma was seen in the cockatoos and African grey parrots. The prevalence of each was about equal in several other species, including conures, eclectus parrots, quaker parrots, cockatiels, parakeets, and caiques. Total submissions of remaining species were low and trends were not interpreted from these data. Birds with inflammatory skin disease and noninflammatory skin disease had a broad distribution in the United States, and also were seen in Sweden. Trends relative to the sex of the bird were not identified, and interpretation was hampered by the large number of birds in many species categories for which the sex was not known. A single large population of lorikeets had 100% prevalence of inflammatory skin disease, but skin disease was not seen in lorikeets from other regions or populations. This finding suggests that lorikeets may be susceptible to inflammatory skin disease, but that it may not be common in the general population for this species. No budgerigars met criteria for this study suggesting that this common pet species may not be prone to inflammatory or traumatic skin disease. Very few non-psittacine cases fit criteria for inclusion in this study; this may be because fewer dermatopathies are recognized due to less human contact with these birds, or that a lower prevalence of inflammatory skin disease exists for nonpsittacine species.

The etiology for inflammatory skin disease in the study birds was not determined. Based on the large number of affected species, obvious species trends, and wide demographic distribution of affected birds, it is considered likely that more than one etiology may exist. The pattern of the inflammation is most suggestive of cutaneous hypersensitivity, or a cutaneous manifestation of systemic inflammation. In a detailed report of the normal histology of the avian integument, inflammation is not described. In the author’s opinion, the presence of inflammation in the skin of birds is not normal, may be a source of discomfort or pruritis for affected birds, and provides at least one plausible explanation for the feather picking or self mutilation seen in some psittacine birds. Inflammation for which the cause can not be identified probably should not be regarded as nonspecific, incidental, or insignificant. Our findings support previous reports that inflammatory skin disease may be prevalent in feather picking birds based on examination of paired biopsy specimens. Our findings are in contrast to those of a previously published report that did not associate inflammatory skin disease with feather picking birds; however, sample size was much smaller in that study (8 birds total, 1 per species), and a paired sampling technique with multilevel histologic examination was not used.

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Lyckeby, Sweden; Kraft Mobile Vet Services, Snohomish, WA; Los Angeles Zoo, Los Angeles, CA; Latah Creek Animal Hospital, Camano Island, WA; Old County Animal Clinic, Plainview, NY; Dr. Susan Clubb, Loxahatchee, FL; Regiondjursjukhuset Helsingborg, Helsingborg, Sweden; Safari Animal Care Center, League City, TX; Sno-Wood Vet Hospital, Snohomish, WA; Summertree Animal & Bird Clinic, Dallas, TX; The Toledo Zoo, Toledo, OH; Valley Animal Hospital, Roanoke, VA; Village Vet Hospital, Bellingham, WA; West Valley Pet Clinic, Woodland Hills, CA; Windcrest Animal Hospital, Wilmington, DE; and Yukon Vet Hospital, Yukon, OK. The author also thanks Jamie Kinion for data retrieval.

LITERATURE CITED

Table 1. Prevalence and sex of birds with inflammatory and noninflammatory skin disease associated with clinical dermatopathy, feather picking or self-mutilation, based on paired biopsy technique.

<table>
<thead>
<tr>
<th>Species</th>
<th>Total</th>
<th>Inflammatory (%)</th>
<th>Sex&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Trauma (%)</th>
<th>Sex&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cockatoo</td>
<td>98</td>
<td>26 (27)</td>
<td>7.16.3</td>
<td>72 (73)</td>
<td>15.38.19</td>
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<td>Grey</td>
<td>77</td>
<td>20 (26)</td>
<td>11.2.7</td>
<td>57 (74)</td>
<td>22.11.24</td>
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<tr>
<td>Macaw</td>
<td>48</td>
<td>38 (79)</td>
<td>12.16.10</td>
<td>10 (21)</td>
<td>2.7.1</td>
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<tr>
<td>Lorikeet&lt;sup&gt;b&lt;/sup&gt;</td>
<td>39</td>
<td>39 (100)</td>
<td>0.0.39</td>
<td>0 (0)</td>
<td>0.0.0</td>
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<tr>
<td>Amazon</td>
<td>30</td>
<td>23 (77)</td>
<td>4.5.14</td>
<td>7 (23)</td>
<td>1.3.3</td>
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<tr>
<td>Conure</td>
<td>28</td>
<td>14 (50)</td>
<td>8.3.3</td>
<td>14 (50)</td>
<td>4.5.5</td>
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<td>Eclectus</td>
<td>22</td>
<td>14 (64)</td>
<td>6.4.4</td>
<td>8 (36)</td>
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<td>Quaker</td>
<td>13</td>
<td>7 (54)</td>
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<td>6 (46)</td>
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<td>Lovebird</td>
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<td>5 (45)</td>
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<td>1.1.4</td>
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<tr>
<td>Cockatiel</td>
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<td>2.2.1</td>
<td>6 (55)</td>
<td>5.1.0</td>
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<td>Parakeet</td>
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<td>3 (43)</td>
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<td>4 (57)</td>
<td>1.0.3</td>
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<tr>
<td>Caique</td>
<td>6</td>
<td>4 (67)</td>
<td>1.1.2</td>
<td>2 (33)</td>
<td>0.2.0</td>
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<tr>
<td>Hawkshead</td>
<td>4</td>
<td>3 (75)</td>
<td>0.2.1</td>
<td>1 (25)</td>
<td>1.0.0</td>
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<tr>
<td>Senegal</td>
<td>3</td>
<td>2 (67)</td>
<td>0.1.1</td>
<td>1 (33)</td>
<td>0.0.1</td>
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<tr>
<td>Jardine</td>
<td>3</td>
<td>2 (67)</td>
<td>0.1.1</td>
<td>1 (50)</td>
<td>0.1.0</td>
</tr>
<tr>
<td>Alexandrine</td>
<td>2</td>
<td>2 (100)</td>
<td>0.1.1</td>
<td>0 (0)</td>
<td>0.0.0</td>
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<tr>
<td>Parrotlet</td>
<td>2</td>
<td>1 (50)</td>
<td>1.0.0</td>
<td>1 (50)</td>
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<td>“Parrot”</td>
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<td>2 (50)</td>
<td>1.0.1</td>
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<tr>
<td>Non-psitt&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>1 (25)</td>
<td>0.1.0</td>
<td>3 (75)</td>
<td>0.1.2</td>
</tr>
<tr>
<td>Totals</td>
<td>412</td>
<td>211 (51)</td>
<td>57.58.96</td>
<td>201 (49)</td>
<td>56.77.68</td>
</tr>
</tbody>
</table>

<sup>a</sup>Sex ratio is male.female.unknown.
<sup>b</sup>Represents a single population.
<sup>c</sup>Species not known.
<sup>d</sup>non-psittacine species.
COMPARISON OF SUTURE MATERIAL FOR CLOACOPEXY IN THE PIGEON (Columba livia)

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Abstract

Cloacopexy is a common surgical procedure indicated for the treatment of recurrent cloacal prolapse. Suture material recommended for cloacopexy has included polydioxanone, polyglactin-910, polypropylene, and nylon.1-3 The ideal suture material for cloacopexy would persist in tissues long enough to promote adhesion formation while resisting the harboring of microorganisms.

Our study evaluates the effects of three absorbable suture materials (chromic catgut, polyglactin-910, and polydioxanone) as well as one non-absorbable suture (polypropylene) in pigeons (Columba livia) undergoing cloacopexy. Four birds served as controls by undergoing a ventral midline incision and removal of the ventral fat pad. Standard incisional cloacopexy was performed in 40 birds using chromic catgut, polyglactin-910, polydioxanone, or polypropylene (in 10 birds each). Humane euthanasia was performed at 3, 9, and 16 wk post surgery. No gross evidence of inflammation or granuloma development was identified during complete necropsies. Cloacopexy sites were excised en bloc, and histologic evaluation and scoring was performed using hematoxylin/eosin stains and special trichrome stains. The chromic catgut, a capillary, multifilament suture material, was expected to promote a significant inflammatory reaction; however, pigeons with catgut had low scores, most similar to the scores of control birds. Inflammation was most prominent in birds receiving polyglactin-910. Fibrosis was most prominent in surgical sites containing polyglactin-910.

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LITERATURE CITED

NEURAL LARVA MIGRANS DUE TO *Baylisascaris procyonis* IN COCKATIELS: THE USE OF SEROLOGY FOR ANTEMORTEM DIAGNOSIS, AND A PROSPECTIVE, CONTROLLED CLINICAL TRIAL ON PREVENTION USING PYRANTEL-MEDICATED FEED IN EXPERIMENTAL INFECTIONS

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Abstract

*Baylisascaris procyonis*, the raccoon roundworm, causes neural larva migrans (NLM) in 37 avian species, including 18 species of parrots. Diagnosis of NLM is difficult because of the paucity of larvae in the avian central nervous system (CNS) in most cases. Treatment regimes are generally unsuccessful, so prevention is crucial.

A three-stage, prospective, controlled clinical trial was conducted to study three aspects of psittacine *Baylisascaris* NLM: (1) the use of serology in antemortem diagnosis; (2) the development of an experimental model; and (3) prevention using pyrantel pamoate as a feed additive.

In Part I, cockatiels were exposed to *B. procyonis* by inoculation with larval excretory-secretory antigen, or by crop gavage with infective eggs. Blood was collected at regular intervals for serologic testing using enzyme-linked immunoabsorbent assay. Preliminary serology demonstrated seroconversion.

In Part II, cockatiels (n=27) were infected *per os* with one of three different doses of infective eggs (1,440, 2,200, or 2,500). The incidence of NLM across all groups was 89%; *B. procyonis* larvae were found in CNS tissue of all affected birds.

In Part III, cockatiels (n=28) received 2,500 infective *B. procyonis* eggs p.o. and were maintained on a medicated pelleted diet (0.2% pyrantel pamoate). No typical cases of NLM were seen in these birds throughout the 14-wk study, and in a subset that were euthanatized (n=14), no larvae were found in tissues nor were histologic lesions consistent with NLM seen. All non-medicated control birds (n=7) developed NLM. Pyrantel pamoate as a feed additive appears to be effective in preventing experimental NLM in cockatiels.

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LITERATURE CITED


MARINE ECOSYSTEM HEALTH IN GABON, CENTRAL AFRICA

Sharon L. Deem, DVM, PhD, Dipl ACZM,1* Charley Potter, MS,2 Tim Collins, BS,3 Richard Parnell, PhD,4 Howard Rosenbaum, PhD,3 and Suzan Murray, DVM, Dipl ACZM1


Abstract

The 6.5 billion humans alive today are stressing the earth on an unprecedented scale with landscape and seascape modifications, over consumption of natural resources, pollution, and global trade and travel, all of which are increasingly impacting natural ecosystems. Today over 60% of the human population lives in coastal areas and the coastal human population is increasing at twice the rate of inland populations. The negative impacts that humans have on the health of oceans are immense. Oceans have been our sinks for disposal and discharge. Humans have harvested protein from the oceans for thousands of years, although this harvesting has reached unsustainable levels only in the last 100 yr. The impacts of pollution and over-exploitation are being noted in all the world’s oceans with devastating effects in some regions.

In the Gulf of Guinea (GoG) of West and Central Africa, oil and gas development has historically been on-shore and in shallow water. In recent years, changes have begun focusing on deep water exploitation using ultra-deep extraction technology. The United States and Europe will invest $30-40 billion (possibly up to $360 billion) in the next decade for oil and gas from the region. In addition to these natural resources, the GoG remains one of the richest marine environments on earth, containing locally and globally important fish stocks in a marine ecosystem that is mostly intact.

Resource extraction and trade has led to large scale coastal development and increased vessel activity in the GoG. Industrial trawlers routinely flout fishing zone restrictions along the Gabonese coast. Although there is a seasonal ban on shrimp fishing, other methods that would reduce by-catch and decrease the negative impact of fishing, such as harvest control and turtle excluder devices, are not practiced. Oil extraction processes are often associated with some degree of leakage with environmental contamination from spills. The seismic activity required for oil reserve discoveries may potentially have negative impacts on animals in the marine environment. Marine debris (human garbage) is common on many of the beaches and in the inshore water courses along the coast (Deem, unpublished data); this contamination is most likely a source of morbidity and mortality for marine species in the region.

The GoG has also been identified as a globally important site for a variety of marine mammals, including humpback whales (Megaptera novaeangliae), Atlantic humpback dolphins (Sousa teuszii), West African manatee (Trichechus senegalensis), common dolphins (Delphinus

*Corresponding author.
capensis), bottlenose dolphins (Tursiops truncatus), killer whales (Orcinus orca), rough toothed dolphin (Steno bredanensis), and sperm whales (Physeter macrocephalus). In addition to the marine mammal diversity, the GoG is also home to a variety of sea turtles, including green (Chelonia mydas), hawksbill (Eretmochelys imbricata), and olive Ridley (Lepidochelys olivacea) turtles; it has some of the most important nesting sites in the world for the highly endangered leatherback turtle (Dermochelys coriacea).2

Currently, we know little about the health of the GoG ecosystem. Assessing the health of an ecosystem is often approached by one of three methods: (1) ecosystem distress syndrome, (2) counteractive capacity, and (3) risk analysis.6 With each of these methods, various indicators of stress and/or ecosystem responses are measured. Assessing wildlife health can serve as an indicator of ecosystem health. The marine ecosystem health program in Gabon, Central Africa focuses on sentinel wildlife species as one means of assessing the health of this ecosystem. Through the collection of baseline data and long term monitoring, the health of the GoG will be assessed in conjunction with monitoring of the increasing anthropogenic pressures in the region.

The marine ecosystem health program is currently divided into three projects: 1) nesting female and hatchling leatherback turtle health studies, 2) determination of causes of sea turtle mortality, and 3) development of a marine mammal stranding network.

For the first project, standardized physical examinations are being performed and baseline blood health indices are being determined in conjunction with leatherback tagging and monitoring programs. Additionally, a hatchling orientation study is on-going, with a specific aim of determining the influence of artificial lights on hatchling survival.

For the second project, a standardized approach of assessing sea turtle carcasses has been developed in order to determine the causes of mortality. A workshop is scheduled for October 2006 to train regional biologists in sea turtle necropsy and data collection techniques. To date, assessments have been performed on 102 olive Ridley, 4 green, and 3 leatherback turtle carcasses found washed ashore in the southern 380 km region of Gabon from September-November 2005.5 Although standardized sampling and data collection are still being implemented, it appeared that most of these mortalities were fisheries-related, based on physical findings (i.e., flipper amputations from machetes, monofilament lesions).

For the third project, a proposal to establish a marine mammal stranding network along the coast of Gabon, and ultimately throughout the GoG region, has been written and submitted to various funding agencies. Once funded, this network will ensure proper sample and specimen collection for natural history and health data. These data will be used for the documentation of marine mammal species found in the region and the determination of the causes of mortality. The need for a marine mammal stranding network is clear. In 2002, a rough toothed dolphin stranded at Sette Cama (Collins, unpublished data), providing the first direct evidence of the species presence in Central Africa. In 2004, two stranded dolphins (unidentified) were reported by ecoguides on beaches of Loango National Park; in 2005, a neonatal sperm whale washed ashore in the same region. This latter animal was freshly dead and although tissues were collected for DNA analysis, no other samples were collected as there was no veterinary involvement at that
time. During 2005, we also learned of five humpback whales that stranded in Gabon and Congo. Unfortunately, again no samples were collected as our stranding network had yet to be developed and a veterinarian was not yet incorporated into the marine mammal conservation program in the region.

Stranded sea turtles and marine mammals serve as highly visible environmental indicators of ocean health. Although there are a few biases with using stranded marine animals as sentinels, these animals do provide invaluable data to assess both the health status of species examined and the marine ecosystem where they live. Many marine conservation programs in the GoG have been established for a number of years. The integration of a veterinary health component into some of these programs will allow us to gain a better understanding of the health of marine wildlife in the GoG as one indicator of the health of this ecosystem.

LITERATURE CITED

POST-RELEASE MONITORING IN GREAT APE REINTRODUCTION: CURRENT TECHNIQUES IN EVALUATING HEALTH AND BEHAVIOR

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Abstract

Reintroduction of great apes for animal welfare and conservation purposes has been successfully attempted in the last few years. Post-release monitoring is essential to determine the viability of a released population and the impact of the population on the ecosystem.

Before reintroduction, a detailed plan for monitoring the individuals released should be developed. Worker safety should be a priority when considering methods of monitoring. Physical attacks on field workers have occurred with reintroduced common chimpanzees. Monitoring methods that provide little or no interaction with the released animals are preferable, to minimize disease exchange, maximize human and animal safety, and to encourage natural behavior in the animals. New remote sensing technology can be used to complement more traditional behavioral monitoring methods, and would be an asset in monitoring solitary individuals and those that leave the study site.1,4

Behavioral data should be collected on all individuals released in a regular, systematic manner.5 The program Cybertracker has been used with hand-held computers to gather data on the health and behavior of free-ranging great apes, and could be adapted to be used for reintroduced great apes. This allows for easy integration with computer analysis programs, such as Epi Info™ and GIS mapping software.

Disease monitoring is an essential part of post-release monitoring, yet little data on the disease status of reintroduced primates is available. Fecal and urine samples should be collected on a regular basis, and preserved for laboratory evaluation. Fecal floatation, urine test strips, and point-of-care Giardia spp. and Cryptosporidia spp. kits can be utilized in situ. Viral pathogens, such as simian immunodeficiency virus,3 simian T-lymphotropic virus,2 and rotavirus6 have been isolated from fecal samples of wild great apes. Additional research would expand the availability of diagnostic tests useful to both wild and reintroduced great apes.

LITERATURE CITED


Abstract

The Gilbert’s potoroo (Potorous gilbertii) is a small macropod presumed to be extinct since 1870, until a small population was rediscovered in 1994. This remnant population is estimated to be less than 40 individuals and is restricted to an 1800-ha protected region within Two Peoples Bay Nature Reserve in Western Australia. Shortly after its rediscovery, eight potoroos were captured to establish a captive breeding colony. A 3-yr health monitoring program began in February 2005, in order to determine the prevalence of specific diseases in the wild and captive populations and correlate the effects of identified diseases on reproductive success and survivorship.

Twenty-seven potoroos (22 wild and 5 captive) have been sampled to date, and infections with potentially pathogenic micro-organisms have been found. Conjunctival, urogenital, and/or pharyngeal swabs were positive on Chlamydiales PCR testing result for 12 of 19 potoroos (63%). The pathologic significance of these Chlamydiales organisms remains unknown. A Treponema-like spirochete was isolated from the reproductive tracts of seven males and seven females. Current studies aim to determine whether this organism is associated with balanoposthitis, which has been found to affect all male potoroos, both in captivity and in the wild. There has been no serologic evidence of toxoplasmosis or cryptococcosis. Strongyles and other nematodes have been the most frequently identified gastrointestinal parasites based on fecal parasitologic examination.

The health monitoring study that has been incorporated within the Gilbert’s potoroo recovery program highlights the importance of disease investigation and veterinary involvement in endangered species recovery programs.

LITERATURE CITED


Abstract

Recovery of the black-footed ferret (*Mustela nigripes*) is one of the most ambitious breeding and reintroduction efforts in conservation. Rescued from the brink of extinction with only 18 animals remaining, this North American carnivore now has ~850 individuals in the combined ex-situ and in-situ population. Black-footed ferrets have been reintroduced to the western Great Plains, yet success has varied among sites. Some populations have expanded, while others have produced limited numbers of wild-born kits and rely on yearly augmentation from the ex-situ breeding program. A multi-disciplinary biomedical survey of wild black-footed ferrets was conducted to assess health, disease, immunology, genetics, and reproduction. From 2002 through 2006, 253 wild black-footed ferrets (134 males, 119 females) were captured at reintroduction sites in South Dakota (n = 129), Montana (n = 2), Wyoming (n = 33), Mexico (n = 12), Utah (n = 19), Colorado (n = 6), and Arizona (n = 52). Each animal was trapped and anesthetized for a health exam and blood collection, then returned to the capture site. In this study, we report a serologic survey to assess antibodies to sylvatic plague (*Yersinia pestis*), tularemia (*Francisella tularensis*), toxoplasmosis (*Toxoplasma gondii*), and canine distemper virus in reintroduced black-footed ferrets and/ or wild-born descendants at various reintroduction sites. Blood samples also were evaluated for heartworms (*Dirofilaria immitis*) using a commercially available, enzyme-linked immuno-sorbent assay (ELISA) for detection of adult *D. immitis* antigen in plasma or serum (DIROCHEK®, Synbiotics, Inc., San Diego, CA 92127 USA), as well as blood smears to detect circulating microfilaria.

All ferrets lacked antibodies to sylvatic plague. Positive titers to tularemia were detected in 11 animals in South Dakota (n = 4), Wyoming (n = 2), and Utah (n = 5). Only two animals in South Dakota had positive titers to toxoplasmosis. Antibodies to canine distemper virus were not detected in unvaccinated, wild-born animals. Following vaccination, protective titers were observed for at least 6 mo after an injection of the recombinant vaccine PUREVAX® (Merial, Inc., Athens, GA 30096 USA). For heartworm assessment, 36 of 233 (15.5%) blood samples tested positive for *D. immitis* antigen by ELISA (antigen+) and/or presence of microfilaria (microfilaria†). Of the 36 positive samples from 33 individuals, 13 were antigen+/microfilaria†, 17 were antigen+/microfilaria- and 6 were antigen-/microfilaria+. All 33 positive ferrets appeared healthy with no evidence of dyspnea, and three ferrets were recaptured up to 1 yr later.
with no symptoms of heartworms. Although DIROCHEK® claims to be a highly specific, sensitive test for *D. immitis* (detecting female uterine antigen in the filarid nematode), we proceeded to validate the test by molecular methods. Using DNA extracted from the positive ferret blood samples, filarid DNA was amplified, sequenced, and identified as a filarid species that was not closely related to *D. immitis*. The species of filarid could not be identified in an extensive filarid DNA sequence database. The anatomic location of adult worms in the ferrets remains undetermined.

To date, these results demonstrate the susceptibility of the reintroduced and wild-born black-footed ferret populations to the potentially fatal sylvatic plague and show the need for distemper vaccinations in wild ferrets. Data also indicate that the commercial, antigen based ELISA kit results in false positives and is not adequate for heartworm surveillance in the black-footed ferret. This comprehensive biomedical survey illustrates the need to understand factors influencing survival of endangered species after reintroduction. This collaborative, multi-disciplinary approach also demonstrates the benefits of collaboration among veterinarians, scientists and wildlife managers.

ACKNOWLEDGMENTS

This project is dedicated to the memory of Dr. Elizabeth (Beth) Williams, a prominent wildlife pathologist, disease scientist, colleague, and friend. Beth and her husband, Dr. Tom Thorne, had remarkable accomplishments in life as wildlife veterinarians and made substantial scientific contributions to the black-footed ferret recovery program.
CALIFORNIA CONDOR (*Gymnogyps californianus*) CONSERVATION IN BAJA CALIFORNIA: SUCCESSES AND CHALLENGES ACROSS THE BORDER

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Abstract

Only a few hundred years ago, the California condor (*Gymnogyps californianus*) ranged from British Columbia, Canada to Baja California, Mexico. As European pioneers settled within its range, this large and impressive species declined dramatically to near extinction in the mid-1980. The main goal of this project is to restore a condor population to the Sierra San Pedro Martir Mountains of Baja California, where this keystone species survived until as recently as 1945. The Sierra San Pedro Martir was selected because of its remoteness and sparse human population. After years of reconnaissance and political negotiations on both sides of the border, the project started with the construction of a condor release pen in early summer of 2002. In August 2002, the first six of 18 condors were transported to the site and were released by October of the same year. We plan to reintroduce five to seven condors per year until the anticipated carrying capacity of 20 pairs is reached, so far 10 condors fly freely in the Sierra. We anticipate that one day soon these magnificent birds will range along the Pacific coast, over the San Pedro Martir range, to the Gulf of California.

The project field crew is made up of Mexican students and biologists, and the work is managed through the Applied Animal Ecology Division within the Center for Reproduction of Endangered Species (CRES) at the Zoological Society of San Diego. It is carried out in close corporation with our program partners, Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE) and El Instituto Nacional de Ecologia (INE) under the Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT). The importance of veterinary involvement in the California condor recovery program in the United States has been reported previously.3, 4 As is seen in other reintroduction programs; the veterinarian’s role includes monitoring the health status of these endangered birds in the wild and in captivity, as well as providing care to clinically ill or injured birds.5

The medical and pathology support for the California condor release program in Baja California, Mexico is provided by the veterinary department of the San Diego Wild Animal Park (SDWAP) and Department of Pathology of the Zoological Society of San Diego, respectively. Also, a partially funded Mexican wildlife veterinarian has been a valuable component of the health care support system since the project started 4 yr ago. The professional challenges for the field veterinarians in Baja California are unique when compared to those seen by our veterinary colleagues working with the release programs in the United States. Veterinarians in Baja California also assist as the bridge for communication between different local, state, and federal agencies in Mexico and the U.S. Daily bureaucratic challenges are common; situations, if not
managed correctly, could cause a breakdown in organizational relationships resulting in decreased participation between different national and international governmental agencies. The California condor represents the first CITES I category species reintroduced into Mexico after complete extirpation; therefore, rules and regulations are new novel for organizations on both sides of the border. Other unique challenges include the accessibility to the remote location of the condor release site in the San Pedro Martir National Park: the roads are primitive and often dangerous; weather conditions vary from extreme heat to freezing temperatures; and there are periods of deep snow due to the high elevation (2400 m/7800 ft). Despite these challenges, the Sierra Mountains create a healthy habitat and unique ecosystem for the future of the condor in Mexico.

International movement of animal and disease is important to both sides of the border. The animal health department of Mexico (SAGARPA), the equivalent of the USDA in the United States, requires that birds that enter the country be negative for Newcastle disease and avian influenza by cloacal and respiratory sampling, respectively. The birds must also be serologically negative for *Salmonella pullorum* prior to entry. These requirements are based on the government’s concern for the health of the poultry industry. All released condors are vaccinated against West Nile Virus using a DNA vaccine prior to leaving the US, but this vaccine is not required by the Mexican government. Once in Mexico, birds immediately enter a 30-day quarantine period in a holding facility at the release site in the Sierra San Pedro Martir. The condors are then re-tested for Newcastle’s disease and avian influenza by SAGARPA before being released from quarantine. At that time, each condor receives a full health examination, which serves as the last exam prior to release into the wild. Blood samples for complete blood count, biochemistry analysis, chemistries, lead levels and serum banking are obtained during this examination and compared with condor reference values. Also at this examination, radio transmitters and identification tags are affixed to the wings of each condor prior to release.

Two deaths have been reported in the Baja Mexico condors since 2002. One mortality was due to predation by a bobcat (*Lynx rufus*) that entered the aviary through a discrete passage in a pile of adjacent boulders. Repair of the pen and an electric fence perimeter have since made the captive birds more secure. The mountain lion (*Felis concolor*) population and its potential impact on the condor release program also needs to be addressed. The second death, of a young and newly released condor, remains undetermined however it was at least scavenged upon if not predated by a bobcat. Dangerous interactions have been observed in the Baja release program between condors and other predators such as mountain lions and coyotes (*Canis latrans*) eating from the carcasses offered, and golden eagles (*Aquila chrysaetos*) with aggressive territorial behavior. All released birds were equipped with radio transmitters, which assisted in the recovery of the carcasses, but management of released condors remains a challenge in this area due to their tendency to fly great distances over rough terrain and the lack of quality roads. Another problem found was that the movement of live birds, carcasses, and bio-samples across both sides of the border is difficult and requires permits that sometimes take days to weeks for clearance approval.

No infectious diseases have been detected in any of the condors reintroduced into Baja Mexico. They are routinely screened for END or AI when they arrive to quarantine, but after that only serum is banked for serologic studies if needed. One case of lead poisoning occurred due to
ingestion of a bullet fragment in a food item that was donated to the program. An elevated blood lead level was discovered during a routine health examination using a portable blood lead analyzer (LeadCare Analyzer, ESA, Inc., Chelmsford, MA, 01824 USA). Fortunately, the bird was asymptomatic and was transported back to the SDWAP. Radiographs confirmed the presence of a metallic density and endoscopic removal of the bullet was successfully performed. The bird was placed on chelation therapy with Ca-EDTA for 5 wk. The bird recovered uneventfully and was sent back to the release site after 3 mo of hospitalization. Lead poisoning has been reported previously as one of the most common causes of death among the wild and released California condor population.2,3,7

There are no published studies that provide information regarding the health of the environment surrounding the Baja Mexico release site. Specifically, we are interested in determining potential health risks to the release condor population including evaluating the presence of heavy metals, pesticides, insecticides, agricultural fertilizers, rodenticides, and other intoxicants. Other concerns include the risks of predation, poaching, legal hunting (and type of bullets used) and infectious disease agents in the area need to be studied. The California condor appears to be susceptible to West Nile Virus infection (a chick died of this infection in Ventura County, CA last year) and the low surveillance of the disease in the wildlife of México pose an additional problem. The fear or reality of an outbreak of avian influenza H5N1 on either side of the border will undoubtedly affect the potential health of the birds but will also restrict the legal movement of this bird reducing the chances for emergency medical intervention if needed. An expanding conservation education and outreach program, highlighting the condor release program, has been initiated in an attempt to reach residents in the immediate release area. Involvement of locals will be critical for the success of the program.

Mexico is a country and culture where concern for the environment and conservation issues is still in the process of development. The response of Mexican society to the presence of this magnificent and endangered bird, with all of its conservation issues, has been encouraging but remains uncertain. Direct participation of national and international non-government organizations, local and federal government agencies, universities and the Zoological Society of San Diego is crucial for the future of the reintroduction program and establishment of a viable California condor population in Baja California, Mexico. Zoo veterinarians can play a major role in conservation programs due their diverse training in medicine and management of diseases in individuals and populations. But on an international setting they also need to have the capability of addressing problems related with not only medicine but different ideology, language, and culture.

LITERATURE CITED


CONSERVATION OF THE Gyps VULTURES IN INDIA: VETERINARY SUPPORT FOR AN IN-SITU PROJECT

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Abstract

The once ubiquitous Gyps spp. vultures of India, Nepal, and Pakistan have, over the last decade, suffered a catastrophic population crash. As the magnitude of the decline became apparent, national and international organizations moved to determine its cause and conserve the species. The post mortem finding in affected vultures of visceral gout and residues of diclofenac, a non-steroidal anti-inflammatory drug (NSAID), was a turning point. Disease-modeling and a direct investigation strongly incriminated secondary ingestion of diclofenac as the cause of the vulture decline.

Tests have been carried out on related Gyps species to determine an alternative NSAID to replace diclofenac. Meloxicam was found to be safe in vultures and thus offers an alternative drug for use on domestic ruminants. Despite diclofenac being banned by the Indian government in March 2005, this legislation had not been fully enacted over 1 yr later.

In India the Zoological Society of London (ZSL) is working in partnership with the Bombay Natural History Society (BNHS) and the Royal Society for the Protection of Birds (RSPB) to run a program for vulture conservation.

An initial research center, funded by the Darwin Initiative in the UK, to study the cause of the decline was established at Pinjore, Haryana. This has been expanded into a breeding center as part of the captive breeding program. A second center is being built at Buxa in West Bengal and additional centers have been proposed. It is proving increasingly difficult, because of continuing population declines, to collect birds from the wild to form founder breeding groups. However there are now representative groups of all three threatened species (G. bengalensis, G. indicus and G. tenuirostris) in captivity. A number of the birds are permanently disabled individuals that have been rescued by wildlife rehabilitators.

The BNHS now employs three full-time veterinary surgeons to work on the vulture project, with the ZSL providing veterinary and husbandry advice and support, both from the UK and on-site in India through regular visits to the project.

The Indian veterinary undergraduate course includes avian medicine teaching but it is exclusively devoted to poultry-related topics. Thus the ZSL has provided veterinary training in India pertinent to the management of the vultures, with the goal of ensuring that the in-situ
project veterinary team can become more self-sufficient and expand their expertise within this specialized field.

In October 2005, a 6-day workshop was conducted. Veterinarians and biologists from the BNHS were trained, with additional veterinarians and wildlife rehabilitators participating. Through lectures, postmortem dissections, and wet-labs many aspects of avian medicine, anesthesia, surgery and more general wildlife rehabilitation were covered.

In addition to establishing the skills needed to manage the vultures held in the breeding centers, part of the rationale for the workshop was to preemptively train a veterinary team in anticipation of the 2006 Kite Festival in Ahmedabad, Gujarat. During this annual festival many bird species are injured or killed by the kite strings that are covered with powdered glass. After the 2005 Kite Festival a visit to a rescue facility run by the Animal Help Foundation (AHF) showed them to be overwhelmed by the volume of injured birds. (The AHF is a charity primarily devoted to the care of domestic species and runs a stray dog neutering program). The ZSL and BNHS extended an invitation for an AHF veterinarian to attend the October workshop.

For the 2006 Kite Festival, the AHF facilities were relocated at a new site outside the city limits and the AHF was better prepared to accept the influx of birds. Their veterinary team was augmented by a BNHS veterinarian, a veterinarian from the Central Zoo in Katmandu, and the author. The large number of casualty birds, including the black kite (*Milvus migrans*), allowed the veterinarians to familiarize themselves with equipment and techniques while providing improved management of the injured birds. A protocol had been set up so that injured vultures would be prioritized for rescue. When an injured vulture was reported, a team, including a veterinarian, would be sent out to provide on-site first aid. Initial treatment was often restricted to the critical placing of hemostats on major vessels to prevent exsanguination. After transport to the AHF, center vultures were stabilized on intravenous crystalloid fluids and given antibiotics and meloxicam. They were then triaged for anesthesia and surgery.

On the Saturday of the Kite Festival, seven injured vultures underwent emergency general anesthesia (using isoflurane) and surgery to stop continued blood loss and to repair the propatagial injuries. All seven vultures survived.

Over the time during and directly after the 3-day Kite Festival, 20 injured vultures were admitted to the center, comprising over 20% of the remaining Ahmedabad population. Survival rates were markedly higher than in previous years, with only two vultures dying after admission compared with over 50% of those rescued in 2005. The residual disabilities are far less severe than in previous years but still preclude the release of these birds back to the wild. It is anticipated that the casualties will join other birds at one of the BNHS breeding centers.

The current vulture decline is limited to several countries in Asia. It reached a crisis point, with three species on the verge of extinction, in just a few years. This is a completely novel population collapse in terms of its cause and the species involved. Thus the in-situ conservationists and veterinarians could not be expected to have the range and depth of expertise required to immediately address and arrest the decline. Ex-situ veterinary support by colleagues
with broad avian skills and specific experience within zoological collections has facilitated establishment of the founder groups of birds. Further involvement is anticipated in future years as the vulture groups mature, breed, and provide offspring for release into the wild.

The precipitous decline of the *Gyps* species where diclofenac has been used in agricultural veterinary medicine should be noted by all involved in conservation. Lobbying should be actively undertaken to ensure that diclofenac is not distributed to other continents for use in the veterinary field.

**ACKNOWLEDGMENTS**

Thanks are due to colleagues at ZSL, in particular Nick Lindsay, Head of International Programmes at ZSL and Claire Cunningham and Ilona Furrokh in the Veterinary Hospital who organized equipment acquisition and shipping. Thanks also to colleagues at RSPB and the BNHS, in particular Drs. Prakash and Das. Both the AHF and Kartik Shastri were pivotal to the success of the work during the 2006 Kite Festival in Ahmedabad. Work on the project has been supported by a Darwin Initiative Grant and the Bird of Prey Trust. The Universities Federation for Animal Welfare provided financial support for the October 2005 workshop in Pinjore. The isoflurane vaporizer, that has proved so invaluable in providing safe anesthesia for the vultures, was a donation from the AZA Raptor TAG members, coordinated by Scott Tidmus.

**LITERATURE CITED**

VETERINARY CONTRIBUTIONS TO THE TURKS AND CAICOS IGUANA (*Cyclura carinata*) RESTORATION PROJECT

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Abstract

The endangered Turks and Caicos iguana (*Cyclura carinata*) is the smallest of eight species of Caribbean rock iguanas, all of which are threatened with extinction. Increasing land development in the region has led to habitat destruction and expanding populations of introduced predators, particularly domestic cats and dogs. As a result, the Turks and Caicos iguana is found on an increasingly smaller number of cays in the Turks and Caicos Islands, in an area encompassing only 5% of its historic range.

In 2000, a project was initiated by postdoctoral millennium fellow Glenn Gerber, of the Zoological Society of San Diego’s Conservation and Research for Endangered Species (CRES), to restore populations of this species to several protected islands. In 2002 and 2003, a total of 218 animals were safely relocated to protected translocation cays. Physical exams, complete blood counts, serum chemistries, serum cortisol levels, and body measurements were performed prior to, and following, translocation. Captured animals with poor body condition, or evidence of ongoing infectious processes, were eliminated from the translocation group.

Follow-up studies have shown a remarkable 98% survival rate among translocated animals. Nesting behavior and hatchlings have been documented on each of the translocation cays. Juveniles hatched on translocation cays have demonstrated considerably faster growth rates and earlier age of sexual maturity than juveniles hatched on source cays. Education efforts by CRES, and collaboration with government officials and local private businesses, have helped to make the Turks and Caicos iguana a flagship species for environmental conservation in the region.

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Abstract

What is a “wildlife veterinarian”? This would seem to be a very simple question to answer: a wildlife veterinarian is a veterinarian who works with wildlife, but given the diversity of professional interests and niches found at any meeting of the American Association of Wildlife Veterinarians (AAWV) or the American Association of Zoo Veterinarians (AAZV), it becomes clear that there is not necessarily a straightforward answer.

There are many professional organizations and groups in veterinary medicine. Most of these are clearly defined by their geography, their species of interest, or the body system in which they specialize. However, the AAWV and the AAZV are both organizations dedicated to the health of wildlife and, as such, have common goals and interests. Historically, “wildlife veterinarians” have been focused on disease issues of free-ranging populations, while “zoo veterinarians” have been concerned with clinical medicine in captive individuals. While there may be some truth to this statement, as with any generalization, it is also loaded with inaccuracy. It is neither sufficient nor accurate to state that AAWV members are “wildlife veterinarians” and AAZV members are “zoo veterinarians.” So what is it that sets the members of these two organizations apart?

The AAWV was established in 1979 as an organization of veterinarians interested in all aspects of wildlife health.2 One of its main objectives is to enhance the contribution of veterinary medicine to the welfare of the wildlife resource by promoting a philosophy of animal management, preventive medicine, and disease recognition in free-ranging species.1 The AAWV works to educate veterinary students, veterinarians, government agencies, and wildlife interest groups on matters of wildlife and ecosystem health, with an emphasis on wildlife management, preventive medicine, and the inter-relationship between humans, domestic animals, wildlife, and the environment in disease.1 It also serves as an advocate to promote the use of veterinarians in wildlife resource management and research, and encourage cooperation between veterinarians and resource management professionals.1

The AAZV was established in 1960 as a professional organization for zoo practitioners.4 Since that time, it has expanded to become an international organization dedicated to applying the
principles of comparative veterinary medicine to zoo and wildlife species. One of the organization’s major objectives is to advance programs for preventive medicine, husbandry, and scientific research for captive and free-ranging wild animals. Its constituents work in clinical zoo medical practice, diagnostic laboratories, reproductive and pathologic laboratories, pharmaceutical companies, governmental health agencies, and wildlife management agencies. The mission of AAZV is to improve the health care and promote the conservation of both captive and free-ranging wildlife species. Over the years, the AAZV has undergone major evolution and in 2002 a strategic planning workshop was conducted to chart a path for the AAZV of the future. A dominant theme from this workshop was the increasing importance of conservation and field participation by AAZV members.

There are distinct differences in the membership roster of the two groups, with most AAZV members being based in zoos and aquaria and most AAWV members being based in government agencies and/or academic institutions. Traditionally, the members of AAWV are experienced in addressing disease issues in free-ranging populations. They are closely integrated with biologists and resource managers in determining how to address disease issues in wildlife. AAWV members work with disease issues in threatened and endangered species, but also in non-native pests and in game species that are routinely harvested. AAZV members traditionally work with disease issues on an individual or small population basis, with particular attention to free-ranging populations of threatened and endangered species. However, as AAZV members have become more active participants in the conservation of free-ranging populations, the lines between the two organizations have become more and more blurred.

Given their common goals and interests, AAWV and AAZV will continue to partner in issues of wildlife health. A recently signed memorandum of agreement solidifies the relationship through several means, including a joint “Committee on Wildlife Health and Conservation.” This committee is charged with promoting the shared goals of AAZV and AAWV regarding the health, welfare, and conservation of free-ranging wildlife and their ecosystems. Disease issues such as tuberculosis, West Nile virus, and avian influenza emphasize the current and pending need for individuals from both organizations to collaborate and cooperate. In a world that is rapidly shrinking, “wildlife veterinarians” will need to work together, whether they are based out of state agencies, zoological parks, universities, or private practices.

ACKNOWLEDGMENTS

We acknowledge the many leaders and members of the American Association of Wildlife Veterinarians and American Association of Zoo Veterinarians who created, developed, and strengthened these organizations into what they are today.

LITERATURE CITED

ADENOMYOSIS AND INTRAPARTUM UTERINE RUPTURE IN AN AFRICAN WILD DOG (Lycaon pictus)

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Abstract

A 7-yr-old African wild dog (Lycaon pictus) multiparous bitch, which previously had delivered without complication (>seven pups at a time), began parturition late on 16 November 2005. The next morning, she had delivered three live pups and lay recumbent, straining. The bitch continued to experience dystocia throughout the day and died that night.

Necropsy revealed three placental attachments in the right uterine horn and one in the left. A full-thickness rupture of the right horn at the middle placental attachment and an autolyzed fetus, lying free in the abdomen, were present. Myometrium adjacent to the rupture was subdivided into irregular pseudolobules by fibrous connective tissue tracts and rare, small endometrial glandular acini. Small islands of endometrial glands and surrounding stroma extending deep into the myometrium occurred in the left uterine horn, in some places close to the serosa (adenomyosis). Death was attributed to hypovolemic and endotoxemic shock after intra-partum uterine rupture.

Uterine rupture has been reported in domestic canids²,⁴ and is precipitated by events like periparturient trauma, uterine wall alterations, uterine torsion, or inappropriate manual or chemical treatment.⁵ In this case, the small litter may have resulted in abnormally large and unevenly distributed pups,²,³ facilitating birth canal obstruction, increased uterine contractions and uterine rupture.² Adenomyosis of the uterine wall may have provided less resistance to contractions. The cause of adenomyosis is unknown although prolonged estrogen stimulation is postulated.¹ To our knowledge, this is the first report of both adenomyosis and uterine rupture in a wild canid.

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LITERATURE CITED

URINARY TRACT PATHOLOGY AND HEMATURIA IN GRANT’S GAZELLE (Gazella granti)

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Abstract

Two adult female Grant’s gazelle’s (Gazella granti) were evaluated for chronic gross hematuria at two separate zoological institutions. In Case 1, urine obtained by urethral catheterization was positive for Bacillus sp. The gazelle was treated with antimicrobials based on culture and sensitivity however hematuria persisted after repeat urine cultures yielded no microorganisms. Paired serial blood samples were negative for antibodies to common Leptospira interrogans serovars. Cystoscopy determined the source of hematuria to originate from both ureters. Bilateral renal biopsies showed only minimal nonspecific changes. The cause of hematuria in this case was presumptive idiopathic renal hematuria. In Case 2, urine could not be obtained prior to initiation of antimicrobial treatment. Biopsies from bladder showed minimal change. Bilateral renal biopsy revealed mesangioproliferative glomerulonephritis. Both gazelles exhibited sub-mandibular edema and hypoproteinemia concurrent with the episodes of hematuria. There was no known exposure to other causes of hematuria in ruminants including bracken fern (Pteridium aquilinum).1,2

Since these two initial cases, gross hematuria has been noted as a frequent clinical finding in Grant’s gazelles at one of the institutions. This finding and relative frequency of renal pathology within the herd prompted a retrospective evaluation of urinary tract disease in the captive population. Four additional cases involving confirmed urinary tract disease were identified between the previous two institutions. Pathology included chronic glomerulonephritis, bilateral renal amyloidosis, renal tubular necrosis and tubulointerstitial nephritis, chronic urocystitis, and urinary bladder rupture secondary to obstructive blood clots. An additional case of severe chronic hematuria associated with a unilateral renal infarct was identified from a third institution (Miller, personal communication).

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LITERATURE CITED

DISSEMINATED HISTOPLASMOSIS IN TWO MARAS (Dolichotis patagonum) AND A WALLABY (Macropus rufogriseus) IN CAPTIVITY

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Abstract

Histoplasmosis is a worldwide distributed disease but is more frequent in tropical and subtropical climates.3 In Europe, it has been described in wild badgers (Meles meles).6 The dimorphic fungus Histoplasma capsulatum var. capsulatum has a virulent yeast-phase that is found in the tissues of infected mammals. Infection is acquired from the environment usually by inhalation of infective mycelial-phase.3 This study describes an outbreak of histoplasmosis in maras at Africam Safari (Puebla, México) and an isolated case in a wallaby at Aqualeón (Tarragona, Spain).

A young adult captive-born male mara was presented for necropsy with a history of weight loss. Eight months before its death, another mara died with disseminated histoplasmosis (Rosas-Rosas et al., 2004).3 At necropsy of the second mara, there was marked thickening of the colonic and cecal mucosa with watery intestinal contents. A 3-yr-old, captive-born male wallaby (Macropus rufogriseus) housed at a zoo in northeastern Spain had at necropsy whitish areas throughout the liver with increased consistency.

In both cases, foci of granulomatous inflammation involved mainly the intestine, liver, lymph nodes, and adrenals. Abundant 2-4 µm in diameter, PAS- and GMS-positive yeast-like organisms were observed in the cytoplasm of macrophages and adrenocortical cells. These organisms stained positive for Histoplasma capsulatum antigen by immunohistochemistry. H. capsulatum var. capsulatum was isolated from the mara and by PCR was determined to be closely related to an isolate obtained from a mara dying previously of histoplasmosis at the same colony. PCR was also positive for H. capsulatum in the wallaby. Mice inoculated with homogenates of soil samples from the mara facility seroconverted to H. capsulatum. Intradermal histoplasmin and candidin testing was negative for all maras in the colony.
Histoplasmosis is uncommon in any species and can occur in immunocompromised and immunocompetent humans; however it has been described in a variety of domestic and wild mammals. There is also one report of an epizootic in a zoo in the USA, and it was also diagnosed in a colony of wallabies infected with a retrovirus. The immunologic status of the affected maras and wallaby is unknown, but there is evidence of stress-induced immunosuppression in the mara colony, and there was an ongoing outbreak of a variety of infectious diseases at the wallaby colony.

Although most pathologic findings are characteristic of histoplasmosis in other species, there were no pulmonary inflammation in any case.

**LITERATURE CITED**

PERINEAL PAPILLOMATOSIS IN A COLONY OF RED RUFFED LEMURS

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Abstract

Papillomas in primates are similar to those occurring in other species and occur on any surface covered by stratified squamous epithelium. They may be solitary or multicentric, have potential for spontaneous regression, and occasionally can transform to squamous cell carcinoma. Many primate papillomas have been associated with various papillomaviruses. There is a single tumor study that lists a papilloma occurring in the skin of a ring-tailed lemur (Lemur catta), although the site of the lesion was not specified. This appears to be the first report of this condition in red roughed lemurs (Varecia variegata rubra).

A breeding pair of red-ruffed lemurs has produced three litters in 2002, 2003 and 2005. Offspring in 2002 were stillborn. The 0.2 offspring in 2003 were examined at 5 mo of age and both were found to have perineal lesions diagnosed histologically as papillomas, likely of viral etiology. A parent-reared, female born to these parents in 2005 was diagnosed with identical perineal papillomas at 8 mo of age and again at 10 mo of age. Lesions were examined during a regular scheduled preventive medicine examination and found to be isolated to the skin surrounding the perineum. Lesions were multifocal, round, raised, flat areas of pale discoloration of variable size. Lesions were not found on a male sibling. Routine hematology, rectal culture for enteric pathogen screen, thyroid panel, and intra-dermal tuberculin testing results were unremarkable. Lesions regressed to total resolution by 11 mo of age. Treatment has been non-specific with broad-spectrum antibiotic use and oral anti-inflammatory ointments to minimize any discomfort. Adult animals of this social group have not been found to exhibit skin lesions during routine physical examinations.

Histologically the papillomas were comprised of discreet foci of well differentiated but hyperplastic stratified squamous epithelium with a prominent granular layer supported by inflamed fibrovascular stroma and a mixed perivascular inflammatory cell infiltrate in the underlying dermis. Intracellular edema was prominent in epithelium of the granular layer, with occasional balloon degeneration and superficial erosion or crusts. No intracytoplasmic or intranuclear inclusions were seen. A viral etiology and possible familial disposition is suspected for this condition, and electron microscopic, immunohistochemical and molecular studies are in progress at the time of this writing.
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LITERATURE CITED

DESCRIPTIVE STATISTICS OF CAPTIVE GIRAFFE (Giraffa camelopardalis) MORTALITY IN AMERICAN ZOO AND AQUARIUM (AZA)-ACCREDITED FACILITIES FROM 1988 - 2005

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Abstract

A survey was conducted to identify primary causes of mortality in the captive giraffe population held at American Zoo and Aquarium Association (AZA)-accredited facilities in the United States. Data on management practices, reproductive and behavioral information, as well as clinical histories and necropsy results were submitted from 44 facilities that house giraffe. According to studbook data, there were 670 reported mortalities in the indicated time period; 210 (31%) of these giraffe were represented in the surveys collected. The surveys were divided into three groups for analysis: neonates (giraffes less than 4 mo of age), sub-adults/juveniles (4 mo to 3 yr), and adults (3 yr and older). Preliminary results indicate that primary mortality concerns for neonates include infections, non-specific failure to thrive, trauma, and stillbirths of undetermined cause. Mortality of sub-adults was often associated with trauma or nutritional deficiencies. Adult mortalities were often associated with lameness connected to arthritis or chronic hoof problems, or wasting. A striking finding across all age categories is the number of animals that had no histories of clinical disease signs and that were found either acutely dead or in lateral recumbency with death following. Statistical analysis is ongoing but illustrates that a controlled investigation of the captive giraffe population is warranted to better identify risk factors associated with specific causes of mortality.

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PATHOLOGIC FINDINGS IN NEW WORLD CAMELIDS IN SWITZERLAND, WITH EMPHASIS ON DICROCOELIOSIS AND MYCOBACTERIOSIS

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Abstract

There is a long tradition of keeping New World camelids in zoological gardens. Llamas and alpacas have gained much popularity among private holders during the last 10 yr, mostly as companion animals or as trekking or breeding animals. Accordingly, knowledge concerning diseases in these species has increased and revealed that the spectrum of diseases differs significantly from those in domestic animals. Direct access and close contact to the animals often occur in zoos and under private ownership, especially with children. Therefore the recognition of diseases, particularly potential zoonoses, represents a critical issue.

During the past 5 yr, about 130 llamas and alpacas have been necropsied in our institution. Among the neonatal crias (<1 mo of age), the main causes of mortality correlate with the literature\cite{1,2} and include low body weight and “poor doers,” lack of milk intake and failure of passive immunoglobulin transfer, postpartum infectious diseases (rotavirus, Streptococcus sp., Enterobacter sp.) and malformations. The exact cause of the “poor doers” is mostly not known, but prematurity and “intrauterine growth retardation” (IUGR), as defined by Adams,\cite{1} have to be considered. Based on our experience, dicrocoeliosis in the cow should be considered as possible cause of abortion and IUGR secondary to suboptimal uterine environment.

In juveniles and adults, the most important problems are related to parasite infestation, including liver flukes, gastro-intestinal nematodes, and coccidia. Other significant causes of mortality are mostly comparable with the standard literature on new world camelids\cite{2,3,7,8} and include dental problems, infectious diseases (especially Listeria monocytogenes and Mycobacterium microti), tumors (lymphosarcoma, C1-squamous cell carcinoma, hemangiosarcoma), obstructive urolithiasis in males, and intoxications (moldy hay, toxic mushrooms, oak bud).

In contrast to the common liver fluke Fasciola hepatica, which is found throughout tropical and temperate regions in the world and has commonly been described in NWC, there are only very rare reports concerning infestation with the lancet fluke Dicrocoelium dendriticum\cite{2,6,7}. It is however a common problem in NWC in Central Europe.\cite{4,9} Based on our necropsy material, the lancet fluke has a prevalence of about 40%, and is diagnosed as cause of mortality in >25% of NWC older than 6 mo. The parasite is present in pastures that provide adequate conditions (calcareous or alkaline soils) for the survival and development of terrestrial snails and ants, is distributed throughout much of Europe and Asia, and is also found in parts of North America (NE regions) and Australia. This parasite lives in the bile duct and gall bladder of mammal species, mainly ruminants, and its biologic cycle requires two intermediate hosts (a terrestrial
snail and an ant). In the end host, the young flukes migrate directly up the biliary duct system of the liver, without penetration of the gut wall, liver capsule, and liver parenchyma in contrast to fascioliasis. Diagnosis and treatment still remains a difficult issue. Clinical diagnosis of dicrocoeliosis is often challenging as symptoms are unspecific and usually associated with very rapid decline in general condition or sudden death. When reported, clinical signs last only hours to few days duration and include decreased appetite, recumbency, dyspnoe, cardiac arrhythmia, and/or abortion. Blood analysis may indicate increased liver values, hypoproteinemia, and/or anemia, however these changes are often not evident and therefore of little diagnostic value. Parasite eggs are passed irregularly in batches into the feces and therefore clinical diagnosis of dicrocoeliosis requires repeated coprologic examinations. Good therapeutic results have been obtained upon oral treatment with a single dose of Praziquantel at 50 mg/kg BW. At necropsy the animals are usually in a good body condition. Severe pulmonary edema and sero-fibrinous exudations in the body cavities (thorax, pericardium and/or abdomen) are consistent, striking changes. The liver is severely enlarged (up to four times the normal weight), with increased consistency and a mottled appearance emphasizing the lobular pattern, and variable numbers of parasites gush out of the biliary ducts on the cut surface. Histologically, the major changes consist of portal bridging fibrosis associated with bile duct proliferation and variable inflammatory infiltrates. Occasionally focal abscesses or granulomas can form around degenerated parasites or eggs. In the lungs, beside severe congestion and alveolar and interstitial edema, a vasculopathy is commonly observed in the middle and small arteries, characterized by endothelial thickening and presence of edema and/or fibrin within or surrounding the vessel wall, accompanied by a variable number of inflammatory cells. Exudative changes are not typical findings in domestic ruminants with dicrocoeliosis, but these severe exudations in the body cavities and lungs found in NWC correlate with the acute symptoms and sudden death. It is however unclear how the permeability problems arise and how they relate to the liver problems. Although the pathogenesis of the pulmonary vascular lesions is unclear, these changes might provide a clue to the exudative mechanism. 

Over the last 5 yr mycobacteriosis, caused by *Mycobacterium microti*, was diagnosed in our institute in five llamas and one alpaca from three different owners. Three llamas and the alpaca had been imported from South-America several years previously, whereas the remaining two llamas were offspring from imported, unaffected animals. Clinical signs lasted from several weeks to several months and were non-unspecific, including appetite- and weight loss, recumbency, increased respiratory and cardiac frequency, cardiac arrhythmia, and/or abortion. Concerning the clinical pathologic investigations, the only consistent clinical pathology changes were hypoproteinemia with hypoalbuminemia, increased blood urea nitrogen, and decreased hemoglobin, whereas other chemical and hematologic values showed inconsistent deviations from normal values. Antemortem intradermal tuberculin testing was performed on three llamas several months prior to death and was negative. At the time of death or euthanasia the body condition varied from good to cachectic and necropsy revealed in all cases caseous nodules (1 to 10 cm in diameter) in various organs, including lungs, liver, spleen, mediastinal and mesenterial lymph nodes, and serosal surfaces, in all cases. On the cut section, the nodules were yellowish and firm, and sometimes showed an onion skin-like structure and mineralized centre. On histology, the caseous nodules presented as granulomas composed of large numbers of closely packed, epithelioid macrophages and multinucleated giant cells, admixed with various numbers
of lymphocytes, plasma cells, and neutrophils. Ziehl-Neelsen and Fite-Faraco staining revealed in three cases abundant acid-fast bacilli (AFB) within the macrophages in three cases, whereas in the other three cases AFB were extremely rarely seen. The AFB were identified by spoligotyping as *Mycobacterium microti*, vole type.\(^5\) *M. microti* belongs to the *M. tuberculosis* complex whose members (*M. tuberculosis*, *M. bovis*, *M. bovis* BCG vaccine strain, *M. africanum*, *M. canetti* and *M. microti*) share an identical 16S rRNA gene and show >90% relatedness (85 to 89% relatedness for *M. microti*) at the DNA level. The natural hosts and reservoirs of *M. microti* are small rodents such as field voles (*Microtus agrestis*), wood mice (*Apodemus sylvaticus*) and shrews (*Sorex araneus*). Sporadic cases of *M. microti* infections were previously reported in Europe in cats, pigs, a ferret, a cow, a badger, and a captive vicuña. *M. microti* has to be considered as a potential zoonotic agent, since it has been detected in pulmonary tuberculosis in humans in several European countries, affecting immunocompromised as well as immunocompetent patients. Investigations regarding clinical serologic diagnosis of mycobacteriosis using a multi-antigen print immunoassay (MAPIA) are in progress in the groups of llamas from which the affected cases originated.

**LITERATURE CITED**

A RETROSPECTIVE STUDY OF MORBIDITY AND MORTALITY IN PUDU (Pudu puda) AT THE BRONX ZOO: 1983-2005

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Abstract

The southern pudu (Pudu puda) is the smallest species of deer. Two reports of a novel poxvirus infection in pudu have been published, one of which included secondary fungal infection.1,2 Several fungal-related deaths in neonatal pudu at the Bronx Zoo prompted the review of all pudu health records. The medical records of 64 pudu were examined from 1983-2005: 40 animals were included in this study (18 males, 22 females) and 24 animals were excluded (1 stillborn, 1 aborted fetus, and 22 animals shipped to other institutions). Of the 40 animals, 36 had died and 4 adults (1 male, 3 females) comprised the present Bronx Zoo collection. Clinical syndromes found in neonatal and juvenile pudu were failure of passive antibody transfer (32%), dermatopathy (23%), gastrointestinal disease (14%), ocular conditions (14%), respiratory infections (9%), dental and oral conditions (4%), and trauma (4%). In adult pudu, primary problems included dermatopathy (24%), gastrointestinal disease (12%), musculoskeletal conditions (12%), respiratory disease (9%), dental and oral lesions (7%), renal disease (7%), and trauma (7%). Other less common problems totaled 22%. Necropsy reports of 36 pudu, consisting of 12 neonates (6 males, 6 females), 2 juveniles (1 male, 1 female) and 22 adults (10 males, 12 females) were reviewed. Neonatal and juvenile mortalities were caused by infection (50%), failure to nurse (14%), metabolic conditions (14%), trauma (14%), and unknown (8%). Causes of death for adult pudu included infection (50%), metabolic conditions (22%), degenerative disease (9%), unknown (9%), neoplasia (5%), and trauma (5%).

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LITERATURE CITED


*Morbillivirus* INFECTIONS IN SAKI MONKEYS AND PYGMY MARMOSETS AT A ZOOLOGICAL PARK

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Abstract

Various species of primates are susceptible to natural and experimental infection with the *Morbillivirus* that causes measles. A *Morbillivirus* antigenically similar to the measles virus can cause enteritis in marmosets. A commercial canine distemper-measles vaccine has been tested as efficacious in macques. This report describes two separate episodes of *Morbillivirus* infection and associated disease occurring in a zoological collection of white faced saki monkeys (*Pithecia pithecia*) and pygmy marmosets (*Callithrix pygmaea*), and a possible link to administration of a modified live measles-distemper vaccine.

Four adult female pygmy marmosets were received into quarantine, at which time they were vaccinated for rabies and tetanus, and tested for tuberculosis. All had negative tuberculin responses at 72 hr. None were given measles vaccine during quarantine. Six weeks later, one marmoset was noted to be lethargic, with a swollen face and inflamed oral membranes. Supportive care was administered, but this animal became recumbent and obtunded, and was euthanatized. Canine distemper/measles vaccine and tetanus boosters were administered to the remaining marmosets. Two weeks later a second marmoset became lethargic and developed facial edema and inflamed oral membranes. Supportive care was initiated, but this animal was euthanatized due to disease progression and poor prognosis.

All three saki monkeys were adults. All received tuberculin testing, rabies vaccination and distemper/measles vaccination. Two had previously received rabies vaccinations without adverse effect. None had ever received measles vaccines. All had negative tuberculin responses. All three presented 14 days after vaccination for acute onset of lethargy, inappetence, dehydration, and weakness. In addition, two of the three were noted to be icteric. All three had elevated AST, ALT, bilirubin (direct and indirect) and GGT levels at this time. All received supportive care but two died. Necropsy revealed icterus, mediastinal hemorrhage, reddened tracheal mucosa, dark purple distal lung fields, and slightly enlarged abdominal lymph nodes.

Histologically, necrosis and moderate to severe mixed cell inflammation were seen in the salivary glands, pancreas, intestine, lymph nodes, spleen, uterus, ovary, trachea, lung, oral mucous membranes, skin and brain of the marmosets and saki monkeys. Inflammation was
associated with epithelial syncytial cell formation in most tissues. Intracytoplasmic and intranuclear eosinophilic inclusions were frequent in the marmosets but rare in the sakis. Electron microscopy performed on one marmoset revealed that the intranuclear inclusions in the salivary gland consisted of dense conglomerates of electron dense material. Twisting filamentous profiles were seen in the cytoplasm of some cells, and elongate structures budded from the cytoplasmic membrane of some cells.

RNA lysates were made from formalin-fixed, paraffin-embedded tissue by Proteinase K digestion and Phenol/Chloroform extraction. Reverse transcription reaction was performed with random hexamers and PCR was performed on the cDNA with Morbillivirus consensus primers. Of the five cases, two sakis were positive for human measles, the two marmosets were positive for canine distemper and one saki was indeterminate due to negative result for RNA actin housekeeping gene control. Results of immunohistochemistry for measles were positive for the sakis and positive for canine distemper in the marmosets.

The Morbillivirus outbreak in the saki monkeys appears to be related to the administration of a modified live distemper/measles vaccine, and may represent a vaccine break. Apparently a natural canine distemper virus infection occurred in one marmoset, although the other marmoset’s disease was closely linked to vaccine administration as with the saki monkeys.

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LITERATURE CITED

MOLECULAR EPIDEMIOLOGY OF AVIAN MYCOBACTERIOSIS: IS IT REALLY A TRANSMISSIBLE DISEASE?

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Abstract

Avian mycobacteriosis generally has a low prevalence in most zoological collections, but it can have devastating consequences for collection and conservation program management. The management consequences are based on the assumption that avian mycobacterial infections are readily transmissible (directly or indirectly) from bird to bird, placing all exposed birds at high risk of eventually developing disease. Review of the literature reveals that this is only an assumption, apparently based on the long recognized potential for clustering of cases. In humans and other species, molecular epidemiologic studies have shown that Mycobacterium avium infections are environmentally acquired and are not readily transmissible.1,2 Case clusters in non-avian species are attributed to exposure to the same environmental source, rather than horizontal transmission. In this study, we test the assumption that Mycobacterium avium and Mycobacterium intracellulare infections are transmissible directly or indirectly between birds in captive settings.

We obtained 95 mycobacterial isolates from 62 birds representing 44 different species from the collections of the San Diego Zoo and San Diego Zoo's Wild Animal Park. Isolates were cultured on BACTEC liquid media and LJ and Middlebrook agar. The initial identification of culture isolates was made with chemiluminescent cDNA probes specific for M. avium and M. intracellulare (Accuprobe, GenProbe, San Diego, CA 92121 USA) and confirmed with biochemical tests. DNA was extracted from each isolate and the species identity of each isolate was confirmed by using a multiplex PCR that amplifies a region of the 16S rRNA gene specific to all members of the Mycobacterium genus and regions of the 16SrRNA gene that distinguish M. avium from M. intracellulare.3,4 Eighty isolates were confirmed to be M. avium and 15 were confirmed to be M. intracellulare. Monoclonality of isolates was confirmed by PCR amplification of the 16S-23S rRNA internal transcribed spacer (ITS) region of Mycobacterium avium complex,5 and analysis of the ITS region by denaturing gradient gel electrophoresis (DGGE). Molecular strain typing was performed by two methods on each isolate: randomly amplified polymorphic DNA (RAPD),6 and amplified fragment length polymorphism (AFLP; using AFLP Microbial Fingerprinting Kit from Applied Biosystems, Foster City, CA 94404
USA). Band patterns obtained by agarose gel electrophoresis (RAPD) and automated capillary gel electrophoresis (AFLP) were compared and analyzed using GelCompar II software (version 4.5, Applied Maths, Kortrijk, Belgium).

Analysis of the band patterns revealed differences sufficient to suggest that *Mycobacterium avium* and *Mycobacterium intracellulare* infections in birds are primarily randomly acquired from the environment, as in other species. If direct or indirect bird-to-bird transmission does occur, it appears to be rare. Case clusters likely represent exposure to a common environmental source harboring many molecular strain types. This has very significant implications for management, indicating that *M. avium* and *M. intracellulare* infections can be managed conservatively, as other environmentally acquired infections are.

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LITERATURE CITED

SEROSURVEY AND RISK ANALYSIS FOR DISTEMPER VIRUS OF THE CAPTIVE PHOCID POPULATION IN THE UNITED STATES

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Abstract

Antibodies to distemper virus have been documented in free-ranging pinnipeds throughout the Atlantic and Arctic Ocean populations, but never documented in the Pacific Ocean populations. Risks for spreading this *Morbillivirus* through the captive North American phocid population to the Pacific coast have been a concern. To date, the serologic status of this dynamic captive population is undocumented. From 25 North America zoos and aquaria, serum was submitted from gray seals (*Halichoerus grypus*, n=7) and harbor seals (*Phoca vitulina*, n=96) and assayed for distemper virus via serum neutralization. Historic and environmental risk factors associated with the acquisition and distribution of distemper virus were analyzed by survey. Fourteen seals (gray n=1, harbor n=13) were documented with seropositive titers (≥1:24) indicative of exposure to distemper virus. These seals were distributed across the continent, including the Pacific coast, signaling an as yet undocumented risk to the Pacific pinniped population.
THE VETERINARY HEALTH MANAGEMENT OF THE LIFE CYCLE STAGES OF THE JAPANESE MEDAKA (Oryzias latipes)

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Abstract

For more than 3 yr, a colony of 1200 adults and hatchlings of Japanese medaka, Oryzias latipes, were maintained under optimal conditions. The water pH was 6.8 ± 1.2. The optimal temperature for each tank was maintained at 21 ± 6°C. A specific chemical-free environment was maintained by using filtered water. A light to dark cycle of 12 hr:12 hr, each day was maintained. The fry were maintained on brine shrimp. The sub-adults and adults were fed Tetramin® flakes (www.AquariumGuys.com) three times per day and brine shrimp once per day every other day. A four-panel water-chemistry profile was conducted once per week to monitor the aquarium concentrations of ammonia, nitrites, nitrates, and pH. Fertilized eggs were collected from mature females during the breeding season and incubated in filtered water containing methyl blue, which was used as a fungistatic and bacteriostatic agent. The eggs were allowed to hatch and fries transferred to a nursing aquarium for growth to adults. The developing embryos, larvae and adults were used in the treatment groups, background control groups and concurrent control groups for chronic carcinogenicity and developmental toxicology studies. Terminally ill fish were euthanatized with tetracaine (MS 222) and examined by necropsy with the aid of a dissecting microscope prior to fixing in phosphate buffered saline. Slides for microscopic examination of the tissues were prepared and stained for examination using routine histologic techniques. A mathematic model of the egg production during the 3-yr period was polynomial.

ACKNOWLEDGMENTS

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LITERATURE CITED

ELASMOBRANCH BLOOD SAMPLING: SOME TECHNIQUES AND TRENDS

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Abstract

Hematology and plasma biochemistry parameters are increasingly used for health assessment of elasmobranch species, both in clinical cases and preventive medicine.

Commonly used venipuncture sites in elasmobranchs include the ventral tail vein (or caudal vein), which can be approached laterally or ventrally in most animals under 90 kg, and the posterior cardinal veins, which can be accessed just caudolateral to either dorsal fin. In all elasmobranchs, the samples can be placed into dry heparin. In sharks, dry EDTA may be used, but dry or wet EDTA should not be used in batoids due to rapid hemolysis.

Several blood smears should always be made immediately and air-dried. If the blood is collected in heparin, the hematology must be processed immediately due to thrombocyte aggregation. Due to limited stability of the leukocytes in EDTA, blood collected in EDTA should be processed within 5 hr if refrigerated. Capillary tubes should be centrifuged for more than 5 min at 11,000 g for PCV measurements. Red blood cell counts appear more variable. Natt-Herrick is the preferred technique for total RBC and WBC counts, and is described, along with WBC differentials, elsewhere. It should be noted that nomenclature of some cell morphologies remains confusing, particularly granulocytes, and the clinical significance of the cell types has not been fully elucidated. Hematology results will vary depending on sample handling, technologist, taxonomy, age, environmental parameters including time of year, and pathology, so it remains useful to have baseline values for individual collection animals.

The plasma should be refrigerated, or frozen if analysis is delayed beyond 24 hr. Due to their osmoregulatory mechanisms, elasmobranchs have a plasma osmolality of 800-1100 mOsm/kg, made up primarily of urea, trimethylamine oxides, sodium, and chloride. This will cause an increase in total solids as read by a refractometer when compared to colorimetric assays. Plasma samples will need to be diluted 1:10 for measurement of urea nitrogen and 1:2 for sodium and chloride. It may be useful to run blood gases and lactate levels in elasmobranchs.

At the National Aquarium in Baltimore, blood results have been closely tracked in sand tiger sharks (Carcharias taurus), sandbar sharks (Carcharhinus plumbeus), common nurse sharks (Ginglymostoma cirratum), southern stingrays (Dasyatis americana), and roughtail stingrays (Dasyatis centroura). Although some baseline values are available in the literature, it remains more useful to monitor and track blood results of collection animals in-house, and this is becoming increasingly common in many facilities.
LITERATURE CITED

PATHOLOGY OF CAPTIVE CHAMBERED NAUTILUS (Nautilus pompilius)

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Abstract

The chambered nautilus (Nautilus pompilius), a cephalopod species from the deep water of the Indo-pacific areas,1 is not uncommon in North American aquariums and zoos. Little is known about viral and bacterial diseases of nautilus. The black shell syndrome is the most common problem in captivity7 and has an unknown and probably multifactorial etiology. A retrospective study of 55 chambered nautili (37 males, 16 females, and two of unknown sex) that died at National Zoological Park was performed. The captive life span was short, less than 4 yr, and weight ranged from 244.7-782.6 g for males and 230.2-590 g for females. The most common gross findings were black shell syndrome in 37/55, 10/55 with digestive gland adenitis, 9/55 with cloudy coelomic fluid, 3/55 with esophageal dilation, 3/55 with ingestion of a foreign body and 2/55 with head deformation. Culture of fluids or tissues were processed in 58% (32/55) of the animals. Vibrio spp. was the most common organism identified (13/32), similar to findings in cuttlefish6 and marine fishes.2-4,8 Species included V. alginolyticus (5/13) and V. vulnificus (2/13). Vibrio has been associated with necrotizing inflammation in fishes,2-4,8 lobster,2 and cuttlefishes.6 V. alginolyticus is also a significant pathogen in marine crustaceans.2 Several other bacterial genera, mostly gram-negative organisms, also were isolated. Multisystemic hemocytic inflammation was seen in 44/55 animals. The gills, heart, intestine, renal appendage, digestive gland, and integument were the most commonly affected organs and organ system. Renal mineralization was observed in 20 nautili (36.3%), of which 19 cases were associated with sepsis. Protozoa were the most common parasites (4/6) and were associated with digestive gland adenitis. The renal mineralization observed in 36.3% of the cases could be a consequence of sepsis, could predispose to sepsis, and/or could be related to water quality or nutrition. The nautilus immune system can be compromised by poor water quality, overcrowding, and/or increased bacterial load on the aquatic system.5 Further studies should be done to determine the cause of renal mineralization and identify the parasites of these nautili.

LITERATURE CITED

A NEW(ER) METHOD FOR FISH PHLEBOTOMY

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Abstract

Piscean medicine has rapidly progressed with the advent of improved techniques in aquaculture. This has extended to the veterinary field, where veterinarians play a critical role in preventive health care. The current and most popular techniques for fish phlebotomy are aspiration of the coccygeal vein or the heart. The tail is approached from a 45° angle just ventral and parallel to the lateral line and the needle is advanced to the ventral midline under, or between the scales. The heart is approached from the ventral aspect of the fish. The needle is advanced just caudal to the posterior margin of the bony opercular cavity. Advantages include accessibility in a consistent approach and minimal side effects. Disadvantages with these traditional approaches include lack of visualization or palpation of the vessel or heart, lack of multiple access sites for additional attempts, some difficulty in penetrating the thick, mostly scaled integument, mixing of arterial and venous blood, and the potential for thrombosis, infection, and hemorrhage.

In the approach presented here, the afferent and efferent vessels of the branchial arch in teleost fish was used to evaluate the ease of sampling and quality of the CBC and select sera chemistries. Twenty fish of five species were sampled in the current study, including Largemouth bass (Micropterus salmoides), bluegill (Lepomis cyanellus), white crappie (Pomoxis annularis), green sunfish (Lepomis macrochirus) and sauger (Sauger canadense). Fish were manually restrained after being netted from display tanks. Fish were held in lateral recumbency with dampened vinyl gloves on a dampened plastic liner. The operculum of either the right or left side of the head was abducted and a preheparinized (Heparin, Baxter Healthcare, Deerfield, Illinois 60015 USA) insulin or tuberculin syringe with a 28 or 25 gauge needle was advanced in a plane parallel to the base of the gill arch. Blood was aspirated and immediately placed into lithium heparinized microtainers (Becton Dickenson, Franklin Lakes, New Jersey 07417 USA) for complete blood counts and select sera chemistries. Gentle pressure at the phlebotomy site assisted hemostasis. In three fish, simultaneous samples were obtained from the coccygeal vessel and branchial vessels of the gill arch. Weights of nine fish ranged from 48 g to 200 g, and up to 2 cc of whole blood was obtained from each fish without any observed untoward effects. Once sampled, fish were returned to a holding tank and consistently observed for 15-30 min, then occasionally over the following 7 days. No hemorrhage or other clinical effects were noted in any fish sampled. Opercular movements were symmetric and hydrodynamics, behavioral grouping, and structure selection were unaltered in the captive fish sampled.

Advantages of the branchial arch vessel technique are ease of access, visualization of the vessels, multiple access sites and apparent lack of side effects, though fish were not physically re-examined. Disadvantages are the potential interference with osmotic regulation, oxygenation,
mixing of arterial and venous blood, infection, hematoma or hemorrhage, though none of the latter were observed. Use of preheparinized syringes has the potential for hemodilution and cellular morphology alterations with any of the above techniques, but was elected in these cases to mediate the efficient clotting ability of fish.

This technique may provide the clinical veterinarian, technician, or aquarist additional sites for fish phlebotomy. A larger study to compare and contrast the CBC and select sera chemistries of simultaneous samples from the coccygeal and branchial vessels is underway and involves keeper level staff fishing from two ponds on zoo grounds. This technique is also being evaluated as a means of humane euthanasia for ill fish. Ease of sampling, multiple site access, and lack of apparent complications may provide the clinician with an easier method to obtain blood samples in fish.

ACKNOWLEDGMENTS

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LITERATURE CITED

SEA TURTLE CONSERVATION IN GEORGIA AND AN OVERVIEW OF THE GEORGIA SEA TURTLE CENTER ON JEKYLL ISLAND, GEORGIA

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Abstract

Along the coast of Georgia, a cluster of eight barrier islands, are separated from the mainland by an extensive system of salt marshes and sounds. Unlike other barrier islands of the east coast, Georgia’s remain relatively undeveloped and retain much of their native wilderness.

All seven species of sea turtles are listed as federally threatened or endangered under the Endangered Species Act (ESA). The primary causes of the marked decline of sea turtle populations worldwide include loss of nesting beaches to human development; excessive harvesting of sea turtles and eggs; injury or death of turtles entangled or ingesting marine debris; and incidental capture and drowning during commercial fisheries activities. Additionally, infectious disease such as fibropapillomatosis (FP) and pollution are also having a negative affect on sea turtle populations.

Five species of sea turtles can be found in Georgia’s coastal waters; however, the loggerhead (Caretta caretta) is the only one to nest in significant numbers with approximately 1,000 nests found annually. The green (Chelonian mydas) and leatherback (Dermochelys coriacea) sea turtles occasionally nest in Georgia and use the coastal waters as a foraging habitat and migratory pathway. Kemp’s Ridley sea turtles (Lepidochelys kempi) migrate through and forage in Georgia waters as sub-adults. During the summer of 2005, the first Kemp’s Ridley nest in Georgia was found on Wassaw Island (Georgia Sea Turtle Stranding and Salvage Network (GSTSSN), 2005), which is unusual because this species typically nests in large numbers (e.g., arribada) at Rancho Nuevo, Mexico. The hawksbill sea turtle (Eretmochelys imbricata), exploited for its beautiful shell in other parts of the world, is found only occasionally in Georgia waters.

Major threats to survival of Georgia’s sea turtles are numerous, including both biotic and abiotic nesting threats (rain, tidal wash over, rising sea level, predation), boat collisions, and interactions with various fisheries related activities especially trawling fisheries. All US shrimp trawlers are now required to be equipped with Turtle Excluder Devices (TEDs), which allow captured turtles an escape route. As human populations increase along the Georgia coastline, additional threats of marine pollution, light pollution, and collisions with boats have increased. Stranded sea turtles are often found on the coastal areas of Georgia, most of which are dead and a small percentage still alive. From 1995 to 2004, the average annual number of stranded sea turtles in Georgia was 238 (GSTSSN, 2005). Over the past decade, there has been a steady increase of stranded live turtles along the southeastern Atlantic coastline (Pers. comm., W. Teas, 2004). Currently, Georgia’s stranded live sea turtles are evaluated and provided emergency care by the author and
Georgia Department of Natural Resources (GADNR) wildlife biologists. Since there are no facilities in Georgia in which to rehabilitate the turtles after the initial evaluation, they must be transported long distances to reach a suitable facility, with the closest being located in Charleston, SC and near Daytona, FL. On occasion, these facilities are filled to capacity and the turtles have to be prematurely released or housed in sub-optimal conditions.

The Georgia Sea Turtle Center (GSTC) will eliminate long distance travel to and from these facilities. Rehabilitation should be part of the overall sea turtle conservation program because the most common age class of turtles to present for rehabilitation consists of older sub-adult and mature adult turtles. These are the most valuable members of the population, because they are either close to or are currently capable of reproducing. Several components of the natural history of the sea turtle emphasize the importance of the older age classes to the population: (a) sea turtles are long-lived animals, potentially surpassing human life spans; (b) the loggerhead sea turtle does not reach reproductive maturity until approximately 30 yr of age; and (c) it has been estimated that for every 1000 eggs laid, only one will survive to become a mature adult. An additional reason for the importance of rehabilitation in sea turtles is that most of the illnesses and injuries they encounter are either directly or indirectly caused by humans; therefore, we have an obligation to assist in their recovery. To fill the need for rehabilitation, efforts have been underway for several years to create a facility in Georgia to care for injured and ill sea turtles so that more of them reach reproductive age.

An historic power plant in the historic district on Jekyll Island will be renovated and serve as the educational component of the Georgia Sea Turtle Center. Additionally, facilities for rehabilitation and veterinary care will be added onto the existing building. The primary focus of the center will be to educate the general public regarding sea turtle biology, natural history, and conservation; to conduct health related research on free-ranging sea turtles in Georgia; and to rehabilitate injured and ill sea turtles found in Georgia and surrounding states.

For more information on the GSTC and how you can help sea turtles and the center, go to www.georgiaseaturtles.org and www.jekyllislandfoundation.org.

LITERATURE CITED

OMPHALITIS AND SEPTICEMIA IN A FLORIDA MANATEE (Trichechus manatus latirostris)

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Abstract

Perinatal death ranks among the top three categories of mortality in the Florida manatee (Trichechus manatus latirostris), and has averaged 23% of overall mortality over the last 10 yr. Similarly, young juveniles comprise a significant proportion of cases presented to manatee rehabilitation facilities. Causes of perinatal mortality vary considerably, and may include still birth, abandonment and/or separation from the mother, cold stress, brevetoxicosis, predation, and omphalitis. Most causes of manatee perinatal mortality, however, remain undetermined due to decomposition of recovered carcasses. This case report describes a 1.59m male Florida manatee that was rescued due to weakness, severe body lesions, and lethargy. On physical examination, the animal demonstrated multifocal skin abscessation and necrosis with excavation of tissue in the fluke, peduncle, and flippers. The manatee was euthanatized due to the severity of its condition and poor prognosis. Necropsy revealed extensive septicemia, with purulent material in the umbilicus, urachus, urinary bladder, kidney, pleura, flipper joints, vertebral column, and spinal cord. Numerous anaerobic bacterial species, including Fusobacterium spp., were cultured from the abscesses. Histopathology confirmed the clinical diagnosis of bacterial septicemia, with particularly devastating necrotic damage to the infected spinal cord. The root of infection in this manatee calf was believed to be located in the umbilicus. Complete evaluation of freshly dead juvenile manatees such as this case is important to better understand the causative factors and pathogenesis of disease in this significant manatee mortality category.

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TAKING CARE OF BUSINESS: ALIGNING THE ROLE AND SOUL OF THE ZOO VET

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Abstract

This presentation discusses an approach for zoo veterinarians to evaluate their careers, career development, and life choices for happiness. Zoo veterinarians are challenged to think of career development within a broader context which transcends technical competence and fulfilling the position of zoo veterinarian. This article explores the six components of this broadened definition of career development. These include self-reflection, building community, understanding personality, understanding organizational behavior dynamics, aligning the inner self with the organizational culture, and making career decisions. Each of the components are defined and illustrated, with examples of how the components are utilized in making personal choices about one’s career and calling.

Introduction

In most professions, career development is usually considered in relation to specific skills and techniques necessary to perform one’s job. This definition might include learning to perform job tasks more effectively, as well as learning new techniques. This is often too narrow to serve a zoo veterinarian throughout his or her career, as it does not take into account further developing interpersonal skills, problem solving skills, and learning to work within groups. It does not take into account the necessity of assessing one’s own self and one’s needs, against the needs of the zoo which employs the veterinarian.

This presentation challenges zoo veterinarians to step back to examine their career development from this broader perspective. Career development is a life-long process and has many stages depending upon the age, years of experience, and situation of the zoo veterinarian. It also involves more than just taking some classes or attending a seminar.

The six components of career development include:

1. Continuous self-reflection and assessment in terms of knowing one’s authentic inner self and one’s personal vision;
2. Working towards building a sense of community in one’s work;
3. Learning about one’s personality and how it influences others;
4. Assessing the dynamics of the workplace in terms of organizational behavior;
5. Alignment of inner-self with the organization’s culture;
Ultimate Goals

What is happiness? Dr. Masrua Emoto describes happiness as “being at peace with one’s self, feeling secure in one’s future, and waking up in the morning with anticipation of a new day.” This is a simple yet powerfully concrete description of happiness. If a zoo veterinarian leaves for work each morning and does not feel at peace, but instead has his or her stomach in turmoil, something is in conflict. If the zoo vet is not secure in the future, there is something operating within the work environment that is in conflict. If the zoo veterinarian wakes up and does not anticipate the start of a new day of work (more than an occasional day here or there), something is not in alignment.

Generally, when any of these three areas are in conflict, there is some type of misalignment between the role of the zoo veterinarian and the very soul of the veterinarian. Role is defined as the professional position held, and soul is defined as the very essence of the person – the authentic self that makes one unique. The soul includes the personal vision of one’s purpose and the anchor value system that is unique only to that individual. The personal anchor value system consists of those values that an individual uses to perceive and judge the way the world works.

How can this almost spiritual perspective help the zoo veterinarian to be more effective in his or her position and career in general? This presentation explores this question by addressing the six career development components of self-reflection, building a sense of community, personality, interpersonal skills and leadership, organizational dynamics, alignment of inner self and organization, and making career decisions.

Self-Reflection and Assessment

Know Thy Inner Self

The first component of career development for the zoo veterinarian is to become acquainted with his or her inner self. To do this, it is necessary to become comfortable in using reflective techniques to gain a better understanding of one’s self in terms of one’s purpose beyond being a zoo veterinarian. Only through understanding the inner self, can conscious decisions be made about how well one’s personal needs match with the organization, the job of the zoo veterinarian, the culture of the zoo, and the way the zoo does business.

Openness and honesty to one’s self examination is very critical at this stage. Many zoo veterinarians felt called to be a zoo vet when they encountered a particular field of study, experienced a first visit to the zoo, or watched a documentary on zoos. Perhaps parents encouraged their child to move toward that field as a profession. By recalling these early encounters, and how they evoked a sense of self that was only dormant in the individual at the time, the zoo veterinarian may recover the heart and motivation that made him or her enter the profession.

Questions to ask one’s self in this self-reflection include: If you had a chance to start over, would you remain a zoo vet? Why? What does your answer tell you about who you are and who
you have become? Your inner zoo veterinarian voice acts as a guard at the gate of selfhood, warding off what insults your integrity and welcoming whatever affirms it. However, do you revisit it often? Is your inner zoo vet in need of some growth, renewal, affirmation, or change? If you think of yourself as having an inner zoo vet voice, how do you try to listen to that voice? What encourages you? What hinders you?

Another area the zoo veterinarian can explore in this self-reflection deals with responding to the questions: Can you only perform that which you love, and live your anchor values in the role of a zoo veterinarian? Is there a different scenario in which you can live out this passion with the anchor values you hold dear to you? What is your vision of what it looks like when your soul and role are aligned? What would you be doing and where would you be doing this work?

Through self-reflection and getting in touch with a personal vision and the anchor values that are important and unique to one’s self, a zoo veterinarian can develop the mindset that nobody owns him or her, and the zoo veterinarian controls his or her own destiny based on what is needed for role and soul alignment. Zoo veterinarians, as well as any employee, needs to make the paradigm shift that they are self-employed in a sense – not owned by any zoo. They “sell” their skills to the zoo for either a short-term period or a longer term of employment. These skills are marketable across the globe.

Building a Sense of Community in One’s Work

In addition to becoming reflective about the inner self and how the inner self relates to one’s profession, insights are needed to assist in building a sense of community with where one works. Community is an outward, invisible grace, the flowing of personal identity and integrity into the world of relationships. Only when one is in community with one’s self, can community with others be found. This is another critical reason for “knowing one’s self.”

Questions a zoo veterinarian might ask of himself or herself include: What are the forces in your work situation that drive people toward community? What are the forces that drive people away from community? What is the balance of the forces? Is there a proper balance? How might some of the positives be amplified? How might some of the negatives be diminished?

Assessing the community one works in, is important to better understand one’s self, and to compare one’s personal vision, mission and values to the zoo community where the zoo veterinarian works. What are the purpose/mission, values, principles, and work methods of the workplace? Is the zoo moving towards a sense of empowered community where the attitude is that “we are all one team”? Or is it stuck in an outdated hierarchy of power and control, “carrot and stick” mentality? How is the zoo veterinarian contributing to that type of behavior? Is the zoo vet a contributing factor to not only his or her own unhappiness, but also to the unhappiness of others?
Personality Preferences and Their Influence on Others

A zoo veterinarian is the leader of medical animal care, but the work is often accomplished in partnership with superiors, co-workers and subordinates. Medical expertise and hierarchical position mean nothing, if others are not willing to listen and follow one’s advice and/or actions. Whether in a formal leadership position or not, the zoo veterinarian must learn the skills of inspiring others to follow in a given direction. Leading involves the ability to influence and persuade others to take one’s advice and/or direction.

In order to be effective in this role, a zoo veterinarian must have insight into how his or her personality style and interpersonal skills influence others. The zoo veterinarian must know how his or her very essence perceives the world, and how this perception impacts on interactions with others. In theory, the zoo’s culture and/or personality is formed by the combination of every person’s attitudes, beliefs, assumptions and work products. Therefore, the alignment of the zoo veterinarian’s individual personality with the zoo’s overall cultural personality can be positive or negative.

One might assume that people are so different, and there are so many personalities, that it is next to impossible to understand and predict people’s behaviors. However, Jung explained that one can understand humans through two common variables that can be very predictive of behavior. These include perception (the way people take in the world around them) and judgment (the assumptions people place on what they see occurring around them). Jung also noted that individuals tend to be energized either by external factors (extraversion) or by internal factors (introversion). By mapping various combinations of these variables, he created an analytic model of four temperaments and 16 personality “types.” The Myers Briggs Type Indicator Assessment (MBTI) is a test which provides an individual with feedback regarding his or her individual personality behavioral preferences.

It is important to note that this test provides insight into tendencies, or preferences, and is not a strict determinant of what exact actions one will take in every situation. However, one can achieve better insight into one’s self and others, by understanding the MBTI personality preferences. One is able to make better assessments of how one influences others, to make better decisions about what one needs from others, and to adjust one’s words and actions accordingly. It takes some effort to learn and understand the preferences. The best way to begin, is to take the MBTI in a seminar or with a business coach. This person will administer the test, and provide interpretation of results with detailed explanation of the preferences.

The following illustrates how an interpretation of types can be useful in the workplace. For example, a person who through the assessment is determined to be an ISTJ (Introverted Sensing with Thinking and Judging) is thorough, exacting, systematic, hardworking and careful with detail. This type of person enjoys working within organizations to improve procedures and processes, and remains loyal through both good and bad times. A person who is an ESFP (Extraverted Sensing with Feeling and Perceiving) is friendly, outgoing, fun loving, likable, and naturally drawn toward others. This person enjoys working in groups with other lively fast-paced people, offering alternatives based on common sense. When these two types come
together within an organization, some conflict can be predicted. The ISTJ prefers working within procedures and processes, possibly at the expense of the feelings of others. The ESFP may overemphasize subjective data in an effort to maintain harmony among people, and may spend too much time socializing and neglecting tasks. Somehow, these two personalities must adapt to each other, and find common ground.

One cannot control one’s personality type, or that of others. And it is important to recognize that no personality type is negative or the best. Each style has its strengths and weaknesses, if overused to the extreme. However, by understanding each type, one can be alert and adjust oneself in areas that are known to be pitfalls. The veterinarian can also recognize the preferred learning style of another type, and choose to emphasize those preferences when trying to influence that person. This “flexing” process involves meeting the preference of the other person’s style, while still meeting one’s own needs.

However, not all zoos are created equal. Even if a zoo veterinarian has the most effective people and leadership skills possible, some organizational dynamics may not coincide with the soul of that individual. That is why the skills of learning about one’s self and being willing to engage in self-reflection are critical throughout one’s career. A zoo veterinarian needs to recognize when it is no longer personally and professionally healthy to remain in a certain position.

Organizational Behavior

In addition to knowing one’s purpose, and understanding how personality relates with other personalities in the workplace, it is important to recognize and understand the three-organization dynamics of leadership self-deception, groupthink,6 and the Abilene Paradox.4 One needs to know whether they are occurring within the organization, to assess whether he or she is causing any of these dynamics, and to analyze whether they are affecting the zoo veterinarian’s work in a negative way.

Leadership Self-Deception

Leadership self-deception runs rampant in corporate America. It is a dynamic in which a leader recognizes there is a problem, but does not recognize that he or she is part of that problem, nor how he or she is part of the problem. An excellent illustration of this occurred during the 1840’s. Dr. Ignaz Semmelweiss (Reiss), a physician in a Vienna teaching hospital, found that a large percentage of his patients in a maternity ward died of infection.9 In fact, pregnant women preferred to run the risks of childbirth at home because of the mortality rate within the hospital. Dr. Semmelweiss observed that he and many of his colleagues had the highest percentages of mortality. He proposed that the doctors themselves could be part of the problem. His colleagues and the administrators were astonished that he would profess such nonsense. He was shunned and almost laughed out of his profession.

Eventually, Dr. Semmelweiss postulated that fatal infections were being spread among patients by doctors who failed to wash their hands between examinations and their work in the teaching college with cadavers. He instituted a disinfection procedure in which physicians were required
to wash in a chloride of lime solution after autopsies, and with soap and water between patient visits. Doctors also had to change into clean lab coats before examining patients. As a result, mortality rates from infectious diseases declined in the ward. However, it was not until much later that his findings were recognized as a major contribution to the medical field. He continued to be shunned by most of his colleagues for the remainder of his life. There is a great price to pay for calling on leaders or our colleagues to recognize their self-deception. Choices must be made to blow the whistle on it, ignore it and live with it, or choose to leave the situation.

Groupthink

The second group dynamic that can occur is called “groupthink.” This is when a group continues in agreement, although there is evidence to support the conclusion that they should not. They literally talk themselves into contradicting the evidence, due to fear of going against the group by bringing up conflicting facts. The most notorious example of groupthink is the disaster of the Challenger Space Shuttle on January 28, 1986. The engineering firm, Morton Thiokol, was under great pressure to approve the launch of the Challenger. NASA wanted to launch, and many politicians, the public, and NASA were impatient with the firm. There were even threats of terminating the large financial contract, and replacing them with another engineering firm.

However, there had been too many explosions and the group was concerned. Under great pressure from NASA, the group held a meeting and decided to give approval even though there was evidence that the conditions of the day were not conducive to a successful launch. The O-rings (rubber seals that joined the two sections of the rocket together) had never been tested successfully below the temperature of 53 degrees Fahrenheit. On days with temperatures below 20 degrees, the O-rings did not seal and hot gases escaped during the “burn.” However, at the engineer’s meeting the day before the launch, the decision was made to launch. Some team members kept their concerns to themselves, out of fear of losing their job and/or the contract.

What were the results of the groupthink dynamic? Seven lives were lost, the space program was set back several years within the national agenda, and the public lost confidence in NASA, which caused enormous funding cuts over many years.

Groupthink can occur in any organization where there is some type of pressure to move in a certain direction, despite strong conflicting evidence against that direction. An executive director may be under pressure from the public or Board, and may feel the need to move in a certain direction despite contradictory data. A group of keepers may avoid or ignore clear evidence, due to organizational territorial issues. Incorporating an effective problem-solving process that values data and guards against groupthink, is extremely beneficial. In order to accomplish this, it is important that all leaders to learn to use effective project team tools and techniques.

The Abilene Paradox

One final group dynamic that may coincide with groupthink, or may occur on its own, is the Abilene Paradox. This happens when one person (often the leader) within a group, asks the group about taking an action. Everyone perceives that the person suggesting the action wants to do it, so everyone agrees to it even though many do not want to do it or do not think it is a good
idea. The group believes it has reached an agreement. Later, it is discovered that the team members did not actually agree but went along with it because they thought everyone else had agreed. The art of true consensus-building is needed, in order to avoid the Abilene Paradox.

**Importance of Understanding Organizational Behavior**

It is essential that the zoo veterinarian understand groupthink, leader self-deception, and the Abilene Paradox to avoid falling into their traps, and to be able to provide leadership to avoid these traps within his or her responsibilities. First, the veterinarian must be aware that people within an organization can create some very bizarre group dynamic behaviors that are not always in the best interest of others or the organization as a whole. Second, the zoo veterinarian needs to be able to identify when these dynamics are occurring, to take positive corrective action and/or to protect himself or herself. Third, if caught unaware in the middle of these dynamics, a veterinarian may find his or her energy being dramatically drained. These are irrational behaviors, but the individual caught in them often tries, unsuccessfully, to apply logic to deal with them. This can sap energy levels which would be better used to protect oneself, to help find an outside solution, or to remove oneself from an unhealthy and unproductive situation.

**Keeping One’s Soul Alive in a Role**

Career Development as a Life-Long Process

How does one keep his or her soul alive in a career? Professionals often think that once they graduate and land that dream job, career development is complete. However, this is not true. Career development continues throughout a person’s life, and is not solely concerned with learning new skills or techniques, or finding a new job. Although these elements play a part, the key to career development is to learn about where one needs to be, to fulfill the true self.

Career issues can crop up by choice, by force, or by accident. When one begins to feel a need for change, the feeling comes from a misalignment of role and soul, from a variety of sources. One might be experiencing a significant life change – a parent or friend dies, a friend or oneself develops a serious illness – and this life change causes one to reconsider one’s anchor values more clearly.

In addition to life changes, the workplace can change dramatically. A new executive director who is not in sync with the zoo veterinarian’s values may take power. Natural disasters, animal deaths, or funding shortfalls may lead to the zoo receiving public and/or financial pressure and new tensions. Perhaps there are industry changes regarding exhibit requirements, or internal management changes in the way the zoo conducts business. External politics can intervene if the zoo receives public tax dollars. Board members may use their position as a springboard for higher-level political positions, and ensnare the highly visible position of zoo veterinarian in the middle of an internal hierarchical struggle. The zoo veterinarian’s workplace is a constant changing landscape. Keeping oneself aware of the landscape, as well as the landscape of one’s inner self, is a wise investment of time and effort.
Doing the Homework

The zoo veterinarian needs to constantly revisit the question: “How can I keep my soul alive in this role?” As a new zoo veterinarian, it is important to learn about the mission, values, principles and work methods before accepting the job. Dialogues with the executive director and other staff are helpful to develop common ground as to the zoo vet’s role and the expectations – from both personal and organizational standpoints. Role ambiguity (i.e., overlaps between various colleagues) must be clarified between all parties to ensure effective working relationships without constant conflict. If there are differences, it is essential to work through the conflicts rather than to ignore them.

A key path to solving job conflict is to insist on role clarification. This concept involves examining and clarifying the relationship(s) between the various jobs found in the zoo. Too often, written job descriptions exist, but nothing is in place to help people understand the details of those jobs, nor how to relate to one another in different positions. The zoo veterinarian’s position becomes extremely precarious if others do not clearly understand the role of the attending veterinarian in zoos under the animal welfare act. How much time has been devoted by all concerned parties, to fully explore and understand the implications of this role? How can these issues be resolved while avoiding the dynamics of “blaming” the zoo veterinarian? Have there been open honest dialogues with the executive director, senior management team, keepers, and others so that areas of conflict can be discussed and resolved? Conflict management and resolution are excellent skills to learn, and there are many seminars available on this topic. Even if the zoo veterinarian is already in the organization and is experiencing the uneasiness of potential conflict, it is not too late to begin these dialogues.

In performing these explorations and dialogues, one needs to continuously examine one’s self and one’s core values. There is a very strong relationship between personality and job-related behavior. It is important to constantly upgrade one’s understanding of oneself – how one perceives the world, and what blind sides or weaknesses one exhibits – simply due to personality type. Having self-knowledge maximizes effectiveness in working with one another. A zoo veterinarian needs to understand how and why his or her medical knowledge, degree, actions or words might be threatening to others within the zoo community. Zoo veterinarians must accomplish their work through guiding, coaching, inspiration and influence, rather than through expertise, degree, and hierarchical position.

Conclusion

A zoo veterinarian cannot be successful by simply focusing on the technical aspects of the job. First, one must broaden one’s horizons to better understand oneself through self-reflection on one’s life purpose. Second, through studying personality types, a zoo veterinarian must learn to be effective in relating to others, and to use the strengths of his or her personality traits to increase success. Third, the zoo veterinarian needs to be aware of the dynamics of self-deception, groupthink, the Abilene paradox, and other organizational behavior theories to avoid being blind-sided by their effects.
If a zoo veterinarian is unaware of how to begin some of these activities for personal career development, he or she can seek help through a colleague, a business coach, training, or mentoring from a trusted peer or superior. A business coach, life coach, or mentor functions in the space between individual and organizational values, helping individuals to align with the organization. A life guide or coach helps individuals assess if individuals are aligned with the organization’s values, and helps determine if it is in their best interest to align themselves with their organization or to leave the organization. If the decision is to leave the organization or field, a life guide or coach can help individuals explore options for transformation to another level of vocation or to a new position that enables role and soul alignment for a more fulfilled happy life and career.

A zoo veterinarian has many choices. Through reflection on a work situation, a zoo veterinarian might assess that there is a positive alignment of role and soul, and continue in a successful career. For another, an assessment might demonstrate minor misalignment, and corrective action can be taken. Some development of the tools and techniques discussed here, combined with a willingness to be a risk taker, may result in successful re-alignment and improved effectiveness. For another, the path to alignment might come at too great a personal cost for one’s own health, family’s welfare, and overall fulfillment of one’s purpose on this earth. It might be wise for that individual to part company with the current zoo, with the industry, or even with the job of a zoo or wildlife veterinarian. There is one guarantee as one steps out for this journey. A zoo veterinarian’s calling is stronger than any contract or job. If he or she has a finger on the pulse of a true calling, the perfect venue for role and soul alignment and happiness in life is waiting!

LITERATURE CITED
ZOO VET, I QUIT: VOLUNTARY DEPARTURES FROM CLINICAL ZOO MEDICINE

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Abstract

This paper provides some thoughts and observations about what factors would cause someone to voluntarily leave the “dream” job of clinical zoo veterinarian, as well as a brief discussion about some of the options that people who have left clinical zoo medicine have pursued.

Introduction

The job of a zoo veterinarian is perceived by many to be a “dream” job—glamorous, fulfilling and challenging. That the number of students interested in zoological medicine as well as the number of postgraduate training opportunities specific to the field has expanded greatly over the past 20 yr bears witness to this perception. Successfully pursuing a career in zoological medicine requires hard work, dedication and maybe a little luck. Why then, one might ask, would anyone who has a job as a zoo veterinarian want to leave the field? This presentation will attempt to shed some light on some of the factors that play a part in zoo veterinarians deciding to choose to pursue life “outside,” and on where they go after escaping from the confines of the zoo.

Discussion

Why would someone want to leave the dream job of working as a zoo veterinarian? The brief answer is that something has caused the person to wake up and realize that the reality is different from the dream. In some cases, the person comes to realize that the dream has become something more like a nightmare. Other times, the wake-up call comes from circumstances outside of work. Sometimes, the choice to leave is a pro-active move to avoid ending up in a situation where involuntary removal from a job is a likely outcome. For some, economics play a factor in the decision to leave work in a zoo. The income potential from working in a private practice can be considerably more than the salary of the average zoo veterinarian.

Satisfaction with work seems to be one of the common reasons cited for with making the choice to leave a zoo. A reality of zoo work is that one has to deal with economic, time and political factors that may impose restrictions or limitations on the ability to fully pursue investigation of clinical problems. This can result in frustration at having to spend time just “putting out fires” (especially when the same fires seem to flare up time and time again) and eventually lead to job “burn out.” The realization that the fun has gone out of work is frequently cited as a reason for choosing to leave clinical zoo work. Some individuals recognize the early signs of “burn out” and act to change their situation before it become untenable. Often these individuals leave work in clinical zoological medicine for new and different challenges in related fields such as
pathology or academia. Some express satisfaction at being able to more completely pursue cases—being able to find out “why” something happened rather than just having to deal with the immediate problem. Others note that being out of the zoo, they have to justify and find financial backing to pursue investigation of an interesting clinical case or disease outbreak, whereas in the zoo situation they left behind, they might have been free to pursue a case that was of interest without having to justify or fund the investigation. In general, zoo veterinarians who have chosen to leave a traditional clinical job and go into different related fields express satisfaction at the change and seem to relish the different challenges that their new jobs present.

Individuals may also leave for the more uncertain but also more autonomous world of work as a relief veterinarian, or as an independent contractor working off grants or contracts with NGOs or government agencies. The key descriptive term when it comes to doing relief work or working as an independent contractor is “uncertain.” An independent contractor must actively solicit work, formulate proposals and successfully apply for grants to fund the work. Opportunities to work as an independent contractor or as a relief zoo veterinarian are sporadic and dependent on unpredictable factors. There is neither job security, nor financial stability. There can be months without any work. Unless one is in the enviable financial position of not needing a regular source of income, one needs some sort of “back-up” job that can provide income but will also allow taking time off when relief work opportunities arise. Working as a relief veterinarian or an independent contractor is not a job for someone who wants a low-stress, familiar, comfortable work environment. It is a field best suited for someone who is highly adaptable, skilled at quickly assessing new workplace “cultures,” and flexible in how they approach clinical zoo medicine. Moving to a new location and starting a new job score high in stress factor rankings and are two of the essential elements in relief work. The willingness to “pull up stakes,” sometimes on relatively short notice, leaving home and family for a length of time that may vary from weeks to months is another factor that must be considered by anyone considering work as an “itinerant” zoo veterinarian.

Negotiating work conditions and figuring out licensure requirements for a relief position can be challenging. While salaries for zoo veterinarians have improved, it is still not uncommon for zoos (or sometimes even zoo veterinarians) to think that a “relief vet” rate is exhorbitant, even when that rate is comparable to rates charged by private practice relief veterinarians. Traditionally, zoo veterinarians have accepted salaries that are much lower than those they would be earning in private practice. The occasional zoo veterinarian will, based on lifestyle choices and family responsibilities, choose to leave the field for the more lucrative realm of private practice. A relief zoo veterinarian is essentially in private practice, providing the same services as a small animal relief veterinarian, with additional special skills and experience unique to zoological medicine. In negotiating contracts for relief work, the lack of fringe benefits (which would normally be provided by a zoo to its employees) should taken into account. The veterinarian must provide for private health insurance, professional liability insurance, temporary accommodation and incidental expenses associated with living away from home, and must cover all of this while maintaining a separate “home base.”

Family-related circumstances such as pregnancy/maternity leave or family leave to care for an aged parent or other relative with a serious illness are, in the author’s experience, the most
common reason that a zoo relief position opens up. Ironically, these same circumstances can be the reasons why one might choose to leave a full-time clinical zoo position. The opportunity for relief work may also present itself when a zoo is searching for a full-time, “permanent” veterinarian. Whether the temporary lack of a “permanent” veterinarian is due to the voluntary or involuntary departure of the previous veterinarian carries implications for the relief veterinarian. The degree of difficulty of a temporary position can be quite variable and dependent on the unique circumstances of the situation. For example, a temporary position that opens up due to involuntary departure of the incumbent zoo veterinarian can be a very challenging and stressful situation. Zoo relief work isn’t a career option that will work for everyone. It requires a different outlook on zoo work, an ability to adapt to how other people practice medicine, and the willingness to accept financial and job instability. But for the zoo vet who doesn’t want to work at a “permanent” full-time job, but isn’t yet ready to completely leave the field, relief work or work as an independent contractor may be viable options.

Individuals who go into zoological medicine tend to be type-A personalities: hard-working, compassionate, goal-oriented, creative problem solvers. As such, when faced with the realization that work as a clinical veterinarian isn’t as fulfilling as it once was, some choose to move up within the zoo hierarchy. The challenges associated with moving into positions that deal more with policy and implementing programs are cited as the impetus for some to move beyond the boundaries of clinical zoological medicine. It is not uncommon to see veterinarians transition from positions as clinicians to department heads or even zoo directors. There have also been cases where a senior veterinarian finds that he/she has become mired in the meetings, management and political issues and identifies that situation as the source of diminished job satisfaction. Some choose to leave such a position for one which will involve more clinical and less management work.

The pressures and responsibilities attendant to work as a zoo veterinarian, and their effect on quality of life, play important roles in the choice to leave the world of clinical zoo medicine. Striking a balance between the responsibilities of a job that is intellectually, physically and sometimes emotionally demanding and having a “normal” personal life can be very challenging. Childcare, spouse or partner career choices, personal or family health concerns and the baby-boomer issue of caring for aged/infirm parents are all considerations that have caused zoo veterinarians to leave the field. Because of the physical demands of practicing zoological medicine, age-related health conditions may cause some to consider leaving behind full-time zoo work. These are not issues that are unique to our profession. It is only because the job of zoo veterinarian is perceived to be a “dream” job that choosing to leave for personal reasons may be seen to be very radical.

Conclusions

In summary, there is no easy answer to why someone chooses to leave work in a zoo and where they can go after “escaping” from the zoo. Some exchange the role of clinical zoo veterinarian for a position higher up the hierarchy within a zoo. Others move outside the walls of the zoo and go on to careers in related fields such as pathology, academia, research, lab animal medicine, or work for government agencies or for NGOs. Some leave zoological medicine for the more
financially lucrative world of private practice. A few leave to pursue other interests, but still make occasional forays back into zoos doing relief work or working on fixed term contracts. In the final analysis, it can be said that the choice to leave clinical zoo medicine is taken, based on decisions about quality of life. It is never an easy decision to leave the security of a job, let alone a “dream” job. But in the end, people make that choice for a variety of personal and professional reasons. The job of zoo veterinarian is interesting and challenging but has both good and bad points. In the final analysis, it’s just a job.
Abstract

Papers detailing how conflicts arise between zoo veterinarians and other zoo management staff, and proposing various conflict resolution techniques, have been presented at other AAZV conferences. This paper moves beyond these subjects, to identify which situations might be serious enough to result in job termination or loss. Veterinarians who have left their positions involuntarily often identify some contributing factors (such as personal backgrounds, personalities, poor conflict-resolution skills, zoo hierarchical structure, or institutional philosophy) which interfered with conflict resolution and led to the end of employment. Zoo veterinarians can learn to recognize these warning signs, identify which factors can be addressed and which are irresolvable, and avail themselves of advice, networking, and executive coaching in order to successfully transition through involuntary departure from zoo veterinary medicine.

Introduction

We’ve all heard stories about our colleagues having been forced to leave a position they’ve been in forever. You think that you would be smarter or a better clinician and that it couldn’t possibly happen to you. As hard as it is to believe, there may well be a time when things go badly for you as a zoo veterinarian. There will be signs telling you that there is trouble ahead and that you may be voluntarily (under protest) or involuntarily leaving your employment. Unfortunately, we often don’t see it coming and we are ill prepared to deal with leaving employment the “hard” way. We hope this paper will help you to acknowledge that this outcome could happen to you, and that your reactions should not be fear or resentment, but proactive questions such as “how can I recognize and avoid this if possible?”, “what if this happens to me?” and “how will I deal with it if I can’t avoid it?”. In an effort to aid their colleagues, a number of veterinarians with first hand experience in leaving zoo jobs the “hard” way were willing to share what they learned through this difficult experience through interviews. Certain common threads and lessons learned were identified and incorporated into this paper. In the discussion that follows, statements in bold italics are aphorisms that individuals found helped them through their difficult times, or that the authors felt were particularly appropriate to the circumstances.

Discussion

You Really Haven’t Made It in this Industry Until You’ve Been Fired Once or Twice

Some zoo veterinarians stay or rise in a clinical position for their entire career, but this is far from the norm. There is no data on the length of time for a zoo vet’s employment in the same
zoo. Some have estimated that it takes up to 5 yr for zoo veterinarians and directors to develop enough humility and mutual respect for each other to develop a good working relationship. If this never occurs, then the chances are good that the veterinarian will not be the one who stays employed at that institution. In addition, changes in governance, institutional philosophy, job expectations, co-workers, natural disasters, or one’s own actions can dramatically influence the zoo veterinarian’s likelihood of staying in his/her job. The individual may decide to leave voluntarily before being forced out, or may end up leaving under duress (either being forced to resign or being fired). As is true in many other workplaces, zoos retain the “right to hire or fire” any employee. There is no implied “right” of employment until retirement age. Termination of employment can come at any time and for any number of reasons (stated or unstated.)

Conflict, Perceptions, and Communication

The reasons most commonly cited for involuntary departure from the zoo veterinarian’s job revolve around deep-seated conflicts between the veterinarian’s perception of his/her role in the institution, and the perception of that role (or how he/she carried it out) among key decision-makers (CEO/Director, General Curator) in upper management. Numerous papers which identify areas of potential conflict, and communication issues between the zoo vet and other animal management staff have been presented previously. Details regarding how conflicts arise, and conflict resolution techniques are not the subjects of this paper. However, veterinarians who have left their positions involuntarily often identify key contributing factors which interfere with conflict resolution and lead to the end of employment. These include lack of consensus regarding the zoo veterinarian’s job responsibilities, disparity of personal backgrounds or agendas, lack of effective conflict-resolution skills of the participants, lack of support for the veterinarian’s role (as the veterinarian understands it) within zoo hierarchical structure, complacency, or changes in institutional philosophy, finances or goals.

Dr. ________ Cares Deeply For The Animals in His/Her Care, Sometimes He/She Cares Too Much (Statement from a Performance Evaluation)

How can a zoo veterinarian care “too much”? Veterinarians tend to be hard-working, dedicated, compassionate people, often with deep empathy towards the animals under their care. We tend to work long hours and take our responsibilities for looking after the health and well-being of the animals under our care very seriously. Others may feel that “caring too much” indicates that we have lost perspective and have focused too much on an individual animal. Or it may be that we have neglected to make our institution aware (or institutional decision makers do not embrace the consequences) of the responsibility placed upon the attending veterinarian by the United States Department of Agriculture Animal Welfare regulations to ensure animal welfare at the zoo. We need to make sure our institutions understand and recognize that veterinarians are obliged to be advocates for the animals. And we need animal management staff to feel less threatened or territorial when animal welfare-related concerns are brought up. In recognizing and addressing “turf” sensitivity, veterinarians must use enormous skill, and may benefit from additional training in how to discuss such issues without stimulating serious, career-ending resentments. One approach is to ensure that the zoo veterinarian’s job description includes details on duties and responsibilities related to animal welfare, and specifies that the veterinarian must accompany
the USDA inspector during facility inspections. The veterinarian must be aware of any animal health or welfare issues, and be empowered to follow up with corrective actions.

What is the Difference Between God and a Zoo Veterinarian? God Knows that She is Not a Zoo Veterinarian.

A major area of job-ending conflict concerns lack of consensus between the veterinarian, animal husbandry staff, and/or the director, on the veterinarian’s role and level of authority in preventing or correcting husbandry or exhibition problems. Often, zoo veterinarians identify significant keeper and veterinary staff frustration with recurring medical problems caused by husbandry deficiencies. Zoo veterinarians are trained to consider husbandry improvements as a legitimate area of disease prevention, but may not have that authority recognized. He/she may not be allowed to participate in exhibit design, collection planning and diet decisions, or veterinary recommendations may be ignored. An independent panel of experts evaluating animal care at the National Zoo concluded that veterinarians should, in consultation with keepers, curators and the nutritional staff, have the authority and responsibility for animal health care decisions at the zoo. Another conclusion was that it should be clear to all parties that the veterinarians have final authority for health care decisions.1 Unfortunately this is not always the case in many zoos. The personalities of the involved individuals, and the openness and effectiveness of their communication skills usually determine whether conflicts are truly resolved, or simply turn into festering resentment on either side.

Recent changes in “zoo culture” can be a source of unresolvable conflict. There is an increasing trend for municipal zoos to be managed as nonprofit business corporations. This has changed a previous “animal-driven” culture toward a more “business operations-driven” culture. Zoo directors/CEOs, their Board members, and donors increasingly see the zoo as a business, and animals are only considered as one important variable in business decisions. Business-oriented cultures place value on corporate terminology, strategic goal-setting, detailed decision trees and action plans, deadlines, calculated risk-taking, profit margins, cost-cutting, and job descriptions with clear performance-based measures. Some of these values are challenging for a veterinarian to apply. Deaths and medical records can be counted, but how can the veterinarian count the number of diseases or deaths prevented, or place value on the length of time invested in appropriate “bedside manner”? In order to increase gate receipts, curators and directors are under pressure to design, build and open cutting-edge exhibits with minimal cost and time, and it is easier for the general curator and director to move forward without addressing veterinary concerns. How can one quantify the value of a well-quarantined animal which has been allowed sufficient time to adjust well to its exhibit? This requirement to measure effectiveness is a new fact of corporate life, implemented to varying degrees in various zoos. Ultimately, the zoo veterinarian must be able to propose some way to measure his/her value to the institution and to prove effectiveness, within this new culture. This may require additional training in business communication skills and techniques. Alternatively, some veterinarians (like their physician colleagues in managed care practices) end up leaving the profession because their personal values conflict with the business values.
No Good Deed Ever Goes Unpunished. Just Because You’re Paranoid, Doesn’t Mean They’re Not Out To Get You.

Other influences, such as the general economy, have affected the zoo industry. Financial pressures to get more money at the gate, reduce staffing costs through layoffs, and hold department heads accountable to do more with less, cut across all industries. In some cases, zoo colleagues believe that their departure was intended to cut the senior vet’s salary and retain the “cheaper” associate. There may also have been a perceived tangential benefit in getting rid of the experienced veterinarian, in order to change previous decisions or change the collection focus away from the experienced veterinarian’s perceived expertise.

The Only Group that Has Worse Politics than the Zoo is the Air Traffic Controllers

Why does conflict exist between the veterinarian and the director or general curator? In addition to previously published issues, deep differences in personal backgrounds, agendas, and personality preferences are often identified by former zoo veterinarians. Non-veterinarians may feel uncomfortable with veterinarians, if they consider the veterinarian to be academically superior. They may be suspicious of the vet, due to profound differences in background or personality. Perhaps they are jealous because they wanted to be a vet and didn’t succeed. Perhaps the zoo veterinarian’s interest in conservation or education threatens the curator’s desired job advancement. Many directors bond more easily with curators because they are former curators themselves, or they network together more effectively at American Zoo and Aquarium Association (AZA) meetings. Some curators are more effective at providing good news (animal births, new animal acquisition ideas) to the zoo director, and the veterinarian is identified only with animal disease, death, or dire warnings about exhibits and costly changes. Some curators are just better politicians, and are more skilled in mirroring the director’s desires, interests, and goals.

When differences in perceptions and backgrounds are allowed to prevent consensus-building in animal decisions, compromise drops out of the picture. Many animal-oriented individuals (including veterinarians) have insufficient practice in developing adequate people skills to resolve personal or business conflicts. Neither side will give in, because each side believes that compromise will show weakness. In reality, compromise between the two should show strength, while building good will and mutual respect. When conflicts occur over and over again, they ultimately become power and control struggles where neither side allows questioning and both sides fear being criticized. Unresolved conflicts on small matters lead to conflicts on large matters, and the outcome negatively affects hospital staff, keeper staff and ultimately the animal collection. In order to prevent this, there must be mutual trust and respect between individuals, mutual commitment to consensus-building, and agreement that veterinary input into exhibit design, diets, animal introductions, collection plans, and other matters will benefit the animal collection.
The Influence of Zoo Hierarchical Structure on Conflict Resolution

Unfortunately, what often occurs in zoos with veterinarian-general curator conflicts is a stalemate, rather than a compromise, and both sides feel unappreciated and not respected. If both individuals are on equal standing within the organizational structure, then serious conflicts can be resolved by taking the question to the next higher authority, such as the Chief Operating Officer or Director. If that individual is a skilled manager, both sides are treated fairly and openly, a mutually satisfactory decision is made, and both parties are guided toward building early consensus in the future. However, former zoo vet colleagues report that some current zoo hierarchical structures interfere with effective compromise between veterinarian and animal husbandry staff. When the veterinarian reports to the curator, and there is a difference of opinion on an issue, the veterinarian runs the risk of either arguing with his/her direct supervisor, or going around the supervisor to the Director for a final decision. In either option, the veterinarian risks angering the boss and inviting disciplinary action. This dilemma becomes even more implacable when the veterinarian asserts that deficiencies in animal husbandry are contributing to an animal health problem. Often, those husbandry decisions were made or enforced by the general curator, and the veterinarian is thus forced to criticize the boss. When hierarchical dilemmas occur, mutual trust and future consensus often become impossible, and the veterinarian’s job security is compromised.

Recognizing the Problem and Taking Effective Corrective Action

In many cases, former zoo veterinarians failed to recognize that small problems in conflict resolution or communication had built up to the degree that the job was threatened. As time passes, some zoo veterinarians believe that previous disagreements are successfully resolved, and move on to current cases. They also may rely excessively on their technical expertise, reputation, or skill in verbal interactions with one audience, and fall into lazy habits. In some cases, early self-critical insight may allow veterinarians to adjust their self perception, and take corrective actions or enhance their personal skills. Some veterinarians forge excellent alliances with keepers, but neglect to consider their reputation among upper management. The opposite situation also occurs. In order to identify this, consider your own role in the process/problem. If it is still early in the “game,” consider: How are you perceived by keepers, curators, and upper management when disagreements occur? Remember that perception is someone’s reality. If one person (a curator, general curator, your hospital staff or the director) can make people perceive that you are being obstreperous and are not a team player, then this becomes a self-fulfilling prism through which all eyes will judge you. Consider how you respond to people and problems. Are you saying, “No, I can’t do that” or “No, that can’t be done because it will be risky to the animals.” Step back and ask yourself how you would respond to this kind of answer over and over again. Perhaps you should try a different tactic, try to put a positive spin on all situations, and appear agreeable. Instead, say “I can do that after I finish this…” or “That can be done if these things are done …to eliminate any problems for the animals.” You come across as being positive, cooperative, and a team player. Gaining insights into one’s perception by others, and enhancing one’s personal approach to daily business, can be improved through consultation with executive or life coaches. Consider asking for this help as part of your institutional personnel development plan, or consider privately investing in your own career development.
There are No Sweeter Words than “I Told You So”

The veterinarians we interviewed recommended several areas in which current zoo veterinarians should constantly assess their own performance, and try new tactics when necessary. They recommend against appearing to be a naysayer, by identifying potential serious problems which will cost the zoo money if something goes wrong. Zoo veterinarians should try to propose solutions rather than simply pointing out problems, and make it clear how preventing potential problems will save money and enhance both parties’ reputation and effectiveness. Statements should include “Here’s my comment on this situation, here are the risks and here are my proposals for how to reduce or eliminate those risks…” Veterinarians should always try to document that they tried to address potential problems before they occurred. They must persuade non-animal staff through positive explanations of consequences, while backing the veterinary perspective with hard facts.

Consider Being More Flexible So that You Can Tie Yourself into Knots

No matter how talented or well known you are, if you don’t treat people honestly, fairly, and with respect, relationships are doomed. There is also a tendency for a veterinarian to become complacent about his/her performance over time. You need to be more on edge, and recognize that you need to earn respect, every day and with every case. With every new curator and keeper, you must analyze how you will work with them and determine what each individual needs from you. Learn about different personality types, and match your expectations and verbal delivery to their perceptions of the world, the animals, and you. Be aware that failure to focus on each individual, and constantly re-earn respect and trust, could result in negative impressions that are passed on to others. Keep in mind that, unlike private practice veterinarians, your clients have not chosen you to perform a service and may not recognize the “value” of the services you provide. Your clients (keepers, curators, directors and the animals) are “stuck” with you. If they do not like the way you practice medicine, they can’t go to another veterinarian but they can work to get rid of you. Keep as objective as possible, and be willing to use different methods to persuade various individuals to support your point of view. As duties and time demands increase, it is tempting to cut corners or focus on required paperwork in order to meet deadlines. Do not neglect the chain of command, and meet frequently face to face with animal collection managers, supervisors and keepers. Focus on customer service. Work at being seen and known as a positive, caring, competent zoo veterinarian who is a part of the zoo “team” and working with the best interests of the zoo animals and institution in mind.

I No Longer Need to Punish, Deceive, or Compromise Myself, Unless, of Course, I Want to Stay Employed

Always put the animal first. There is always room for compromise but not to the extent that your ethics and values are compromised. Spend more time bragging about what you do, quantifying the things you accomplish, money that you save, and problems that you help resolve. Make sure the curators and keepers are aware of your hard work. Print out MedARKS to show what you did that week, and provide quantifiable justification if you require additional resources. If questions are openly asked about your department’s function or efficiency, consider bringing in colleagues
from AAZV and AZA to evaluate your program. It is better to be proactive in this regard, rather than having your boss do this or ask random zoo directors or curators for their opinions. Pick your battles carefully, and don’t ever think you know everything. Listen carefully, incorporate other perspectives, and give credit where it is due. Make your best decision and if you are not respected and treated with consideration, you should consider leaving.

Be sure you have good support staff who are working with (and for) you. Treat them with respect, give them support and ensure that you are respected and supported by them. If there are problems with your support staff, deal with them quickly and effectively. Utilize the services of your Human Resources department, and don’t avoid taking appropriate disciplinary action. The employee, who is not working with you, can become the person who is actively working against you. Be aware of the potential for problems when veterinarians are employed at your zoo in a non-veterinary capacity. Be pro-active in addressing issues, such as differences of medical opinion that might arise. Is the other veterinarian going to be involved (or be asked for a second opinion) on clinical cases or in emergencies? If so, keep them involved, committed to the same veterinary program principles, and subject to appropriate discipline if they engage in unprofessional conduct or undermine veterinary departmental effectiveness and cohesion.

A Good Scapegoat is Nearly as Welcome as a Solution to the Problem

In order to avoid being kept out of the loop on decisions that should have veterinary input, take a proactive approach to being seen as agreeable, visible, and cooperative. Go out of your way to have face to face contact with upper management, including the Board of Directors, so that these individuals see you in a positive light. When dealing with the press, be careful to share the spotlight with the director, curators or keepers. Remember that they all need their “15 min of fame,” and that sharing these experiences creates emotional bonds and common goals. Be careful to present yourself and your work to the press in a positive manner, and focus on the benefit of the animals. Doing so can only help engender a positive perception of you and your work in the public and staff’s eyes. This will be a benefit to you if troubles (internal or external) arise.

In many zoos, an Animal Welfare or Animal Health Board Committee has oversight on USDA issues or an IACUC function. Be sure that you are allowed to actively participate on this committee, since it can greatly support your cause. Work to ensure that this committee is not functioning in a watchdog or oversight role for the veterinary department. Make it clear that you, as the zoo veterinarian, must practice zoological medicine without being second guessed by a committee of non-zoo veterinarians. If your zoo doesn’t have faith in your abilities to provide quality care to the animals under your care, then you should consider leaving.

Recognizing Irreconcilable Differences and Moving On

Perhaps you did try to be positive and effective, are appreciated by the public, press and the Board, but conflicts continue. Or perhaps you didn’t succeed and you are facing a boss who is trying to push you out the door. There will be subtle warning signs, for which you should be watching. Does your boss change frequently? Are you excluded from senior management meetings? Are you excluded from decisions and information, such as exhibit changes, dietary
issues, and animal introductions? Are your recommendations ignored? Are other staff members rising in authority and recognition, while your authority declines? Near the end, there may be obvious signs, such as sudden change in previous glowing performance appraisals, disciplinary memos, and repeated meetings with your boss and Human Resources staff. Now you are still doing your job but you are perhaps compromising your veterinary program and perhaps the principles on which your work satisfaction depends. It is time to look into hiring a “head hunter,” keep an eye on the “positions available” section of the AAZV website, and start thinking about alternative career pathways. Consider taking on some part-time relief work, and brush up on your domestic animal skills (small animal medicine, equine, food animal). Consider employing the services of a career counselor to help get your resume up to date and explore your options.

Remember that a Kick in the Pants is a Step Forward

Unlike curators, keepers, and directors, veterinary professionals have numerous other employment options to pursue within this field. You will find as a zoo veterinarian that you are better trained to perform these other job opportunities than you imagine. Consider your new job as a sabbatical from zoo animal medicine, a time to learn new things, try out something you have been wanting to do, hone your skills in a specific area and determine if you want to return to being a zoo veterinarian or not. You will likely find that you are greatly appreciated and respected in your new job, a feeling which you have been missing for a long time. Almost all of the individuals interviewed said that leaving their job was the best thing that could have happened to them. They were sorry that they stayed at their previous zoo as long as they did.

It’s Best to Avoid Standing Directly Between a Competitive Individual and His Goals

Ask yourself why you are staying. It may be for personal reasons, such as waiting for children to finish a school term or having a spouse/partner who doesn’t want to leave his/her job. Do you see yourself as the only one at the zoo who really cares for and defends the animals against exploitation by Development, Public Relations, the general curator or even the director? Please recognize that the zoo will go on without you. In fact, it may be a better place if your replacement is a more effective advocate for the animals. Are you staying around because you don’t want to “lose” and allow your adversaries the pleasure of winning and pushing you out? Consider that you might not be the real problem; you might just be in the way of someone who is determined to have things done his/her way. When you find that you are letting your boss or co-workers define who you are and how you practice medicine, and when your vision of the zoo diverges from that of your boss and/or your Board, start looking for another job. You need to evaluate how you want to grow personally and professionally, and how the institution is likely to grow. If either of you are not on the same path, or if you recognize that you feel negatively about the zoo and zoo management, you have lost your effectiveness; you need to move on.

Recognize the signs that your body is giving you, including lack of ability to fall asleep, lack of energy, lack of appetite, irritability and extreme pessimism. If you dread going to work and facing another meeting, this is a “red flag” indicating that you should go. Take counsel from
your friends, colleagues and especially your family, as to how the job is affecting you. They often see things more clearly than you can.

The Politics are So Bad Because the Rewards are So Small

Be aware that colleagues and family may not understand what you are going through and may try to convince you that things aren’t as bad as you make them sound. It’s not that they don’t care about you; they just can’t understand the situation you are in. You may even doubt your own perceptions, or your own value and expertise. So take counsel from professionals; utilize the Employee Assistance Program (although the zoo may have access to some of this information) or invest in a private counselor. Consider seeking counsel from the Human Resources department (particularly if your zoo is under the auspices of a larger municipal organization) but be aware that there may be hidden political agendas at play between the zoo and that entity. It is also highly likely that your boss has also sought the advice of the HR department, and is working directly with them on your disciplinary issues. The department works for the institution, not for you. Talk with other zoo veterinarians who have had similar experiences. Before things escalate, seek legal advice so that you know your rights.

I’ve Been Thrown Out of Better Places than This

If you decide to fight to keep your job, seek legal counsel, carefully document all interactions with your supervisor, have your notes notarized shortly after meetings, and keep a close eye on your personnel file (so you aren’t caught off guard if your supervisor tries to slip in a disciplinary memo without giving you a copy). Thoughtfully and unemotionally respond to memos concerning job performance issues and make sure that copies of your replies are lodged in your personnel file. Your legal counsel should clearly explain the pros and cons of pursuing a lawsuit against your employer. Be wary of a lawyer who tells you that you “can’t lose”—get a second opinion! Evaluate the financial and emotional costs of filing a lawsuit. Carefully consider what you would consider to be an acceptable settlement. There are risks and benefits to pursuing a lawsuit, not only to yourself but to your family and to the zoo. Carefully consider whether you want to go public with your grievances. Are you prepared for the potential scrutiny of the press? Are you willing to put your loved ones through a public ordeal just to uphold your beliefs? Are you willing to take the risk of being perceived not as a righteous “whistle-blower” but as a disgruntled employee? If you wish to remain within the zoo profession, consider what effect going public may have on your reputation, and your future.

Never Have a Pissing Contest with a Skunk

Recognize that effective consensus and teamwork always require both sides to exert maximum effort toward mutually agreed-upon goals. Some individuals and institutional cultures simply do not share the same core beliefs, goals, priorities, and values as the zoo veterinarian and they are unlikely to work effectively toward a solution. Recognize that you might be working with individuals that have pathologic destructive personalities and hidden agendas.6,21 These are people who can be found in any business and are often very personable but lack any conscience
and are out to succeed at any cost. Removing yourself from this work environment may be your only recourse since they will only tolerate your success if it serves their needs.

Find Your Aim in Life, Before You Run Out of Ammunition

Finally, the day comes and you are called into your boss’ office, the head of human resources is there, and they hand you “the memo.” It indicates that you are being asked to resign or that you are being fired. There may be any number of reasons—organizational, professional, administrative, personal, managerial—cited for your dismissal. Your clinical competence may be called into question. None of these reasons may seem valid to you. As difficult as it is to accept, the bottom line is that they want you to go away. You will no longer be working at “your” zoo.

Whether you decide to resign with a settlement, get forced to resign, decide to sue or go to the press, you’re out of a job. In your heart, if you fight your dismissal you will likely hope to be reinstated in your old job. In reality this rarely happens. When you leave your office for the last time, you may have no other job prospects. You are likely never to come back to your zoo again. Losing your job is one of those life experiences (like the death of a loved one or divorce) that have profound long-term impact on your life. It is hard for others to understand the mystical experiences that are a part of being zoo veterinarian, such as raising a baby gorilla or assisting in the successful artificial insemination of an elephant. Leaving a zoo career is like being forced to give up driving a “classic Jaguar” and start driving a “classic Gremlin.” Both cars will get you somewhere, but no one is proud of the latter. This change is never easy to live through, but you can come out of it a stronger and wiser person. Full psychologic recovery can take a very long time.

You may wish to seek employment elsewhere in the zoo industry. If that is the case, carefully consider your part in being forced out of your old job. Recognize that you may have to take proactive measures in order to avoid having your job applications summarily dismissed. Carefully review what happened to you, and seek objective outside counsel on how you might have handled things differently. Be smart, learn from your mistakes and don’t fall into old, ineffective, self-defeating patterns. Seek the counsel of other zoo veterinarians. As difficult as it may be at the time, consider networking with colleagues and putting forth your version of what happened. It may surprise you how many people are sympathetic and understanding. Many have experienced and survived similar experiences. Don’t be embarrassed that you have been “let go” or “forced out” of a job. Anyone who works in the field knows that bad things can happen to good people and that the politics of zoo life can result in excellent, competent veterinarians losing their jobs. Attend AAZV meetings, as you will be surprised at the number of people that will come up to you to provide support and tell you how much better you look since you left your zoo job. It is hard to swallow your pride and come to the meeting when you feel that you’ve been a “failure” or may be the subject of gossip or pity. Remember that zoo veterinarians are a unique collection of individuals, and are the only people who can really understand what you’ve been through. You will realize that they are a supportive group of colleagues and maybe even compassionate and caring friends.
Zoo veterinarians who may be prospective new employers of “cast-off” zoo veterinarians should take the time to contact these applicants and find out their side of the story. Don’t make assumptions about why someone left (or was forced out of) a job. If the applicant wasn’t successful, take the time to personally tell them why he/she didn’t get considered or didn’t get the job. Be honest with them. Treat them as you would want to be treated if you were in their place.

There is Life after Zoo Vetrerinarians and Surprisingly it May be Better. There is also a Life Parallel to Being a Zoo Vetrerinarian – Invest in it.

Learn to seek creative activities away from your work that you can escape to. Take time to be with your family, and actively participate in the lives of your children and your family. You only have one chance in life to do this. Above all, remember that you are not your job, and your job is not your life. There is life outside of work. Work should be what we do in order to allow us to live our lives. We shouldn’t be living to work.

Summary of Key Concepts

- Veterinarians must be well versed in the contents of the Animal Welfare regulations and how the veterinarian’s role is defined in oversight of animal welfare.
- Ensure that your job description accurately and fully describes your responsibilities, as attending veterinarian, for safeguarding animal welfare. Make sure that animal management staff are aware of this aspect of your job description, and understand that this means you need to be actively involved in animal management decisions.
- Get to know your USDA inspector well enough to be able to call him/her for clarification on the regulations or for assistance when problems arise.
- The veterinarian should report to the director, not to a general curator. Negotiate for equal standing with the general curator within the organization.
- Safeguard yourself as soon as you realize that a problem might be brewing. Seek legal counsel so you will know your rights; carefully document meetings and, if appropriate, have your meeting notes notarized shortly after the meeting.
- Keep a close eye on your personnel file so that your supervisor can’t slip in disciplinary memos without you being aware of them.
- Thoughtfully respond to your memos from your supervisor. Make sure that copies of your correspondence are lodged in your personnel file.
- If you are not happy in your present job, carefully assess the situation and decide whether it might be better to move on rather than to stay and risk becoming frustrated, ineffective, and embittered. Consider your overall health and well-being. Is the job worth it?
- Be honest enough with yourself to say what sort of environment you will be most comfortable and successful in.
- Be true to yourself and who you are; let go of who you are not. You are not your job. You are not in a career; you are in a job.
ACKNOWLEDGMENTS

The authors wish to thank the anonymous individuals who generously provided insight on their situations so that others might learn from their experiences. Although these individuals are only known to the authors, they are outstanding individuals in the field of zoo veterinary medicine. From these interviews it was apparent that they have survived horrendous situations and by their participation in this paper they have shown themselves to be true friends to all of us.

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CAREER TRANSITION OPTIONS FOR VETERINARIANS IN ZOOLOGICAL MEDICINE

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Abstract

Approximately one-quarter of United States veterinarians are employed in federal, state, or local government, academia, industry, nongovernmental organizations and other non-private practice settings. There is a critical need, both nationally and internationally, to increase the number of veterinarians working in public and corporate practice, including food safety and food security, infectious and zoonotic diseases, population medicine, laboratory animal medicine, pathology, and biomedical research. State governments and several agencies in the federal government have, or will soon have, a severe shortage of veterinarians. Zoological medicine veterinarians have a unique combination of health professional training and professional skills, which make them highly suited to take a leadership role in meeting some of these needs—several zoological medicine veterinarians have made successful career transitions into these sectors. Zoological medicine veterinarians often have highly developed non-technical competencies that are sought by prospective employers, including: oral and written communication skills, personnel management and administration skills, adaptability and flexibility, and interpersonal and teambuilding skills. Many veterinarians, both new graduates and seasoned practitioners in zoological medicine, indicate an interest in directing their careers toward non-clinical work in the ecologic health or animal welfare arenas and very few positions in these arenas specifically indicate veterinary credentials; therefore, veterinarians compete for employment with non-veterinary scientists for the vast majority of positions. Zoological veterinarians must become savvy in identifying a niche and marketing their unique set of credentials; success is often dependent on the presence of excellent mentors and exceptional networking skills.
REPAIR OF HORN AND FRONTAL BONE AVULSION IN A FOREST BUFFALO (Syncerus caffer nanus) WITH A METHACRYLATE PATCH

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Abstract

A 2-yr-old female forest buffalo presented with acute trauma to the right horn following a fight with a conspecific. The trauma was significant, resulting in the complete avulsion of the horn base and associated frontal bone, exposing the frontal sinus.

The animal was immobilized with 3.3 mg of carfentanil (Zoo Pharm, Laramie, Wyoming 82070 USA) mixed with 100 mg of xylazine (Lloyd, Shenandoah, Iowa 51601 USA) in a single dart. Supplemental restraint was achieved with 500 mg of ketamine (Vedco, St. Joseph, MO 64530 USA) i.v., as a bolus. At the conclusion of the examination and treatment episode, chemical restraint was successfully antagonized with 5 mg atipamezole (Pfizer Animal Health, Pittsburgh, Pennsylvania 15274 USA) i.v., 95 mg atipamezeol i.m., and 300 mg naltrexone (INNOVRx Pharmacy, Yorba Linda, California 92886 USA) i.v.

Examination of the affected area of the skull revealed complete avulsion of the horn, cornual process, juxtaposed skin, and frontal bone as a unit, leaving an 8 cm opening into the frontal sinus. The area was debrided and lavaged to remove visible debris and contagion. A methacrylate (Nasco West, Modesto, California 95356 USA) patch with enrofloxacin (Bayer Corp., Atlanta, Georgia 31192 USA) and ampicillin (American Pharmaceutical Partner, Schaumberg, Illinois 64530 USA) was formed to cover the defect. A small amount of this liquid was painted just inside the frontal sinus to create a purchase on the frontal bone to help hold the patch in place. A gauze sponge saturated with the methacrylate/antibiotic mixture and was then laid over the bony defect, covering the opening into the frontal sinus. The remaining liquid was then poured over the gauze patch creating a solid patch over the entire defect, extending out over the affected skin by approximately 2 cm circumferentially. Systemic antibiotic therapy was initiated with procaine penicillin G (Agrilabs, St. Joseph, Missouri 64530 USA) at the point of triage, followed by enrofloxacin by dart for a total of 7 days.

Eleven days later the animal was sedated because the initial methacrylate patch had partially fallen off. The residual methacrylate from the original cap was removed, along with a mucinous discharge, the remnants of the gauze patch, and redundant regenerative sinus mucosa. At this time the frontal sinus was partly closed. The area was debrided and another methacrylate cap was placed over a central layer of hydrophilic wound dressing that covered the healing frontal sinus fistula.
The methacrylate cap remained in place for another 68 days when it spontaneously fell off. The result was a firm, well-epithelialized healed scar covering the entire defect. The resulting healed scar was monitored visually every few days for an additional 3 wk and at that point the animal was discharged from medical surveillance for this problem. Six years later the animal has regenerated a new horn which somewhat resembles the original horn. Management of this kind of injury has been reviewed for domestic cattle, and requires aggressive triage followed by regular wound care measures.\(^1\) Managing this kind of severe trauma in wild artiodactylids using these same techniques can be very difficult. The authors feel the aggressive initial triage, along with the benefits of methacrylate wound coverings as an alternative to intense daily wound management provided an optimal approach for management of this severe, possibly life-threatening injury.

LITERATURE CITED

SURGICAL REPAIR OF STIFLE INJURIES IN SMALL GAZELLE SPECIES

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Abstract

Small gazelle species are typically excitable and often flighty in captivity. As such, physical or chemical restraint can be problematic and careful planning and an experienced team is needed to ensure the safe handling of the animal. In spite of this, traumatic injuries can result. Intra- and inter-specific aggression can also lead to injuries especially in intact males. Fractures of long bones are common in the worst case scenarios but traumatic joint injuries can also occur. These injuries can be insidious at first and potentially carry a worse prognosis to return to normal function. Three cases of stile injuries in small gazelles at Busch Gardens Tampa Bay underwent surgical interventions with varied results. Standard small animal techniques were utilized keeping in mind the differences in the ruminant stifle.

Case 1

An intact 10-yr-old female Dorcas gazelle (Gazella dorcas) was immobilized to evaluate forelimb pedal osteomyelitis. Approximately 12 hr later she was found in sternal recumbency and weakly responsive to stimuli including hand restraint. She was treated for suspected reanarcatization but on exam she was found to have luxated her right patella medially and had some internal rotation of the stifle. The gazelle was treated with 30 mg ketoprofen (Ketofen®, Fort Dodge Animal Health, Fort Dodge, Iowa 50501 USA) i.v. and 25 mg naltrexone (ZooPharm, Laramie, Wyoming 82070 USA) and fasted overnight for further examination and possible surgery the next day. The next morning the gazelle was hand restrained and given a pre-anesthetic of 0.5 mg medetomidine (Domitor, Orion Corporation, Espoo, Finland) and 3 mg butorphanol (Torbugesic, Fort Dodge Animal Health, Fort Dodge, Iowa 50501 USA) i.m., transported to the zoo hospital, intubated and maintained on isoflurane (IsoSol®, VEDCO, Inc., St. Joseph, Missouri 64507 USA). Examination found the animal in fair condition with a Grade 3 medial patella luxation of the right stifle. An anterior drawer sign was not present but the internal rotation was significant and different from the unaffected stifle. Radiographs demonstrated a bony density between the tibial eminences assumed to be an avulsion of the anterior cruciate ligament (ACL). The limb was prepped and draped routinely for exploration of the joint and attempts at a repair. A parapatellar approach from the medial aspect was chosen. The sartorius muscle was partially avulsed and bruised, the medial patellar tendon was torn and the medial aspect of the joint capsule was ruptured. The joint was opened more along the tear on the medial aspect. The ACL was partially avulsed with a bony fragment attached from the anterior aspect of the tibia. The menisci were intact and lying in normal position. An extra-capsular repair was chosen for the ACL rupture so the joint was flushed and closed. A hole was drilled across the tibial tuberosity at an angle about 30 degrees down from the horizontal. Fifty pound test monofilament line was threaded through this hole, tunneled under the patellar tendon...
and then anchored to a stainless steel screw placed in the lateral femoral condyle. Tightening of this suture greatly reduced the degree of internal rotation. A medial fixation was not deemed necessary as the joint appeared stable. The patella was returned to a normal position and held in place by imbricating the parapatellar tendon and the fascia. Closure was routine and the gazelle recovered well. Immediate postoperative care comprised of stall rest, enrofloxacin (Baytril 100®, Bayer Corp., Agriculture Division, Animal health, Shawnee Mission, Kansas 66201 USA) 100 mg p.o. s.i.d. for 10 days, and 75 mg etodolac (Etogesic®, Fort Dodge Animal Health, Fort Dodge, Iowa 50501 USA) p.o. s.i.d. Two weeks post surgery, the gazelle was sedated with medetomidine and butorphanol as before for suture removal and radiographs. The bone screw was still in place, the internal rotation resolved but the range of motion in the joint was reduced by 50%. The gazelle was returned to the herd 2 wk later. The original pedal osteomyelitis was recurrent and required several further interventions. Six months after the surgery this gazelle was euthanatized due to unmanageable pedal osteomyelitis. Necropsy confirmed this in both front feet along with a thyroid carcinoma.

Case 2

An intact 3-yr-old female Dorcas gazelle (Gazella dorcas) was manually restrained to examine the interdigital area of the left front limb. A proliferative and necrotic mass was excised and the gazelle given 300,000 IU penicillin G benzathine and procaine combination (PEN BP-48, Phoenix Scientific, Inc., Fort Dodge, Iowa 50501 USA) s.c. A follow-up treatment was given 48 hr later again with manual restraint. When released the gazelle was lame on the right rear. The lameness was mild and another penicillin treatment was given under manual restraint 48 hr later. Five days later the gazelle had a grade 3/5 lameness in the right rear limb and the stifle was grossly swollen. The following day the gazelle was immobilized with 0.25 mg carfentanil (ZooPharm, Laramie, Wyoming 82070 USA), transported to the zoo hospital, intubated and maintained on isoflurane. Physical exam revealed a Grade 3 medial patellar luxation and radiographs confirmed this diagnosis. Two days later the gazelle was immobilized again with 0.25 mg carfentanil, intubated, placed in dorsal recumbency and prepped for surgery. A medial para-patellar incison was made from the proximal tibia that extended proximally ¼ the length of the femur. A large area of bruising was found in the sartorious with the tensor fascia lata and joint capsule torn open. The joint capsule was open enough to examine the joint. All structures appeared intact and there were no signs consistent with a torn cruciate ligament. The tear in the fascia lata was extended enough to freely move the patella back into position. The joint capsule was closed with 3-0 polydioxione, the necrotic sartorius muscle was excised bluntly and the fascia lata closed in two layers of Lembpert sutures. The parapatella tendon was also imbricated to the fascia lata with 2-0 polydioxione in a Lembert pattern. Subcutaneous and skin closure was routine. The patella remained stable at the end of surgery. Two milligrams of butorphanol was given intra-operatively to slow and smooth out the recovery. Aspirin was dispensed at 650 mg p.o s.i.d. for 3 days for postoperative analgesia. Four days later the gazelle was fully weight bearing and moved to a larger pen for continued convalescence. While in this larger pen, several attempts to dart the gazelle failed due to her running and actually escaped into a secondary containment area before being herded into the primary pen. The gazelle was successfully immobilized and returned to the display and the remaining Dorcas herd 2 wk post surgery. Today this gazelle is still in the herd at Busch Gardens.
Case 3

A 3.5-yr-old hand-raised intact male Thomson gazelle (*Gazella thomsonii*) was housed with three females adjacent to an impala herd with an intact male. Several episodes of fence fighting were recorded. This male Thomason gazelle was examined after a 3 day period of intermittent non-weight bearing lameness that was worsening. The gazelle was immobilized with 0.5 mg carfentanil. On initial exam the right stifle was grossly swollen on the lateral aspect and had severe lateral instability with internal rotation. The gazelle was intubated and transported to the zoo hospital. Radiographs showed an area of periosteal reactive bone on the lateral distal femur. The following day the gazelle was immobilized again, intubated, placed in dorsal recumbency and prepped for exploratory surgery of the right stifle. A left parapatellar approach was made extending from the tibial plateau and extends proximally up the distal 1/3 of the distal femur. Bruising and swelling was extensive in all layers of the soft tissues. The joint capsule was incised and both cranial and caudal cruciate ligaments were torn. The lateral collateral ligament was only partially avulsed. An extra-capsular ligament repair technique was performed as in Case 1 with the addition of a medial screw placed near the medial femoral epicondyle and a medial suture being placed. Fifty pound test monofilament was used for the lateral suture and 40 pound test on the medial suture. The lateral suture was placed over the patella tendon in an effort to stabilize a very deranged joint, sacrificing range of motion in flexion. This technique had been used by one of the authors in dogs with severe traumatic injuries to the stifle and when healed provided a stable limb with limited range of motion in the stifle. Both sutures were secured with a crimped stainless steel ring. The fragments of the cruciate were resected and the joint closed in a continuous layer. The soft tissues and skin were closed routinely. Recovery was slow but uneventful. Enrofloxacin 254 mg p.o. s.i.d. and etodolac 254 mg p.o. s.i.d. for 10 days were given for postoperative analgesia and infection control and to treat a concurrent infection of a fractured horn. The gazelle refused medicated feeds but ate romaine lettuce and hay well. The gazelle did well for 1 mo post surgery but failed to make any attempts to use the limb. A follow-up immobilization and radiographs demonstrated the failure of the lateral screw, migration of the crimped clips securing the sutures, medial patellar luxation, and an avulsion fracture of the tibial plateau. The limb was prepped as before and an incision was made over the previous one. The patella could not be reduced without lengthening the incision. This was thought to weaken the joint so a limb salvage procedure was opted for. The patella was sharply excised and a five-hole 12-mm wide plate designed for repairing fractures of the distal tibia was fitted on the medial aspect of the stifle. Two 1-inch stainless steel screws were placed above and below the joint. Soft tissues were closed over the plate and the skin closed in routine fashion. The stifle was very stable but the limb was left 6 cm shorter than the opposing limb. Recovery was prolonged but uneventful. Postoperative medications were again attempted as above with nearly complete compliance. One month post surgery the gazelle was able to toe touch and bear a small amount of weight on the limb but carried it at any thing faster than a walk. This animal has been returned to the breeding group and continues to do well as of this writing.

Discussion

The sources of the stifle injuries in the above cases were all iatrogenichusbandry related; capture inducedrelated, or as a result of incompatible species or individuals housed in close proximity.
In the first two cases, standard techniques from small animal orthopedic surgery appear to be a reasonable approach to traumatic injuries of the stifle. Patellar luxation have been reported in sheep, deer, goats, and llamas. In the above cases, imbrication was sufficient to return the stifle to normal function but there is no reason not to expect other techniques to work (i.e., trochleoplasty) if indicated. A genetic predisposition for patellar luxation has been proposed for certain breeds of sheep. While trauma was the immediate cause of the luxations in the above Dorcas gazelle, genetic tendencies may need to be considered for a small population.

Several anatomic differences between dogs and ruminants should be noted. There is extensive fat stored in the ruminant stifle, the cranial cruciate has two distinct bands, and the absence of fabella in ruminants. The fabella is an anchoring point for sutures for extracapsular stabilization techniques in dogs. This was overcome in Case 1 and 3 by anchoring a bone screw near the epicondyles and placing the sutures over them. Other techniques are available for larger animals that would not require this screw placement. Fibular head transposition is a technique required for larger dogs (greater than 50 pounds) and would have likely been a better option for the Thomson gazelle. The complications seen in this case can all be ascribed to size of the animal, the flighty nature of this individual, and the added forces exerted on the lateral screw with the unorthodox placement of the lateral suture over the patellar tendon. The severe nature of the injury and the failure of the first surgery left limb salvage or amputations as the only viable options. Adapting ready made bone plates and commercial stainless screws allowed us the option of limb salvage first with reasonable results. Functional return to use and pain free convalescence are the main goals in any surgical procedure. Standard techniques can be adapted and utilized by the zoo clinician to provide care that may not be available otherwise or involve logistics that would delay the procedure.

LITERATURE CITED

USE OF SERIAL PERCUTANEOUS ETHANOL INJECTIONS AND PARTIAL HEPATECTOMY FOR THE SUCCESSFUL MANAGEMENT OF A HEPATOCELLULAR CARCINOMA IN AN ASIAN SMALL-CLAWED OTTER (Amblonyx cinereusa)

Todd L. Schmitt, DVM, 1* Judy St. Leger, DVM, Dipl ACVP, 1 Thomas H. Reidarson, DVM, Dipl ACZV, 1 Steven C. Rose, MD, 2 Robert F. Mattrey, MD, 3 and Marquis E. Hart, MD 2

1 SeaWorld, San Diego, CA 92109 USA; 2 University of California, San Diego Medical Center, San Diego, CA 92103 USA; 3 MRI Institute, San Diego, CA 92103 USA

Abstract

A 10-yr-old, 3.6-kg sexually intact female Asian small-clawed otter was observed to have abdominal distention. Upon further examination under general anesthesia, a large 6 × 8 × 8 cm centralized mass associated with the liver and ascites were identified with abdominal ultrasound. A liver biopsy confirmed hepatic neoplasia. Contrast-enhanced magnetic resonance imaging (MRI) using gadoversetamide (OptiMARK, Tyco Healthcare/Mallinckrodt, St. Louis, Missouri 63134 USA) at 0.14 mmol/kg was performed to delineate the margins of the tumor. During exploratory surgery, the mass was considered inoperable. Therefore, palliative treatments for hepatic neoplasia were investigated, such as radio-frequency ablation (RFA), chemoembolization, and chemical ablation.5,6

In humans, percutaneous ethanol injection (PEI) is a safe and reliable method for reducing and eliminating focal hepatic tumors, while preserving surrounding hepatic tissue.1,4 Ethyl alcohol causes necrosis of hepatocytes, thereby reducing the size of a hepatocellular mass.3 Ethanol is dosed by calculated tumor volume (H × W × D × 0.52) to a maximum of 20 ml.

Five serial PEI treatments using ultrasound guidance were performed on the otter under general anesthesia. Post-procedural monitoring included standard CBC, serum chemistries, serum ethanol, and bile acids. Mild ethanol toxicity consisting of dysrhythmias and hypothermia were observed during two treatments.2 A follow-up contrast-enhanced MRI was performed to evaluate therapeutic effect. With adequate tumor necrosis, a partial hepatectomy was successfully performed by a liver-transplant specialist from University of California San Diego Medical Center. The otter showed post-procedural dermal pigmentation change, but continues to show no tumor recurrence and remains in good health.

ACKNOWLEDGMENTS

The SeaWorld veterinarians would like to thank the Animal Training staff for their care and assistance with Ethel during these procedures.
LITERATURE CITED


CHEMOTHERAPY FOR CUTANEOUS LYMPHOMA IN A GROUND CUSCUS (Strigocuscus gymnotis)

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Abstract

A 15-yr-old, 3.7-kg, ground cuscus (Strigocuscus gymnotis) presented with a 2-cm superficial skin abrasion on the right lateral thorax caudal to the elbow. Initial treatment with topical antiseptic (Nolvasan, Ft. Dodge Animal Health, Fort Dodge, Iowa 50501 USA) produced no improvement. The lesion quickly progressed to a deeply ulcerated 3-cm area with exposed subcutaneous and skeletal muscle tissue. Multiple biopsies were taken. Pending histopathology results, the cuscus was treated with amoxicillin/clavulanic acid (Clavamox, GlaxoSmithKline, Research Triangle Park, North Carolina 27709 USA) at 62.5 mg p.o. b.i.d. for 14 days and meloxicam (Metacam, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, Missouri 64506 USA) at 0.1 mg/kg p.o. s.i.d. for 5 days.

Complete blood count (CBC) and serum biochemistry results were within normal limits at the time of biopsy. White blood cell count was 7,600/µl (reference range 1,975-11,307/µl) with 3,952/µl lymphocytes (reference range 989-6,485/µl). Radiographs revealed significant vertebral spondylosis but no evidence of tumor metastasis was evident. Histopathology was consistent with a lymphoid malignancy with possible epitheliotropism, but immunohistochemical staining for lymphoid/myeloid neoplastic processes was negative. Antibodies tested were CD45, CD45R, 3C6, 3C10, CD20, CD79A, and CD3. Negative staining was suspected to be due to the novel species tested with the standard antibodies.

Single modality oral chemotherapy was chosen based on successful outcomes of cutaneous lymphoma treatment in domestic animals and for ease of administration.1,3 One treatment with CCNU (Lomustine, Bristol-Myers Oncology, Princeton, New Jersey 08543 USA) at 2.7 mg/kg p.o. (10 mg total dose) was given 8 days post biopsy. A mild decrease in appetite was noted initially. Recheck bloodwork performed 1 wk post chemotherapy revealed a decreased leukocyte count of 3100/µl, so treatment with amoxicillin/clavulanic acid (62.5 mg p.o. b.i.d.) continued for 14 days. No other adverse side effects were noted.

Treatment with 10 mg CCNU p.o. continued at approximately 3 wk intervals for a total of four doses. Complete response, defined as 100% reduction in size of measurable tumor for at least 21 days,3 was evident after the fourth dose of CCNU and the dosage interval was thus increased to every 5 wk. Repeat biopsy taken 4 mo after initial diagnosis was interpreted as cutaneous lymphoma with a strong reaction of almost all tumor cells to anti-CD3 antibody, consistent with a T-cell tumor.2 Despite this histologic evidence of neoplasia, no macroscopic lesions were
present and the cuscus showed no signs of illness. CCNU was continued at 10 mg p.o. every 6 wk for another four doses.

At the time of publication, 255 days after initial clinical remission, a superficial lesion reappeared at the site of the tumor. Histopathology is again consistent with cutaneous lymphoma. No evidence of metastasis is present on radiographs. CCNU dosing will be increased to every 3 wk.

Oral chemotherapy in this case produced extended clinical remission of an isolated round cell tumor. Advantages of this treatment included minimal side effects and ease of administration. This type of therapy thus could be considered in other species with round cell neoplasia.

LITERATURE CITED

FIRST REPORTED CASE OF TOXOPLASMOSIS IN A NORTHERN SEA OTTER 
(Enhydra lutris kenyoni) IN ALASKA

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and Pam Tuomi, DVM¹

¹Alaska SeaLife Center, Seward, AK 99664 USA; ²United States Fish and Wildlife Service, 
Marine Mammals Management Office, Anchorage, AK 99503 USA

Abstract

In January 2005 an adult male northern sea otter, ELs-05-01 stranded in Seward, Alaska. On  
presentation to the Alaska SeaLife Center (ASLC) rehabilitation program, the animal was  
underweight and had infected puncture wounds on its right forepaw with underlying broken  
bones. Neurologic signs were first noted 1 wk later and consisted of catatonia, partial paralysis,  
and fine muscle fasciculations. ASLC collaborates with the U.S. Fish and Wildlife Service  
(USFWS) on a northern sea otter disease screening project whose goal is to better understand  
factors that might be contributing to the decline or constraining the recovery of this species,  
recently listed as threatened in part of its range. As part of this project ASLC routinely sends out  
serum and other samples for serologic and microbiologic testing. As a result of this program this  
animal was found to be positive for antibodies to toxoplasmosis. While neurologic signs resolved  
following 2 wk of ponazuril (Marquis, Bayer HealthCare LLC, Animal Health Division,  
Shawnee Mission, Kansas 66201 USA) 10 mg/kg, p.o. s.i.d., treatment was continued for 60  
days. The medication was placed in the mantel cavity of a squid which was refrozen to prevent  
the otter from removing the medication. Staff ensured the ‘med-squid’ was eaten prior to feeding  
the rest of the diet. Surgical removal of sequestra in the otter’s right forepaw and treatment with  
antibiotics allowed these wounds to heal. Following cessation of all medication, the otter was  
observed for an additional month at ASLC and was released at the end of May 2005. After  
release, the otter was observed multiple times in the area, eating and behaving normally. While  
toxoplasmosis is common in southern sea otters, this finding is a first for northern sea otters in  
Alaska. Since this case, additional northern sea otters in Alaska have tested positive for  
antibodies to toxoplasmosis. These animals were caught during USFWS capture trips. This  
report will put this finding in context with the different patterns of disease and mortality seen in  
southern versus northern sea otters.
CORNEAL TRAUMA IN A GIRAFFE (Giraffe camelopardalis)

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Abstract

This giraffe patient was newborn. It weighed only 48 kg and was measured to be 160 cm tall. On the sixth day of life, an 8-mm corneal lesion was found on the giraffe’s right eye, causing the eye to be swollen and to discharge ocular fluid. The giraffe was tranquilized with 5 mg xylazine (Tranquived Injection, VEDCO, Inc., St. Joseph, Missouri 64504 USA) by intramuscular injection, then given isoflurane (IsoFlo, Abbott Laboratories, North Chicago, Illinois 60064 USA) to induce (5%) and maintain (2.5%) the anesthesia. A third eyelid flap was positioned to protect the corneal lesion. After 1 mo the cornea received another wound from suture friction. Temporary tarsorrhaphy was performed during a second surgery to address this problem. Two months later the suture was removed and the eye was completely recovered.
COMPARISON OF CONVENTIONAL EQUIAXED AND DIRECTIONAL FREEZING IN RHINOCEROS (Ceratotherium simum, Diceros bicornis)

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Abstract

To increase the quality of cryopreserved sperm for potential use in artificial inseminations in rhinoceros, the conventional equiaxed and the new multi-thermal gradient directional freezing methods were compared. Fourteen sexually mature white and two black rhinoceros bulls (Ceratotherium simum, Diceros bicornis) were examined with ultrasound and electroejaculated. Semen samples were immediately extended 1:1 (v:v) with an egg-yolk, DMSO, lactose-based extender and aliquoted into 0.5-ml straws for conventional freezing, and 2-ml and 10-ml glass hollow tubes for directional freezing. In addition to functional assays, the assessment of basic spermatic parameters were evaluated prior to and after both freezing methods. Directional freezing improved the sperm viability by 7% ($P<0.005$), motility by 8% ($P<0.005$), and normal morphology by 26.3% ($P<0.005$) as compared to conventional freezing. Using the previously described egg-yolk extender, xanthenuric acid, cytochalasin D, potassium and EDTA as extender additives were tested individually and collectively, in an attempt to improve the post-thaw sperm quality of both freezing methods. Whereas post-thaw quality with directional freezing was not improved or decreased ($P>0.05$) by any of the extender additives; conventional freezing proved more sensitive to the extender composition. All additives combined had a dramatic negative effect on post-thaw sperm normal morphology ($P<0.005$) and the additive cytochalasin D improved sperm motility by 17% ($P<0.05$) compared to the other additives after conventional freezing. In this first direct comparison of these two freezing technologies, directional freezing proved to facilitate higher gamete survival after cryopreservation and was independent and not reactive to variations in the cryomedia. These results suggest that directional freezing could be a valuable technology for other species with cryosensitive spermatozoan as well.
HIGH INCIDENCE OF CYSTS OF THE CERVIX UTERI IN CAPTIVE MALAYAN SUN BEARS

Frank Goeritz, DVM, PhD,1* R. Hermes, DVM, PhD,1 Katarina Jewgenow, PhD,1 Vaclav Pozivil, DVM, PhD,2 Parntep Ratanakorn, DVM, PhD,3 Lydia Kolter, PhD,4 and Thomas Bernd Hildebrandt, DVM, PhD1

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Abstract

Due to an unexplained low reproduction rate of captive Malayan sun bears (MSB, Helarctos malayanus), the European zoo population has decreased rapidly during the last 8 yr from 73 to 49 individuals. There is strong evidence that pathologic alterations of the female genital tract cause infertility in a variety of wild species in captivity. Therefore the aim of the present study was the investigation of reproductive health by ultrasound examinations.

In the course of the study 17 female MSB (ages 2-25 yr) from Europe and Thailand were anesthetized and examined by transrectal ultrasonography, as described before in ursids.1 The entire genital tract (vagina, cervix, uterine body, uterine horns and ovaries) was visualized in all bears.

In six out of 17 MSB (35.3%) cystic alterations of the uterine cervix were found in different sizes, which did not cause any clinical signs (Table 1). In four of these cases the animals were proven nulliparous. For the other two individuals no exact data was available, but were supposed to be nulliparous, too. The sonograms indicated fluid filled structures within the cervical wall. In one MSB the physiologic structure of the uterine cervix could not be identified as a result of the cystic alterations. The uterus and the ovaries did not show any pathology. In other bears (62 individuals from four different species) cysts in the uterine cervix have never been observed. Type and origin of these cysts have not been characterized. However, microbiologic and histologic analyses are in progress. Surgical removal of large cysts in one animal failed. Ultrasound examination 2 yr later revealed recidivation. In conclusion, we strongly suggest that cysts of the uterine cervix may contribute to infertility in MSB.

LITERATURE CITED

Table 1. Incidence of cystic alteration of the cervix uteri in Malayan sun bears of different ages.

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Number of individuals</th>
<th>Incidence of cystic alteration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-5</td>
<td>7</td>
<td>14.28</td>
</tr>
<tr>
<td>6-10</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>11-15</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>16-20</td>
<td>4</td>
<td>75</td>
</tr>
<tr>
<td>21-25</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
USE OF A CIRCULAR EXTERNAL FIXATOR TO REPAIR A DIAPHYSEAL METATARSAL FRACTURE IN AN ADULT ALPACA (Lama pacos)

Rolando Quesada, DVM,* Luis M. Rubio-Martinez, DVM, PhD, Judith Koenig, DVM, DVSc, Dipl ACVS/ECVS, Krista Halling, DVM, Dipl ACVS, and Kara Schulz, DVM

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Abstract

A 3-yr-old male alpaca was presented due to acute onset of severe lameness of the left hind limb. Repair of a closed, comminuted, non-articular, diaphyseal, metatarsal fracture was first attempted by full limb cast application under general anesthesia, resulting in non-weight bearing and further displacement of the proximal fracture fragment with the risk of penetration of the skin. A circular external fixator was elected to stabilize the fracture under general anesthesia. The modular frame consisted of three rings and three connecting bars. Two 1.6-mm diameter Kirschner wires were drilled through the metatarsus at the level of each of three supporting rings. The fracture was aligned under fluoroscopic guidance. Ambulation occurred almost immediately after surgery, and the patient was discharged from the hospital 13 days later under stall confinement. No complications occurred and the fixator was removed 3 mo later with excellent outcome.

The circular external fixator provided adequate stabilization of the fracture. Placement of the construct was a minimally invasive procedure, decreasing postoperative complications, and resulted in almost immediate postoperative functional use of the limb.

Circular skeletal fixators have been successfully applied for stabilization of long bone fractures in calves, but not in camels or other zoo ungulates.1,2 This technique might be considered for such species provided mild temperament, reduced body size, and individual value. It also represents an alternative when immediate limb use is required or where no other modality is likely to provide an anatomic reduction.

LITERATURE CITED

ULTRASONOGRAPHIC ASSESSMENT AND ULTRASOUND-GUIDED BIOPSY OF THE RETROPHARYNGEAL LYMPH NODES IN ELEPHANTS

Thomas Bernd Hildebrandt, DVM,¹* Robert Hermes, DVM,¹ Parntep Ratanakorn, DVM, PhD,² Wolfram Rietschel, DVM,³ Joerns Fickel, Dr RetNat,¹ Roland Frey,¹ Catherine Reid, DVM,¹ and Frank Goeritz, DVM¹

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Abstract

So far there are no valid diagnostic tools available for identifying latent carriers of endotheliotropic elephant herpes virus (EEHV).¹⁴ For this reason, the lateral retropharyngeal lymph node complex (LARELYNOC) of elephants, identified during postmortem studies as target organ for EEHV and suitable for transcutaneous biopsy, was grossly described.³ Transcutaneous ultrasound (3.5 MHz) was applied behind the ear region to identify the LARELYNOC containing up to four single lymph nodes on each side. The lymph node tissue is situated 20-50 mm below the skin surface. An ultrasonographic assessment of the LARELYNOC and two biopsies were performed on 39 healthy Asian elephants (Elephas maximus). Samples were tested for EEHV via PCR.¹² Whole blood samples were also collected and tested for active EEHV infection. Lymph nodes were ultrasonographically classified as active (calculated mean volume=17.4 ± 6.9 cm³, P>0.001), inactive (calculated mean volume=3.1 ± 0.6 cm³, P<0.001), or chronic active (calculated mean volume=10.6 ± 1.0 cm³, P<0.05). Histology confirmed not only the presence of lymph tissue but also the ultrasonographically diagnosed reactivity status of the lymph node biopsies. Although all samples including whole blood were found to be negative for the EEHV DNA particles, the successful development of this procedure in elephants could prove beneficial for the screening of not only latent EEHV infections but might also be a less dangerous alternative method for the diagnosis of zoonotic infections such as tuberculosis.⁵

ACKNOWLEDGMENTS

The authors like to acknowledge the German Research Council and the Thai government for funding this project. The authors are grateful for additional financial support by the African Lion Safari, Cambridge, Canada and the Zoo Zurich, Switzerland. The authors also thank the staff of all facilities contributing with their help and expertise.

LITERATURE CITED


PLATE FIXATION OF THE AVIAN CORACOID: A CASE SERIES

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Abstract

The coracoid, along with the scapula and clavicle, comprise the avian thoracic girdle. Coracoid fractures and luxations generally occur as a result of a gunshot injury or a collision with a solid object. Birds with coracoid injuries usually cannot fly. Diagnosing a coracoid injury can be difficult on physical examination, as birds may only have a slight wing droop or no wing droop. Radiographs are required to confirm a coracoid injury. Historically, cage rest and/or the placement of intramedullary (IM) pins have been recommended as methods for treating coracoid injuries. Displaced fractures and luxations have a poor prognosis with cage rest and surgery is indicated. The surgical approach to the coracoid and IM pin placement has been described. Internal fixation using plates can provide rigid stability, counteract all four forces acting on bone, and maintain anatomic alignment. Special considerations for bone plate fixation in avian bones have been described. The following represents a case series in which three different coracoid injuries were repaired using internal plating. The first case, a bald eagle (Haliaeetus leucocephalus), presented with a caudoventral luxation of the left coracoid. The second case, another bald eagle, presented with a mid-diaphyseal fracture of the left coracoid. The third case, a scarlet macaw (Ara macao), presented with an oblique fracture of the right coracoid. In all three cases, the surgeries were uneventful, and the birds made complete recoveries. Both bald eagles were released back to the wild after rehabilitation.

LITERATURE CITED

SURVEY OF FOOT PROBLEMS IN A COLLECTION OF CAPTIVE EXOTIC SWINE

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Abstract

Medical records of 58 wild boar (Sus scrofa), 46 red river hogs (Potamochoerus porcus), 46 warthogs (Phacochoerus africanus), 44 Bornean bearded pigs (Sus barbatus), 28 Visayan warty pigs (Sus cebifrons), 24 peccaries (Catagonus wagneri), 7 bush pigs (Potamochoerus larvatus), 6 babirusa (Babyrousa babyrussa), and 1 forest hog (Hylochoerus meinertzhageni) in a captive collection from January 1984 to March 2006 were surveyed for foot problems. The species with the highest percent of the total population with foot problems were babirusa, Visayan warty pigs, and Bornean bearded pigs. The species with the lowest percent of the total population with foot problems were bush pigs, wild boar, and peccaries. The most common foot problems included toe tip abrasions, sole and hoof wall abscesses, hoof wall separation, hoof cracks, and hoof overgrowth. Conditions associated with onset of hoof problems included escape from exhibit, nervous hyperactivity, inappropriate substrate, and direct trauma. Treatments leading to successful outcome included frequent wound care with corrective hoof trimming, wound protection with foot casts, soft padded bandages, or methylmethacrylate toe caps; provision of soft substrate; and judicious use of antibiotics and anxiolytics.
THE EFFECT OF LONG NON-REPRODUCTIVE PERIODS ON THE GENITAL HEALTH IN CAPTIVE FEMALE WHITE RHINOCEROS

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Abstract

This study examined 48 southern and six northern white rhinoceros (Cerathoterium simum simum, C.s. cottoni) using ultrasound and fecal hormone analysis to elucidate causes for female reproductive failure and to determine whether long non-reproductive periods have a detrimental impact on genital health. Results showed that 76% of the nulliparous females had never been bred. 56% of the studied population had reproductive pathology. The stages of the lesions in nulliparous females correlated with age. Due to the severity of the lesions, 28% of the study population was considered post reproductive. The reproductive life span in some individuals was 10-20 yr short. However, in parous females the incidence of pathologic lesions was significantly lower. Seventy-eight percent of females studied had erratic or absent luteal activity. The hormone data corresponded with two ultrasonographic levels of ovarian activity, active and inactive, occurring within an age range of 3-19 yr and 15-38 yr, respectively. This suggests the lack of ovarian activity by reproductive mid-life in non-reproducing females. Our data suggest that the development of reproductive pathology and ovarian inactivity in white rhinoceros is an age-related consequence of long non-reproductive periods. This asymmetric ageing process it seems can be prevented with one pregnancy.

ACKNOWLEDGMENTS

The International Rhino Foundation and SOS Rhino funded this work. The authors are grateful for financial support by the African Lion Safari, Cambridge, Canada; Burgers’ Zoo, Arnhem, Netherlands; La Palmyre Zoo, France, Wild Animal Park, Escondido CA USA. Our team pays tribute to the tremendous support and work of all our American and European colleagues in this study.

LITERATURE CITED

HIGH ALTITUDE DISEASE (BRISKET DISEASE) IN RUMINANTS, PRIMATES, RODENTS AND WALLABIES AT A MEXICAN ZOO

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1 Africam Safari, 11 Oriente 2407 (Col. Azcárate), C.P. 72007 Puebla, México; 2 ConZOOlting Wildlife Management, Serra del Montsant 6, 08415 Bigues i Riells, BCN, Spain; 3 Northwest ZooPath, 654 W. Main, Monroe, WA 98272 USA

Abstract

This study documents for the first time 18 cases (Table 1) of right-sided hypertrophic cardiomyopathy associated with pulmonary arteriosclerosis in zoo animals, including 10 maras (Dolichotis patagonum), one nilgai antelope (Boselaphus tragocamelus), one scimitar-horned oryx (Oryx dammah), two cotton top tamarins (Saguinus oedipus oedipus), two capybaras (Hydrochaeris hydrochaeris) and two wallabies (Macropus rufogriseus) housed at Africam Safari (Puebla, Mexico). In two ruminants (Cases 1 and 2), death was attributed to right-sided congestive heart failure. In the rest of the cases, cardiomyopathy was considered incidental and not related to the cause of death.

Grossly, all cases had cardiomegaly, with right-sided concentric hypertrophy (Table 2), often with dilatation of the right ventricle. The right to left ventricular thickness ratio ranged 1:1 to 1:1.6 in 15 cases. Sixty-one percent had arteriosclerosis of the pulmonary trunk. Histologically, all cases had medial hypertrophy of the small and/or medium sized pulmonary arteries. Other pulmonary arterial lesions found in fewer cases are also listed in Table 2. Chronic passive congestion of the liver was observed in two cases.

The high prevalence of right-sided cardiomyopathy at Africam Safari in the study period (2000-2005) is unusual. Based on the presence of pulmonary arteriosclerosis, 3 the absence of stenosis of the pulmonary valve and severe pulmonary diseases, 2 and the fact that this zoo is located at 2,126 m above sea level, right-sided hypertrophic cardiomyopathy in these cases was attributed to hypoxia of high altitude. 1-3 Cardiomyopathy was considered subclinical in most cases, but caused fatal congestive heart failure in two juvenile ruminants.

LITERATURE CITED

Table 1. Clinical history of 18 cases of antelopes, rodents, primates and wallabies with right-sided cardiac hypertrophy and pulmonary arteriosclerosis at Africam Safari Zoo at México.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Species</th>
<th>Sexa</th>
<th>Ageb</th>
<th>Weight (kg)</th>
<th>Cause of Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Oryx dammah</em></td>
<td>M</td>
<td>1 yr</td>
<td>NR</td>
<td>Congestive heart failure</td>
</tr>
<tr>
<td>2</td>
<td><em>Boselaphus tragocamelus</em></td>
<td>F</td>
<td>1.5 yr</td>
<td>NR</td>
<td>Congestive heart failure</td>
</tr>
<tr>
<td>3</td>
<td><em>Dolichotis patagonum</em></td>
<td>M</td>
<td>Young adult</td>
<td>6.7</td>
<td>Possible acute heart failure</td>
</tr>
<tr>
<td>4</td>
<td><em>Dolichotis patagonum</em></td>
<td>F</td>
<td>Young adult</td>
<td>6.8</td>
<td>Euthanasia – bacterial pododermatitis</td>
</tr>
<tr>
<td>5</td>
<td><em>Dolichotis patagonum</em></td>
<td>M</td>
<td>Adult</td>
<td>7.2</td>
<td>Hyperthermia</td>
</tr>
<tr>
<td>6</td>
<td><em>Dolichotis patagonum</em></td>
<td>F</td>
<td>2 yr 8 mo</td>
<td>7.8</td>
<td>Trauma</td>
</tr>
<tr>
<td>7</td>
<td><em>Dolichotis patagonum</em></td>
<td>M</td>
<td>Adult</td>
<td>7.2</td>
<td>Trauma</td>
</tr>
<tr>
<td>8</td>
<td><em>Dolichotis patagonum</em></td>
<td>M</td>
<td>Juvenile</td>
<td>6.4</td>
<td>Trauma</td>
</tr>
<tr>
<td>9</td>
<td><em>Dolichotis patagonum</em></td>
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<td>2 yr 8 mo</td>
<td>7.2</td>
<td>Trauma</td>
</tr>
<tr>
<td>10</td>
<td><em>Dolichotis patagonum</em></td>
<td>F</td>
<td>Adult</td>
<td>8</td>
<td>Trauma</td>
</tr>
<tr>
<td>11</td>
<td><em>Dolichotis patagonum</em></td>
<td>F</td>
<td>Young adult</td>
<td>6.8</td>
<td>Trauma</td>
</tr>
<tr>
<td>12</td>
<td><em>Dolichotis patagonum</em></td>
<td>M</td>
<td>Juvenile</td>
<td>6.4</td>
<td>Possible acute heart failure</td>
</tr>
<tr>
<td>13</td>
<td>Saguinus oedipus Oedipus</td>
<td>F</td>
<td>4 mo</td>
<td>0.114</td>
<td>Bacterial infection</td>
</tr>
<tr>
<td>14</td>
<td>Saguinus oedipus Oedipus</td>
<td>M</td>
<td>Adult</td>
<td>0.335</td>
<td>Bacterial infection-wasting marmoset syndrome</td>
</tr>
<tr>
<td>15</td>
<td><em>Hydrochaeris hydrochaeris</em></td>
<td>M</td>
<td>Adult</td>
<td>NR</td>
<td>Trauma</td>
</tr>
<tr>
<td>16</td>
<td><em>Hydrochaeris hydrochaeris</em></td>
<td>M</td>
<td>Adult</td>
<td>NR</td>
<td>Trauma</td>
</tr>
<tr>
<td>17</td>
<td><em>Macropus rufogriseus</em></td>
<td>F</td>
<td>Adult</td>
<td>12</td>
<td>Gastric perforation</td>
</tr>
<tr>
<td>18</td>
<td><em>Macropus rufogriseus</em></td>
<td>F</td>
<td>Adult</td>
<td>9.2</td>
<td>Bacterial infection</td>
</tr>
</tbody>
</table>

*M= male; F= female.

*yr= year; mo= month.

*NR= not recorded.
Table 2. Pathologic findings in 18 cases of antelopes, rodents, primates and wallabies with right-sided cardiac hypertrophy and pulmonary arteriosclerosis at African Safari Zoo at México.\(^a\)

<table>
<thead>
<tr>
<th>Case</th>
<th>Cardiomegaly</th>
<th>Right-sided concentric hypertrophy</th>
<th>Dilatation of the right ventricle</th>
<th>Ventricular thickness ratio (RV-LV)</th>
<th>Arteriosclerosis of the pulmonary trunk</th>
<th>Medial hypertrophy of pulmonary arteries</th>
<th>Other pulmonary arterial lesions</th>
<th>Transudates</th>
<th>Chronic hepatic passive congestion</th>
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<tbody>
<tr>
<td>1</td>
<td>++</td>
<td>+++</td>
<td>++</td>
<td>1:1</td>
<td>-</td>
<td>++</td>
<td>AF ++, MF, MN+++, MM++, AN, N+++++</td>
<td>a, b, c</td>
<td>++</td>
</tr>
<tr>
<td>2</td>
<td>+++</td>
<td>+++</td>
<td>-</td>
<td>1:1</td>
<td>-</td>
<td>+++</td>
<td>AN, FN, F N+++ H a, c</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>1:1.2</td>
<td>m</td>
<td>+ to ++</td>
<td>MCV+ a</td>
<td>-</td>
<td></td>
</tr>
<tr>
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<td>++</td>
<td>++</td>
<td>+</td>
<td>1:1.5</td>
<td>f</td>
<td>+ to ++</td>
<td>MCV+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>++</td>
<td>++</td>
<td>-</td>
<td>1:1.5</td>
<td>f</td>
<td>+ to ++</td>
<td>AF +</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>++</td>
<td>++ to +++</td>
<td>-</td>
<td>1:1.4</td>
<td>f</td>
<td>+ to ++</td>
<td>AF +</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>++</td>
<td>++ to +++</td>
<td>+</td>
<td>1:1.3</td>
<td>f</td>
<td>+ to ++</td>
<td>AF +</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>++</td>
<td>++ to +++</td>
<td>-</td>
<td>1:1.1</td>
<td>m</td>
<td>+ to ++</td>
<td>MCV+</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>++ to +++</td>
<td>+++</td>
<td>-</td>
<td>1:1.4</td>
<td>m</td>
<td>+ to ++</td>
<td>AF +, MCV++</td>
<td>-</td>
<td></td>
</tr>
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<td>10</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>1:1.6</td>
<td>f</td>
<td>+</td>
<td>a, c</td>
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</tr>
<tr>
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<td>+++</td>
<td>++ to +++</td>
<td>++</td>
<td>1:1.3</td>
<td>m</td>
<td>+ to ++</td>
<td>N = to ++</td>
<td>-</td>
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<tr>
<td>12</td>
<td>+++</td>
<td>+++</td>
<td>-</td>
<td>1:1.5</td>
<td>f</td>
<td>+ to ++</td>
<td>AF +</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>++</td>
<td>+++</td>
<td>++</td>
<td>1:5</td>
<td>-</td>
<td>++</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
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<td>++</td>
<td>+++</td>
<td>++</td>
<td>1:1</td>
<td>-</td>
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<tr>
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<td>+++</td>
<td>++</td>
<td>1:3</td>
<td>-</td>
<td>+ to ++</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>++ to +++</td>
<td>+++</td>
<td>++</td>
<td>1:3</td>
<td>-</td>
<td>+ to ++</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>+ to ++</td>
<td>+ to ++</td>
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<td>NR</td>
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<td>AF +</td>
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<tr>
<td>18</td>
<td>++</td>
<td>+ to ++</td>
<td>+ to ++</td>
<td>1:2.4</td>
<td>m</td>
<td>+ to ++</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) = mild, ++ = moderate, +++ = severe, - = not found, m = multifocal, f = focal, AF = adventitial fibrosis, MCV = medial cytoplasmic vacuolation, MF = medial fibrosis, MN = medial necrosis, MM = medial mineralization, AN = arterial neovascularization, and FN = fibrinoid necrosis, F = proliferation of fibroblasts, N = narrowing of the lumen of pulmonary arteries, H = acute hemorrhage, a = ascites, b = hydrothorax, c = hydropericardium, NR = not record.
MONITORING FOR BREVETOXIN IN WILD BIRDS COLLECTED IN FLORIDA

Danielle R. Stanek, DVM,1,† Jan Landsberg, PhD,1 Leanne Flewelling,1 Marilyn Spalding, DVM,2 Gabriel A. Vargo, PhD,3 Karen Atwood,1,3 Michelle van Deventer,3 and Barbara Suto4

1Florida Fish and Wildlife Conservation Commission, Fish & Wildlife Research Institute, St. Petersburg, FL 33701 USA; 2University of Florida, College of Veterinary Medicine, Gainesville, FL 32610 USA; 3University of South Florida, College of Marine Science, St. Petersburg, FL 33701 USA; 4Suncoast Seabird Sanctuary, Indian Shores, FL 33785 USA

Abstract

Testing using an ELISA specific for A brevetoxin-specific ELISA was used to test environmental samples, and marine and shorebirds displaying neurologic abnormalities during a prolonged red tide event in the Gulf of Mexico during 2005-2006.1 Histologic examinations were performed on select birds.

Results suggest that coquina clams (Donax variabilis) are efficient bio-accumulators of brevetoxin and may pose an exposure risk as a food source. Gastrointestinal contents of all species of birds examined frequently had high levels (>300 ng/g) of brevetoxin present suggesting ingestion is a primary route of exposure. Highest tissue levels of toxin were most consistently found in gall bladder, followed by liver. Brevetoxin was also detected in kidney, lung, muscle, brain and/or heart in some birds. Brevetoxin was detected in serum or plasma at low levels (1-13 ng/ml) in multiple live birds.

Neurologic symptoms associated with suspected brevetoxicosis include: ataxia, disorientation, hyper-excitability, ascending paralysis and loss of palpebral reflex. Symptoms appeared to be somewhat species specific. Gross necropsy findings frequently included cloacal impaction and/or emaciation. Pulmonary congestion was noted on gross and/or histologic examination of some birds; however due to the low number of fresh carcasses examined no definitive conclusions could be drawn.

ACKNOWLEDGMENTS

The authors would like to thank the wildlife rehabilitators that have provided samples for this research, including Dr. P.J. Deitschel and C.R.O.W. staff, Lisa Miller, Mary Coerver, Amanda Wilkerson, Chris Beatty, Lloyd Brown and many others. We would also like to acknowledge diagnostic support from the Southeastern Cooperative Wildlife Disease Study, particularly Dr. John Fischer and Dr. Kevin Keel; Dr. Betty Miguel and her staff at Kissimmee Animal Diagnostic Lab, and the assistance of Dr. Mark Cunningham and Bambi Ferree of Florida Fish and Wildlife Conservation Commission. This research was supported in part by funds from the National Oceanic and Atmospheric Administration’s Coastal Management Program through the Florida Department of Environmental Protection and the Florida State Wildlife Grant Program.
LITERATURE CITED

THE ROLE OF THE ATTENDING VETERINARIAN AND ADEQUATE VETERINARY CARE IN ZOOS AND AQUARIUMS

Timothy Reichard, MS, DVM1* and Phillip Robinson, MS, DVM2

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Abstract

Every zoo and aquarium in the United States of America is required by the Animal Welfare Act (AWA) to have an attending veterinarian who shall provide adequate veterinary care to its animals. The institution must assure that the attending veterinarian has appropriate authority to provide for adequate veterinary care, and to oversee the adequacy of other aspects of animal care and use. A mechanism of direct and frequent communication is required so that timely and accurate information on problems and animal health, behavior and well being is conveyed to the attending veterinarian. The American Association of Zoo Veterinarians (AAZV) “Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals” provides further direction to the attending veterinarian and were written to conform to the requirements of the AWA.

When the role and authority of the attending veterinarian are compromised there may be legal and animal welfare ramifications. Animal well-being could be harmed if deficiencies occur in husbandry and medical care. The institution could receive monetary fines and potentially lose its exhibitor’s license. In addition, implications for an institution’s reputation and credibility in its community and profession are at stake.

To ensure compliance with the Animal Welfare Act and to provide adequate veterinary care in zoos and aquariums the following measures are recommended:

1. Train animal care staff on the requirements of the AWA.
2. Clearly define, within their job descriptions, the responsibilities of keepers, curators, veterinarians, veterinary technicians, and other key administrative personnel on the subjects of animal welfare and animal care. Identify who has the final authority in making animal welfare decisions.
3. Establish a written protocol for the communication of animal health and well being concerns directly to the attending veterinarian.
4. Follow a program of adequate veterinary care based on the AAZV “Guidelines for Zoo and Aquarium Veterinary Medical Programs and Veterinary Hospitals” and the Animal Welfare Act.
5. Assure that the United States Department of Agriculture inspectors, attending veterinarian, curators, and keepers work in an open and collaborative manner on animal welfare issues.

6. The attending veterinarian reports directly to the institution’s executive director.

7. Institutions should develop their own internal animal welfare review process describing its philosophy about animal welfare and articulating a clear process for the staff to be able to express any animal welfare concerns.

8. Follow the American Zoo and Aquarium Association’s Standardized Animal Care Guidelines.

9. Develop an ombudsman panel jointly between the AZA and AAZV to assist the attending veterinarian, curators, and executive director in resolving animal welfare conflicts that can not been resolved internally.

10. Amend the Animal Welfare Act to require the designation of an Institutional Official for “Licensed Exhibitors” as is required under the AWA rules for Biomedical Research Institutions.

Animal care staff working cooperatively, respecting each other’s roles, and discussing welfare concerns openly and honestly will help assure the well being of the institution’s animal collection.

LITERATURE CITED

DEVELOPING AN INSTITUTIONAL ANIMAL WELFARE PROGRAM: A CASE STUDY

Mark Stetter, DVM, Dipl ACZM* and Jill Mellen, PhD*

Disney’s Animal Programs, Lake Buena Vista, FL 32830 USA

Abstract

In conjunction with the opening of Disney’s Animal Kingdom, we created a standard Institutional Animal Care and Use Committee (IACUC) for Disney’s Animal Programs (Disney’s Animal Kingdom, The Living Seas, Disney’s Animal Kingdom Lodge, Tri-Circle D Ranch). The original focus of the committee centered more on animals involved in research than animal welfare issues associated with a modern zoological facility.

Media attention around animal welfare issues at several zoological institutions over the past 10 yr has encouraged many facilities to closely examine their animal welfare reporting processes. At Disney’s Animal Programs we realized that our IACUC, as we were conducting it, did not fulfill our needs. Our IACUC was more closely aligned with an academic or biomedical research facility rather than a zoological facility that exhibits animal, and whose research is focused on applied, non-invasive research and topics that specifically deal with captive management and conservation. To that end, Disney reorganized our IACUC into an animal welfare committee with a mission and goals better aligned with the issues around care of captive wildlife. This committee still is involved with reviewing research proposals and commenting on the scientific integrity of research projects, but the vast majority of this committee’s work deals with the animal welfare issues concerned with captive management of zoo and aquarium animals.

In the year since this committee was reorganized, we have focused our attention on two major projects. The first was to ensure that all members of Disney’s Animal Programs knew about this committee and its responsibilities. We developed an awareness campaign that included presentations by the animal welfare committee to all employees, and the distribution of large descriptive posters placed in areas to educate everyone about the animal welfare committee. The awareness campaign is intended to educate our staff about responsibility in ensuring uncompromising excellence in animal care and welfare, and support the role of the committee to provide oversight and guidance around animal welfare issues. These presentations are given during information sessions and at local team meetings. It is a 30-min interactive presentation that includes didactic discussions about the differences between animal welfare and animal rights.

The second project was the development of an animal welfare concern reporting process. We wanted to ensure that every employee had a voice, and that all concerns around animal welfare were documented, discussed and addressed. Our animal programs team has always had several mechanisms for bringing forth animal welfare concerns, but they were not always in written form and inconsistencies between animal teams were a factor.
Once established, the new animal welfare committee, Disney’s Animal Care and Welfare Committee (DACWC), developed a process that allowed employees within any animal department to effectively bring forth concerns, first to their leadership, then to the DACWC committee if further action was required. This process attempts to ensure that concerns can be investigated without fear of reprisals, and that all discussions and resolutions are shared with all parties involved. Our communication processes and agreements have always embraced open discussion of concerns, and direct leaders are the first level for dialogue. Concerns cannot be submitted anonymously, but all employees can openly take their concerns to higher tiers of leadership, culminating (if necessary) in the DACWC committee itself, to achieve adequate discussion and, ultimately, satisfactory resolution.

It is well understood that captive animal management is complex and there is wide diversity of opinion regarding how to deal with specific animal issues, including housing, collection, nutrition, enrichment, training etc. We believe that no process or protocol can address all issues, but by providing a safe forum for open discussion, ideas can be presented and discussed for the common benefit of the animals in our care.

ACKNOWLEDGMENTS

The authors are indebted to Jackie Ogden, John Lehnhardt, Tom Hopkins, and Barb Burkhalter for their assistance and direction in creating Disney’s Animal Care and Welfare Committee.
ASSOCIATION OF STRESS IN INDIVIDUAL ZOO ANIMALS: TOWARDS DEVELOPMENT OF STRESS-TRACKING TOOL

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Abstract

In zoos there is a need for concepts of stress to be translated into assessment tools that are accessible to animal care staff. The measurement of stress requires knowledge of (1) what animals respond to with aversion in captive environments, (2) behavioral signs of acute and chronically aversive situations, and (3) long-term biologic consequences of these responses. Measurement of glucocorticoids in feces, urine and saliva is the primary means of studying stress responses in zoo animals, but these measures need to be combined with other behavioral and biologic assessments in order to determine whether stress is a welfare problem or not. In addition, standardized tracking of environmental events that affect animals is essential for monitoring causes of stress. This paper discusses the key elements necessary for developing a zoo animal stress-tracking tool based on studies that pair individual variation in glucocorticoid output with other types of measurements. Results from diverse taxa will be discussed, including black (Diceros bicornis) and white rhinoceros (Ceratotherium simum), polar bear (Ursus maritimus), clouded leopard, (Neofelis nebulosa), Hawaiian honeycreepers (Himatione sanquinea and Hemignathus virens), okapi (Okapi johnstoni), false killer whale (Pseudorca crassidens), giant panda (Ailuropoda melanoleuca), Kori bustard (Ardeotis kori), and orangutan (Pongo pygmaeus).
ASSESSMENT OF SKELETAL AGEING IN CAPTIVE LARGE FELIDS

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Abstract

Due to increased longevity in captive wild mammals, pathology such as osteoarthritic change is becoming more prevalent in zoological collections. Little data are available regarding the severity and progression of arthritic disease in wild mammals.

Skeletal specimens from museum collections were assessed using a scoring system that allowed grading of osteophytes. Specimens were of seven species: cheetah (*Acinonyx jubatus*), clouded leopard (*Neofelis nebulosa*), lion (*Panthera leo*), jaguar (*Panthera onca*), leopard (*Panthera pardus*), tiger (*Panthera tigris*), and snow leopard (*Uncia uncia*). The specimens were predominantly captive animals, but a small sample of wild-caught specimens was also examined. Bony changes on vertebrae and long bones were scored. Dentition was also evaluated.

Similar patterns of bony change were found in both wild and captive animals. Common sites for osteophyte formation on vertebrae were the cranial and caudal articular surfaces, the transverse fovea (rib articulations), and ventral to the vertebral body (leading to synostosis in more advanced cases). As expected, older animals had more extensive lesions. Regions showing higher-grade lesions with increased frequency were the sixth cervical to third thoracic vertebrae, and fourteenth thoracic to third lumbar vertebrae. On the limbs, osteophytes were predominantly peri-articular, with ulnar trochlear notches and acetabular rims commonly affected.

Although there was some overlap between captive and wild specimens’ dental pathology, wild animals suffered more from tooth wear and captive animals more from infection.

These pathologic findings may impact on animal welfare, and bone and dental pathology should be considered an important morbidity factor in aged animals.

LITERATURE CITED

HEALTH EVALUATION OF A BLACK NECKED SWAN (Cygnus melanocoryphus) POPULATION IN A CHILEAN CONSERVATION PRIORITY AREA

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Abstract

Hematology and plasma biochemistry have proved to be useful as physiologic indicators in ecologic research, and for wildlife and conservation programs in natural populations of vertebrates. In avian populations, these parameters have been used for providing information on the physiologic state and adaptation of individuals to their habitat, changes in nutritional state, reproductive status, body condition, and health status. These acquire a serious importance when threatened avian populations are affected by the emergence of infectious diseases. The wetlands of the Ramsar Nature Sanctuary “Carlos Anwandter” (number 6CL001) on the Cruces river, in Valdivia (39º34-49´S; 33º02-18´W), southern Chile, support 119 avian species, mainly waterfowl. The sanctuary contains the largest known breeding colony of black-necked swans (BNS) on its southern zone distribution. Since March 2004, the BNS populations have been affected by a drastic reduction of the common waterweed Egeria densa (“luchecillo”), their main food. According to a study, this reduction was related to water pollution due to recent pulp mill industrial activity upstream of the Cruces River, with three effects on BNS population: (1) a drastic decline in population abundance (from 6,000 to 250 individuals), (2) deaths of >300 individuals with non-specific clinical signs, and (3) a complete absence of reproductive activity.1

With the aim of evaluating health status, we captured 165 BNS from 2003 to 2005 in two sampling periods: (1) a priori environmental episode period (before the initiation of the pulp mill activity): 46 animals were tested between June and September 2003; and (2) a posteriori environmental episode period (after initiation of the pulp mill activity): 119 animals were tested between September 2004 and March 2005. Blood was collected from the medial metatarsal or the superficial ulnar veins.

Eleven hematologic variables, nine biochemical values, serologic tests for Newcastle disease (NCD), Mycoplasma gallisepticum, and bacterial cultures for Salmonella sp. were determined during the first period. Six biochemical values, antibody response to NCD, Adenovirus type 1 (Adv-1), and avian pox virus (APV), and Aspergillus flavus were added to the testing during the
second period. Seventy-seven samples were evaluated serologically. Additionally, necropsies were performed on two adult BNS that died within 18 hr of captivity.

Hematologic and biochemical, parameters were similar ($P>0.05$) between males and females during the first period. Samples from the second period revealed a normocytic, normochromic, non-regenerative anemia; leukopenia; decreases in the body mass (body weight without effect on total length), triglycerides, and uric acid; and an increase in $\beta$-hydroxy-butyrate levels. The methodologies, and serologic and culture results are presented in Table 1.

The BNS were most likely immune-suppressed due to a weight decline following a decrease in their food source. This is the first report of positive serologies for NCD, AdV-1, and $A.\ flavus$ in wild black necked swans. This monitoring study is evidence of variations in flock health a-priori and a-posteriori to the drastic reduction of $Egeria\ densa$ due to environmental contamination.

LITERATURE CITED


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<th># Positives (%)</th>
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<td>2003</td>
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<td>$Salmonella$ sp.</td>
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<td>33 (42.85%)</td>
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<td>AdV – 1</td>
<td>77</td>
<td>17 (22.07)</td>
<td>Agar gel immunodifussion</td>
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<td>Pox-virus</td>
<td>77</td>
<td>0 (0)</td>
<td>Immunodifussion</td>
<td>2004-2005</td>
</tr>
<tr>
<td>$A.\ flavus$</td>
<td>2</td>
<td>2 (100%)</td>
<td>Malt extract agar/Czapek–dox</td>
<td>2004-2005</td>
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EPIZOOTIOLOGIC, DIAGNOSTIC, THERAPEUTIC, AND PREVENTIVE ASPECTS OF PARASITIC DISEASES IN DROMEDARY CAMELS OF INDIA

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Abstract

The single humped camel (Camelus dromedarius) is an important species in the arid parts of India with 0.632 million camels (17th Livestock Census, 2003, India). Some degree of parasitic burden exists in camels irrespective of the control measures adopted. Internal parasitism may endanger the health and performance of camels and may even threaten survival. Hence, parasite control is an on-going task for camel farms.

The commonly encountered internal and external parasitic diseases having economic and pathologic significance include trypanosomiasis, hemonchosis, strongylosis, nematodirosis, and mites. The major loss is due to trypanosomiasis followed by mange and helminthic infections. Some camels may become parasite carriers once infected. Most of the parasitic diseases escape early detection because signs are nonspecific and there is negligible mortality. Although control of parasitic disease relies on the use of anthelminthic, antiprotozoal, and anti-mange drugs, the importance of an adequate nutrition, proper hygiene, and pasture management cannot be overlooked.

Epizootiologic Findings of Parasitic Infections in Camels

Age

All age groups are susceptible to parasitic infections, but, helminthic infections are more common between 1-3 yr of age.12 The ectoparasitic infections are higher in adults of >3 yr of age.11 The reason behind this might be that neonates are generally incapable of responding immunologically to nematode parasites. Adults usually harbor low levels of endoparasites and therefore act as a constant source of infection for more susceptible animals. Re-infection due to free grazing practices may contribute to the development of acquired resistance and low-grade infection in adults.

Sex

Sex has no influence on parasitic infections.11 A higher incidence of parasites in males reported in earlier studies may have been due to males sampled being stall fed versus females sent for grazing. Low grade infection in females may have been due to acquired resistance as mentioned above.
Breed

Four different breeds, Bikaneri, Jaisalmeri, Kachchhi, and Cross breeds found in India are considered. A higher infection rate was noticed in the Kachchhi breed.$^{11,12}$ This may reflect a breed predilection, however, further research is necessary to confirm this. For trypanosomal infections, all breeds are susceptible.$^7$

Season

Winter is most conducive for harboring both ecto- and endoparasites.$^5,12$ The helminthic infections prevail throughout the year but are more predominant during the autumn and winter months.$^9$ For hemo-protozoan infection the period immediately after rains (i.e., August to November) is most common due to the breeding of insect populations. The rugged climatic conditions in winter (September-December) are conducive to ectoparasites spread by direct contact between animals. The temperature and humidity during winter months are most congenial for mite multiplication. Conversely, the high temperature and rapid evaporation during summer are detrimental to transmission of the infective stages of the parasites.

Diagnostic Approach

The diagnosis of parasitic infections under field conditions is based on history and clinical signs. Unthriftiness, weight loss, weakness, tissue destruction, hemorrhages, anemia, reduced absorption of nutrients, and wasting are generally ascribed to internal parasitism. In trypanosomiasis, intermittent fever with disappearance of the hump; edema of the pads and abdomen, periodic convulsions; and diarrhea are noticed. In chronic trypanosomiasis, production losses in terms of milk and meat as well as infertility problems may result in huge economic loss to camel owners. Skin irritation, alopecia, and pustular and scab lesions that reduce hide quality are encountered with ectoparasitism. Anorexia may also occur.

Laboratory examination for internal parasites includes fecal examination by direct smear, sedimentation, and floatation,$^{10}$ as well as eggs/g of feces (EPG) counts using a modified McMaster’s techniques.$^1$ For hemoprotozoan infections (mainly trypanosomiasis), wet blood smear examination and stained thick blood film examinations are done.$^5$ Since the parasitologic examinations do not always detect the trypanosomes in blood, serologic tests are performed in herds. The serologic tests include the enzyme-linked immunosorbent assay (ELISA), immunofluorescent antibody test (IFAT), complement fixation test (CFT), and agglutination test. Immunoassays for detecting circulating trypanosomal antigens have been developed which can differentiate active and resolved infections.$^8$ These serologic tests are specific and sensitive but not widely used under Indian conditions. The Suratex latex agglutination test may be utilized for the diagnosis of trypanosomes in the field.$^6$ The polymerase chain reaction (PCR) is able to detect as few as 10 parasites but this is costly and requires a well equipped lab. For the ectoparasitic infections, skin scraping examination is done for identification of mites.$^2$
Therapy

The drugs commonly used against parasitic infections in camels are listed in Tables 1 and 2.

Anti-Mange Drugs

Synthetic pyrethroids have been proven to be highly effective at comparatively low concentration. They are safe, economic, and have wide safety margins. Recommended drugs include fenvelarate (500 ppm) or deltamethrin (50 ppm), given three times at intervals of 7 days.4 Amitraz (12.5%; 500 ppm) given twice at weekly intervals is also effective in treating mange.13 Herbal formulations (e.g., Himax) are also available in India for treating ectoparasitic infections. The herbal formulations are eco-friendly. There is a need for further research to develop other low cost herbal formulations for treating external parasites as well as endoparasites. Ivermectin at a dosage of 0.2 mg/ kg s.c. once can be used for both ecto and endoparasites and is said to be effective.

Preventive Measures

Preventive measures include regular deworming for control of endoparasites; isolation and treatment of mange affected animals, and control of breeding of insects by maintaining proper cleanliness and hygiene. Herds should be screened for helminthic as well as external parasitic infections periodically, which can help in minimizing the losses due to parasitism. Regular grooming/brushing can help in maintaining healthy pest-free skin coats.

Regular screening of the herd for ectoparasitic, endoparasitic infections should be carried out. The following prophylactic measures are recommended for the control of parasitic infections:

1. Deworming with broad spectrum anthelmintics such as albendazole or fenbendazole should be given at the age of 2 mo when the calf starts taking grass. Deworming should be repeated every 45 days until 6 mo of age then at 3-mo intervals until 1 yr and then at 6-mo intervals.
2. At about 4-6 mo of age (i.e, before the onset of the monsoon in endemic areas) the camel calves should be given a prophylactic dose of suramin or quinapyramine pro salt (antrycide pro-salt; ICI or Triquin, Wockhardt; at a dosage of 0.25 ml/kg s.c.) which can give protection for 3 mo. Every year before the onset of the monsoon prophylaxis against trypanosomiasis should be given in endemic areas.
3. A precautionary measure should be taken to avoid ectoparasitic infections in camels. The neonatal camel calves should not be mixed or kept in the sheds where camels with ectoparasitic infections are maintained since mange is a contagious disease which spreads rapidly. Periodically the sheds should also be sprayed with acaricides. The drug used for deworming should be rotated to avoid the development of resistance. The usage should not be excessive.

ACKNOWLEDGMENTS

The authors are highly thankful to the facilities provided by Livestock Farming Unit of NRC on Camel, Bikaner.
LITERATURE CITED


<table>
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<th>Table 1. Anthelmintic drug dosages for camels.a</th>
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<td>Fenbendazole</td>
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<tr>
<td>Tetramisole</td>
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<tr>
<td>Levamisole</td>
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<td>Ivermectin</td>
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aThe drug dose may be repeated after 3 wk if the infection rate is heavy. In mild to moderate infections, single dose is sufficient.

<table>
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<th>Table 2. Anti-trypanosomal drug dosages for camels.</th>
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<td><strong>Drug</strong></td>
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<td>Suramin</td>
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<tr>
<td>Quinapyramine methyl sulphate</td>
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AN OUTBREAK OF Chlamydophila psittaci IN AN OUTDOOR COLONY OF MAGELLANIC PENGUINS (Spheniscus magellanicus)

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Abstract

This report describes an outbreak of avian chlamydiosis in an outdoor colony of Magellanic penguins (Spheniscus magellanicus) at the San Francisco Zoo in 2005. Affected birds presented with depressed appetite, lethargy, and mint green urates. Findings included elevated white blood cell counts (25,000-60,000/μl), heterophilia and lymphopenia with toxic cellular changes, and increased total plasma protein. Clinical signs and pathology associated with chlamydiosis infection and/or the associated treatments included prolonged anorexia, seizures, keratoconjunctivitis, dermatitis, gout, sepsis, and cardiac insufficiency.

Chlamydophila psittaci infection was confirmed as the cause of death by histopathology and immunohistochemistry in the first three cases. Subsequently the entire colony was treated prophylactically with doxycycline. Oral doxycycline hyclate (Axiom Pharmaceutical Corp., Rockford, Illinois 61107 USA) at a dosage of 17-33 mg/kg p.o. s.i.d. and/or injectable doxycycline (Vibramycin SF I.V., 20 mg/ml, Merknaam van Pfizer Inc., New York, New York 10017 USA) at a dosage of 50-75 mg/kg i.m. every 7 days was administered for a 30-day treatment.

Avian chlamydiosis is an infectious disease with zoonotic potential1-4 and Chlamydophila psittaci is a reportable disease in the state of California. Public Health officials were notified and appropriate quarantine protocols were instituted.

Following histopathologic confirmation of avian chlamydiosis, an attempt was made to establish antemortem diagnostic screening protocols for C. psittaci in Magellanic penguins. Polymerase chain reaction (PCR; DNA) probes for C. psittaci from feces and choanal/cloacal swabs were the most useful in the diagnosis of infected birds and helped to determine shedding status. Results from swabs were superior to direct complement fixation, elementary body agglutination, and PCR blood testing.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the penguin keepers and hospital staff for their hard work and dedication. The San Francisco Zoo wishes to acknowledge Lynn Dustin, VMD, for her truly generous contribution of numerous vials of injectable doxycycline.
LITERATURE CITED

ELEPHANT TUBERCULOSIS DIAGNOSIS: IMPLICATIONS FOR ELEPHANT MANAGEMENT IN ASIAN RANGE COUNTRIES

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Abstract

Serologic tests including the ELISA, MAPIA (Multi-Antigen Print Immunoassay), and a rapid test, VetTB StatPak® (Chembio Diagnostic Systems, Inc., Medford, New York 11763 USA) have recently been developed and show great promise for the diagnosis of tuberculosis (TB) in elephants. 1,3-7 These serologic tests detect antibodies to antigens of Mycobacterium tuberculosis complex organisms and in some cases have detected infection years in advance of active disease and mycobacterial shedding.

The diagnosis of active TB (by culture) or serologic conversion presents management challenges for captive elephants in Asian range countries. Of the 2 billion humans worldwide infected with TB, fewer than 10% will develop active disease. 2 This figure is unknown for elephants. The identification and management of infected elephants has ramifications for elephants and humans alike and issues such as public health and tourism may be impacted.

TB is endemic among humans in Asia and where there is intermingling of elephants and humans, both species may act as reservoirs for disease transmission. The various situations in which elephants are kept in Asia (government-owned, privately-owned, festivals, temples, zoos, etc.) make it difficult to develop a management strategy that will address all circumstances. Other concerns are the cost of treatment for an elephant (~ $50,000 USD) and appropriate monitoring in resource-poor countries.

The authors have recently undertaken the screening of 120 elephants in Nepal to further evaluate the above-mentioned (and other) diagnostic tests. To our knowledge, this is the first organized, large-scale initiative to screen Asian elephants within a range country. Preliminary discussions regarding the management of both culture and serologically positive government-owned and privately-owned elephants in Nepal have been initiated and may serve as a starting point for other countries as more elephants are screened within Asia. Basic options for active (culture-positive) cases include (1) treatment, (2) segregation or (3) euthanasia. Options for latent disease (culture-negative, serologically positive) cases include (1) treatment, (2) segregation and
monitoring for active disease and (3) euthanasia. The particular ownership/husbandry system, available resources and cultural constraints may dictate final management choices in range countries.

ACKNOWLEDGMENTS

The Nepal Elephant Tuberculosis Research Project was made possible with support from the Dodge Foundation, the Mazuri Fund, the Walter J. Ernst Memorial Fund, Elephant Care International, and Busch Gardens, Tampa.

LITERATURE CITED

ALEUTIAN DISEASE VIRUS STATUS OF EUROPEAN MINK (Mustela lutreola) FROM NAVARRA, SPAIN

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Abstract

The European mink, Mustela lutreola, is one of the most endangered carnivores in the world, and mink populations have suffered a dramatic decline in Europe during the 20th century.6 The subpopulation of mink from Navarra (n=420) represents approximately 66% of the total number of mink in Spain.2 Aleutian disease virus (ADV) is a parvovirus with a high degree of variability4 that can infect a broad range of mustelid hosts.3,7 The pathogenesis of this virus in small carnivores depends on both host variables (species, genotype in the American mink, and immune status) and viral factors (e.g., viral strain).1,5 A cross-sectional study was conducted in February-March (pre-reproductive period) 2004 and 2005, and September-December (post-reproductive period) of 2004 to assess the ADV status of the Navarra population of mink. Mink were intensively trapped along seven rivers representative of the European mink habitat in Navarra. Counterimmunoelectrophoresis for the detection of antibodies against ADV was performed on 84 European mink blood samples. All the samples were negative. Protein electrophoresis was performed on serum samples from 82 European mink. Of these, nine (9.6%) had gamma globulin levels exceeding 20% of the total plasma protein. Complete necropsies were performed on 23 European mink from the area. In 17 (74%) of the cases the lesions were compatible with road traffic accidents. There were no histologic lesions associated with ADV. Based on these results, ADV does not appear to represent a significant problem in this population at this time.

ACKNOWLEDGMENTS

The authors thank Alfonso Ceña Martinez, Gabriel Berasategui Echevarría, Iosu Alfaro Vergarachea, Itsaso Bidegain Garbala, Uxue Itoitz Mariñelarena for the trapping of the animals and Benjamín Gómez Moliner for the technical support during the study. This study was supported by Gobierno de Navarra Departamento de Medio Ambiente, Ordenación del Territorio y Vivienda.

LITERATURE CITED


VACCINATION AGAINST HIGHLY PATHOGENIC AVIAN INFLUENZA VIRUS (H7N7) IN DUTCH ZOOS

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Abstract

In 2003 highly pathogenic avian influenza virus (H7N7) struck poultry in the Netherlands. A European Commission directive made vaccination of valuable species in zoo collections possible under strict conditions. We determined pre- and post-vaccination antibody titres in 211 birds by hemagglutination inhibition test as a measure of vaccine efficacy. After booster vaccination with an inactivated H7N1 vaccine, 81.5% of vaccinated zoo birds developed a titre of ≥40, while overall geometric mean titre (GMT) was 190 (95% CI: range=144-251). GMT and percentages with a titre ≥40 were related to taxonomic order. Birds of the orders Anseriformes, Galliformes and Phoenicopteriformes showed higher GMT and a larger percentage of these birds developed titres ≥40 than birds in other orders. There was an inverse correlation between published average weight per species and antibody response.1

In December 2005, when HPAI H5N1 infected birds were found in several countries in the Near East and the virus was thought to spread into Europe, zoo birds were vaccinated against H5, and residual antibody titres to H7 vaccination were determined in 95 birds.

Approximately 2.5 yr after vaccination, 24.2% of the vaccinated birds were still sero-positive, although only 12.6% had a titre ≥40. In Anseriformes, Galliformes and Ciconiiformes titres persisted for longer than in the other taxonomic orders.

In conclusion the results indicate that the vaccination against H7, although initially effective, would not be protective in most birds 2.5 yr post vaccination.

ACKNOWLEDGMENTS

We thank the zoos and people involved in collecting the serum samples, and Theo Bestebroer and Chantal Baas for technical laboratory assistance.

LITERATURE CITED

TUBERCULOSIS IN HUMAN AND NON-HUMAN PRIMATES: A CHALLENGE IN A DEVELOPING COUNTRY

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Abstract

*Mycobacterium tuberculosis* has been reported in a wide range of captive species\(^2\)\(^3\) including Asian elephants (*Elephas maximas*), chimpanzees (*Pan troglodytes*), parrots and as an emerging disease in free living banded mongoose (*Mungos mungo*) and suricates (*Surricata surricata*).\(^1\) *M. tuberculosis* is primarily a human pathogen and of great concern to health professionals in sub Saharan Africa, due to an increased incidence associated with high rates of infection with human immunodeficiency virus. Uganda is now ranked 14 out of 22 countries that have been identified as contributing 80% of the global burden of *M. tuberculosis*.\(^4\)\(^5\) This report documents *M. tuberculosis* in two chimpanzees (*Pan troglodytes*) and an unidentified *Mycobacterium* in a Grey-cheeked mangabey (*Lophocebus albigena*) at the Uganda Wildlife Education Center (UWEC) from 2002 to 2005. The challenges of maintaining susceptible captive nonhuman primates in close contact with a human population with a high rate of tuberculosis are complex and involve a multidisciplinary approach to preventing *M. tuberculosis* in these animals.

LITERATURE CITED

MEDICAL MANAGEMENT OF RESPIRATORY DISEASE IN BONOBOS (Pan paniscus): WORKSHOP REPORT

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Abstract

Beginning in 2005, the Zoological Society of San Diego (ZSSD) Board of Trustees developed Board Advisory Councils encompassing several disciplines important to the mission of the ZSSD. The purpose of these councils is different than the traditional committee structure. The advisory councils generally (1) meet only when needed, (2) are oriented to accomplish a task, (3) are generally single-topic format, (4) include internal and external subject matter experts, (5) lend Trustee-level support to problem solving, and (6) help solve ZSSD problems as well as those of our industry.

Two of these ZSSD councils, the Animal Health and the Living Collections Advisory Councils, combined efforts to address a specific disease problem in an individual species (i.e., respiratory disease in captive bonobos). This joint meeting brought together the American Zoo and Aquarium Association’s (AZA) Species Survival Plan (SSP) veterinary and pathology advisors; infectious disease and public health specialists from the San Diego medical community; ZSSD veterinary, pathology, curatorial, keeper, and executive staff; and ZSSD Trustees together in a lecture, discussion, and workshop format. This approach provided a way to put proper attention on this one serious medical issue.

The format and topics of this 2-day workshop included the following: (1) an overview of the disease in humans and bonobos; (2) a review of the morbidity and mortality in captive bonobo populations; (3) a discussion of the diagnostic methodologies available; (4) a discussion of treatment and vaccination options; and (5) a discussion of environmental, husbandry, and management issues. Following the presentation of these topics, the participants broke into these three working groups: (1) diagnostic methods, (2) treatment and vaccination, and (3) prevention through management and husbandry. Each group was supplied a series of questions to address and asked to develop a list of recommendations and actions steps. These were presented in draft form to the entire group at the end of the meeting. The final executive summary findings and recommendations are presented in this abstract.

A detailed document with working group recommendations and action steps together with written proceedings of the meeting are being made available to the zoological community.
through the bonobo SSP. The recommendations focus on diagnosing, treating, and preventing respiratory disease in bonobos, and all the participants agreed that much more was gained through this process. The recommendations and action steps, when acted upon, should improve overall husbandry and medical care for this species.

**Goals of this Joint Advisory Council Meeting**

The following were the goals of this joint council meeting as stated at the outset of the meeting.

1. Understand the nature and significance of severe respiratory disease in captive bonobos
2. Compare and contrast the disease syndrome to that in humans.
3. Develop recommendations that will improve the ability to diagnose, treat, and prevent the disease in captive bonobos at the ZSSD and other AZA facilities.
4. Develop a set of action plans to address issues not covered at this meeting.
5. Communicate these recommendations with others responsible for the care of captive bonobos.
6. Consider how these principles will apply to bonobo reintroduction programs.

**Key Findings and Recommendations**

*Diagnostics, pathogenesis, and susceptibility:*

1. Identify the spectrum of respiratory pathogens in a population before and during an outbreak. Respiratory pathogens have different predisposition to cause secondary infections and have different response to therapeutic agents. Furthermore, prevention measures rely on the knowledge of the pathogens acting in a population.
2. Develop and improve predictors and diagnostics for acute respiratory distress syndrome (ARDS), one of the causes of respiratory-related mortality in bonobos.
3. Clarify the role that avian and human influenza viruses play in bonobo respiratory disease.
4. Develop antemortem and postmortem diagnostic standards across AZA institutions. Tailor practices to the diagnostic capacities of each holding facility.
5. Consider performing proactive examinations of individuals from a group affected for collection of definitive diagnostic specimens.
6. Bank serum samples for later analysis. Serology of the various diseases is most useful when compared over the course of an outbreak.

*Prevention – Husbandry Issues:*

1. Facilities and training are critical to diagnosing and managing this disease in bonobos. The recommendations available through the SSP suggest facility design standards.
2. Bonobos are highly social animals, and any medical management plans must take that into consideration.
3. Infection control measures implemented only after signs appear are probably ineffective.
4. Develop exposure risk management procedures that are consistently implemented among bonobo facilities.
5. Implement primate safety best practices for both zoonoses and anthropozoonoses.
prevention – and improve compliance.
6. Develop in advance a plan for how to manage husbandry issues during serious group outbreaks.

Prevention – Medical Issues:
1. Respiratory Syncytial Virus (RSV) is so prevalent in the human population and so contagious that exposure to bonobos is inevitable.
2. Pneumococcus vaccine is warranted based on current knowledge. The vaccine has almost eradicated the disease in people, but the disease is still a problem in apes.
3. The efficacy of the pneumococcus vaccine in non-human primates is unknown and should be investigated.
4. Influenza vaccination in bonobos is of questionable value but is likely to cause little harm.
5. There are key behaviors for which bonobos need to be trained in order to facilitate diagnostic and prevention measures (e.g., vaccine administration), treatment, and health monitoring.

Treatment:
1. RSV monoclonal antibody is expensive and has low benefit. Its use in bonobos would be limited to unusual pediatric situations.
2. Symptomatic treatment is most likely helpful and is not likely to mask a decline into severe disease.
3. Identify triggers for antibiotic treatment and first line antibiotics. The recommendations available through the SSP provide guidelines.
4. A “respiratory failure” model to manage and prevent ARDS-related mortalities is available through the SSP.

ACKNOWLEDGMENTS
The authors thank the following individuals for their contributions to this workshop: Dr. Fredrick Frye, Dr. Michele Ginsberg, Dr. Mark Greenberg, Dr. John Leake, Dr. Joshua Fierer, Dr. Tracy Clippinger, Dr. Geoff Pye, Ms. Michele Stancer, Ms. Kim Livingstone, Ms. Peggy Sexton, Mr. Michael Bates, Ms. Donna Gutekunst-Lundy, Ms. Beth Branning, Ms. Peggy Blessing.
MENINGOENCEPHALITIS AND CEREBRAL ABSCESES CAUSED BY Klebsiella pneumoniae IN A PATAS MONKEY (Erythrocebus patas)

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Abstract

A 13-mo-old, 3.4-kg., juvenile male patas monkey (Erythrocebus patas) presented with acute onset neurologic signs including seizure, periodic paresis, favoring of the left arm, and lethargy. Differential diagnoses for the clinical signs included toxoplasmosis, infection, toxins, parasite migration, and trauma. An examination was performed using ketamine (Keta-Thesia™, Burns Veterinary Supply, Inc., Westbury, New York 11590 USA) induction and isoflurane (IsoFlo®, Abbott Laboratories, North Chicago, Illinois 60064 USA) maintenance anesthesia. The physical examination and whole body radiographs were unremarkable. Blood collected for a complete blood count and selected sera chemistries demonstrated hyperglycemia, 175 mg/dl (ISIS7 normal 100 mg/dl) and mild hyperproteinemia, 6.9 g/dl (ISIS7 normal 6.2 g/dl). A toxoplasma titer, chlamydophila (direct complement fixation), zinc level, and an Old World monkey viral panel (African monkey herpesvirus antibody, Herpes simplex-1, measles, cytomegalovirus antibody, and simian immunodeficiency virus antibody) were negative or within normal limits. The animal was given doses of dual-pen (Penicillin G benzathine/procaine, GC Hanford Mfg. Co., Syracuse, New York 13201 USA, 20,000 IU/kg s.c.), trimethoprim/sulfadiazine (TMP/SDZ, Tribrissen®, Schering-Plough Corp., Kenilworth, New Jersey 07033 USA, 30 mg/kg s.c.), and lactated ringers solution SQ (50 ml/kg BW). Recovery from anesthesia was slightly prolonged but unremarkable and he was returned to the primate night house where he lived with four other conspecifics. The next morning, the keeper reported that he had had two seizures in the early morning but when observed by the veterinarian, he was steady, quiet and alert. Diazepam (Ivax Pharmaceuticals, Inc, Miami, Florida 33137 USA, 0.3 mg/kg p.o. b.i.d.) and prednisolone (USP, oral solution, Hi-Tech Pharmacal Co, Inc., Amityville, New York 11701 USA, 0.7 mg/kg p.o. s.i.d. for 2 days) were prescribed for seizures, and sulfamethoxazole/trimethoprim (SMZ/TMP, oral suspension, Hi-Tech Pharmacal Co, Inc., Amityville, New York 11701 USA, 30 mg/kg p.o. s.i.d.) for possible toxoplasmosis or bacterial infection. The animal was reported to be more relaxed and sleeping more than usual later in the day so only a half dose of valium was given that evening.

The third day after presentation, clinical signs had progressed and the animal was becoming more ataxic, paretic, lethargic, sometimes appearing blind. Consultation with a pediatric neurologist at a local hospital, recommended a computed axial tomography (CT) scan. Later that day, he was taken to a local veterinary referral clinic for a CT scan of the brain. The animal was anesthetized by masking under manual restraint, then intubation with isoflurane inhalation. The survey CT scan showed a possibly enlarged right side of the cerebrum (mild deviation to the left from center) with hypodense, irregularly shaped areas. Images taken with intravenous contrast showed multiple large ring enhancing lesions throughout the parietal, temporal, and frontal lobes.
with the majority of the ring lesions seen in the right frontal lobe. The ring lesions were considered consistent with central nervous system (CNS) toxoplasmosis. Blood collected at the CT scan was still unremarkable (hyperglycemia 240 mg/dl, negative toxoplasma titer). The animal was hospitalized and continued long term on SMZ/TMP and prednisone (tablets, Roxane Laboratories, Inc., Columbus, Ohio 43216 USA, 1.5 mg/kg p.o. b.i.d. with a tapering dose), pyrimethamine (Daraprim®, DSM Pharmaceuticals, Inc., Greenville, North Carolina 27834 USA, 1 mg/kg p.o. s.i.d.), folic acid (0.12 mg/kg p.o. s.i.d.), and phenobarbital (Qualitest Pharmaceuticals, Inc., Huntsville, Alabama 35811, 2 mg/kg p.o. b.i.d.). After 5 days of hospitalization, the animal appeared to recover well enough (with very little motor deficits observed), to return to the primate section with continued oral therapy. Two weeks later, the monkey had recovered to almost normal.

Sixteen days after initial presentation, seizure activity was noted again, with pronounced left sided deficits and states of stupor. Throughout the day he continued to deteriorate and by afternoon the monkey was hard to rouse. Another examination was done under isoflurane anesthesia and blood was collected for repeat testing. The white blood cell count had risen slightly [mild leukocytosis 13.3 × 10^3/µl with neutrophilia (ISIS 7 normal 7.5 × 10^3/µl)] and the toxoplasma titer was negative. Parenteral dexamethasone, tribrisen, sodium chloride fluids i.v. and s.c. were administered. The animal recovered well and was again hospitalized for monitoring.

The monkey expired overnight. The primary findings at gross necropsy were slightly reddened lungs, mild splenomegaly, and multiple (5-6) cavitated purulent cysts containing mucoid yellow material in the cerebrum. Histopathology described acute pulmonary edema and congestion, moderate lymphoid hyperplasia in the spleen, and multifocal severe abscessing meningoencephalitis with intrallesional gram-negative rods. Aerobic bacterial culture of the abscesses grew moderate *Klebsiella pneumoniae* with intermediate sensitivity to SMZ/TMP. Anaerobic cultures were not performed. No toxoplasma or amoebic organisms were found.

*Klebsiella pneumoniae*, from the family Enterobacteraceae, are ubiquitous, opportunistic, pathogenic, non-motile, gram-negative rod bacteria that have a prominent polysaccharide capsule14, and variable virulence.13 The bacterium can be found as part of normal primate oral and fecal flora and the mode of infection is thought to be fecal-oral, or possibly by inhalation.4 There are thought to be inciting factors that promote development of clinical disease such as stress or immunocompromise.13 *Klebsiella* sp. infections are difficult to treat,6 are most sensitive to cephalosporins, gentamicin, and amikacin, and are generally resistant to penicillins.13 Primate *Klebsiella* sp. infections are considered a zoonotic disease.2,10

*Klebsiella* infections have been reported in a number of primate colonies.3,4,6,8,11,13 Pneumonia was the most common presenting clinical feature of *Klebsiella* sp. infections but has also caused septicemia, peritonitis, enteritis, and meningitis.3,4,13 *Klebsiella pneumoniae* meningitis has been previously reported in primates3,5,13 although it does not appear to be a major presentation of *Klebsiella* sp. infections, based on the bulk of the literature. The infections are usually acute, sometime peracute, and often no antemortem diagnosis is available due to the fast course of disease and the high mortality.3 An anti-*Klebsiella* capsular vaccine was produced by one
institution and as found to reduce the incidence of *Klebsiella* sp. infections without noted side effects.\(^{12}\)

The juvenile patas monkey of this report succumbed to cerebral abscesses in which *Klebsiella pneumoniae* was isolated. It was not determined why he was predisposed to this infection, as no evidence of immunocompromise was discovered. It was possible that he had another bacterial infection that was resolving (hence the recovery after initiation of treatment) and the *Klebsiella* was a secondary opportunistic infection. The primary working antemortem diagnosis was cerebral toxoplasmosis because 7 mo prior to his death a dikdik (*Madoqua guntheri smithi*), that shared the patas exhibit died of toxoplasmosis\(^1\) and the CT scan highlighted ring lesions, which are often found in imaging cases of toxoplasmosis of the CNS. Additional diagnostics, such as blood culture and cerebral spinal fluid analysis, may have assisted in diagnosing a bacterial meningoencephalitis or septicemia. With *Klebsiella* sp. infections, rapid isolation of the offending organism with antibiotic sensitivities is key to appropriate treatment.

**LITERATURE CITED**

HEMODIALYSIS OF A WESTERN LOWLAND GORILLA (Gorilla gorilla gorilla) WITH FATAL SEPTICEMIA AND PYELONEPHRITIS SECONDARY TO URINE STASIS AND A UTERINE LEIOMYOSARCOMA

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Abstract

A 37-yr-old, 89-kg, female western lowland gorilla (Gorilla gorilla gorilla) presented with acute onset of lethargy, anorexia, reduced movement, and self isolation in late September 2003. Diagnostic exams revealed a urinary tract infection, leukocytosis, neutrophilia with left shift, lymphopenia, nonregenerative anemia, azotemia, hypoalbuminemia, hyponatremia, hypochloremia, and hypophosphatemia. Ultrasonography and palpation identified a 12-cm diameter uterine mass. Initial antibiotic treatment with amoxicillin trihydrate/clavulanate potassium, 12.22 mg/kg p.o. b.i.d. (GlaxoSmithKline, Research Triangle Park, North Carolina 27709 USA), was changed to cephalixin 5.69 mg/kg p.o. b.i.d. (Ceph Int’l Corp, Cranbury, New Jersey 08512 USA) according to sensitivities and recommendations for renal patients. The uterine mass was first described in December 2000 as a 5-cm diameter leiomyoma.

On day 4 after presentation, the gorilla was immobilized for 12 hr of peritoneal dialysis due to increased severity of azotemia and a severe hyponatremia. Peritoneal dialysis resulted in a slight reduction of BUN (4.4%) and creatinine (1.7%), and normalization of serum sodium.

Hemodialysis was performed on day 6 after presentation. The hemodialysis treatment lasted 4 hr. Hemodialysis resulted in reductions of BUN (38%) and creatinine (33%), an improved attitude, and increased fluid consumption. On day 7 post presentation during preparations for whole blood transfusion the gorilla progressively weakened, went into respiratory arrest, and died.

Necropsy revealed septic shock as the cause of death. Lesions included chronic severe bilateral suppurative pyelonephritis with multifocal abscesses from which Escherichia coli, Enterococcus sp., Streptococcus intermedius, and Candida glabrata were cultured. A 14 × 12 × 12 cm well-differentiated uterine leiomyosarcoma tightly occupied the pelvis and had adhesions to surrounding structures. The ureters cranial to the uterine mass were dilated.

This case serves as an example of the successful reduction of azotemia via hemodialysis in a zoo setting. It also suggests that uterine smooth muscle neoplasia in gorillas may cause disease over time.

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LITERATURE CITED

COMPARISON AND CONTRAST BETWEEN RECENT PREGNANCIES, CESAREAN SECTIONS, AND RE-INTRODUCTIONS OF NEONATES IN TWO GREAT APE SPECIES AT BUSCH GARDENS TAMPA BAY

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Abstract

Cesarean sections are relatively uncommon procedures in captive great apes. In the period of less than 3 yr, two such procedures were performed at Busch Gardens Tampa Bay; one in a Bornean orangutan (Pongo pygmaeus) and another in a western lowland gorilla (Gorilla gorilla). In both cases the female recovered well and the infant was successfully returned to the mother after a limited amount of hand rearing.

Case 1

A captive-born 16-yr-old female Bornean orangutan was diagnosed as being pregnant with an over-the-counter home pregnancy test (Clearview Home Pregnancy Test, Unipath Ltd., Bedford, MK 44 3UP, United Kingdom) on September 4, 2002. Labial tumescence allowed an estimated gestational age of 4 wk which coincided well with the last observed breeding. Oral progesterone (R.P. Scherer North America, St. Petersburg, Florida 33716 USA), 100 mg p.o. s.i.d. along with pre-natal vitamins (PreCare, Ther-Rx Corp., St. Louis, Missouri 63044 USA) was started to help support the pregnancy. Transabdominal ultrasound training was instituted and at week 16 the fetus could be visualized. The ultrasound exams occurred at irregular intervals to monitor the progression of the pregnancy. Prenatal care also included training to allow visualization and potential manipulation of the nipples along with presenting an infant.

At 7:30 a.m. on March 11, 2003 the orangutan was seen to start labor with some pushing efforts. By 1:00 p.m. she has passed about 200 ml of clear fluid and continued to push. By 5:30 p.m., the contractions had weakened after having her water break. She was monitored all night and by mid-morning on March 13, 2003 she had not delivered and the contractions had stopped. The orangutan was immobilized with a combination of 150 mg tiletamine/zolazepam (Telazol, Fort Dodge Laboratories Inc., Fort Dodge, Iowa 50501 USA), and 32 mg xylazine (Xylazine 100, The Butler Co., Columbus, Ohio 43228 USA) via blowdart. Ketamine hydrochloride, 500mg (Ketaset, Fort Dodge Laboratories Inc., Fort Dodge, Iowa 50501 USA), was administered to facilitate handling and transportation to the zoo hospital. Intravenous catheters were placed in both brachial veins and 0.5% isoflurane (IsoSol®, VEDCO, Inc., St. Joseph, Missouri 64507 USA) was delivered at a low flow of oxygen with the airway maintained with a jaw thrust. Examination by the consulting obstetrician revealed a viable fetus with a strong heart rate and
fluid in the vaginal vault consistent with placental fluid. The orangutan was prepped for abdominal surgery. A 20-cm midline incision was made from just caudal to the umbilicus to the pubis. Intravenous 100 mg ketamine hydrochloride boluses were given every 15 min p.r.n. during surgery to supplement the isoflurane. The bladder was iatrogenically incised but this allowed visualization of the uterus. The fetal head was located cranial to the brim of the pelvis. The uterus had a tight muscular ring around the fetal head, preventing its passage. A low transverse incision was made into the uterus and a viable female fetus removed. The infant was attended to by a neonatologist but had no complications. The uterus was cleaned out and closed in two layers. The bladder was closed in two layers as well. Closure was in two layers in the linea, with additional closure in the subcutaneous and intradermal layers. The infant was allowed to nurse before being placed in recovery. The infant was placed in an isolette in the holding facility. The following day (Day 1 post surgery), the adult female was given hydrocodone/acetaminophen combination (Vicodin 5/500 mg, Abbott Laboratories, North Chicago, Illinois 60064 USA) for analgesia. On Day 2 the adult appeared more depressed. The incision looked good, her mucus membranes were bright and pink, her mammary glands were swollen, and she was taking fluids from staff. A re-introduction with the infant was attempted but she displayed no interest. Additional attempts on Day 3 and Day 4 were made to reintroduce the infant to the adult with essentially no interest. The infant was hand reared until February 3, 2004 when she was successfully re-united with the mother. The female allowed bottles to be given to the infant/juvenile through the mesh as she was no longer lactating. Today the juvenile and female are with another adult female and continue to do well.

Case 2

A captive-born primigravid 33-yr-old female western lowland gorilla was diagnosed pregnant on April 24, 2005 with an over-the-counter home pregnancy test (EPT, Pfizer Consumer Healthcare, Morris Plains, New Jersey 07950). This gorilla had a history of a pelvic fracture in February 2004 and had a spontaneous pregnancy termination in January of 2005. Three days later the gorilla was immobilized with 185 mg tiletamine/zolazepam (Fort Dodge Laboratories Inc.), and 45 mg xylazine (The Butler Company) via a hand syringe for evaluation of the pelvis. Computed tomography showed excellent callus formation of the fractures. Pelvic exam revealed a smooth ring but a small notch was palpated on the right side. The consulting obstetrician was concerned about a vaginal delivery at this point. Prenatal vitamins and oral progesterone was supplemented as in the orangutan case above. Prenatal training consisted of transabdominal ultrasounds and presentation of the mammary glands to the mesh for examination. The pregnancy was monitored with intermittent sonograms. There was virtually no weight gained during the course of this pregnancy (96 kg versus 98 kg). On November 15, 2005, hemorrhage was noted in the female’s holding area. No signs of labor were observed. Placenta previa or possibly cervicitis was thought to be responsible for the bleeding. The next day, (November 16), a sonogram revealed a viable fetus but the placenta may have moved partially in front of the internal os. The gorilla showed no signs of discomfort and was otherwise well. A cesarean section was planned for in 2 wk, pending her progression to the expected due date. The following evening, (November 17), a considerable amount of hemorrhage was noted in the holding area. Again, there was neither distress nor contractions evident. A sonogram was attempted but the gorilla was not cooperative for this procedure. On November 18, a sonogram
was performed across the mesh but only echogenic images consistent with blood clots could be seen. The gorilla was immobilized as above, intubated, and maintained on 1.5% isoflurane. Ultrasound imaging discovered a term fetus with a slow heart rate (40 bpm) and confirmed a diagnosis of placenta previa. A midline abdominal incision was made from the umbilicus to the pubis. A vertical incision was made in the uterus and a healthy 2154-g male infant was delivered. Closure was routine. Ketoprofen, 400 mg i.m. was given intra-operatively for analgesia and the female recovered uneventfully. The next morning she was essentially normal.

The neonate was managed by the attending neonatologist and the veterinary staff. The infant was bradypneic and bradycardic and was immediately intubated with a 3.0 Cole tube and manually ventilated with 100% oxygen. Atipamezole, 0.4 mg, was administered i.m. Within 1 min the breathing rate increased as did the mucus membrane color and refill. The umbilicus was ligated with chromic gut and he was extubated. The infant was placed on the female’s nipple until she was placed in recovery. The infant was fed 7 ml of a commercial human milk replacer every 2 hr overnight. The following morning the infant was placed alongside the female’s holding pen. The infant was fed for the next 10 days in close proximity to the female. The staff was able to massage the nipples and maintain lactation. On Day 11 the two were reintroduced without complication on Day 11 post surgery.

Discussion

Cesarean sections are uncommon in great apes. A few reports on gorillas and no reports on the procedure in orangutans were found in the scientific literature. The prenatal care and training was similar in both cases. Both animals were conditioned to allow transabdominal ultrasound which proved useful in both cases. Both animals allowed some manipulation of the mammary glands although this was much more successful in the gorilla. The use of progesterone was done in both cases to help support the pregnancy to term as a safe guard against inadequate production by the fetal-maternal unit. The gorilla also routinely allowed hand injections.

The anesthetic and postoperative management did vary between the two animals. Low dose tiletamine/zolazepam (~1.5 mg/kg) with xylazine (~0.4 mg/kg) has provided good inductions for all great apes at the facility. The gorilla was well trained for hand injection which made for a smooth and quick induction. The orangutan needed to be darted and was obese which slowed the induction. The orangutan was maintained during surgery with ketamine boluses and a low flow of isoflurane to help with muscle relaxation. It was thought that ketamine would have the least adverse affect on the infant and due to its short half-life, provide a quicker recovery. This technique had been used previously when a quicker recovery was desired or in cases where isoflurane was not available. The gorilla was intubated and managed only with isoflurane. This appeared to make the uterus much more compliant and easier to close. The use of hydrocodone may have had a negative impact on the recovery of the orangutan as well as she appeared to be depressed while on this drug and inattentive to the neonate when early introductions were made. Ketoprofen appeared to provide excellent postoperative analgesia, as the gorilla was fully recovered the next morning and receptive to the infant. Tiletamine/zolazepam combinations have been thought to be the reason for neonatal hypoxia. In the case of the gorilla, the dose was
lower than that reported and the response to atipamezole implicates xylazine as the cause for the neonatal respiratory depression.

The gorilla had an offspring 10 yr earlier at another facility but failed to care for it properly. The orangutan had never given birth before, but both animals had experience with neonates in other facilities. The close proximity of the neonate to the mother was thought to be essential. The use of the opiates in the orangutan may have hindered her response to the infant.

Risk factors for the gorilla included a healed pelvic fracture, a previous miscarriage, and her age. Pelvic trauma and advanced age are both risk factors for placenta previa in women. The major risk to the orangutan was her obesity with her conception weight of 160 lb. Obesity is a risk factor for term delivery as well as anesthetic management. While both cases resulted in the return of the infant to the mothers, differences in the management may have resulted in a quicker return in the gorilla.
DIAGNOSIS AND TREATMENT OF REPRODUCTIVE DISEASE IN A CAPTIVE GROUP OF GELADA BABOONS (Theropithecus gelada)

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Abstract

A high incidence of female reproductive tract disease has been documented in a group of captive gelada baboons (Theropithecus gelada) at the Wildlife Conservation Society-Bronx Zoo from 1979 to 2005. Medical and necropsy records were reviewed for 19 of 33 animals, and reproductive tract disease was diagnosed in 15 (79%) animals. Diagnosis was confirmed by postmortem examination (47%) or by histopathologic examination of surgical biopsies (53%). Adenomyosis (87%) and endometriosis (40%) were the most commonly identified abnormalities, while both conditions were present in 33% of the cases. Ovarian involvement was not a finding in any case.

Clinical signs suggestive of reproductive disease included irregular menses (80%), lethargy/weakness (60%), dysmenorrhea (40%), anorexia/inappetence (33%), and pale mucous membranes (33%). Only one animal (7%) with reproductive disease had none of these signs. Antemortem diagnostics revealed anemia (73%) and abdominal mass (67%) as the most common examination and clinicopathologic and physical examination findings. Radiography (40%) and ultrasonography (80%) were performed in many cases, while laparoscopy was performed in one case (7%). Hormone therapy was pursued in 27% of the cases; ovariohysterectomy was performed in 47% of the cases.

Reports of reproductive tract disease in the gelada baboon are lacking. The findings of this investigation indicate a high frequency of adenomyosis, and close association of adenomyosis with endometriosis. The latter has been demonstrated to be a significant association in infertile women and baboons.² Spontaneous endometriosis in baboons shares important features with the disease in women,¹ and these features appear to be similar to those seen in the gelada baboon.

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LITERATURE CITED


ENDOEOPIC SINUS SURGERY IN A SUMATRAN ORANGUTAN (Pongo pygmaeus abeli)

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Abstract

A male Sumatran orangutan (Pongo pygmaeus abeli) with a history of a marsupialized air sac and chronic recurrent nasal discharge was immobilized with 6.45 mg/kg ketamine (Narketan®, Vétoquinol AG, 3123 Belp, Switzerland) and 8.07 mg/kg, xylazine (Rompun®, Provet AG, 3421 Lyssach, Switzerland) delivered by blow dart for an admission health exam. The animal was intubated (internal diameter of 14mm; Aire-Cuf®, Bivona Inc., Gary, Indiana 46406 USA) and anesthesia was maintained by administration of isoflurane (Attane™, Provet AG, 3421 Lyssach, Switzerland) in oxygen. Hematology and blood chemistry results were within reference ranges.5 Intrapalpebral tuberculin testing was negative. Thoracic radiographs revealed a moderate, age-related bronchial pattern and a slight increased focal radiopacity in the caudal left air sac region. Multi-resistant Pasteurella multocida and E. coli were cultured in bacteriologic examination of purulent nasal discharge and air sac content. Computer tomography demonstrated a chronic destructive rhinitis, a moderate bilateral empyema in the sinusitis maxillaris and sinusitis sphenoidalis with empyema. The animal recovered well after diagnostic workup.

It was decided to perform a minimally invasive functional endoscopic sinus surgery with the purpose to re-establish ventilation and mucociliary clearance of the sinuses. Preoperative medical management included 10 days of antibiotics (10.75mg/kg cefuroxim-axetil, Zinat®, GlaxoSmithKline, 3053 Münchenbuchsee, Switzerland) according to drug resistance testing with a 3-day course of oral steroids (1.07 mg/kg prednisone, Prednison, G. Streuli & Co. AG, 8730 Uznach, Switzerland). The animal was immobilized and maintained under isoflurane anesthesia as previously described. After local application of gauze swabs soaked with 1 ml epinephrine 1:1000 for 5 min to the nasal mucosa to enhance vasoconstriction, the ethmoidal infundibulum, the maxillary sinus, and the frontal recess were opened by bimanual endoscopic surgery using a 4-mm optic (0° and 45°, Karl Storz, Anklin Ltd., Binningen Switzerland) and a paranasal sinus shaver (Karl Storz, Anklin Ltd., Binningen Switzerland).1 Although surgery was performed without significant blood loss or other complications, the orangutan went into ventricular fibrillation at the end of the procedure. Cardiopulmonary resuscitation was immediately initiated, but was stopped unsuccessfully 60 min later.
Pathologic examination confirmed a severe, diffuse, chronic-active air sacculitis and moderate non-suppurative sinusitis on the right side. Bacteriologic culture revealed a *Corynebacterium* spp. and *Clostridium* spp. infection. Acute cardiovascular collapse was identified as cause of death.

Chronic air sacculitis has been documented as a prevalent problem in captive orangutans.²⁴⁻⁶ Etiology is still hypothetic and most reports focus on therapeutic approaches. The frequency of involvement of chronic sinus infection in the occurrence of chronic air sacculitis, as in the present case, is unknown. Nevertheless, recommended treatments such as long-term antibiotics, according to microbiologic analysis, did not improve the condition in this case. Future clinical investigations of air sacculitis and chronic nasal discharge in orangutans should include a thorough evaluation of skull sinuses.

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LITERATURE CITED

EFFICACY OF AN INACTIVATED VACCINE IN THE PREVENTION OF ENCEPHALOMYOCARDITIS VIRUS INFECTION IN CHIMPANZEEs (Pan troglodytes) AND OTHER SPECIES

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Abstract

Encephalomyocarditis virus (EMCV) is in the genus Cardiovirus and family Picornaviridae. It has a worldwide distribution and infects a wide range of species including mammals, birds and arthropods. In the majority of species infection is incidental without causing disease. 2,5,8 Infection in humans is relatively common, however disease is rare. 6,14 However, the virus EVCV is pathogenic in certain species. The domestic species most commonly affected is the domestic pigs (Sus scrofa). EMCV has also caused disease in numerous species of both free-ranging and captive wildlife. 1,2,5,8,10,13 Non-human primates are particularly susceptible. Species affected include chimpanzees (Pan troglodytes), orangutans (Pongo pygmaeus), gibbons (Hylobates spp.), baboons (Papio spp.), mandrills (Mandrillus sphinx), De Brazza’s guenons (Cercopithecus neglectus), African green moneys (Cercopithecus aethiops), black and white colobus monkeys (Colobus guereza), squirrel monkeys (Saimiri sciureus), golden-lion tamarins (Lentopithecus rosalia rosalia), owl monkeys (Aotus spp.), ring-tailed lemurs (Lemur catta) and ruffed lemurs (Varecia variegata). Non-primate species affected include addax (Addax nasomaculatus), scimitar-horned oryx (Oryx dammah), lowland nyala (Tragelaphus angasi), gerenuk (Litocranius walleri), Thompson’s gazelle (Gazella thomsoni), llama (Lama glama), dromedary camel (Camelus dromedaries), African elephant (Loxodonta africana), black rhinoceros (Diceros bicornis), pygmy hippopotamus (Choeropsis liberiensis), two-toed sloths (Choloepus didactylus), lions (Panthera leo), Goodfellow’s tree-kangaroo (Dendrolagus goodfellowi), Lumholtz’s tree-kangaroo (D. lumholtzi), 1 quokka (Setonix brachyurus), common wombat (Vombatus ursinus) and numerous rodent species. 7 Interestingly there have been no reports of EMCV infection (no seroconversion in EMCV endemic areas) or disease in gorillas (Gorilla gorilla). EMCV is highly pathogenic in African elephants, while Asian elephants (Elephas maximus) seroconvert without developing disease. 2

The epidemiology of EMCV is poorly understood. 2,5 Rodents are thought to be the primary reservoir of the virus. However, virus is rarely isolated from rodents during epizootics of EMCV, so infection in rodents is thought to be transient. Virus is most likely excreted in feces and urine. There is evidence of a correlation between increased rodent numbers and incidence of disease. 4,11,13 Anecdotally this has been our experience at Taronga Zoo. Other species including arthropods may also act as reservoirs or transport hosts for the virus. Animals may be infected by consuming contaminated food or water (the source of infection may therefore be remote from the facility where disease occurs), direct contact with contaminated environments or consumption of...
rodent carcasses. The primary route of infection is oral. Vertical transmission has been demonstrated both experimentally and in natural infections in swine, and has been suspected in some non-human primate species. Whether an infected animal remains subclinical or develops clinical disease depends on many factors, including viral dose, virus strain, species of animal, age, health, and immune status of the animal. EMCV can survive in the environment for extended periods and fomite transmission is possible. The virus does not survive dessication and is readily killed by heating to 60°C for 30 min and most disinfectants. A gender-related susceptibility to the pathogenic effects of EMCV has been observed, with females being more resistant than males. All EMCV related chimpanzee deaths (n = 7) at Taronga Zoo have been males. Numerous unvaccinated female chimpanzees have had elevated antibody titers indicating exposure without disease. This has also been observed in mice and in an EMCV epizootic in African elephants where 83% of fatalities were adult bulls, despite there being a slightly higher infection rate in female elephants.

The most common clinical presentation of EMCV infection in zoo animals is sudden death due to acute, non-suppurative, necrotizing myocarditis in an otherwise healthy animal. Occasional signs such as lethargy, anorexia, weakness, dyspnea, incoordination, salivation and frothing at the nares have been reported 12-24 hr prior to death. Antemortem diagnosis is difficult due to the peracute nature of the disease. Animals rarely survive long enough to seroconvert. Gross pathologic findings can be subtle and include pale streaked or mottled myocardium, epicardial or myocardial hemorrhage, cardiac dilation, pale myocardium, pericardial effusion, hydrothorax, ascites and pulmonary edema and congestion. Histologically there is focal to diffuse, interstitial, non-suppurative myocarditis. Encephalitis is rarely seen in zoo and wild animals. Pancreatic necrosis may be seen in some cases. A definitive diagnosis can be made by virus isolation. The preferred tissues for virus isolation are heart and spleen. Immunohistochemistry can also be used to confirm diagnosis.

The most effective method of preventing EMCV infection in a zoological collection is an intensive, integrated pest management program. In collections where EMCV infections occur it is strongly recommended that qualified and trained pest management personnel are employed to run the program. In addition, a vaccination program for susceptible species, particularly males, is recommended. Various live attenuated and inactivated EMCV vaccines have been developed using several different adjuvant systems. The safety and efficacy in terms of maintaining sustained protective antibody titres against infection have not been fully evaluated for many of these vaccines. In many cases antibody responses were variable and short-lived. An effective inactivated vaccine was developed in response to an epizootic in African elephants in South Africa. The vaccine was shown to produce good antibody titers 7-10 days post vaccination and protected 100% of vaccinated animals from challenge with virulent virus. There is currently no commercially available EMCV vaccine.

Taronga Zoo has had a long history of EMCV infections causing mortality in numerous species. EMCV infection was also likely to have been the cause of severe dilated cardiomyopathy in a female orangutan that survived for approximately 1 yr after onset of clinical signs. The animal had high EMCV antibody titres (1:6,240). EMCV was also the cause of death of an African elephant at Western Plains Zoo, Dubbo, Australia. In 2000, Taronga Zoo, in
conjunction with the NSW Department of Primary Industries, developed an inactivated EMCV vaccine using the highly effective adjuvant Montanide ISA 206. The vaccine was administered to Barbary sheep (*Ammotragus lervia*), Indian antelope (*Antilope cervicapra*), eastern wallaroos (*Macropus robustus*) and chimpanzees. All vaccinated animals developed significant antibody titers. The vaccine has since been used on a variety of susceptible species within the Taronga Zoo collection. Chimpanzees and orangutan are vaccinated annually, while other species such as western lowland gorilla, silvery gibbon (*Hyllobates moloch*), quokka and Goodfellow’s tree kangaroo are vaccinated opportunistically. All animals are vaccinated with a 2 ml dose regardless of body mass, and are anesthetized for vaccination to ensure deep intramuscular injection is achieved. In smaller species the dose may be divided and injected in two sites. The great apes are vaccinated in the deltoid or triceps muscle while most other species are vaccinated in large muscles of the thigh. Only one vaccination reaction has been observed: a quokka receiving 1 ml of vaccine into each hind leg developed a mild cellulitis at the vaccination sites which resolved without intervention after a few days. Species that are relatively easy to restrain and anesthetize receive a primary vaccination and a booster 4 wk later. Most other species are vaccinated just once and then annually or opportunistically. At the time of every vaccination a blood sample is obtained to determine EMCV antibody titers. This is done using a virus neutralization test (VNT), in which a set amount of serum from the animal is passaged in wells, until a dilution titre is obtained in which the EMCV virus in the well can be detected again. Antibody titres $\geq 1:64$ are positive, $\leq 1:32$ is inconclusive and $<1:4$ is negative. The greater the dilution titer observed before virus is detected, the greater the immune response to the vaccine. Eighteen chimpanzees have been vaccinated since 2000. Eight animals had positive titers at the time of first vaccination indicating previous exposure to the virus. Antibody titers were maintained at a high level post vaccination and there was no evidence of waning titers over the 12-mo inter-vaccination interval in the majority of animals. Since antibody titers appear to be maintained at a high level for up to and possibly longer than 12 mo, the inter-vaccination interval has now been increased to 18 mo. A Goodfellow’s tree-kangaroo had a negative antibody titer at the time of first vaccination and an antibody titre of 1:512 at the time of second vaccination 1 mo later. Two quokkas were vaccinated twice, 4 wk apart. Antibody titers at the time of first vaccination were negative and were 1:32 and 1:64 by the second vaccination. A silvery gibbon had a negative titer 15 mo after a single primary vaccination. A male orangutan had a positive titer at the time of first vaccination and maintained high antibody titers post vaccination after three subsequent annual vaccinations. An aged female orangutan has maintained high antibody titers despite never having been vaccinated.

Although live virus challenge has not been conducted there has been no case of EMCV infection causing disease in any vaccinated animal at Taronga Zoo. Pest management has been rigorous since the vaccination program commenced; however, there have been periods of increased rodent numbers. It is therefore presumed that the vaccine induced antibody titres are protective.

**ACKNOWLEDGMENTS**

The authors thank Kaye Humphreys, Peter Kirkland, Karrie Rose and the veterinary nurses and keepers at Taronga Zoo for their assistance with this work.
LITERATURE CITED

MYELOPROLIFERATIVE DISEASE IN A GOLDEN-HEADED LION TAMARIN (Leontopithecus chrysomelas)

Michael J. Adkesson, DVM,1,2* Martha Weber, DVM, Dipl ACZM,1 Mary Duncan, BVMS, PhD, Dipl ACVP,1 Melissa Salgado, BS,3 Erika K. Travis, DVM,1,2 and Randall E. Junge, DVM, MS, Dipl ACZM1

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Abstract

A 9-yr-old golden-headed lion tamarin (Leontopithecus chrysomelas) presented with non-specific signs of illness including pale mucous membranes, unthriftiness, and a recent non-healing pressure sore related to chronic hindlimb neuropathy. Physical examination revealed marked peripheral lymphadenopathy. Bloodwork revealed a regenerative anemia (Hct = 20.7%, RBC = 3.38 × 106/µl, reticulocytes=11%), leukocytosis with a left shift (WBC = 20.1 × 103/µl, 89% segmented neutrophils, 4% band neutrophils, 7% lymphocytes), and hyperglobulinemia (6.1 g/dl). Lymph node fine needle aspirates were indicative of suppurative inflammation, although no associated infectious or inflammatory foci were identified on physical examination or radiographs. Antibiotic therapy was initiated with sulfamethoxazole and trimethoprim (30 mg/kg p.o. b.i.d.; Sulfatrim pediatric suspension, Alpharma USPD Inc., Baltimore, Maryland 21244 USA). Bloodwork 7 days following initial presentation showed no improvement. A second antibiotic was added at this time (enrofloxacin, 10mg/kg i.m. every 24 hr; Baytril, Bayer Healthcare LLC, Shawnee Mission, Kansas 66201 USA). A recheck exam on day 16 showed no change in the lymphadenopathy and minimal improvement in blood parameters. An ultrasound exam on day 19 revealed a 3 × 1.8 cm mass caudal to the right kidney with homogeneous echogenicity. An ultrasound guided aspirate of the mass revealed a pleomorphic population of reactive inflammatory cells and was considered consistent with an abscess. An exploratory laparotomy was performed 2 days later. A 2 × 2 × 2.5 cm, brown, encapsulated, fluctuant mass was found adhered to the vena cava and right kidney. The mass was excised and had no obvious organ of origin. Histopathology revealed the mass consisted of channels containing red blood cells, hematopoietic cell clusters, and occasional multinucleate cells with nodules of lymphoid tissue, which was considered to be consistent with myeloproliferative disease. Surgical recovery was uncomplicated. Bloodwork 13 days following surgery showed slight improvement of the anemia and leukocytosis, however, the animal continued to appear depressed and lethargic. The tamarin was humanely euthanatized 16 days following surgery due to the poor prognosis and a decline in the animal’s attitude. Serology for HSV-1, SRV, STLV, Herpes tamarinus, H. saimiri, squirrel monkey CMV, LCM IgG, and Epstein-Barr were all negative at the time of euthanasia. Necropsy supported the biopsy diagnosis with histopathologic evidence of disseminated myeloid hyperplasia affecting the spleen, lymph nodes, and bone marrow. In contrast to neoplasia of lymphoid origin, myeloproliferative disorders have been rarely reported in the literature in non-human primates. To the authors’ knowledge this is the first report in the
literature of a case affecting a golden-headed lion tamarin. The case is of particular interest due to the difficulty in establishing a definitive diagnosis, particularly as aspirates and bloodwork suggested an infectious etiology. Myeloproliferative disease should be considered as a differential diagnosis in any case of lymphadenopathy of unknown etiology.
INDIRECT OSCILLOMETRIC BLOOD PRESSURE MEASUREMENT IN FOUR AFRICAN ELEPHANTS (Loxodonta africana)

Wm. Kirk Suedmeyer, DVM, Dipl ACZM and Deborah Fine, DVM, Dipl ACVIM

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Abstract

The elephant is the largest living land mammal and in danger of extinction. The few literature citations involving blood pressure (BP) measurements have utilized direct arterial measurement of immobilized or stationary conditioned elephants. These investigations determined that BP’s in the healthy elephant are generally higher than most other clinically normal mammals studied but similar to unsedated domestic cattle and horses, and increased in laterally recumbent elephants. This project was undertaken to compare cited direct arterial measurements to indirect oscillometric BP measurement of systolic, diastolic, and mean arterial pressure (MAP), and heart rate (HR) in four stationary, non-sedated African elephants.

Four female African elephants ranging in age from 28-38 yr of age were used in this study. One elephant (E3) had a history of fetal retention of 5 yr and bilateral scleral injection but was clinically normal in all other regards. The three remaining elephants had no significant clinical histories.

All four elephants were conditioned to present the tail for placement of a standard occlusive BP cuff (Cardell™, CAS Medical Systems, Inc. Branford, Connecticut 06405 USA). Use of this indirect oscillometric unit has been compared with simultaneous direct arterial measurement in anesthetized African lions (Panthera leo), and an immobilized African elephant at the Kansas City Zoo. Blood pressure results in each animal studies were virtually identical in both techniques.

The width of the cuff was approximately 40% the circumference of the tail (12 cm cuff on an average 27.5 cm tail circumference) of the elephant, in accordance with general recommendations for obtaining BP measurements in domestic animals. Cuff placement was at the distal extent of the caudal tail fold. Three sets of BP’s, heart rates, and respiratory rates were obtained on three different occasions in each elephant (Table 1). Each elephant was sampled at the same time of day and had not been exercised.

Blood pressure measurements obtained in three of the four elephants in this population compared favorably with reference ranges obtained invasively (direct arterial) in unsedated African elephants. In the elephant with scleral injection and retained fetal mummy (E3), overall BP measurements were higher, on average, than the other three elephants and ranges reported in a previous study of direct arterial pressures in unsedated African elephants. This may reflect a
hypertensive state related to increased systemic vascular resistance associated with a retained calf. However, this elephant is the oldest of the four animals studied, and blood pressure parameters generally increase with age in humans and this may be the case with this elephant. Further investigation into the potential causes for a clinical hypertensive state in this elephant are being pursued.

The advantages of this technique are the non-invasive application, portability, and comparable results to direct arterial measurement. Disadvantages are that BP measurement can be altered by cuff size, placement, and movement. In this study, cuff placement and size was identical in all elephants, and the only movement was associated with masticatory efforts involved with positive food enrichment, eliminating two of the three variables. Additional elephants are being evaluated and refinement of BP measurement techniques are being completed to help define normal indirect oscillometric BP values in the African elephant.

Use of an indirect oscillometric measuring device for obtaining BP measurements in African elephants may prove to be an easily applied valuable ancillary diagnostic tool when evaluating cardiovascular parameters without the need for sedation or immobilization.

ACKNOWLEDGMENTS

The authors thank the Kansas City Zoo elephant care staff for their expertise in behavioral conditioning of the African elephants at the Kansas City zoo and the countless individuals and institutions striving to conserve the elephant.

LITERATURE CITED

Table 1. Indirect oscillometric blood pressure measurements in African elephants (*Loxodonta africana*) (pressures in mm Hg, rates/min).

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<thead>
<tr>
<th>Animal</th>
<th>Date</th>
<th>Time</th>
<th>Systolic</th>
<th>Diastolic</th>
<th>MAP</th>
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IDENTIFICATION OF TWO NOVEL HERPESVIRUSES ASSOCIATED WITH OCULAR INFLAMMATION IN ASIAN ELEPHANTS (Elephas maximus)

James F.X. Wellehan, DVM, MS, Dipl ACZM,* April J. Johnson, DVM, April Childress, and Ramiro Isaza, DVM, MS, Dipl ACZM

Zoological Medicine Service, Department of Small Animal Clinical Sciences, College of Veterinary Medicine, University of Florida, Gainesville, FL 32610 USA

Abstract

Disease caused by a herpesvirus (EEHV) is a serious concern in Asian elephant (Elephas maximus) calves.1 Herpesviruses are known for latency and life-long infections, with periodic shedding from mild inflammatory lesions in adapted adult hosts, and ocular disease has been seen with other herpesviruses in other species. Ocular inflammation is not uncommonly seen in Asian elephants. Degenerate PCR primers targeting a conserved region of herpesvirus DNA-dependent DNA polymerase2 were used to amplify products from eye swabs of eight Asian elephants with epiphora, blepharitis, and conjunctivitis. Nucleotide sequencing of the PCR products showed two novel herpesviruses distinct from EEHV. Comparative sequence analysis shows that these viruses are probable members of the subfamily Gammaherpesvirinae. The sequence phylogeny of these viruses has implications for both viral and host evolution. Further understanding and characterization of these viruses is needed to understand their role in elephant health.

LITERATURE CITED

PRELIMINARY RESULTS OF A CABERGOLINE TRIAL IN CAPTIVE ELEPHANTS WITH HYPERPROLACTINEMIA

Ray L. Ball, DVM1* and Janine Brown, PhD2

1Busch Gardens Tampa Bay, 3605 Bougainvillea Drive, Tampa, FL 33674 USA; 2Smithsonian Institution, National Zoological Park, Conservation & Research Center, Front Royal, VA 22630 USA

Abstract

Introduction

An Asian elephant (Elephas maximus) at Busch Gardens Tampa Bay (BGT) was diagnosed with hyperprolactinemia, with a persistently elevated serum prolactin concentration greater than 15 ng/ml, by the Conservation & Research Center (CRC) laboratory in January 1996. She also had a number of other problems, including uterine disorders that resulted in consistently elevated progesterone. In March 2002, she was given cabergoline orally at a dose of 1 mg twice weekly p.o. for 6 mo. Cabergoline is a long-acting dopamine receptor agonist with a high affinity for D2 receptors. It exerts a direct inhibitory effect on the secretion of prolactin. Cabergoline (Dostinex®, Pfizer Inc. Kalamazoo, Michigan 49007 USA) was purchased from a local pharmacy. Serum prolactin concentrations declined almost immediately after treatment initiation, followed about 1 mo later by a drop in progesterone to baseline. Progesterone secretion remained low until November 2002 when she resumed cycling based on the observation of a normal luteal phase based on serum progesterone profile. From November 2002 through January 2004 she exhibited four normal estrous cycles. Prolactin secretion also remained within the normal range for elephants,1 over 1 yr after treatment withdrawal. This female suffered no adverse effects due to the cabergoline treatment. There were no behavioral changes noted or changes in appetite. Given the need to increase reproductive rates of African elephants (Loxodonta africana) to prevent captive extinction, it might be efficacious to treat genetically valuable females with cabergoline in the hope it will reinitiate reproductive cyclicity. Nearly 1/3 of African elephants with hormone data are not cycling normally, and in an earlier study 1/3 of these (11 of 30) were found to have increased serum prolactin levels.1

Methods and Materials

A clinical trial was undertaken with six captive African elephant females that were identified as good candidates for a cabergoline treatment study (i.e., they are acyclic and had mean prolactin concentrations of >15 ng/ml). The treatment consisted of 1 mg cabergoline given twice weekly p.o. for 6 mo. Serum was banked and then analyzed at the CRC for progesterone and prolactin.1 All elephants were thought to be otherwise healthy. Because prolactin is known to be an inflammatory marker,4 all candidates were required to have a negative lateral flow immunochromatograpy (Rapid Test) and multiple antigen immunoassay (MAPIA) for Mycobacteria tuberculosis.5
Results

A summary of the results is given in Table 1. The treatment period is complete for three elephants, all of which showed a decrease in prolactin levels. Elephant 1 showed a good response while on treatment, but did not cycle and serum prolactin has subsequently risen to pre-treatment levels. Increasing the dose in Elephant 2 and 3 reduced prolactin to baseline levels, but again did not result in a return to ovarian cyclicity. Elephant 4 was taken off the study after only a few doses due to increased aggressive behaviors. This is believed to be due to changes in the group social dynamics and not related to the cabergoline, as this behavior has continued after withdrawal of the drug. Based on these findings, the two newest candidates, Elephant 5 and 6, with very high prolactin concentrations have been placed on 2 mg/twice weekly for 1 yr pending continuation of this project.

Discussion

Normalization of prolactin levels facilitated the return of normal cycles in an Asian elephant, but none of the African elephants have resumed cycling so far. Thus, while the use of cabergoline shows promise in reducing elevated prolactin levels in both Asian and African elephants, other factors may need to be considered or a longer course at higher doses may be required for treatment to be successful in reinitiating ovarian activity. The latter suggestion is supported by two of the animals (Elephants 2 and 3) in this limited trial, in which a decline in prolactin occurred after the dose was increased. Understanding the etiology of hyperprolactinemia in elephants may also help in returning females to normal cycling. Relapse of hyperprolactinemia is more common in humans with micro- or macroprolactinomas.2 Chronic estrogen stimulation is also known to increase prolactin levels.3 A proposed pathophysiology is that elevated estrogen levels from persistent cycling will lead to elevated prolactin levels and acyclicity. A difference between the two species in the causes of and potential treatment options for hyperprolactinemia should also be evaluated more closely.

ACKNOWLEDGMENTS

We would like to thank the participating zoos for their cooperation and patience during this trial.

LITERATURE CITED

Table 1. Treatment dates, doses, and responses to cabergoline treatment in captive elephants.

<table>
<thead>
<tr>
<th>Elephant Number</th>
<th>Dates of Treatment</th>
<th>Dose</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2/2005-1/2006</td>
<td>1 mg (2X/wk)</td>
<td>Prl&lt;sup&gt;a&lt;/sup&gt; averaged ~15 ng/ml. After treatment, Prl declined to normal baseline (~6 ng/ml) until 9/05 and now has returned to slightly elevated concentrations (~13 ng/ml). No change in cyclicity status.</td>
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<tr>
<td></td>
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<td>Prl averaged ~30 ng/ml, but had started to decline before treatment. During treatment, prl averaged ~10 ng/ml, with occasional spikes of 20-50 ng/ml. No resumption in cyclicity. Decided to increase dose.</td>
</tr>
<tr>
<td></td>
<td>2/2005-Current</td>
<td>2 mg (2X/wk)</td>
<td>Prl decreased further to ~5 ng/ml from 2/17-4/27, but then surged for 3 wk in May 2005, followed by now baseline levels (&lt;10 ng/ml). No change in cyclicity status.</td>
</tr>
<tr>
<td>2</td>
<td>6/2004-2/2005</td>
<td>1 mg (2X/wk)</td>
<td>Prl averaged ~40 ng/ml pretreatment, decreased to ~25 ng/ml, but still considered elevated and no change in cyclicity status, so increased the dose.</td>
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<td></td>
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<td>Within 2 wk, prl declined to normal baseline (&lt;10 ng/ml) and remained low until treatment withdrawal. After 2 wk, prl started to rise, peaked at 70 ng/ml, and now remains elevated at ~30 ng/ml. No change in cyclicity status.</td>
</tr>
<tr>
<td>3</td>
<td>8/2004-12/16/2004</td>
<td>1 mg (2X/wk)</td>
<td>Stopped after a couple of weeks due to aggressive behavioral change</td>
</tr>
<tr>
<td>4</td>
<td>5/28/2005-6/14/2005</td>
<td>1 mg (2X/wk)</td>
<td>Variable Prl, ranges from 20-80 ng/ml. Recommend 2 mg twice weekly for 1 yr.</td>
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<tr>
<td>5</td>
<td>Pending</td>
<td></td>
<td>Very high average prl (off curve) &gt;80 ng/ml. Recommend 2 mg twice weekly for 1 yr.</td>
</tr>
<tr>
<td>6</td>
<td>Pending</td>
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<sup>a</sup>Serum prolactin.
SERUM CORTISOLS IN CAPTIVE ASIAN ELEPHANTS (Elephas maximus) IN DIFFERENT MANAGEMENT SYSTEMS AT BUSCH GARDENS TAMPA BAY

Ray L. Ball, DVM1* and Otto Fad

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Abstract

Introduction

Cortisol is a widely accepted measure of stress in wild and captive animals. In the past, captive elephant management systems have been criticized as potential stress inducers. The analysis of fecal cortisols is non-invasive and has been used to give long term evaluations of social and ecologic pressures in elephants and other species.2 Salivary cortisols have also been used as a minimally invasive technique to measure social stress in captive elephants.1 The herd of Asian elephants at Busch Gardens Tampa Bay (BGT) changed from a traditional contact management (free contact, FC) to a protected contact (PC) system utilizing positive-reinforcement based operant conditioning in 2004. Serum cortisols were measured after the change and evaluated along with banked samples from before. Long term sampling will be utilized to measure this transition but evaluating a single process will hopefully reflect the overall changes that can be expected with this change in management. While the individual variations are notable and other issues potentially confound the issue, it appears that this transition has lowered the serum cortisols in this herd. In addition to serum cortisol measurements, the actual process of collecting the samples appears to be less stressful behaviorally. Pathologic processes should not be discounted when considering cortisol levels in evaluating stress in captive elephants.

Methods and Materials

Six female Asian elephants (Studbook numbers 30, 32, 304, 34, 35, 3) had been managed in a free contact system for many years. Studbook number 304 was captive born and the others were wild born. Serum was collected intermittently during this management system to bank and for reproductive hormone analysis. The elephants were placed in lateral recumbency by the handlers and blood collected from the ear vein on the caudal aspect of the down ear. Reproductively sound animals were bled more frequently than the others. Serum was frozen at -80°C until analyzed.

In August 2004, the first group of three animals was moved to the new barn and started the new positive-reinforcement, PC management system. Within 5 wk, all animals had been moved over. All animals had been trunk washed and were culture negative for Mycobacterium tuberculosis and negative on the newly developed MultiAntigen Print ImmunoAssay (MAPIA) and lateral-flow technology (Rapid Test) developed to detected antigen to M. tuberculosis.
As the caudal aspect of the ear was used for sampling, each elephant was asked to station in a static chute designed to allow training of voluntary ear-presentation for manipulation and blood collection. Handler safety and creating an effective learning environment for the elephants required training each to proceed to the chute solo and station there calmly. General desensitization techniques were applied as session durations were increased. Within the chute, individual elephants had significant room to maneuver. Since no physical restraint or sedation was utilized, animals were trained to cooperate fully and voluntarily allowing for blood sampling and other husbandry procedures. By May 2005, training for voluntary blood draws was firmly established on all six animals.

The first approximately 20 samples collected under this new system were matched against the samples collected in the previous system. Samples were selected against if the animal had an active problem or was on therapy for any reason. Several animals had undergone a drug trial and these samples were selected against as well. Serum was again stored in -80°C freezer until analyzed at Conservation and Research Center (CRC) Endocrine Research Laboratory, Smithsonian Institution, National Zoological Park, Front Royal, VA. T-tests were utilized to discern any statistically significant results in the mean serum cortisols collected from animals before and after the implementation of the new husbandry systems. Results were considered significant at alpha levels <0.05.

**Results**

The results and simple means of serum cortisols are listed in Table 1. Elephant No. 34 had essentially the same level of cortisol in both systems. Elephant No. 32 had a reduction in the mean cortisol level of approximately 32% (20.84 versus 14.28 ng/ml) from the FC to the PC system. Elephant No. 304 had a similar reduction of 37% in the mean cortisol (22.59 versus 14.29 ng/ml). Statistical analyses results are reported here (means, standard deviations, t-test results).

**Discussion**

Serum was chosen over salivary and fecal sampling as a means to measure cortisol for several reasons. While fecal and salivary cortisol changes can reflect stresses within a reasonable period after the stressor (approximately 24 hr), serum cortisols is more likely to be reflective of the stressors closer to the moment of sampling. The methodology is straightforward and less subject to the hazards for sample storage. Timeliness of the sample result is also a benefit to serum sampling. Blood sampling is a required husbandry practice in all elephant holding facilities belonging to the American Zoo and Aquarium Association (AZA). While fecal cortisol samples may be useful to look at over a long term period to evaluate the transition from FC to PC, we choose to additionally look at how one specific task, blood collection, was affected by making this transition. Fecal cortisols have been used to measure stress in transportation and environmental stress in some species, but are not thought to be reflective of the stress in a diagnostic procedure itself. For this evaluation, the lag time period between the potential stressor (blood collection) and the means to measure the stressor are same. Elephants No. 304 and 32 both had significant reductions in the mean serum cortisol levels. Both are in good health.
and had no apparent inflammatory problems. The logical deduction here is that the sampling process itself is less stressful in the PC management than the FC management. Elephant 34 and 30 had essentially the same level of serum cortisol as measured by the mean in the different management systems. Elephant 34 has developed significant uterine leiomyomas during the time period measured. Elephant 30 has recently had clinical bouts of anterior enteritis and is suspected of having a dietary hypersensitivity to wheat. Even with these two pathologic processes, the serum cortisol did not rise. Elevations in cortisol are quite often explained as resulting from social, behavioral, or environmental causes and little attention is paid to inflammatory causes. Associations between infections and elevated cortisols\textsuperscript{3,5} have been noted in wild animals. It is reasonable to assume that if these two processes did not exist, these levels would indeed be lower. Based on the other two elephants, a reduction of approximately 30% could be expected. Overall it appears that collecting blood from the elephants at BGT in the PC system is less stressful than the FC system. As this is an example of how the routine husbandry and medical husbandry is now conducted, it can be expected that the overall net effect is going to be lowered stress in the elephants at BGT.

ACKNOWLEDGMENTS

We would like to thank the Pachyderm Palace (Elephant management) Team and the Veterinary staff at Busch Gardens Tampa Bay, but especially the six elephants for their patience with us.

LITERATURE CITED

Table 1. Serum cortisol concentration of Asian elephants at Busch Gardens Tampa Bay in free contact management (FC) and protected contact management (PC). | #34 DOB: 1970 | #30 DOB: 1972 | #304 DOB: 1972 | #32 DOB: 1969 |
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Mean FC 19.66 22.59 20.85
Mean PC 20.68 17.37 14.29

Dates in bold were during the period of free contact (FC) and non bold dates were during the period of protected contact (PC).
Clinical Evaluation of Distal Limb Radiography and Growth Plate Closure in the Juvenile Asian Elephant (Elephas maximus)

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Abstract

The thoracic limb digits of 11 healthy juvenile Asian elephants (Elephas maximus) were evaluated radiographically to assess normal developmental anatomy. Parameters evaluated included: the location(s) of centers of ossification, relative age at time of phalangeal ossification, and relative times of growth plate closure in the bones of the distal forelimb. Specifically, the third phalanx (P3) of each digit was evaluated, as well as the first (P1) and second (P2) phalanges of the third digit (D3). A retrospective evaluation of radiographs from juvenile elephants was also done to augment the data set. This study reports the methods used to obtain high-quality radiographs of the elephant foot, the locations of centers of ossification based on radiographic evaluation, and the relative times of growth plate closure within the digital bones. The settings used to obtain the radiographs used in this study for P3 are presented in Table 1. Radiographs of D3, P1, and P2 were obtained in a similar manner, using a 45° angle for focal spot positioning. The kilovoltage power and milliampere seconds were adjusted as needed. Radiographic evaluation of the juvenile Asian elephants revealed variability in the shape of P3 based on age of the animal and degree of ossification of P3. The relative times of growth plate closure and number of ossifications were also determined. The information presented will help clinicians in radiographing elephants, interpreting foot radiographs, and recognizing normal versus abnormal anatomy. It will also help in aging juvenile elephants, investigating diseases and deaths, and recognizing normal patterns of toe and foot development.

Acknowledgments

The authors thank the College of Veterinary Medicine’s Resident Intramural Competitive Grants Program for financial support; the Radiology Department and Zoological Medicine Service at the University of Florida’s Veterinary Medical Center for technical assistance; and Zoo Atlanta and Feld Entertainment for the opportunity to work with their elephants and trainers.
Table 1. Radiographic techniques for the third phalanx of the juvenile Asian elephant (*Elephas maximus*) forelimb using two film/cassette speed combinations.

<table>
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<th>400 speed combination</th>
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<td></td>
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<td>Mean</td>
<td>n^a</td>
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<td>164</td>
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^aNumber of phalanges evaluated. Range represents minimum and maximum values recorded. All radiographs were done using the MinX 80 portable radiography machine, using a 45° angle for focal spot positioning.
BIOCHEMICAL MARKERS OF BONE IN ASIAN ELEPHANTS (Elephas maximus): A CROSS SECTIONAL ANALYSIS OF TWO SERUM MARKERS OF BONE FORMATION AND ONE SERUM MARKER OF BONE RESORPTION

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Abstract

Conventional radiography has traditionally been employed for investigations of skeletal disease of captive elephants. However, it is predominantly cortical bone which is assessed by standard radiography, and quantitative assessment of bone is only possible when pathology is advanced. A precise and relatively non-invasive method of quantitatively assessing bone, in isolation, or as a compliment to standard radiography would have positive health and welfare implications for elephants, because skeletal disease is prevalent in both extant species in captivity. The advent of biochemical markers of bone metabolism represents a watershed in non-invasive diagnostics of normal bone homeostasis and pathology in humans and animals alike. These markers are classified as markers of formation and resorption and are comprising of enzymes expressed by osteoblasts or osteoclasts, or organic compounds released during the synthesis or resorption of bone matrix.

In this study, two human enzyme immunoassays (METRA™ Osteocalcin EIA kit, METRA™ BAP EIA kit, Quidel Corporation, San Diego, California 92121 USA) and one radioimmunoassay (UniQ™ ICTP RIA, Orion Diagnostica, Espoo, Finland) were validated and used to measure osteocalcin (OC), bone alkaline phosphatase (BAP), and the C-terminal telopeptide domain of type I collagen (ICTP) respectively, three biochemical markers of bone, in serum procured from a small sample population (n=12) of captive Asian elephants (Elephas maximus) of various ages, from three European zoos. Serum from four adult females sampled on 7 days consecutively were also analyzed to assess the existence and magnitude of the intra-individual, day-to-day variability of these markers.

Excellent cross reactivity was found to exist between assay antibodies and elephants marker antigens. Significant inverse correlations were found between the age of the animals and concentrations of all three markers. Strong significant positive correlations were also noted between serum concentrations of all three markers. No statistically significant intra-individual variability was found over 7 days in the population of adult females for any of the markers assessed. The results suggest a promising role for biochemical markers of bone turnover in monitoring skeletal growth and bone disease in captive Asian elephants.
ACKNOWLEDGMENTS

The authors wish to thank Drs. Willem Schaftenaar, DVM, and Dr. Andreas Knieriem, DVM, of Rotterdam and Hannover Zoological Gardens, respectively, whose co-operation and provision of vital samples were imperative to the completion of this research. In addition, sincere thanks go to Professor David Church, and the Department of Clinical Studies, Royal Veterinary College, London, for financial support of this study.

LITERATURE CITED

MANAGEMENT OF DIGITAL OSTEOMYELITIS IN AN ASIAN ELEPHANT (Elephas maximus)

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Abstract

A 47-yr-old female Asian elephant was diagnosed with osteomyelitis of the left front digit 5, involving phalanges 1 and 2. Based on culture results of Pseudomonas and Bacteroides, enrofloxacin and metronidazole rectal suppository treatment was started. Serum levels were measured and different formulations were developed to attempt to deliver appropriate drug levels.

The osteomyelitis progressed over the next 55 days. Enrofloxacin was discontinued based on culture and sensitivities (C&S) and regional limb perfusion (RLP) using amikacin started. From this point on, daily treatments with RLP have been performed. The 3-g amikacin dose was based on 5% of the elephant's systemic dose. Two weeks later, RLP with 6 g of ampicillin was started on alternate days based on C&S, and the following week, 400 mg fluconazole was added on a third day in response to C&S and tissue biopsies indicating invasive Candida.

Despite aggressive medical therapy, radiographs and bone biopsy indicated the osteomyelitis continued. Surgery was performed 3 mo after systemic antibiotics were initiated. All infected bone and tissue was identified with methylene blue, and removed. Only the most proximal third of P1 remained post surgery. Post surgery, daily sterile bandage changes were performed and rotational RLP treatment was continued with amikacin (8 g), ampicillin (15 g), and fluconazole (800 mg). This daily treatment regime, with some drug adjustments, has been continued for 6 mo.

One month after surgery P1 was radiolucent at the distal margin, and was progressing to a fragmented appearance, indicating the osteomyelitis may still be present. Amikacin serum levels were collected post RLP, before the tourniquet was removed. Systemic therputic levels were reached, but not the recommended 10 times MIC. Amikacin was replaced with 12 g of ceftazidime in the RLP rotation. Two months post surgery a fragment of the remaining P1 was easily biopsied from the healing surgical tract with culture results indicating Enterococcus, but not Pseudomonas. Three months post surgery we reinstituted enrofloxacin suppositories at a higher dose.

At 5 mo post surgery, cultures indicated that we had successfully eliminated Pseudomonas and anaerobic growth; however, the healing site continued to yield various gram-negative bacteria, including a Klebsiella resistant to ceftazidime. We replaced ceftazidime with 12 g of ceftriaxone and continued ampicillin and fluconazole in the 3-day RLP rotation. Since this last medical
alteration the remaining P1 fragments have been radiographically unchanged for 3 mo and the surgical wound has been reduced to a tract that is <2 mm in diameter and 4 cm deep.

The current success of this treatment is attributed to a very tractable patient that has allowed daily medical care for over 8 mo. We are continuing her daily treatments and I will give an update on the progression of the case.

ACKNOWLEDGMENTS

The authors would like to acknowledge the RVTs and elephant keepers who have worked above and beyond their duties in providing excellent care for this elephant. For a large part of this treatment period, the elephant keepers have been providing 24-hr care.
THE TOENAIL “ABSCESS” IN ELEPHANTS: TREATMENT OPTIONS INCLUDING CRYOTHERAPY AND PATHOLOGIC SIMILARITIES WITH EQUINE PROLIFERATIVE PODODERMATITIS (CANKER)

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Abstract

Foot problems potentially represent the single most important clinical disease of captive elephants.3 Predisposing factors include obesity, lack of exercise, nail or sole overgrowth, improper foot care, poor hygiene, inappropriate enclosure surfaces, poor conformation, malnutrition and secondary skeletal disorders such as degenerative joint disease.3,13,14 Furthermore, factors such as elephant management philosophy, disposition of elephants, facilities and competency of staff in caring for elephant feet will contribute significantly to the foot health of captive animals.13 It is important to note that these conditions are rarely reported in free-ranging elephants.6 The elephant toenail abscess is characterized grossly by proliferative outgrowth of “crab meat-like” tissue that may acutely rupture through the surface of the nail wall and/or adjacent cuticle or sole. True abscess formation with localized collections of suppurative material is not a consistent clinical feature. In most cases, the inciting cause of these lesions are typically not found and are likely due to one or more of the predisposing factors listed above. Once established, these frustrating lesions require extensive, intensive and prolonged medical attention. If not cared for properly, these wounds may progress to phalangeal osteomyelitis and the need for surgical intervention.1,2,4,5 Sole abscesses are equally frustrating and difficult to manage with proposed etiologies similar to toenail lesions.8,17

There are no reports in the literature describing the pathology of the classic proliferative abscess tissue of the elephant nail abscess. Although variously interpreted as fibrous or granulation tissue, the authors are unaware of previous histologic descriptions of this tissue. Biopsy samples of toenail abscess tissue from two Asian elephants (Elephas maximus) at the San Diego Wild Animal Park (SDWAP) consisted of stratified squamous epithelium arranged in columns resembling horn tubules. The predominant histologic finding was marked, near diffuse, hydropic degeneration of keratinocytes. There were multifocal areas of suppurative inflammation with admixed bacterial colonies. Inflammatory foci comprised only a small portion of the lesion and were interpreted as the external surfaces of the biopsy with likely secondary bacterial colonization. Because descriptions of the normal histology of the elephant toenail could not be located, a grossly normal toenail from a different Asian elephant was obtained to compare histologic features with those of the toenail abscesses. Sections demonstrated formation of the
toenail in a manner similar to that of the hoof of the horse and cattle with tubular, intertubular and laminar horn. Primary and secondary epidermal laminae were identified.

Proliferative lesions of horn-producing epithelium associated with ballooning degeneration and inadequate keratinization of keratinocytes, have been described in horses as equine “canker” and coronary band dystrophy.9,19 Equine canker is most commonly observed in the hind feet of draft horses and begins in the frog sometimes with extension to the sole and hoof wall. Grossly, lesions are characterized by soft white papillary to “cauliflower-like” tissue associated with a foul odor. Similar to what is noted in elephant foot problems, predisposing factors for the development of equine canker include poor hygiene or wet environmental conditions.

There is a lack of gross and histologic description of the normal nail and sole tissue of the elephant12 and further investigations are warranted. A review of the anatomy and histology of the normal equine hoof15 may provide a basic understanding of the elephant nail until more specific and detailed elephant information is available. From our investigation, the authors offer that a more accurate description of the elephant toenail abscess would be proliferative pododermatitis, the term synonymous with equine canker. A more colloquial term such as “elephant canker” may be appropriate, as well.

Canker in the horse is an uncommon but difficult to treat disease of the hoof.16,18,19 Historically, treatment options for elephant toenail abscesses include corrective trimming, superficial debridement and application of topical disinfectants or antibiotics.2 Others have constructed innovative sandals to treat and protect the affected sole or nail with success.8 The use of regional intravenous perfusion of the affected limb with antibiotics has also been successful.11 Since the elephant nail abscess now appears to be histologically and clinically comparable to equine canker, this novel characterization of an old disease may offer unique insight for treatment. In the least, it has provided our practice with a new list of treatment options and experienced equine clinicians for consultation who have been managing patients with a similar disease for many years.

One of the Asian elephants at the SDWAP has had chronic toenail abscesses for over 2 yr. Radiographs of the affected digits, as reported by others to assess degree of involvement,7 have fortunately been negative for evidence of osteomyelitis. Several bacterial and fungal cultures of deep tissue biopsies and swabs of affected lesions have resulted in a mixture of organisms with no consistent single etiologic agent. Biopsies were found negative for presence of viral DNA (elephant papillomavirus and herpesvirus) by PCR. Typical elephant foot care at the SDWAP includes trimming and debriding with hoof knives, foot soaks and topical antibiotics. Although difficult, attempts are made in keeping the affected foot clean and dry. Following recommendations for the treatment of equine canker,10 we recently implemented the routine use of cryotherapy in all elephants with proliferative pododermatitis with improved success in the control and recession of exuberant nail lesions.

The proliferative tissue of the nail is first cleaned then disinfected, debrided, trimmed with hoof knives and allowed to dry. Modified brass branding tools with contact surfaces of variable size (2-5 cm diameter) and shape (round or ovoid) are placed into liquid nitrogen (-196 C) for several
minutes and then placed directly on the cankerous tissue for 30-60 sec. This process is then repeated 4-5 min later, following a complete thaw of tissue. Within 24 hr, the cryoburned tissue becomes macerated and necrotic and is readily removed with gentle scrubbing. Cryotherapy offers the advantage of destroying tissue to a deeper level than trimming alone and provides hemostasis, as well. Because of decreased sensation at the cryotherapy treatment site, a memorable painful event is avoided and the elephant patient is more routinely accepting of this technique. With the use of hoof knives, we typically remove 2-3 mm of proliferative tissue before the patient refuses further treatment, presumably due to discomfort. With cryotherapy, we are able to remove an additional 3-5 mm of tissue by cell freezing and necrosis. The result is quicker resolution of cankerous lesions without the need for aggressive, and potentially painful, interventions.

In conclusion, it appears that elephant nail abscesses can best be described as proliferative pododermatitis, or canker, as is seen in other species. Further gross and microscopic descriptions of normal and pathologic nail or sole lesions are necessary. Routine cryotherapy has shown promise in the treatment of these chronic, frustrating and potentially devastating lesions of our captive elephants.

ACKNOWLEDGMENTS

The authors would like to thank our colleagues of the Department of Veterinary Services at the San Diego Wild Animal Park; Department of Pathology, Zoological Society of San Diego; equine veterinary consultant, Dr. Lynn Richardson; and Jeff Andrews and his elephant care staff at the San Diego Wild Animal Park.

LITERATURE CITED

WHAT IS MEDICAL INFORMATICS AND WHY IS IT IMPORTANT?

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Abstract

Introduction

The information age is definitely here with all of its advantages and frustrations. We are constantly bombarded with information overload and the challenges of information management. Information technology allows us to process information differently, with the primary differences manifest in electronic records and the use of the computer. Information technology also allows us to retrieve information in an entirely different way. Electronic retrieval can be faster and more accurate, but accuracy is dependent upon the construct of the system used for the electronic record and the accuracy of the data.

Hence, the field of medical informatics, a relatively new discipline, which intersects information science, medicine, and health care, was born. Medical Informatics is a multi-disciplinary field that includes librarians, computer scientists, educators, and clinicians. It is also the name of an academic discipline developed and pursued over the past decades by a world-wide scientific community engaged in advancing and teaching knowledge about the application of information and communication technologies to healthcare: the place where health, information and computer sciences, psychology, epidemiology, and engineering intersect. Medical Informatics research is diverse, including clinical outcomes, quality improvement, genomics (bioinformatics), population biology, public health, and education at all levels.6

History

In human medicine, health care is monitored and directly affected by quality control systems. These in place systems allow for an easier implementation of medical informatics. There are two main organizations for human medical informatics: AMIA, the American Medical Informatics Association and IMIA, the International Medical Informatics Association. AMIA states, “Medical informatics has to do with all aspects of understanding and promoting the effective organization, analysis, management, and use of information in health care. While the field of medical informatics shares the general scope of these interests with some other health care specialties and disciplines, medical informatics has developed its own areas of emphasis and approaches that have set it apart from other disciplines and specialties.”1 IMIA’s basic goals and objectives are to: (1) promote informatics in health care and research in health, bio and medical informatics; (2) advance and nurture international cooperation; (3) stimulate research, development, and routine application; (4) move informatics from theory into practice in a full range of health delivery settings, from physician's office to acute and long term care; (5) further the dissemination and exchange of knowledge, information, and technology; (6) represent the...
medical and health informatics field with the World Health Organization and other international professional and governmental organizations; (7) move theory into practice by linking academic and research informaticians with caregivers, consultants, vendors, and vendor-based researchers; (8) promote the cross-fertilization of health informatics information and knowledge across professional and geographic boundaries; and (9) serve as the catalyst for ubiquitous worldwide health information infrastructures for patient care and health research.9

AMIA’s bimonthly journal, JAMIA, presents peer-reviewed articles that assist physicians, informaticians, scientists, nurses, and other health care professionals in developing and applying medical informatics to patient care, teaching, research, and health care administration. JAMIA has rapidly established a reputation for presenting high-quality, cutting-edge information. Each issue contains state-of-the-art reviews, discussion forums, and invited editorials presented as brief reviews or full-length papers. A variety of formats accommodates work at all stages, from model formulation through definitive studies.1

The Association for Veterinary Informatics (AVI) was founded by a group of about 20 veterinarians meeting in St. Louis for the 1981 American Veterinary Medical Association (AVMA) Annual Convention.2 Goals of the AVI include: Serving the membership as an educational resource, promoting the use of information technology and electronic communications in all aspects of the profession, and developing and promoting standards in veterinary information management. The Association has sponsored Symposia on Computer Applications in Veterinary Medicine at various major veterinary meetings. The Talbot Symposium occurs during the annual AVMA meeting and addresses a wide range of topics including computer technology adaptation in veterinary medical practice.5

Various academic informatics programs exist throughout the country. Stanford School of Medicine includes the department of Stanford Medical Informatics, which describes the need for its program: “Nowhere is this need more acute than in biomedicine, where scientists and practitioners routinely confront conflicting sources of knowledge and burgeoning numbers of data. Workers in biomedicine urgently require new methods that will enable them to access and apply discipline-specific knowledge, to make sense out of clinical and experimental data, to learn from those data, and to advance their underlying disciplines as a result.”11

Various other academic human medical informatics programs exist, but there is only one program in veterinary medical informatics. This interdisciplinary academic, research, and service program, which provides postgraduate training opportunities for veterinarians, is within the Office of Research and Graduate Studies of the Virginia-Maryland Regional College of Veterinary Medicine (VMRCVM). The importance of veterinary medical informatics and the differences from human medical informatics is well described by this group:

“Veterinary medical informatics endeavors to study the structure and properties of medical information and particularly, medical information about animals. To date, most attention has focused on practice management systems which feature appointment scheduling, admission records, pharmacy records, accounting functions, cost-analysis, and cost-control functions. Veterinary informatics experts are also developing programs in areas such as diagnostic decision
assistance, expert consultant systems for diagnostic and management assistance, drug
information systems, and interactive teaching tools. Events of the recent past have highlighted
another role for veterinary medical informatics, namely to facilitate integration of animal
medical data into information systems dedicated to supporting Public Health and responding to
threats of Bioterrorism and Agriterrorism. Finally, government agencies involved in veterinary
medicine depend increasingly on sophisticated electronic documents to receive information from
the industries they regulate and to communicate with their constituents and with the public.
Much of what can be accomplished in veterinary medical informatics depends on standard means
of representing findings and diagnoses, laboratory tests, therapeutic interventions, etc. Unique to
veterinary medical informatics is the need to standardize representations of animal anatomy,
animal behaviors and the animals themselves (including the role animals may serve in
production systems or as companions). To that end, the VMRCVM veterinary medical
informatics program emphasizes the study of medical information standards (SNOMED®, HL7
and LOINC®) Systematized Nomenclature of Medicine ("http://www.snomed.org"); Health
Level 7 ("http://www.hl7.org"); Logical Observation Identifiers Names and Codes
("http://www.regenstrief.org/loinc") and inclusion of veterinary medical content therein.12

Why is Medical Informatics Important?

Applications of medical informatics range from biomedical data representation and retrieval,
health information standards, imaging informatics, health information technology dissemination
and evaluation, and telemedicine, to very specific applications such as a Veterinary
Computerized Anesthetic Record System (VCARS), in testing at the VMTH at UC Davis. The
highly successful paper anesthetic record was replicated in the computer application. This shows
how alternate form factors can help preserve what is good about the paper form world while still
making available the benefits of real-time data capture.13

SNOMED® (the Systemized Nomenclature of Medicine) was developed in response to the need
for standardized data. “SNOMED® recognizes the unique requirements of veterinary medicine,
supplying an extensive array of concepts for non-human disorders, anatomic structures, and
veterinary procedures. Creation of a Non-Human subset allows viewing of content exclusive to
veterinary medicine, while concept definitions place animal disorders, findings, and procedures
in a broad-based medical context.”10 SNOMED Clinical Terms (SNOMED CT®), is the
universal health care terminology that makes health care knowledge usable and accessible
wherever and whenever it is needed.10

Why are standardized terms even important? In a paper entitled “Word search performance for
diagnosis of equine surgical colics in free-text electronic patient records,” key word searches for
four GI disorders (enterolithiasis, displacement, torsion or volvulus, and adhesions) were done.
The sensitivity of these word searches ranged from 33-98%, and it was concluded that if GI
disorders were uniformly named search limitations would be minimized. Results suggested that
searches of free text electronic patient records are susceptible to inaccuracies for a variety of
reasons. This study identified one-third of the relevant cases from the medical record database,
and on the other hand, for every 100 records the word search retrieved, only two cases were
relevant. Reasons for these results were: synonymous expression of GI disorders, derivational
variation in expression (e.g., enterolith versus enterolithiasis), surgical findings were not reported in the record, misspellings, and inflectional variations in expression including singular versus plural, or past, present, and future tense. Free-text retrieval is based on the assumption that it is a simple matter for searchers to imagine all of the exact words and phrases under which the desired information might be recorded.\textsuperscript{8}

Implementation of veterinary medical informatics on an even broader scope could affect the zoo medicine and wildlife community, especially when working with federal agencies. This is illustrated by the proposed Consolidated Health Informatics (CHI) Initiative; Health Care and Vocabulary Standards for Use in Federal Health Information Technology Systems. The CHI initiative is a collaborative effort to adopt Federal government-wide health information interoperability standards (messaging and vocabulary). These standards will be implemented by Federal agencies to allow the Federal government to exchange electronic health information.\textsuperscript{7} Electronic communication and interactions of zoo and wildlife electronic medical systems and records would be better facilitated if we also utilized these messaging and vocabulary standards. Informatics knowledge is the important link which will build the information and messaging standards that in turn, will tie agencies together. The USDA, in tackling a national animal identification system, is planning to link to a network of private and state-operated animal tracking databases.\textsuperscript{3,4} the zoo medicine community also has important animal identifier tracking needs.

Research

Medical informatics can involve very detailed research and is a discipline so specialized, it requires the mastery of its own specialized terminology. The research can be very esoteric or practical. Research also actively occurs in the various academic venues such as at the Yale College of Medical Informatics which lists the following clinical informatics project as an example: exploring the use of mobile, pen-based devices that incorporate guideline knowledge to provide clinical decision support and overcoming challenges to user acceptance.\textsuperscript{14}

Research also occurs in areas such as disease management and the Internet, decision support, the human-computer interaction and interfaces, the electronic medical record, telemedicine, and standardized medical terminology.

How Does This Affect You?

The information demands of digital imaging will eventually affect all of us in institutions and/or private practice. Important standard image structure and communication protocols will need to be fully incorporated into our systems (DICOM - Digital Imaging and Communications in Medicine\textsuperscript{®},) in order to affect legal standardization of images.

Other effects primarily reflect the need and implementation of standards for a more global approach to important veterinary medical information.
Issues

Harmonizing standards is an important issue and not always appreciated by everyone anxious to implement well-designed electronic medical records. Again this issue is succinctly expressed in a veterinary medical informatics newsletter:

“The great thing about standards is that there are so many to choose from.”

This is a favorite quote used by those working on standards because it seems like an endless battle to keep standards from conflicting with each other. HL7 is the undisputed leader of messaging standards. Standards must work closely together if things are going to work. The best way to ensure that this happens is for the standards development organizations to work together directly. That is what is happening with the Continuity of Care Record standards for transfer of patient information when a patient is referred to a specialist or skilled nursing facility. Are there lessons here for veterinary referral practice informatics? 5

Perhaps the biggest challenge for the use and implementation of veterinary medical informatics involves implementation. We must overcome “techno-phobia” and reluctance to change what has always seemed to work for us in the past. These issues will only continue to become more and more important. We have the opportunity to embrace medical informatics and utilize the skill and expertise of groups and individuals well-trained in this new and evolving field to help the zoo and wildlife medicine community advance further into the information age.

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14. YCMI Research Projects (www.ymci.med.yale.edu/projects.html)
ORIENTATION TO THE AMERICAN ASSOCIATION OF ZOO VETERINARIANS’ (AAZV) WEBSITE, WEB DIRECTORY, AND LISTSERV (AAZV-L)

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Abstract

As electronic communication becomes the norm around the world, the American Association of Zoo Veterinarians (AAZV) continues to strive to provide this service to its membership. The AAZV provides three outlets for this mode of communication: the AAZV website, the Web Directory, and the AAZV listserv (AAZV-L).

AAZV Website

The AAZV website provides a large database of information relative to the workings of the organization, and also provides information related to animal health, disease, and conservation. At this time, the website averages 400 visits per day, generating about 2800 accesses to the website’s documents. The Home page for the website is located at www.aazv.org. The Home page has four major areas including: a menu listing categories that will allow visitors to navigate to the 370+ documents on the site, links to organizational news, links to medical and conservation news, and a search engine which allows a keyword search for documents within the AAZV website. Let’s look at these individually.

Search Box

By entering keywords into this box, the entire AAZV website is searched, and any documents found containing the keywords are listed. In this way, it is relatively easy to find the information you may be seeking if you are not sure where to start looking on the site. At this time, only html (“website code”) documents can be searched, so a special link www.aazv.org/aazv_doc_biblio.htm will take members to a document containing an alphabetic list of PDF, Excel and Word documents which might not show up in a keyword search.

Organizational News

This section provides links to current information of concern to our organization’s members. Annual Conference information, special meeting information, and important organization documents may be found here. At the bottom of this window is a link to the previous information that has been posted in this section.
Medical and Conservation News

This section provides links to current information of concern regarding emerging diseases, current diseases, important conservation documents, etc. At the bottom of this window is a link to the previous information that has been posted in this section.

Main Menu

*AAZV Organization*: This page contains information regarding officers, past presidents, bylaws, AAZV mission/objectives and benefits, membership, financial support/grants, strategic plan, and other misc. documents useful to the organization’s members.

*Committees*: This page contains information regarding all of the AAZV Committees. Each Committee has their own page listing chairs, members, annual reports, and variable information provided by the Committee.

*Job Openings*: This page is the most visited page on the AAZV website. It contains job openings for zoo and wildlife veterinarians, residents, interns, veterinary technicians, postgraduate, and other academic and research positions. All positions are dated at posting, and usually contain an application deadline. To keep the page as current as possible, postings are deleted 1 mo after the application deadline, which gives extra time in the event the position is not filled by the deadline.

*Education Center*: This is another very active webpage on the AAZV website. This area is useful for veterinarians, as well as veterinary students. There are links to: upcoming meetings and workshops, ACZM exam information, externship opportunities by State, internship and residency opportunities by institution, manuscript and poster competition and awards information, and the student zoo and wildlife clubs.

*Student Links*: This page is primarily for veterinary medical students and contains links to externship opportunities by State, student zoo and wildlife clubs, and student manuscript competition.

*Grants/Awards*: This page contains links to information regarding: financial support for attending the AAZV conference, student and postgraduate award competitions, poster award competition, and other grants and awards being offered in the field of zoo and wildlife health, nutrition, and conservation. The annual recipients of the awards, and their work, are listed on the Awards Committee page.

*Meetings/Workshops*: This is the place to go to get information on upcoming AAZV and allied health organization meetings, workshops, other continuing education offerings.

*JZWM*: This page is the home for information regarding the Journal of Zoo and Wildlife Medicine. Links to manuscript submission guidelines and fees are found here. This is also the page to find links to the JZWM abstracts in Arabic, Czech, German, English, French, Italian,
Japanese, Portuguese, Russian, and Spanish. The organization is very grateful to have a team of dedicated translators that make this possible.

Current/Emerging Dz: This page contains links to numerous disease information protocols and guidelines. This is the page to visit when issues like monkeypox, West Nile virus, and avian influenza arise. There are also links to the CBSG Disease Risk Handbook and the Investigation of Infectious Disease Outbreaks in Captive Wildlife Facilities PowerPoint presentations.

SSP/TAG/VAG Info: This page will be your stop for information related to SSPs, TAGs, and Vet Advisors. Information found here includes: link to SSP/TAG/VAG Species Reports, Protocols, Guidelines, and Info (you will select from a list of species), links to American Zoo and Aquarium Association (AZA) documents explaining SSPs and TAGs, link to the AZA Contraception Advisory Group documents, and a link to necropsy and pathology protocols (a secure area to be discussed below). This page also has a link for AZA members who are not AAZV members so they may have access to the secure information.

Contraception Center: This is a link to the AZA Wildlife Contraception Center at the St. Louis Zoo (http://www.stlzoo.org/animals/scienceresearch/contraceptioncenter/).

International Zoo Vet Forum (IZVF): This is a link to the ISIS sponsored forums, which includes the IZVF. The forum can be reached by clicking on this link or through the ISIS website: http://forums.isis.org/forums/cgibin/Ultimate.cgi?action=intro&category=1&BypassCookie=true. This very active forum is the place to communicate with colleagues concerning medical and conservation issues. Messages are archived, so you may search them to find out if your questions have been addressed in the past. This forum is open to all veterinarians working full time in zoo and wildlife positions. For more info, contact the moderator, Dalen Agnew (dwagnew@ucdavis.edu).

Links: This is a page providing links to many Veterinary and Allied Health Organizations around the globe, Disease Organizations, Governmental Organizations and Regulations, Medical/Surgical Information Sites, Commercial Sites having relevance to AAZV members, and Literature/Search Engines.

Zoo News Digest: Every week or so, a gentleman by the name of Peter Dickinson pulls together the latest news, good and bad, from zoos around the world, and sends the information out on a listserv known as Zoo News Digest. He has kindly agreed to allow those zoo news links to be incorporated into a listing accessible from the main AAZV page. Updates will occur when provided by Mr. Dickinson. Interestingly, this is in the top ten most visited pages on the AAZV website.

Sitemap: Can’t find where to start on the Homepage? The Sitemap provides a bit more detail to the links available on the AAZV website. If this isn’t enough, then use the Search Box function explained above.
Members Only: This link is available only to AAZV members, and is username and password protected. Here you will find AAZV Organization, Current/Emerging Disease, Membership Directories, Documents, and AZA Animal Health Committee documents deemed to have information that should not be accessible to the general public. If you are an AAZV member, and do not have access to this area, contact Tom Curro (tomc@omahazoo.com).

AAZV Web Directory: This is a link to the AAZV WebDirectory described below.

AAZV Web Directory

The Web Directory is a searchable database of AAZV members and their various employment and personal information. All AAZV members are encouraged to register for this directory. At the present time, 286 AAZV members have registered. You need to be an AAZV member, and you need the AAZV Member’s Only username and password to get started. A link to the instructions for registration may be found on the AAZV home page below the Medical/Conservation News box. During the registration process, you will designate your own username and password. This will allow you to securely make editions to your WebDirectory information, keeping the directory as current as possible. If you have questions regarding the AAZV WebDirectory, contact Tom Curro (tomc@omahazoo.com), Lisa Done (ExoticVet@aol.com), or Dalen Agnew (dwagnew@ucdavis.edu).

AAZV Listserv (AAZV-L)

The AAZV-L, sponsored by Googlegroups, allows for dissemination of timely and/or urgent organizational information to all of its members, directly to their email in-boxes. This listserv is only open to AAZV members, and cannot be viewed by the general public. At this time, other than those that have opted-out, all current AAZV members are registered on the AAZV-L, and should be receiving periodic digests of AAZV-L postings. If you are an AAZV member not currently on the AAZV-L, contact Tom Curro (tomc@omahazoo.com) to be added to the listserv. You do not need to have a Googlegroups account to be part of the AAZV-L. But if you do have your own account, you will be able to access archives of past messages, as well as use the links included in the digest emails. The AAZV-L General Instructions and Guidelines will be emailed to you upon registration.

The combination of these three forms of electronic communication (Website, WebDirectory, and AAZV-L) will ensure that AAZV members are kept up-to-date-and informed on issues relevant to all.
LITERATURE SEARCHES FOR LUDDITES: A PRIMER

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Introduction

Ludd·ite: one of a group of early 19th century English workmen destroying labor-saving machinery as a protest; broadly: one who is opposed to especially technologic change. Etymology: perhaps from Ned Ludd, 18th century Leicestershire workman who destroyed machinery.1

Be it for writing a case report, checking on a new employee’s resume, developing an Institutional Animal Care and Use Committee (IACUC) report, conducting relevant and novel research, or making a treatment plan for a clinical case (otherwise known as “evidence-based treatment”), a veterinarian’s skill in conducting a thorough review of the available medical literature can be as valuable as the ability to use a stethoscope. The resources available are considerable, though many are associated with academic institutions and not readily available to the clinical veterinarian. PubMed and multiple search engines are freely available, however, and are powerful tools and easy to use with practice. In addition, there are a growing number of journals available on-line. Most are available only by subscription or through a university, but some are free over the web. There are several excellent textbooks available for those who catch the computer “bug” and want to delve more deeply into the topic or use these tools more effectively.2,3 A review of some of the available resources and some basic search techniques will help the Luddite (or the willing, but digitally challenged) veterinarian to effectively use these resources.

Search Engines

The clinician can often benefit from resources freely available on the web. In fact, many journals are listed on both the major medical databases and on many of the commonly used web search engines. Search engines are a personal choice – every computer aficionado will have a favorite. It is best to pick one and stick to it so that you can get used to its particular grammar. On the web, there are “directories” and “crawlers.” Directories are categorized lists of sites compiled by robots or human editors. These are ideal for narrowing down a topic or finding general information on a broad range of topics, but are often too broad to be useful. Examples are:

www.yahoo.com
http://www.lycos.com
Crawlers are software programs that regularly scan the internet and index the contents of individual websites. These are perfect for hard-to-find information, but they can provide an overwhelming database of results if searches are not carefully conducted. These can return results in the hundreds of thousands! A few examples are:

- www.google.com
- www.altavista.com
- www.content.overture.com/d/home/
- http://www.teoma.com/
- http://ask.com/
- http://search.msn.com/
- http://www.looksmart.com/

Metasearches are a collection of multiple search engines run simultaneously. These can combine the coverage of several search engines to give a very complete coverage of the internet, but they are the most likely to provide an overwhelming quantity of potentially useless information. Examples are:

- http://www.dogpile.com/ (my personal favorite)
- http://www.mamma.com

Search strategies are a learned skill, but a few hints will help. It is important to choose your initial terms carefully. Use the most direct and precise words possible. For example, the term “murine” will give more scientific and/or animal sites than the term “mouse.” Time spent initially in picking words carefully will be saved in the number of hits you must screen. Use the terms in the correct order: (e.g., if you enter “dog shows” you will get results on various dog shows, clubs, and events, but if you enter “show dogs” you will get specific information on dog breeds). Some punctuation marks can also assist you:

1) The + symbol gives you all the websites with both terms listed together (e.g., veterinary+law [not veterinary law]), allowing you to concentrate your search on “hits” (also known as positive search results) where both terms occur together.

2) The – symbol helps reduce and narrow subjects by eliminating words you do not want to associate with your word of interest (e.g., abortion–rights [not abortion rights]) gives you all the sites having to do with abortion that do not relate to abortion rights.

3) “Quotation marks” are excellent for narrowing a search to a specific phrase (e.g., “leptospiral abortion”).

4) These symbols can be used concurrently on the same search line.

Some search engines have other filters as well, allowing you to choose a language (e.g., English- or German-only articles) or to limit adult content (an important tool when searching for articles on reproductive diseases).

Finally, most search engine homepages have a tutorial. Spend a few minutes using the tutorial and it may save you hours later.
Medical Literature Resources

While the search engines can provide a dizzying array of information, the quality of that information may be variable, limited, or even suspect. For the best medical information (though perhaps, not the most up-to-date), the peer-reviewed literature is certainly preferable and is necessary when publishing in journals. There are many literature resources available, often geared to specific scientific fields. Unfortunately, many of these are only available through universities or are associated with expensive fees. Library privileges, however, can often be negotiated with local universities, particularly if a clinical veterinarian has an adjunct appointment. As a last resort, dating a graduate student is always an option.

Of the available medical databases, PubMed is by far the most complete, available, and for the most part, user-friendly. It covers over 4000 journals and has 11 million records back to 1966 with worldwide coverage. And best of all, it’s free. It can be found at:


Other databases available (usually via universities) and pertinent to zoo and wildlife veterinarians are:

Biosis http://www.biosis.org/
CAB http://www.cabi.org/
Current Contents http://scientific.thomson.com/products/ccc/
Web of Knowledge http://www.isiwebofknowledge.com/
Web of Science http://scientific.thomson.com/products/wos/
Zoological Record http://scientific.thomson.com/products/zr/

All of these databases, however, have subscription costs that can be quite substantial. For this reason, only PubMed searches will be discussed, though these same techniques can be used for other databases if you are lucky enough to have access.

Searching in PubMed is fairly simple, but a few tricks will help you reduce the number of references you will need to screen. To search, type a word or phrase into the query box at the top of the page (http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?DB=pubmed) and click “Go” or press the “Enter” key. Just as in search engines, term choice is crucial. Identify the key concepts you are looking for and use the most specific terms possible. Determine alternative terms, if you do not get appropriate results (e.g., search for both *Toxoplasma gondii* and *T. gondii*). You will see many of the same references with both term, but you may see some references that are found in only one of the two searches.

PubMed has the useful quality that it will search for the term you typed as well as related terms. For example, if you type “face” as a search word, PubMed will automatically search for “cheek,” ”chin,” ”eye,” and “forehead.” If you want it to only search for “face,” type that word in parentheses. You can also search using truncated terms, using the wildcard symbol “*.” For example, if you want to find references on “infarct,” “infarcts,” “infarction,” “infarctions,” and
“infarctive processes,” you can search using the term “infarct*” and all these terms will be included. Unfortunately, using this wildcard will turn off any of the automatic features of PubMed, which would have also identified references with the term “heart attack” in it. Finally, it will do no good to include terms such as “a,” “it,” “also,” or “these.” These terms could potentially return every document in the database and so PubMed has not indexed them.

You can connect search terms using Boolean logic. George Boole was a 17th Century mathematician who devised a logical combinatorial system composed of logical operators such as “AND,” “OR,” and “NOT.”

- **AND** will return only citations which include both terms
- **OR** will return all citations which include either term
- **NOT** will block citations which include the term preceded by NOT

For example, searching with the following string of terms: “Bovine AND abortion OR endometritis NOT Chlamydia” would return citations pertaining to bovine reproductive diseases, but would not include citations in which the term “Chlamydia” appeared.

Note that these Boolean logic terms are in all capital letters. The computer will process these terms from left to right and from within parentheses, then outside the parentheses.

Once you have identified a reasonable number of references, you can alter the display. Initially, they are displayed in summary format (author, title, journal, year, volume, and pages). To view more information you can use the menu attached to the display button to pick “Abstract,” “Citation,” or “MedLINE” format. You can also select specific references (by clicking in the box by its author line) and have only those references displayed in a more complete format. You can also use this check box to send these documents to a clipboard for later review (using the “Send to” button and later, the “Clipboard” on the “Features” toolbar). These clipboard items are, unfortunately, lost if the clipboard is inactive for more than 1 hr, but you can save it to your desktop or a disk. You can also use the “Send to” button to put the documents in a text format that is easy to print and file a hard copy.

Adjacent to every citation, there is also a link to “Related Articles.” Clicking on this will pull up many articles with similar subjects as your initial search, and often turns up new and interesting articles you may have missed on the first search.

An important aspect of PubMed is “Limits,” which is found on the Features toolbar. This provides a pull-down menu for “Publication Type,” “Languages,” “Subsets,” “Ages,” “Human or Animal,” “Gender,” “Entrez Date (date it was added to the database),” “Publication Date,” and others. You can also restrict your search to only those references which contain an abstract. These limits can be turned off later by unchecking the “Limits” box.

Full articles can be ordered directly from the PubMed webpage (via Loansome Doc), but this is associated with a fee and you must develop a relationship with a neighboring medical library. An additional (and free service) is the “Cubby.” You must register to use this service, but it
allows you to store search strategies and update your searches (useful if you are monitoring the most current literature for a particular disease or treatment). The PubMed website also provides an excellent tutorial for the website along the left margin of the homepage.

### Journals On-Line

An increasing number of journals are being published on-line as well as in print (the Journal of Zoo and Wildlife Medicine is one). These journals are rarely available as individual subscriptions, however, and are usually controlled by one of the large publishing houses that sell subscriptions providing access to a battery of related journals. These subscriptions are generally intended for libraries and large institutions. PubMed, however, provides a large number of on-line journals free of charge at:

http://www.pubmedcentral.nih.gov/

In addition, many publishers are retrospectively scanning journals and make their archives available on-line. Within 1 yr, the Journal of Zoo and Wildlife Medicine will be one of these journals, with all issues dating back to its first volume available.

### Other Favorites

The Internet is an amazing tool – regardless of who might have invented it. It can save time and resources by making information immediately available. It can, however, be a great time-waster if it is not used effectively. Hopefully, the hints provided in this article and a bit of practice will make it one of the most effective diagnostic instruments in your medical arsenal. As a parting gift, I would like to offer a few of my favorite zoo and medically relevant websites – feel free to pass on yours:

http://animaldiversity.ummz.umich.edu/site/index.html
http://www.protocol-online.org/
http://www.vetpathology.com/
http://www.embl-heidelberg.de/~uetz/livingreptiles.html
http://medicine.ucsd.edu/cpa/
http://w3.vet.cornell.edu/nst/
http://www.med.unc.edu/embryo_images/
http://www.ummz.lsa.umich.edu/birds/birddivresources/families.html

and of course,
http://www.aazv.org

### LITERATURE CITED

E-MAIL ETIQUETTE FOR EFFECTIVE COMMUNICATION

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Abstract

Introduction

Different forms of electronic communication have existed since the 1970’s, but commercial use of the Internet for this purpose did not occur until the late 1980’s. The widespread use of Internet “electronic mail” (e-mail) as a global communication standard started in the early 1990’s, when major service providers became readily available. In the last 13 yr, e-mail communication has become one of the easiest and most widespread means of disseminating information.

The ease of this method of communication also poses some problems not encountered when communicating by other means. By following simple guidelines of etiquette, the effectiveness of e-mail can be maximized. “Etiquette” is defined as the set of rules or customs that control accepted behavior in certain situations. By using proper etiquette, you can minimize the likelihood that an e-mail message will be ignored, deleted, or perceived in the wrong way. Although specific logistics on how to use e-mail vary by software, these common guidelines are applicable to all e-mail communications. These guidelines are organized as “General usage,” “Content,” “Sending,” and “Mailbox Management.”

Rules of General Usage

Rule 1: E-mail is the Property of Your Company

All e-mail communications and the space where they are stored are the property of your company. Therefore, companies retain the right to access and monitor communications at all times. As an agent of your institution, your communications represent yourself as much as they represent your institution, regardless of content. Your usage of company e-mail may make the institution vulnerable to unnecessary risks, including liabilities, security vulnerabilities and privacy violations. For this reason, some companies have added disclaimers to the “signature” of all e-mail sent from their company accounts.
Rule 2: E-mail is Not Truly Private

You must be careful and judicious when discussing private or sensitive topics by e-mail, including veterinary advice. Although generally secure and safe, e-mail is not truly private, since most companies reserve the right (and have the capability) to monitor e-mail communications. E-mail messages can be retrieved even after deletion. In addition, e-mail that is sent to an intended recipient can be forwarded to other recipients, creating a permanent trail of evidence of your communication to people who you never intended to receive it. It is also very easy to print received messages and share them in the “old fashioned” way. Most people are more likely to read (and share) e-mail intended for somebody else than with traditional paper correspondence.

For government-owned or government-funded zoological (or other non-profit) institutions, all e-mail communications be part of “open records” acts and equally accessible as all paper records.

In medicine, advice provided by e-mail can be legally interpreted as practicing medicine. While it is acceptable to provide advice or discuss cases with colleagues as a consultant, keep in mind that “remote” diagnosis or providing primary medical advice must be done judiciously and ethically. If you provide veterinary advice to an owner (or keeper or curator), you should ensure there is a valid veterinarian-patient-client relationship, or you may be practicing veterinary medicine illegally.

Rules of General Content

Rule 3: Always Use a Subject Line

Most e-mail software will display the sender and a subject. It is easier for a user to skim through topics and prioritize messages. By having a subject line, you validate that it is an important and real e-mail, and not spam or a hoax. Your subject line should be updated to reflect the content of your e-mail. It is easy to look up an old address and hit reply without updating the subject, but this can be disorienting to the receiver.

Rule 4: Avoid Multiple Subject Communications in a Single Message

Unless topics are related or somehow connected, avoid multiple discussions in an e-mail. Most users may skim through a long message, and multiple issues may be ignored. So, if a topic is important enough to warrant an e-mail communication, make it the sole topic of that message.

Rule 5: Avoid E-mail-Based Arguments and Flagrant Responses

If you get an e-mail that has a negative tone, avoid the temptation to reply in an escalating, negative way. Body language and tone can not be interpreted in e-mails, so it is easy to misperceive the tone of a message. To avoid making a situation worse, step away from the message, think through the consequences carefully, and reply later when you have calmed down. If negative confrontation is needed, try other means of communication – such as a phone conversation or a person-to-person discussion.
Take the “high road” on blatantly flagrant, negative communications. Be professional in your response. Do not be afraid to ignore unproductive communications or reply with a simple, diplomatic line. Breaking off a cycle of negative “flaming” communications can be done with a message such as “Let’s discuss by phone” or “Let’s meet.”

Rule 6: Avoid “Spam”

Spam has no place in professional communications. This includes jokes, chain mails, advertisements, and political or religious propaganda. All of these communications should be done from a personal e-mail account. See rules #1, 2 and 7.

Rule 7: Be Conscientious about Separating Professional and Personal Use of E-mail

You should limit the usage of company e-mail to professional communications related to the performance of your job duties. Personal e-mail use takes up unnecessary company resources. Some organizations provide guidelines for personal use of company e-mail, but in general, this should be avoided. Remember that all of these communications are company property (Rule #1) and they are never truly private (Rule #2). There are instances where the overlap of the two is unavoidable, such as when e-mailing certain colleagues and this is acceptable in most instances. In addition, you should avoid using personal e-mail accounts for professional communications, as these may construe misrepresentation of company guidelines.

Rule 8: Avoid Using All-Caps; Reconsider When Needing to Use “Emoticons”

Using all caps when typing, GIVES THE IMPRESSION THAT YOU ARE SCREAMING. All-caps are sometimes used for EMPHASIS in a sentence, but in general should be avoided (unless you want to be screaming). Punctuation marks can effectively offer the same emphasis.

Another popular way to emphasize parts of sentences is by the use of “emoticons.” Emoticons are visual images (such as smiling ☺, or sad faces ☹) made by combining certain punctuation marks. Some software recognizes these punctuation marks and automatically replaces them with actual images. Their usage in professional communications is discouraged, because they may not be interpreted in the context that they are meant by a sender. Some believe that emoticons can be used to “tone down” certain remarks, or to emphasize when something is meant as a joke. Often the use of these “emoticons” is a sign that you should rephrase the sentence.

Rule 9: Use Spell Check

Professional communication should be professional. It is easy to use a spell check or grammar check to free a message of spelling mistakes. Proper spelling conveys a sense of education and professionalism in a medium of communication where other cues can not be used. Remember that you are representing your institution, and you should act professionally.
Rule 10: Use a Signature

Although you may believe that your name will be recognized, having a signature will remind the recipient of who you are, what you do, and where you currently work. Some e-mail services will display an abbreviated sender’s name, and your signature is a way to assure that the recipient will know who is sending a message. It is easy to set up automatic signature lines in your e-mail software, and some organizations may have institutional guidelines for the usage of standardized staff signatures. In general, signatures should be kept to a maximum of 5 lines:

a. Your name: It may be appropriate to add titles such as DVM, PhD, MS, Board Certifications or Diplomate status, etc for professional communications.

b. Your title: Use the professional title or name of your position in which capacity you are establishing the communication. If you act in more than one capacity, it may not be necessary to list all your job titles; this might be interpreted as boastful.

c. Your institution: Include the official name of your institution unless you are using a personal e-mail account, avoid adding your institution in your signature, where it may be construed as misrepresentation.

d. Phone and/or fax numbers: Provide only your work numbers. Leave your personal home number for personal e-mails only.

e. E-mail address: Although the e-mail is in your sender communication, add it to your signature because some people may print communications for further reference.

In some cases, a personal quote or institutional statement or disclaimer is added after your signature. You should avoid unnecessarily lengthy signatures. In general, images in the signature create unnecessarily large e-mail messages and some e-mail software will not recognize it.

Rules for Receiving and Sending E-mail

Rule 11: Do Not Open Unknown or Unexpected Attachments

Many computer viruses may be imbedded in e-mail programs or forwarded as e-mail attachments. These messages should be deleted. If you open them, you could expose yourself and your company to the effects of these viruses. Even updated virus protection software may not prevent you from being infected, as viruses can evolve faster than ant-viral software. A virus may come from a known sender who was infected and inadvertently distributed the virus to contacts in his/her e-mail address book. If you get an unexpected attachment and are not sure whether to open or delete it, call your IT professional before opening it.

Rule 12: Mailing Lists and Out of Office Rules

“Out of office” messages can be set up to automatically respond when you are away from your office. This could create a problem if you are subscribed to certain listserves or mailing lists that may not recognize “out of office” automated messages. In these cases, your computer will reply with an automated message to all senders in the list. Since this will include yourself as a recipient in the mailing list, your automatic rule may reply again. This will flood everybody in the list with messages from your automated mailbox. More sophisticated automated rules will only send one message per recipient, so they will respond to a mailing list or listserv only once - but this is not
always the case. If you are going away and set up an automated message, you should do one of the following:

1) Temporarily unsubscribe. (This may actually be a good time to permanently unsubscribe from mailing lists that don’t serve your interests any more).
2) Set up your “out of office” rule to not respond to specific mailing lists or senders.
3) Set up your “out of office” rule to respond only to messages sent directly to you
4) Contact your IT manager to ensure that you set up the rule properly

Rule 13: Use ‘Cc” (carbon copy) Lines Judiciously

Although it is easy to copy senders in an e-mail, you should check the recipients in a “Cc” field. If the “Cc” recipients are not intended as primary senders, you should not expect a response from them unless you specifically request so. Do not copy unnecessary recipients just for your own convenience. Also see Rule #14.

Rule 14: Use of “Bcc” (blind carbon copy) Field

The “Bcc” field should be used to enhance communications, not to create a “secret” trail of communications. If you are the recipient of a “Bcc” message, avoid replying to the senders to whom the mail is intended for. (This defeats the purpose of being “blind copied”). You can reply to the sender individually.

The “Bcc” field can be used to improve mass mailings. When sending messages to a group of people, do not put too many of subjects in the “To” field. Recipients will get a message with a large header, and this will also expose the e-mail addresses of the all the recipients to the entire group. If the identity and list of recipients is not essential, you can put all the recipients in the “Bcc” field. This will prevent each recipient from seeing all the other recipients’ identities.

Rule 15: When Replying, Double Check the List of Recipients

Mass sent e-mails may be a good way for a sender to send information to a large number of people without having to do so individually, but recipients should be careful when replying. Unless you want the whole group to be informed, reply to the individual sender. Do not forget to update the subject line if you are replying with regards to a different topic.

Rule 16: Don’t Forward Large Files Unless You Must

When sharing large attachments (e.g., pictures or PDF documents), keep in mind that a large file will take up space in a recipient’s mailbox, but also in your own “SENT ITEMS” mailbox. You may want to check with a recipient before sending an important, but large, document. Some e-mail services limit the size of message that can be received, and the message may be undeliverable. Your recipient’s mailbox may also be limited. Finally, downloading large attachments may be a burden on some “dial-up” services and slower computers.
Rules for Mailbox Management

Rule 17: Clean Your Mailbox

Although you think of your messages as “your” mailbox, the messages are actually taking up shared space somewhere else. You should always delete e-mails that you do not need, or file messages of importance, in the same way that you would manage paper correspondence. Avoid saving messages just for the sake of preserving their contact information. Contact information can be stored elsewhere. If you exceed the allocated space to your e-mail inbox, you may not be able to receive or send e-mail.

Most e-mail software will allow you to create a personal folder in your local computer, and this is a good alternative to occupying “shared” space. However, remember that e-mail stored locally in your computer may not be available if you try to access e-mail remotely or from a different computer terminal. In addition to your “INBOX,” remember to delete messages out of your “SENT” mail folders. Once your e-mail has moved to your “DELETED” folder, you should empty these items eventually. Those messages are still occupying space somewhere until you permanently delete them.

Conclusion

The details on how to use specific e-mail software programs vary and are beyond the scope of this presentation. However, using these common rules will help you be more effective in communicating by e-mail. Certain aspects of e-mail will always have to be judged on a message-specific basis, such as cultural content and language differences, but using basic rules of etiquette will simplify the structure of these communications.
USE OF THIAFENTANIL (A3080), MEDETOMIDINE, AND KETAMINE FOR ANESTHESIA OF CAPTIVE AND FREE-RANGING GIRAFFE (Giraffa camelopardalis)

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Abstract

Giraffe (Giraffa camelopardalis) anesthesia remains a major challenge due to their unique anatomy and physiology, which predisposes them to life-threatening, anesthesia-related complications.1,3,15 Historic verbal and published reports describe the use of several drugs and drug combinations for giraffe anesthesia.1-5,9,13-15 The most widely used anesthetic regimens have involved use of opioids alone or in combination with sedatives (e.g., xylazine) or tranquilizers (e.g., azaparone).1-3,5,9,13-15 Current methods for field anesthesia generally involve darting giraffe with very high doses of an opioid (etorphine, thiafentanil or carfentanil) combined with hyaluronidase for rapid induction, and then reversing the opioid as soon as the giraffe is recumbent, to reduce consequences of the opioid overdose.14,15 This anesthetic technique greatly limits what can safely be done to a giraffe while it is recumbent. A combination of medetomidine and ketamine is currently considered a safe and reliable alternative to opioid combinations for captive giraffe, but is considered less than optimal for capture of free-ranging giraffe.1,2,4

A newer drug combination, thiafentanil (A3080)-medetomidine-ketamine, has safely and successfully been used for chemical restraint of other difficult hoofstock species in the field.6-8,10 Currently, a total of 50 anesthetic events with this combination have been performed on giraffe: 12 captive, 29 free-ranging, ground-darted, and 9 free-ranging, helicopter-darted. Dosing requirements are markedly different between the three study groups: (1) captive - thiafentanil 5.8 ± 1.5 µg/kg + medetomidine 12.9 ± 5.1 µg/kg + ketamine 0.65 ± 0.18 mg/kg; (2) free-ranging, ground-darted - thiafentanil 6.6 ± 1.5 µg/kg + medetomidine 15.9 ± 3.7 µg/kg + ketamine 0.50 ± 0.19 mg/kg; and (3) free-ranging, helicopter-darted - thiafentanil 10.0 ± 4.0 µg/kg + medetomidine 14.0 ± 9.4 µg/kg + ketamine 0.39 ± 0.20 mg/kg. Weights of giraffe were estimated by body measurements as previously described.11 The degree of excitement associated with helicopter darting appears to negate the effects of medetomidine, so at least twice the dose of thiafentanil is required to slow giraffe in the field.

Onset of action was ultra-rapid in all three groups (<1.5 min) but time to recumbency varied greatly (3 min in captive giraffe to 12 min in free-ranging, helicopter-darted giraffe). Nine of 29 free-ranging, ground-darted giraffe and seven of nine free-ranging, helicopter-darted giraffe...
needed to be cast with ropes. Most giraffe were rated to have good muscle relaxation once recumbent and were considered safe to work around for all ground personnel during the monitoring period. Most study animals exhibited an accentuated apneustic breathing pattern. Significant physiologic alterations seen during the study were mild to severe hypoxemia, mild hypercarbia, and a moderate mixed acidosis. The hypoxemia was persistent throughout the monitoring period while the hypercarbia and acidosis improved through the monitoring period.

Anesthesia was reversed with 30 mg naltrexone for each mg thiafentanil and atipamezole at 3-5 times the medetomidine mg dose, half i.v. and half i.m. in most cases. Arousal time was rapid in most animals. It was necessary to give the giraffe ample time to gain full awareness before stimulating them to rise or they would tend to be ataxic when they stood and would often fall back down. Once standing, most blind-folded, haltered, free-ranging giraffe were calm during chariot loading with very little kicking, rearing, or bolting attempts. Evidence of medetomidine-associated re-sedation was seen in some giraffe post reversal requiring additional supplements of atipamezole.

In conclusion, thiafentanil-medetomidine-ketamine is a useful anesthetic combination for captive and free-ranging, ground-darted giraffe, especially for longer procedures and when good muscle relaxation and analgesia are required. As with most anesthetic protocols, oxygen supplementation or respiratory support should be available when using this drug combination on giraffe. Resedation in giraffe given medetomidine has been reported before, is worrisome, and requires further study.

ACKNOWLEDGMENTS

This study was funded through a grant from the Morris Animal Foundation (#D03ZO-63). The authors wish to thank Drs. Peter Buss and David Zimmerman of South African National Parks, JJ van Altena of CatchCo Africa, and the South African National Parks and CatchCo capture teams for their assistance with this study and Dr. Cobus Raath of Wildlife Pharmaceuticals, South Africa for supplying many of the drugs used in this study.

LITERATURE CITED


**REVERSIBLE ANESTHETIC COMBINATION USING MEDETOMIDINE-BUTORPHANOL-MIDAZOLAM IN IN-SITU AFRICAN WILD DOGS (Lycaon pictus)**

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**Abstract**

In the past, there have been numerous drug combinations used to immobilize the African wild dog (*Lycaon pictus*) with varying success. Drug combinations that have been used include ketamine and xylazine, medetomidine and ketamine, tiletamine and zolazepam, and phencyclidine and ketamine. The major disadvantage of these drug combinations is that at least one component of the combination is non-reversible leading to prolonged recovery times. This may be critical in immobilizing these animals in free-ranging settings as sedated wild dogs left alone may fall prey to other predators or lose contact with their pack. Additional drug combinations utilizing fentanyl and xylazine were fully reversible however PO2 levels were low and PCO2 levels were elevated. Thus there is a need for a safe, fully reversible drug combination with rapid immobilization and good muscle relaxation. For field conditions a drug combination that would last 30-40 min with a quick recovery time (<5 min) would be ideal. The aim of this investigation was to utilize a new combination of medetomidine, butorphanol, and midazolam to produce a 30-40 min anesthesia that was fully reversible.

In this study three packs of enclosed African wild dogs, containing 23 males and 13 females, ranging in weight from 18.2-37.5 kg were utilized. The animals were anesthetized via remote injection and monitored with capnography, blood gas analysis, heart rate, respiratory rate, pulse oximetry and blood pressure. Each wild dog was darted with a combination of medetomidine (mean ± SD = 44.5 ± 9.1 µg/kg i.m.), butorphanol (0.24 ± 0.06 mg/kg i.m.) and midazolam (0.29 ± 0.11 mg/kg i.m.). The animals were then reversed with an intramuscular injection of atipamezole 3 mg, naltrexone 10 mg and flumazenil 0.2 mg. Mean induction times (until the dog was laterally recumbent) were 6 ± 5 min and total working time (from the time the dog could be handled until it was reversed) was 38 ± 6 min.

**ACKNOWLEDGMENTS**

The authors thank the Hoedspruit Endangered Species Centre and Juliette Erkestadt for their support of this project.

**LITERATURE CITED**


COMPARATIVE PHYSIOLOGIC EFFECTS OF THIAFENTANIL-AZAPERONE AND THIAFENTANIL-MEDETOMIDINE-KETAMINE IN FREE-RANGING UGANDA KOB (Kobus kob thomasi)

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Dept of Large Animal Clinical Sciences, 52 Campus Drive, Saskatoon, SK, Canada S7N 5B4;
WARM Department, Faculty of Veterinary Medicine, Makerere University, P.O. Box 7062, Kampala, Uganda

Abstract

Thiafentanil is a potent μ-opioid agonist drug, that is slightly less potent than carfentanil, and has a shorter duration of action than carfentanil or etorphine. Thiafentanil administration will rapidly induce anesthesia, but when used as the sole agent, it can induce muscle rigidity. Thiafentanil can be effectively antagonized with naltrexone. Potent opioids are often combined with tranquilizers or sedatives to improve muscle relaxation and decrease opioid requirements. A combination of thiafentanil (Wildlife Pharmaceuticals, Inc., Karino, South Africa), medetomidine (Wildlife Pharmaceuticals, Inc., Fort Collins, Colorado 80522 USA) and ketamine (Produlab Pharma, Ruams-donksveer, Netherlands) has been evaluated for anesthesia in gemsbok and roan antelope. One objective of this study was to evaluate the efficacy and physiologic effects of a similar combination (TMK) in Uganda kob.

This study was performed in Queen Elizabeth National Park, Uganda, from February 18-23, 2005. The ambient temperature for this period ranged from 17-38°C. Male kob were approached by vehicle on their mating grounds. A Bushnell 400° lazer range finder (Bushnell Corporation, Overland Park, Kansas 66214 USA) was used to determine range, and the animal was darted in the hindquarters with either a Pneudart® 193 projector (Pneudart Inc. Williamsport, Pennsylvania 17701 USA) or a Dan-inject® JM rifle (Dan-Inject, Børkop, Denmark). Induction time was taken as the time from dart placement to sternal recumbency while down time was taken as time from sternal recumbency until time of antagonist administration. Recovery time was taken as time from antagonist administration to standing. The kob were weighed, and body weight was used to

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determine the actual dose of drugs administered. Naltrexone (Wildlife Pharmaceuticals, Inc., Fort Collins, Colorado 80522 USA) (N) was used to antagonize thiafentanil in both groups. It was administered half i.v. and half i.m. at a ratio of 50 (N):1(T) in the TMK group and 40(N):1(T) in the TA group. Atipamezole (Antisedan™ Orion Pharmaceuticals, Espoo, Finland) was administered at three times the medetomidine dose, by i.m. injection, in the TMK group. Comparisons of induction and recovery characteristics and blood gas data were performed between groups with a Students t-test. A significance level of $P<0.05$ was used.

Data were obtained from eight animals in the TMK group. These animals received an actual dosage (mean ± SD) of 15.16 ± 3.3 μg/kg of medetomidine, 15.16 ± 3.3 μg/kg of thiafentanil, and 0.99 ± 0.04 mg/kg of ketamine. Data were obtained from nine animals in the TA group. These animals received an actual dosage (mean ± SD) of 57.3 μg/kg of thiafentanil and 0.46 mg/kg of azaperone. Induction and recovery characteristics are summarized in Table 1. HR, RR, and rectal temperature are summarized in Table 2. This table illustrates the mean values of the first reading obtained from the animal and the final reading before reversal. Table 3 illustrates blood gas values.

Rolling during induction of anesthesia accompanied by regurgitation were the major complications noted in the TA group. Three of nine animals anesthetized with TA regurgitated. None of the eight animals anesthetized with TMK regurgitated. The TA animals that regurgitated had recently returned from water and this probably contributed to regurgitation.

Quality of anesthesia was superior with TMK. Animals in this group had good muscle relaxation and no movement. Animals anesthetized with TA had more spontaneous movement. Quality of recovery was superior with TA. Antagonism of thiafentanil resulted in a rapid and complete reversal of anesthesia. Recovery was slow from TMK, and was characterized by stumbling and ataxia. Animals recovering from TMK needed to be closely watched to protect them from other kobs and predators. Since both medetomidine and thiafentanil had been antagonized, the narcosis and ataxia probably resulted from residual ketamine.

Hypoxemia was a major complication with TMK, probably related to the addition of an alpha-2 agonist drug. Two animals in the TMK group developed profound hypoxemia ($PaO_2<25$ mm Hg). This was accompanied by tachypnea and tachycardia, indicative of hypoxic stress.

Thermoregulation was good with both treatments and was somewhat surprising given the fact that ambient temperature approached 40°C.

Induction times were surprisingly fast with TA. The most rapid induction occurred in 25 sec. The longest induction was still less than 3 min in duration. This characteristic is highly desirable in the anesthesia of free-ranging animals.

Based on these results TA proved to be the superior combination in this situation. The induction and recovery characteristics were ideal in this potentially hazardous environment, and the cardiopulmonary stability should decrease the risk of complications from hypoxemia. The quality of anesthesia produced by TA may be improved with the addition of a benzodiazepine drug, or a low dose of an alpha-2 agonist. TMK may be more useful in a captive situation, where
induction and recovery can be closely controlled. Supplemental oxygen should be available to
offset hypoxemia during anesthesia with TMK. It is possible that recovery characteristics may be
improved if this mixture is used without ketamine.

ACKNOWLEDGMENTS

The authors thank the students of the 2005 Africa experience rotation for their assistance, these included final year
students from the Western College of Veterinary Medicine and graduate students from Makerere University. We
also thank the Uganda Wildlife Authority for their support of this research. Funding assistance was also provided by
the 2005 Africa experience rotation and the WCVM research fund.

LITERATURE CITED


Table 1. Induction times, down times, and recovery times in Uganda kob receiving
thiafentanil-medetomidine-ketamine (TMK) or thiafentanil-azaperone (TA).

<table>
<thead>
<tr>
<th></th>
<th>TMK n=8</th>
<th>TA n=9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction time (mean ± SD)b</td>
<td>3.7 ± 1.8 min</td>
<td>2.1 ± 0.71 min</td>
</tr>
<tr>
<td>Range</td>
<td>1.1 - 7.1 min</td>
<td>0.42 - 2.9 min</td>
</tr>
<tr>
<td>Down time (mean ± SD)b</td>
<td>21.6 ± 6.8 min</td>
<td>14.3 ± 2 min</td>
</tr>
<tr>
<td>Range</td>
<td>15 - 35 min</td>
<td>12 - 17 min</td>
</tr>
<tr>
<td>Recovery time (mean ± SD)b</td>
<td>6.2 ± 3.4 min</td>
<td>1.1 ± 0.2 min</td>
</tr>
<tr>
<td>Range</td>
<td>2 - 11 min</td>
<td>0.72 - 1.3 min</td>
</tr>
</tbody>
</table>

bDenotes a significant difference between treatment groups P≤0.05.
Table 2. First and last reading of, heart rate (HR), respiratory rate (RR) and rectal temperature (TEMP) in Uganda kob receiving thiafentanil-medetomidine-ketamine (TMK) or thiafentanil-azaperone (TA).

<table>
<thead>
<tr>
<th></th>
<th>TMK n= 8</th>
<th>TA n = 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>First HR (beats/min) mean/range</td>
<td>65/42-96</td>
<td>91/60-140</td>
</tr>
<tr>
<td>Last HR (beats/min) mean/range</td>
<td>66/36-120</td>
<td>72/60-110</td>
</tr>
<tr>
<td>First RR (breath/min) mean/range</td>
<td>22/4-42</td>
<td>17/5-24</td>
</tr>
<tr>
<td>Last RR (breath/min) mean/range</td>
<td>34/6-72</td>
<td>18/7-28</td>
</tr>
<tr>
<td>First TEMP (°C) mean/range</td>
<td>38.9/37.1-40.2</td>
<td>38.8/37.5-40.2</td>
</tr>
<tr>
<td>Last TEMP (°C) mean/range</td>
<td>38.9/37.2-39.9</td>
<td>39.0/37.6-40.8</td>
</tr>
</tbody>
</table>

*aAll kob were routinely cooled with water.

Table 3. Arterial blood gas values from Uganda kob receiving thiafentanil-medetomidine-ketamine (TMK) or thiafentanil-azaperone (TA).

<table>
<thead>
<tr>
<th></th>
<th>TMK n=8</th>
<th>TA n=9</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaCO₂ mm Hg (mean ± SD)</td>
<td>59.8 ± 6.8</td>
<td>53.7 ± 6.0</td>
</tr>
<tr>
<td>PaO₂ mm Hg (mean ± SD)*</td>
<td>37.0 ± 15.2</td>
<td>56.6 ± 10</td>
</tr>
<tr>
<td>Ph (mean ± SD)</td>
<td>7.32 ± 0.06</td>
<td>7.32 ± 0.05</td>
</tr>
<tr>
<td>Base excess (mean ± SD)</td>
<td>3.8 ± 63.4</td>
<td>1.3 ± 1.2</td>
</tr>
</tbody>
</table>

*Denotes a significant difference between treatment groups \(P \leq 0.05\).
CHEMICAL IMMOBILIZATION OF FREE-RANGING PLAINS BISON (Bison bison bison) AND ROCKY MOUNTAIN BIGHORN SHEEP (Ovis canadensis canadensis) WITH A TILETAMINE-ZOLAZEPAM-XYLAZINE-HYDROMORPHONE COMBINATION

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Abstract

Twelve plains bison (Bison bison bison) (PB) and eleven bighorn sheep (Ovis canadensis canadensis) (BHS) were successfully immobilized using a partially reversible combination of tiletamine-zolazepam-xylazine-hydromorphone. PB were darted from a helicopter in March 2005 and 2006 in Prince Albert National Park, Canada and BHS were darted from the ground in February 2006 in Kootenay National Park, Canada. Darting was accomplished with either a Dan-inject® (Dan-Inject of North America, Fort Collins, Colorado 80522 USA) model JM rifle with pressurized darts or a Pneu-dart® (Pneu-Dart Inc., Williamsport, Pennsylvania 17703 USA) model 196 rifle with powder-charged darts. BHS were either weighed directly (n=7) or body weight was estimated from a chest girth measurement (N=4) while body weights for PB were estimated from PB of known age, sex, and weight occupying similar habitat from Elk Island National Park, Canada. Both xylazine HCl (Bayer Inc., Toronto, Ontario M9W 1G6 Canada) and hydromorphone (Sabex Inc., Boucherville, Quebec J4B 7K8 Canada) were used to reconstitute vials of tiletamine-zolazepam (Telazol®, Fort Dodge Animal Health, Fort Dodge, Iowa 50501 USA) at a fixed ratio of 1.5 to 1 to 0.2 of tiletamine-zolazepam, xylazine and hydromorphone, respectively. The drug solution was prepared as follows: 1.32 ml of xylazine HCl (250 mg/ml lyophilized from 100 mg/ml solution and reconstituted) and 0.67 ml of hydromorphone (100 mg/ml) were used to reconstitute a 500 mg vial of tiletamine-zolazepam. The mixed solution had a final volume of 2.6 ml that contained approximately 192 mg/ml of tiletamine-zolazepam, 128 mg/ml of xylazine and 25 mg/ml of hydromorphone. Immobilized animals were blindfolded and placed in sternal recumbency. Venous blood was drawn from the jugular vein and arterial blood was drawn from coccygeal or femoral artery in bison. Oxygen saturation and pulse were determined with a pulse oximeter probe placed on either the tongue or inserted in the rectum (Model V3402, Surgivet Inc., Waukesha, Wisconsin 53186 USA). Blood gas values were analyzed within 3 hr with a handheld analyzer (i-STAT Portable Clinical Analyzer, i-STAT Corporation, East Windsor, New Jersey 08520 USA). Hydromorphone was reversed in both PB and BHS with naltrexone (Wildlife Pharmaceuticals Canada, Calgary, Alberta T2N 4G3 Canada) at a dosage of 0.05 to 0.1 mg/kg intramuscularly. In PB, xylazine was reversed with tolazoline HCl (Summit Veterinary Pharmacy, Aurora, Ontario L4G 6W3 Canada) at a dosage of 3 to 4 mg/kg injected half i.v. and half i.m. In BHS, xylazine was reversed with either tolazoline as described for PB or atipamezole (Novartis Animal Health Canada Inc., Mississauga, Ontario L5N 1V9 Canada) injected i.m. at 0.1 mg/kg. The zolazepam component of tiletamine-zolazepam was not reversed due to the low dosage used, even though specific benzodiazepine antagonists are available. Statistical significance was assessed using a single factor ANOVA.
with \( \alpha = 0.05 \) and \( P \leq 0.05 \) considered significantly different for induction time, reversal time, and handling duration.

Dosages and immobilization characteristics were very similar regardless of species (Tables 1 and 2). Higher initial dosages of tiletamine-zolazepam, xylazine and hydromorphone were used for PB immobilized with a single dart (Table 1) due to capture and pursuit method (helicopter). Multiple darts were required to achieve immobilization in both PB and BHS due to failure of complete ejection of dart contents (n=5), poor dart site (n=2) or weight underestimate (n=1). Induction and reversals were smooth and rapid and times were comparable to published dosages of medetomidine-tiletamine-zolazepam and carfentanil-xylazine combinations for PB\(^1\)\(^2\) and faster than previous studies using tiletamine-zolazepam-xylazine or ketamine-xylazine combinations for BHS.\(^3\)\(^4\) Two additional PB did not become immobilized after being darted and chase was abandoned when no drug effects were observed after 10 min while all 11 BHS that were darted were successfully immobilized.

In contrast to tiletamine-zolazepam-xylazine combinations without hydromorphone,\(^1\)\(^3\) both PB and BHS reversed quickly and smoothly using either tolazoline or atipamezole to reverse xylazine and naltrexone to reverse hydromorphone. No significant difference in reversal time was observed between BHS reversed with tolazoline or atipamezole. Mean induction and reversal times were significantly longer for both PB and BHS immobilized with multiple darts versus single darts, although handling duration did not differ (Table 2). Mean (± SD) oxygen saturation measured with a pulse oximeter was 83.6 ± 7.6% in BHS (range 66-98%) and 82.5 ± 7.9% in PB (range 66-96%). Mild to moderate hypoxemia was observed in both BHS and PB, but values were superior to those reported for bison immobilized with tiletamine-zolazepam-xylazine alone,\(^1\) and supplemental oxygen was not considered necessary in any animal. All animals were tractable, relaxed, and in a satisfactory plane of anesthesia to allow minor procedures such as radio-collaring, rectal palpation, and venipuncture without spontaneous arousal. Profuse salivation was noted in approximately one-third of BHS immobilized with this combination. Blood gas data collected on seven PB (Table 3) indicated mild to moderate hypoxemia with some evidence of hypoventilation based on PaCO\(_2\) values. All PB demonstrated moderate to severe metabolic acidosis and increased serum lactate. This probably resulted from the helicopter pursuit prior to capture. Hypoxemia is a frequent complication when using tiletamine-zolazepam-xylazine or narcotic-alpha-2 agonist combinations in large ungulates.\(^5\)\(^6\)\(^7\) No mortality or renarcotization was observed in any animal immobilized in this study. Mean drug volumes to achieve immobilization using single darts were 4.24 ± 0.42 ml for PB and 0.78 ± 0.13 ml for BHS allowing the use of smaller drug volumes compared to tiletamine-zolazepam-xylazine combinations.\(^1\)\(^3\) These drug volumes are comparable to other potent drug combinations for PB and BHS.\(^8\)\(^9\)\(^10\) Reversal times were faster and more complete than reported with tiletamine-zolazepam-xylazine combinations from other studies with BHS\(^3\) and PB\(^1\) due to lower dosages of tiletamine-zolazepam and xylazine that could be used as a result of combining these drugs with hydromorphone. This combination seems to be an effective alternative to provide safe, reliable, reversible immobilization of free-ranging BHS and PB with few complications and relatively low cost. Advantages include low volume, rapid and complete reversal and relative lack of side effects.
ACKNOWLEDGMENTS

The assistance of Parks Canada staff in Kootenay and Prince Albert National Parks is gratefully acknowledged, particularly Alan Dibb, Sybilla Helms, Nicole Obee, Ronan Eustace, Dan Frandsen and Lloyd O’Brodovich. Helicopter capture was possible with the services provided by Bob Doerksen of Transwest Air.

LITERATURE CITED

Table 1. Mean (∀ SD) dosages (mg/kg) of drugs used for immobilization and reversal of plains bison and bighorn sheep.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Darts</th>
<th>Tiletamine-zolazepam</th>
<th>Xylazine HCl</th>
<th>Hydromorphone</th>
<th>Tolazoline HCl</th>
<th>Atipamezole</th>
<th>Naltrexone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plains bison</td>
<td>Single (n=7)</td>
<td>1.98 ± 0.21</td>
<td>1.32 ± 0.14</td>
<td>0.26 ± 0.03</td>
<td>4.0 ± 0.39</td>
<td>N/A</td>
<td>0.09 ± 0.03</td>
</tr>
<tr>
<td></td>
<td>Multiple (n=5)</td>
<td>3.35 ± 0.24</td>
<td>2.23 ± 0.16</td>
<td>0.45 ± 0.03</td>
<td>4.27 ± 0.23</td>
<td>N/A</td>
<td>0.09 ± 0.03</td>
</tr>
<tr>
<td>Bighorn sheep</td>
<td>Single (n=8)</td>
<td>1.64 ± 0.07</td>
<td>1.08 ± 0.05</td>
<td>0.22 ± 0.01</td>
<td>3.73 ± 0.74</td>
<td>0.11 ± 0.01</td>
<td>0.18 ± 0.04</td>
</tr>
<tr>
<td></td>
<td>Multiple (n=3)</td>
<td>1.87 ± 0.63</td>
<td>1.24 ± 0.24</td>
<td>0.25 ± 0.09</td>
<td>3.17 ± 0</td>
<td>0.11 ± 0.01</td>
<td>0.2 ± 0.08</td>
</tr>
</tbody>
</table>

* Two or more darts required for induction.

Table 2. Comparative immobilization characteristics for plains bison and bighorn sheep immobilized with tiletamine-zolazepam-xylazine-hydromorphone (Mean ∀ SD).

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Darts</th>
<th>Induction time*a (min)</th>
<th>Handling time*b (min)</th>
<th>Recovery time*c (min)</th>
<th>Chase Time*d (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plains bison</td>
<td>Single (n=7)</td>
<td>9.5 ± 3.5</td>
<td>43.8 ± 4.6</td>
<td>6.5 ± 2</td>
<td>1.25 ± 0.5</td>
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<td>Multiple (n=5)</td>
<td>19.3 ± 5.5</td>
<td>47 ± 6.1</td>
<td>12 ± 5.75</td>
<td>2.45 ± 1.6</td>
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<tr>
<td>Bighorn sheep</td>
<td>Single (n=8)</td>
<td>9 ± 2</td>
<td>50.8 ± 11.2</td>
<td>10.3 ± 6.4</td>
<td>N/A</td>
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<tr>
<td></td>
<td>Multiple (n=3)</td>
<td>41 ± 17</td>
<td>37.3 ± 15.2</td>
<td>9.3 ± 12.3</td>
<td>N/A</td>
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</tbody>
</table>

*a Time from dart injection to sternal recumbency.  
*b Time from sternal recumbency to standing following reversal.  
*c Time from injection of reversal drug until ambulatory.  
*d Cumulative chase time not including time required to slowly haze bison into open areas.  
*e Skewed mean due to single BHS with 48-min induction time due to multiple darts.

Table 3. Blood gas values for plains bison immobilized with tiletamine-zolazepam-xylazine-hydromorphone (n=7).

<table>
<thead>
<tr>
<th></th>
<th>Mean ∀ SD</th>
<th>Range</th>
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<tr>
<td>pH</td>
<td>7.15 ∀ 0.14</td>
<td>6.88 – 7.28</td>
</tr>
<tr>
<td>paCO2 (mm Hg)</td>
<td>50.31 ∀ 5.74</td>
<td>42.3 – 56.4</td>
</tr>
<tr>
<td>paO2 (mm Hg)</td>
<td>63.00 ∀ 21.50</td>
<td>37 – 101</td>
</tr>
<tr>
<td>Base Excess (mmol/L)</td>
<td>0.29 ∀ 13.90</td>
<td>-15 – 25</td>
</tr>
<tr>
<td>Bicarbonate (mmol/L)</td>
<td>20.04 ∀ 8.10</td>
<td>7.6 – 31</td>
</tr>
<tr>
<td>Total CO2 (mmol/L)</td>
<td>19.43 ∀ 6.55</td>
<td>9 – 28</td>
</tr>
<tr>
<td>SpO2 (%)</td>
<td>75.86 ∀ 12.64</td>
<td>57 – 88</td>
</tr>
<tr>
<td>Lactate (mmol/L)</td>
<td>14.44 ∀ 4.18</td>
<td>8.13 – 20</td>
</tr>
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</table>
IMMOBILIZATION OF FREE-RANGING HOFFMANN’S TWO-TOED (Choloepus hoffmannii) AND BROWN-THROATED THREE-TOED (Bradypus variegatus) SLOTHS USING MEDETOMIDINE-KETAMINE: A COMPARISON OF PHYSIOLOGIC PARAMETERS

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Abstract

Recent literature has confirmed the safety and efficacy of ketamine and medetomidine (KM) combinations for immobilizing a variety of captive and free-ranging nondomestic species.1-3 Physiologic effects of KM include rapid induction/recovery, excellent muscle relaxation, peripheral vasoconstriction, initial hypertension, bradycardia, and bradypnea. While this drug combination has been evaluated in free-ranging two-toed sloths,1 there are no published data evaluating the efficacy of KM in three-toed sloths. The objectives of this study were to evaluate the safety and efficacy of KM in free-ranging two- and three-toed sloths in Costa Rica, and to compare physiologic parameters across species and gender.

Free-ranging Hoffmann’s toe-toed (Choloepus hoffmannii) (n=26) and brown-throated three-toed sloths (Bradypus variegatus) (n=15) were manually captured and immobilized using ketamine (2.5 mg/kg) and medetomidine (0.02 mg/kg) administered intramuscularly. Approximately 10 ten min after injection, each sloth was examined, and blood, fecal, and ectoparasite samples collected. The following physiologic parameters were monitored every 5 min for the duration of anesthesia: pulse rate, respiratory rate, body temperature, indirect systolic blood pressure, and indirect peripheral oxygenation. After 45 min, atipamezole (0.1 mg/kg) was administered i.m. to facilitate recovery. All sloths recovered uneventfully.

Physiologic parameters were compared across time, gender, and species. All sloths demonstrated a significant time-dependent decrease in pulse rate, respiratory rate, and blood pressure. Peripheral oxygenation remained similar over time for all sloths. Significant species differences were evident in respiratory rate (Choloepus > Bradypus) and blood pressure (Bradypus > Choloepus). Pulse rate showed a significant interaction between species and gender, such that Bradypus males and both Choloepus genders had greater pulse rates than Bradypus females. Gender differences were significant for body temperature (males > females), and blood pressure (males > females).
Results of this study suggest that KM is a safe and effective anesthetic combination in free-ranging two- and three-toed sloths.

LITERATURE CITED


COMPARATIVE PHYSIOLOGIC EFFECTS DURING CARFENTANIL-XYLAZINE ANESTHESIA IN NORTH AMERICAN ELK (Cervus elaphus) SUPPLEMENTED WITH NASOPHARYNGEAL MEDICAL AIR OR OXYGEN

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Abstract

This study compared specific cardiopulmonary effects and the overall quality of anesthesia during carfentanil-xylazine anesthesia in hypoxemic versus normoxemic elk.

Eight female habituated elk (Cervus elaphus) weighing 245 ± 20 kg (mean ± SD) were studied with a randomized crossover design. Each elk was insufflated with oxygen (OXY) or medical air (AIR) through its nasopharynx at 10 L/min throughout anesthesia. Baseline data were collected before intramuscular (i.m.) injection of 10 μg/kg carfentanil (ZooPharm, Fort Collins, Colorado 80524 USA) and 0.2 mg/kg xylazine (Anased™ Vet-A-Mix, Shenandoah, Iowa 51601 USA). Arterial blood gases, direct arterial pressure, heart and respiratory rate, and somatic reflexes were assessed at 3 min intervals for 30 min. Elk were reversed i.m. at 30 min with 1 mg/kg naltrexone (ZooPharm, Fort Collins, Colorado 80524 USA) and 2 mg/kg tolazoline (Lloyd Laboratories, Shenandoah, Iowa 51601 USA).

Induction and recovery times were analyzed with a paired t-test. Physiologic responses over time and between treatments were compared with one and two-way ANOVA and a Bonferroni’s post hoc test. Incidence of rigidity and movement at different levels of PaO2 were compared with a Chi-square test. Significance was set at \(P<0.05\).

Induction and recovery times were significantly shorter in OXY, (208 ± 39 sec) and (333 ± 63) respectively, versus AIR, (306 ± 84) and (532 ± 201). Elk in OXY had significantly higher PaO2 and PaCO2, and significantly lower pH and heart rate compared to AIR. Maximum PaCO2 was 89 ± 5 in OXY, and 64 ± 4 mm Hg in AIR. Minimum PaO2 was 75 ± 30 in OXY, and 28 ± 6 mm Hg in AIR. There was a trend (\(P=0.08\)) towards decreased respiratory rate in OXY. Frequency of rigidity and movement increased at PaO2<70 mm Hg.

Animals nasally insufflated with air experienced slower inductions and recoveries, severe hypoxemia (PaO2<35 mm Hg), and increases in heart rate, muscle rigidity, and movement. The prolonged inductions and recoveries as well as the physiologic features in AIR are attributed to increased catecholamine release, decreased cerebral perfusion, and changes in blood brain barrier permeability in the face of severe hypoxemia.
Nasal insufflation of oxygen prevented hypoxemia and improved the quality of anesthesia but induced greater hypoventilation and respiratory acidosis. Oxygen supplementation in these elk offset complications related to hypoxemia but interfered with their hypoxic drive.

ACKNOWLEDGMENTS

The authors thank Dr. Rob McCorkell for his invaluable assistance with the project. Major sources of funding for this project were provided by the Western College of Veterinary Medicine Research Fund, and the Saskatchewan Canada Agrifood Innovation Fund Specialized Livestock Research Trust.
ROMIFIDINE HCl AS ADJUVANT TO DISSOCIATIVE ANESTHESIA IN BIG WILD CAPTIVE FELIDS IN BRAZIL

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Abstract

Restraint is the most important limiting factor in wildlife practice1 and a variety of drugs can be used to produce sedation or anesthesia in wild animals. This paper reports the use of romifidine hydrochloride, in combination with other drugs, including tiletamine hydrochloride, zolazepam, ketamine hydrochloride, and atropine sulfate to produce field anesthesia in big wild felids. The objective of this study was to evaluate both the efficacy of the drug combinations and the allometric scaling method of dosage calculation. Romifidine is a highly concentrated alpha-2 adrenoceptor agonist originally produced as a sedative for horses. Romifidine’s use in combination with dissociative anesthetics for in the chemical restraint of large wild felids have yielded encouraging results.3-7 Allometric scaling method was recently reviewed,2 and it permits extrapolation of drug doses between animals of different sizes and/or taxa, facilitating the use of data obtained in a “model animal” (animal for which the drug was developed) for the treatment of a “target animal” (wild or domestic patient).

From June 1999 to December 2005 the staff of the Service of Wildlife Medicine of the Universidade Paranaense (Umuarama, PR, Brazil) anesthetized 18 jaguars (Panthera onca), six pumas (Puma concolor), 29 African lions (Panthera leo), and three tigers (Panthera tigris), in several Brazilian zoos, conservation units, and circuses. Jaguars, pumas, and lions were anesthetized with a combination of romifidine, tiletamine, zolazepam, and atropine (RTZA). Tigers were anesthetized with the association of romifidine, ketamine, and atropine (RKA). All doses were established by allometric scaling, using a 10-kg dog and a 500-kg horse as models. Using the dog model, the following doses were used: tiletamine plus zolazepam at 5 mg/kg; ketamine at 10 mg/kg; and atropine at 0.05 mg/kg. Using the horse model, romifidine was administered at 0.08 mg/kg. In all cases the drugs were administered intramuscularly by darts delivered by a blowgun. All patients were subjected to careful monitoring immediately after losing the righting reflex until fully recovered by exhibiting normal ambulation. During anesthesia, physiologic parameters (heart frequency, respiratory frequency, rectal temperature and SpO2) and response to painful stimuli were monitored every 10 min.
Animals anesthetized with both combinations lost the righting reflex (RR) within 2-15 min post injection (MPI), and deep anesthesia occurred in all cases, beginning between 5-18 min MPI. All patients showed excellent myorelaxation during the study and remained safely anesthetized for 60-115 min MPI. Conscious reactions were noted between 96-170 min MPI and the return of the RR was noted between 126-380 min MPI. Prolonged recovery (more than 4.0 hr) was observed in three animals (two lions and a puma) and was likely due to cold ambient temperatures (5-8°C degrees centigrade) during the anesthetic procedure. Supplemental heat was not available when the procedure was performed under field conditions. The proposed anesthetic protocols proved to be safe and effective in many medical procedures including physical examination, identification transponder placement, biologic sample collection, declawing, and dental and general surgery.

The results of this study lead the authors to conclude that the use of romifidine in association with dissociative anesthetics is a good option in chemical restraint and field anesthesia of big wild felids. Its use with tiletamine and zolazepam provided safe and effective anesthesia in jaguars, pumas, and lions. Good results were also obtained in tigers when using romifidine in combination with ketamine. Unfortunately, alpha-2 adrenergic reversal agents such as yohimbine and atipamezole were not available in Brazil during this study. Their use is advocated and will be investigated in future studies with expected decreases in recovery times.

The results of the tested romifidine protocols appear promising for the zoo and wildlife practitioner. Furthermore, allometric scaling proved to be a useful tool for determining a safe initial dose of the anesthetic agents in the wild felids in this study.

ACKNOWLEDGMENTS

The authors thank the zoos, circuses, and conservation units that have called the staff to anesthetize their animals. This research was partially supported by the Research Institute of the Universidade Paranaense – UNIPAR.

LITERATURE CITED

COMPARISON OF INDUCTION AND RECOVERY CHARACTERISTICS AND CARDIOPULMONARY EFFECTS OF SEVOFLURANE AND ISOFLURANE IN BALD EAGLES (*Haliaeetus leucocephalus*)

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Current addresses: †Rutgers Agricultural Research & Extension Center, 121 Northville Road, Bridgeton, NJ 08302 USA; ‡Virginia Department of Game and Inland Fisheries, 4010 West Broad Street, Richmond, VA 23230-1104 USA

Abstract

Due to reported isoflurane-associated arrhythmias in bald eagles (*Haliaeetus leucocephalus*),1 other anesthetics may be superior in this species. Sevoflurane and isoflurane were compared in 17 captive bald eagles in a crossover study. Anesthesia was rapidly induced via facemask with isoflurane (4%) and sevoflurane (7%) delivered in oxygen (1.5 L/min) and maintained via endotracheal tube at approximately 2.5 MAC for isoflurane (3.5%) and sevoflurane (5%). Time to induction, extubation, and recovery were recorded. Blood was collected via catheter from the ulnar artery for blood gas analyses performed at 10, 25, and 40 min post intubation. Body temperature, heart rate, respiratory rate, oxygen saturation by pulse oximeter, end tidal CO₂ (ETCO₂), direct systolic, mean and diastolic blood pressures, and electrocardiograms were recorded every 5 min post induction. Repeated measures ANOVA was used to test for main effects of treatment and time. Significance was defined as $P<0.05$.

Both isoflurane and sevoflurane resulted in a smooth, rapid induction to and recovery from anesthesia. Recovery time was significantly longer during isoflurane anesthesia versus sevoflurane. A significant decrease in respiratory rate over time occurred with both agents while heart rate significantly decreased with sevoflurane only. Heart rate, ETCO₂, and direct systolic, mean and diastolic blood pressures were significantly higher during isoflurane anesthesia compared with sevoflurane anesthesia (Table 1). Arrhythmias were observed during isoflurane (5/17) and sevoflurane (4/17) anesthesia, and the types of arrhythmias were similar. Sevoflurane anesthesia had fewer side effects overall, suggesting sevoflurane may be preferable to isoflurane, especially in compromised bald eagles.
ACKNOWLEDGMENTS

The authors thank the staff of the American Eagle Foundation, The Wildlife Center of Virginia and The University of Tennessee, Knoxville, College of Veterinary Medicine for their cooperation and assistance. We also thank Drs. T. Hadley, J.M. Sykes, and L. Brazelton for their assistance with data collection. This research was supported by the Morris Animal Foundation.

LITERATURE CITED


Table 1. Comparison of selected significantly different results from isoflurane and sevoflurane anesthesia in bald eagles. Values are reported as mean ± standard error.

<table>
<thead>
<tr>
<th></th>
<th>Isoflurane</th>
<th>Sevoflurane</th>
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</thead>
<tbody>
<tr>
<td>Recovery time (sec)</td>
<td>326 ± 64</td>
<td>195 ± 63</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>266 ± 15</td>
<td>241 ± 15</td>
</tr>
<tr>
<td>ETCO₂ (mm Hg)</td>
<td>53 ± 8</td>
<td>28 ± 8</td>
</tr>
<tr>
<td>Direct systolic blood pressure (mm Hg)</td>
<td>194 ± 13</td>
<td>146 ± 13</td>
</tr>
<tr>
<td>Direct diastolic blood pressure (mm Hg)</td>
<td>158 ± 13</td>
<td>135 ± 13</td>
</tr>
<tr>
<td>Direct mean blood pressure (mm Hg)</td>
<td>176 ± 12</td>
<td>138 ± 12</td>
</tr>
</tbody>
</table>
DETERMINATION OF MINIMUM ANESTHETIC CONCENTRATION OF ISOFLURANE IN THICK-BILLED PARROTS (Rhinchopsitta plachyrhyncha)

Julio A. Mercado, MVZ, MPVM,1,*, R. Scott Larsen, DVM, MS, Dipl ACZM,2 Raymund F. Wack, DVM, MS, Dipl ACZM,2 and Bruno Pypendop, DrMedVet, DrVetSci, Dipl ACVA3

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Abstract

The thick-billed parrot (Rhinchopsitta plachyrhyncha) is an endangered species native to the southwestern U.S. and northern Mexico. Clinically, anesthesia in this species has been maintained with relatively low concentrations of isoflurane and unexplained mortalities related to anesthesia have been observed (Lamberski, pers. com.). This study was conducted to determine if the minimum anesthetic concentration (MAC) of isoflurane is lower in thick-billed parrots (TBP) than values reported for other species of birds. Fifteen healthy thick-billed parrots were induced and maintained with isoflurane. Birds were intubated, artificially ventilated, and monitored. The first bird was maintained at 1.00% isoflurane; after 15 min at the target vaporizer setting, an end-tidal isoflurane sample was measured via a modified endotracheal tube. The toe was then pinched to evaluate whether the bird had a conscious response to a painful stimulus. This bird was recovered, and the isoflurane equilibration concentration was then increased or decreased by 10% for the next bird, depending on whether the previous bird did or did not respond to the painful stimulus. This “up and down” approach was used for all birds, and quantal analysis was used to make an estimate of MAC. Using these methods, the MAC for isoflurane in thick-billed parrots was estimated to be 1.07%, which is lower than the MAC estimated for cockatoos (1.44%), sandhill cranes (1.34%) and Peking ducks (1.30%). This may help explain clinical problems observed in these birds under anesthesia. By defining the species-specific requirements of thick-billed parrots, isoflurane anesthesia can be performed more safely in this endangered species.

ACKNOWLEDGMENTS

This research was supported by funding from the Center for Companion Animal Health and the Veterinary Medicine Teaching Hospital at the University of California, Davis. The authors thank the animal care staff at the Sacramento Zoo and the Anesthesia Service at the UC Davis School of Veterinary Medicine for their assistance with this investigation.

LITERATURE CITED

HUMAN EXPOSURE TO WILDLIFE CAPTURE DRUGS: FIRST, DO NO HARM

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Abstract

Using potent capture drugs carries the inherent risk of human injury. Accidental and intentional exposure to a large variety of capture drugs has been described previously. These include the alpha-2 agonists medetomidine, detomidine and xylazine, the opioid agonist etorphine and the opiate agonist/antagonist butorphanol. Though prevention is the mainstay in avoiding capture drug related accidents it is important to establish protocols to deal with potentially lethal exposure. Accidental capture drug injection is always to be considered an emergency that will require calm, prompt and organized action. The published protocols available in veterinary literature for dealing with accidental exposure are often conflicting. Whereas the manufacturer of a European etorphine product (Large Animal Immobilon,™ C-Vet Veterinary Products, Leyland, Lancashire, UK) advocates the use of the partial antagonist diphrenorphine in cases of human exposure in its product information, others point out that it is not suitable for use in humans. Only a solid knowledge base can guarantee the principle of "Primum non nocere" – “First, do no harm.” A significant amount of human literature and experience dealing with the pharmacologic effects of standard capture drugs and their antagonists is available. However, this information has in many cases not been incorporated into accidental exposure protocols.

Especially when working in remote locations, the capture team must be completely self-reliant in dealing with possible life threatening situations that could include cardio-respiratory arrest, CNS depression, respiratory depression and hypotension. A thorough theoretic understanding and most importantly, practical experience in cardiopulmonary resuscitation is essential. It is critical that several members of the team are trained in this manner. Similar to the use of antagonists in drug exposure, the published cardiopulmonary resuscitation protocols are often conflicting. Only recently an international consensus document was published.

It is important to be aware of the legal implications in administrating medical treatment to accident victims by persons that might not be officially qualified and that laws governing this issue vary by country. As a minimum when working in the field the following precautions should be adhered to: use capture drugs only with a second, trained person present; respect the potency of the drugs and do not take chances by underestimating a potentially dangerous situation; never work with opioid drugs without having the human antidote and administration protocol in the emergency kit; and limit personnel present when working with the drugs.
LITERATURE CITED

SEDATION AND ANESTHESIA TECHNIQUES IN CETACEANS

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Abstract

Cetacean sedation and anesthesia technique development has lagged behind that of terrestrial mammals over the last 40 yr. This has been due in part to a number of different factors including misinformation on cetacean respiratory physiology and its response to sedatives and anesthetic agents, popular myths and fear of the potential impact of “voluntary” breathing capability, improper use of some anesthetic agents, and inadequate monitoring and support of sedated and anesthetized animals. In addition there have been only a limited number of institutions that displayed these animals in any significant numbers, or that employed full time veterinary staffs that were more likely to investigate proper sedation and anesthetic protocols.

While Navy veterinary personnel pioneered anesthesia in the 1960’s and 70’s,1 most other facilities did not begin to commonly use sedation and anesthesia techniques until the 1980’s. Clinical presentations requiring sedation or anesthetic procedures in cetaceans are no different than terrestrial species and the need for safe and effective drug protocols is just as important. Initial sedation attempts at Sea World Orlando were based on the recognition that few veterinarians or curators felt that these animals could be safely sedated. As a result, the dosage levels were started low and increased over numerous applications. The drug requirements for initial use of sedatives included the potential for reversibility, a wide safety margin, a history of use in numerous species, low cardiac or respiratory compromise, and preliminary low dose trials which developed to clinically useful levels. Drugs which fit these requirements included diazepam (Hospira, Inc., Lake Forest, Illinois 60045 USA) meperidine (Demerol, Abbott Laboratories, N. Chicago, Illinois 60064 USA), midazolam (Versed, Roche Laboratories, Inc, Nutly, New Jersey 07110 USA) and lately butorphanol (Trobugesic-SA, Fort Dodge Animal Health, Fort Dodge, Iowa 50501 USA).

Diazepam has been used orally as well as parenterally. Oral diazepam dosages range from 0.1 mg/kg of body weight for anti-anxiety or appetite stimulation to 0.2 mg/kg for sedation for transport. The onset of effect can range from less than 1 hr to 4 hr, partially depending on the amount of food present in the stomach at the time of ingestion. Parenteral diazepam has been used intravenously (i.v.) as well as intramuscularly (i.m.). The i.v. dosage has ranged from 0.05 to 0.1 mg/ kg for diazepam. The drug can be somewhat irritating and has in one case caused perivascular necrosis in the ventral fluke vein area. The i.m. dosage has ranged from 0.5 to 0.15 mg/kg.
The introduction of midazolam to the market, with its increased reliability for predictable i.m. sedation effects, can replace the use of diazepam except in those cases where the clinician is uncomfortable with substitution or when seizure activity is anticipated. It was hoped that midazolam would also be beneficial for cetacean use if it produced amnesia similar to that seen in humans. Intramuscular midazolam sedation dosages have ranged from 0.045 to 0.1 mg/kg of body weight. It has not been used i.v. at this point. One of the disadvantages of the benzodiazepines is the ability of a fractious or excited animal to override the sedation effect. In a case where an animal is overly excited the clinician should be cautious about redosing since overdosing is possible. In general, the cetacean that is given midazolam or diazepam i.m. should be closely monitored. Acceptable peak effects are reached by approximately 25 min during which time the animal is left in the water and observed for changes in respiratory behavior, loss of equilibrium, capability to surface, and ability to recognize and avoid environmental obstacles. When given for short procedures, midazolam and diazepam are generally reversed with flumazenil (0.5 mg/ml, Bedford Labs, Bedford, Ohio 44146 USA) administered in a volume equal to that of the sedative.

Meperidine was initially introduced in cetaceans in combination with diazepam or midazolam for procedures that were likely to be painful such as tooth extraction or local surgical approaches. Used in combination with midazolam at 0.06 to 0.075 mg/kg, it was initially introduced at 0.025 mg/kg and eventually increased to 0.05 to 1.0 mg/kg. Some clinicians have used it up to 2.0 mg/kg i.m. alone. Meperidine is often not reversed unless the patient is showing signs of extended depression or incoordination when used alone or after the reversal of other anesthetic or sedative drugs.

The use of butorphanol in cetaceans has increased the potential list of sedative options in these animals. To date it has been given at dosages of 0.05 to 0.15 mg/kg i.m. in three different species including killer whales (*Orcinus Orca*), false killer whales (*Pseudorca crassidens*), and bottlenose dolphins (*Tursiops truncatus*). The time from administration to peak effect is similar to midazolam at 25 min. Its use has some advantages over midazolam in that it appears to be more difficult for the animal to override the sedation level with an increase in excitement. One male *Tursiops* was reported to have increased activity and excitability shortly after administration of butorphanol. This was believed to be due to an adverse drug interaction with aminophyline with which the animal was being treated for pneumonia. The effect was immediately reduced then eliminated within 10 to 15 min after the reversal agent, naltrexone, was given at 0.01 mg/kg i.m.

Parameters monitored in sedated cetaceans have included respiration rate and depth, blood gases at the start of a procedure and 15 min later, electrocardiogram, and heart rate by palpation. Many animals have also been supplemented with oxygen delivered on inspiration by a demand valve held 6 to 8 in from the nares (blow).

General anesthetic procedures are not as common in cetaceans but three have been performed at Sea World Orlando in bottlenose dolphins for pyometra, a postpartum ruptured uterus, and a kidney biopsy. Induction has varied from the use of i.v. ketamine (Bioneche Pharma Ltd., London, ON Canada N6A 5R7), i.v. propofol (Bedford Laboratories, Bedford, Ohio 44146 USA).
or mask induction prior to maintenance gas anesthesia. Mask induction is not recommended because of the potential for complications with blood gas imbalance. Intubation has been performed through the oral cavity with manual repositioning of the larynx and placement of the endotracheal tube through the glottis. The dolphins were then provided isoflurane and respirations were assisted with mechanical ventilation. Blood gas analysis showed that each dolphin developed hypercapnea which likely contributed to delayed arousal at the end of the procedures in two of the animals. Changes in respiratory support including increasing respiratory rate and pressure were able to reverse this anesthesia-induced complication.

ACKNOWLEDGMENTS

The authors would like to thank the Sea World Animal Care, Training, Veterinary and Discovery Cove staffs for their assistance with the animals involved. In addition we would like to thank those individuals that have pioneered improvements in the cetacean medicine field.

LITERATURE CITED

COMPARISON OF ISOFLURANE AND CARBON DIOXIDE ANESTHESIA IN ROSE-HAIRED TARANTULAS (*Grammostola rosea*)

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Abstract

Thirty-two sub-adult to adult rose-haired tarantulas (*Grammostola rosea*) were randomly divided into two groups. One group was anesthetized with 5% isoflurane in oxygen and the other with 100% carbon dioxide. The tarantulas were anesthetized in a chamber fashioned from a clear plastic jar. Isoflurane was delivered by a standard veterinary vaporizer. Carbon dioxide was supplied via a laparoscopy insufflation unit. Times to first effect, loss of righting reflexes, loss of movement with and without external stimuli, and recovery time were recorded (Table 1). Subjective comments regarding the anesthesia episodes were also recorded. Statistically significant differences were detected between the groups in all of the recorded times. Animals anesthetized with carbon dioxide had a shorter time to first effect and loss of movement as well as a reduced recovery time in comparison to those in the isoflurane group. Subjectively, the tarantulas anesthetized with carbon dioxide seemed distressed during induction and recovered in an agitated state. Tarantulas anesthetized with isoflurane had a smoother induction and recovery, but often displayed some movement in response to stimuli for extended periods of time. All tarantulas recovered completely and have remained healthy for greater than 2 yr following the experiment, with the exception of two animals which died from apparently unrelated causes.

Both anesthetic agents appear to be safe and efficacious as used in this study. It should be noted that repeated carbon dioxide anesthesia causes impaired reproduction, growth and survivability in a number of invertebrate species.¹-⁴ The tarantulas in this study did not show any obvious ill effects following carbon dioxide or isoflurane anesthesia, but reproductive behavior and capability was not evaluated.

ACKNOWLEDGMENTS

The authors would like to thank Shane Christian for managing the tarantula colony at the North Carolina State College of Veterinary Medicine.

LITERATURE CITED


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**Table 1.** Comparison of carbon dioxide and isoflurane anesthesia characteristics in rose-haired tarantulas (*Grammostola rosea*).

<table>
<thead>
<tr>
<th>Anesthetic</th>
<th>Mean time to onset (sec) SD</th>
<th>Mean time to loss of righting reflex (sec) SD</th>
<th>Mean time to loss of movement (sec) SD</th>
<th>Mean time to recovery (sec) SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide (n=16)</td>
<td>41 ± 15</td>
<td>64 ± 33</td>
<td>199 ± 88</td>
<td>285 ± 195</td>
</tr>
<tr>
<td>Isoflurane (n=16)</td>
<td>124 ± 61</td>
<td>238 ± 154</td>
<td>318 ± 160</td>
<td>486 ± 279</td>
</tr>
</tbody>
</table>
SYSTEMIC CALICIVIRUS EPIDEMIC IN CAPTIVE EXOTIC FELIDS

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Abstract

Feline calicivirus (FCV) has been associated with upper respiratory tract disease in domestic felines.2 Recently, strains of FCV resulting in severe systemic forms of FCV infection have been recognized, particularly as outbreaks in catteries or humane shelters.1,3 These virulent systemic strains of FCV have been associated with clinical signs such as cutaneous ulcers, subcutaneous edema, and alopecia, and pathologic findings including pancreatic, hepatic, and splenic necrosis with mortality rates as high as 60%.

An FCV epidemic in exotic felids presented with a 5-day-old, Amur tiger cub (Panthera tigris altaica) with tongue ulcerations. Tongue ulcerations appeared and progressed in three litter-mates of this cub the following day. Disease progressed in all cubs to include sloughing of the tongue epithelium and sloughing of the carpal, tarsal, metacarpal, and metatarsal foot pad epithelium. Oral ulcerations were also noted in adult African lions (Panthera leo), and Amur tigers, but not two adult snow leopards (Panthera uncia) housed in the same building. All adult cats had been previously vaccinated for FCV. Detection of FCV RNA in oral secretions by a reverse transcription polymerase chain reaction assay (RT-PCR) confirmed FCV infection in the tiger cubs and one lion. A male lion and a male tiger cub died during the epidemic with gross lesions of FCV including tongue ulcerations and footpad sloughing. RT-PCR confirmed FCV in multiple tissues. A stray cat live-trapped outside the feline building during the epidemic was found by virus isolation to be positive for FCV.

ACKNOWLEDGMENTS

The authors would like to thank Doug Armstrong for his assistance. The authors would also like to thank Potter Park Zoo staff, Potter Park Zoo Society staff, Baker College Veterinary Technology students, and all the Michigan State University College of Veterinary Medicine staff and students who assisted with these cases.

LITERATURE CITED

IDIOPATHIC CHYLOTHORAX IN A CLOUDED LEOPARD (*Neofelis nebulosa*) AND A RING-TAILED LEMUR (*Lemur catta*)

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**Abstract**

**Introduction**

Chylothorax is a rare and serious condition reported in small animal and human medicine resulting from the accumulation of chyle within the thoracic cavity. Chyle is a triglyceride and chylomicon rich lymphatic fluid derived from the emulsification of dietary long chain fatty acids and secreted into the lymphatic system from the intestinal mucosal cells. It is typically opaque with a total protein of 2.5-4.5 g/dl and has a predominantly lymphocytic nucleated cell count of 400-10,000 cells/dl. Biochemically, chyle has a triglyceride level greater than that of the serum, has a cholesterol level less than the serum, and generally has an alkaline pH.

Chylothorax is thought to be due to either direct trauma resulting in rupture of the thoracic duct or disease processes that results in obstruction of the thoracic duct or prevents lymph flow to the venous circulation. Identified disease processes include neoplasia, granulomas, thrombosis/obstruction of the vena cava, right sided heart failure, mediastinal masses, lung lobe torsion, foreign bodies, lymphatic abnormalities, congenital thoracic duct abnormalities, constrictive pericarditis and heartworm infection. Diagnostic evaluation to determine the underlying cause of the chylous effusion includes radiography, ultrasonography, fluid analysis, echocardiography and serologic testing. If an underlying disease process is identified, then treatment is directed toward resolving it. However, an underlying disease process is often not identified, and the condition is considered idiopathic.

Medical management of idiopathic chylothorax, including palliative thoracocentesis, dietary manipulation, and pharmaceutical control, has met with mixed results. Resolution rates in medically managed cases has ranged from 20-75%. Thoracocentesis may alleviate acute episodes of respiratory distress associated with accumulation of pleural fluid, however frequent or long term use of thoracocentesis has been shown to result in hypoproteinemia, hyponatremia, hyperkalemia, lymphopenia and malnutrition. Additionally, chylous effusions are irritating to the pleura and can result in a fibrosing pleuritis resulting in fluid pockets. Low fat diets and diets rich in medium chain triglycerides have also been recommended in order to decrease production of chyle. Rutin, a bioflavenol benzopyrone compound extracted from the Brazilian Fava tree, has been used in both human and veterinary medicine for the treatment of chylothorax with some success. Rutin is thought to have anti-oxidant, anti-inflammatory, antithrombotic, cytoprotective, vasoprotective and immune modulatory properties. Orlistat and octreotide have each been reported in human medicine for the treatment of chylous effusion. Orlistat is a reversible inhibitor of gastric and pancreatic lipases which is thought to...
decrease the amount of triglycerides available for intestinal uptake and therefore decrease the production of chyle. Octreotide is a long-acting somatostatin analog that acts to decrease lymph fluid excretion and reduce lymphatic flow, thereby reducing chyle production.

Surgical management of chylothorax may include pleurodesis, thoracic duct ligation, cisterna chyli ablation with thoracic duct ligation, pleuroperitoneal shunt, thoracic omentalization and pericardectomy. Various chemical sclerosing agents, such as tetracycline and talc, have been used to induce pleurodesis. Caudal thoracic duct ligation (TDL) has been the surgical method of choice, however up to a 60% recurrence rate has been seen in some studies. More recent studies have achieved better results by combining TDL with either cisterna chyli ablation or pericardectomy. One other technique described uses an active pleuroperitoneal shunt device. This device has an afferent end placed in the thoracic cavity, a pump mechanism that is placed under the thoracic musculature, and an efferent end placed in the abdominal cavity. This technique has size limitations and has been reported to fail due to obstruction.

The incidence of chylothorax in non-domestic species is unknown. There is one case report of idiopathic chylothorax in a black and white ruffed lemur that responded favorably to medical treatment with rutin. As described above, both medical and surgical treatments of chylothorax are available, but the results are often disappointing and the outcome can be poor. Two cases that were seen recently at the University of Florida Veterinary Medical Center (UFVMC) are discussed below.

Case Reports

Case 1

A 1.5-yr-old intact male clouded leopard (Neofelis nebulosa) was referred to the UFVMC for treatment of chylothorax. The leopard had a 2-wk history of progressive dyspnea and had been placed on oral antibiotics (cephalexin 500 mg p.o. b.i.d.) and rutin (1000 mg p.o. b.i.d.) by the referring veterinarian prior to admission. Whole body radiographs, abdominal and thoracic ultrasonography, echocardiography, thoracocentesis with fluid cytology, CBC and blood chemistry profile were performed upon admission. Radiographic, ultrasonographic and serologic testing were consistent with a diagnosis of idiopathic chylothorax. Due to the severity of his clinical signs, thoracic duct ligation with cisterna chyli ablation was performed. Follow-up radiographs over the next 10 days revealed recurrence of pleural effusion and progression of restrictive pleuritis. Thoracocentesis was performed as needed for management of dyspnea. Due to the lack of clinical response to the initial surgery and severe nature of his clinical signs, a second surgery was performed 7 days following the initial surgery. At this time, the initial ablation and ligation was evaluated and underwent revision. The pericardium was found to be thickened and a pericardectomy was performed. Multiple fibrous adhesions were noted throughout the thoracic cavity and the right cranial and middle lung lobes were observed to be atelectic and fibrosed and were subsequently removed. Chest tubes were placed for management of the effusion. Over the next few days, repeated thoracocentesis contributed to the development of hypoproteinemia which did not resolve despite treatment with intravenous human albumin. The animal was euthanatized 7 days after the second surgery due to its declining condition and
development of neurologic signs consistent with hypoxia. Gross postmortem and histologic examination did not identify an underlying or inciting cause for his disease.

Case 2

A 6-yr-old intact male, privately-owned ring-tailed lemur (*Lemur catta*) presented for evaluation of a 4-day history of respiratory distress and progressive anorexia. Radiographs, thoracocentesis with fluid cytology, CBC, blood chemistry, thoracic and abdominal ultrasound, echocardiography and serology for heartworm and toxoplasmosis were performed. Test results were consistent with a diagnosis of idiopathic chylothorax. Medical and surgical options were discussed with the owner but were declined and the animal was discharged. He returned 1 mo later for recurrence of dyspnea and weakness. Palliative thoracocentesis was performed and treatment options were again discussed with the owner but were declined. He returned again in 3 mo with recurrent signs. Survey radiographs and thoracocentesis were performed and findings were consistent with his previous visits. At this time, he was started on 250 mg of rutin (GNC Rutin 500 mg p.o. t.i.d.). At the time of this report, 3 mo from his last visit, his condition remains unchanged according to his owner.

**LITERATURE CITED**

HEALTH ASSESSMENT OF FREE-RANGING HOFFMANN’S TWO-TOED (Choloepus hoffmanni) AND BROWN-THROATED THREE-TOED (Bradypus variegatus) SLOTHS IN COSTA RICA

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Abstract

During a ten day period in August 2005, free-ranging Hoffmann’s two-toed sloths (Choloepus hoffmanni) (n=29) and brown-throated three-toed sloths (Bradypus variegatus) (n=20) were manually captured and immobilized using intramuscular ketamine (2.5 mg/kg) and medetomidine (0.02 mg/kg). Sloths were physically examined and blood samples collected for serum biochemical analysis and hematology. Remaining serum was stored frozen and tested at a later date for presence of arboviral antibodies at the Center for Biodefense and Emerging Infectious Diseases.

All individuals in this study appeared healthy based on routine physical examinations. Hematologic parameters and serum biochemical analysis were compiled into reference ranges for both species. Results were compared between species and genders by the Kruskal-Wallis test for non-parametric data, and analysis of variance (ANOVA) for parametric data. Serum albumin, globulin, blood urea nitrogen, alanine aminotransferase, total white blood cell count, absolute segmented neutrophil, lymphocyte, and basophil counts were significantly higher in Choloepus compared to Bradypus. Alternatively, serum glucose, creatinine, total calcium, and aspartate aminotransferase were significantly higher in Bradypus. No gender differences were observed.

Serum samples (n=45) were tested against Mayaro, Murutucu, Oropouche, Utinga, Munguba, Venezuelan equine encephalitis, St. Louis encephalitis (SLEV), and Ilheus (ILHV) viral antigens using the hemaglutination inhibition (HI) assay and against La Crosse, Punta Toro, Piry and Changuinola (CGLV) viral antigens using the complement fixation assay (CF). Seventy-one percent of the serum samples (32/45) were SLEV antibody positive, confirmed by plaque reduction neutralization test (PRN), and exact titers were determined. Fifty-five percent of the sera (23/45) were antibody-positive to both SLEV and ILHV viral antigens. Thirty-one percent
of the sera (14/45) were antibody-positive to CGLV antigen. None of the samples were positive for West Nile virus specific antibodies.
DEVELOPING OPTIMAL SPERM CRYOPRESERVATION FOR GENETIC MANAGEMENT IN THE GIANT PANDA

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Abstract

The ex situ giant panda population is not self-sustaining as many individuals do not reproduce primarily because of behavioral deficiencies and geographic isolation. Techniques including sperm cryopreservation and artificial insemination can improve captive genetic management by ensuring every individual reproduces, regardless of temperament or location.

To compare methods used for giant panda sperm cryopreservation, semen samples from five adult (5.5-20.5 yr old) males were collected, split into three aliquots and cryopreserved using three freezing methods: (1) manual 2-step, (2) automated Cryomed®, and (3) field-ready dry shipper. After cryopreservation, each sample was thawed at: (1) 22°C, (2) 37°C, and (3) 50°C. After thawing, samples were assessed for sperm motility (0-100%), forward progressive status (scale, 0-5; 5 is best) and intact acrosomes (0-100%).

Results indicated that all cryomethods resulted in high quality giant panda sperm post thaw. However, post-thaw sperm motility was higher (P<0.05) in the manual 2-step method thawed at 50°C (70.7 ± 3.2%) and 37°C (68.5 ± 2.9%) and dry shipper method at 50°C (69.5 ± 3.4%) compared to the automated Cryomed® at 22°C (51.9 ± 3.7%), but was similar (P>0.05) to the 2-step/22°C (63.8 ± 2.5%), dry shipper/22°C (58.9 ± 3.7%), dry shipper/37°C (62.9 ± 3.6%), Cryomed®/37°C (60.3 ± 3.5%) and Cryomed®/50°C (65.9 ± 3.1%). Forward progressive status also was higher (P<0.05) using the dry shipper/50°C (3.6 ± 0.1) and 2-step/50°C (3.5 ± 0.1) than the Cryomed® at 22°C (2.9 ± 0.1) and 37°C (3.0 ± 0.1), but was similar (P>0.05) to other methods (2-step/22°C, 3.2 ± 0.1; 2-step/37°C, 3.4 ± 0.1; dry shipper/22°C, 3.2 ± 0.1; dry shipper/37°C, 3.3 ± 0.1; Cryomed®/50°C, 3.3 ± 0.1). Acrosomal integrity did not differ (P>0.05) among cryomethods. These data demonstrate that all methods are effective and result in high-quality post-thaw sperm, but optimal cryopreservation methods for giant panda sperm are the 2-step manual and dry shipper technique when samples are thawed at 50°C.
UNIQUE REPRODUCTIVE HORMONE PROFILES IN THE CRITICALLY ENDANGERED IBERIAN LYNX (Lynx pardinus)

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Abstract

The Iberian lynx is the most endangered of the world’s felid species. The current population is estimated at fewer than 200 animals, most of which are living in fragmented populations in situ. In 2004, an Iberian lynx captive breeding program was initiated in Doñana National Park (Huelva), Spain both as a hedge against extinction and to extend our understanding of species biology. In March 2005, three Iberian lynx cubs were born from a 3-yr-old dam, the first successful birth in captivity.

The present study evaluated the hormonal control of reproduction in the Iberian lynx. Daily fecal samples were collected from four adult females (2-4 yr old at study onset) and three adult males (1.5-3 yr old) from April 2004 through May 2005 to characterize seasonal and reproductive endocrine profiles. All of the evaluated animals were wild-caught. Samples were shipped frozen from Spain to the National Zoo’s Conservation & Research Center, and metabolites of estrogen and progestin (female) or testosterone (male) were quantified using enzyme immunoassays. Hormonal metabolite concentrations greater than twice baseline were considered elevated.

There were marked seasonal changes in estrogen metabolites in all females. Estrogen concentrations fell to baseline from 11 May through 20 July 2004 and remained at nadir until January 2005. In the presumed early breeding season (January through July), estrogen metabolite levels increased above baseline from 17 January through 30 January 2005. Once elevated, estrogen metabolite profiles remained static with no evidence of estrogenic cycling, rather only an increased and sustained pattern. The mean and peak estrogen metabolite concentrations were lower ($P<0.05$) in the 2004 non-breeding (mean ± SEM; mean, 1.2 ± 0.2 µg/g feces; peak, 6.0 ± 2.4 µg/g feces) compared to both the 2004 and 2005 breeding seasons (mean, 7.9 ± 2.7 and 10.2 ± 4.3 µg/g feces; peak, 10.2 ± 4.3 and 47.3 ± 22.6 µg/g feces, respectively). Compared to other felids species studied in our laboratories, estrogen metabolite concentration in the female Iberian lynx was ~10-fold greater during the breeding season. In contrast to estrogens, there were no ($P>0.05$) seasonal variations in progestin metabolite concentrations (overall mean and peak, 32.1 ± 3.6 and 132.0 ± 10.9 µg/g feces, respectively).
2005, signs of estrus (vocalization and conspecific sexual interest) were observed from 17 January, and breeding was observed in all females from 24 January through 11 February. Initial seasonal elevations in estrogens occurred from 0 to 5 d following initiation of estrous behaviors. One female that copulated multiple times on 24 January gave birth to three cubs on 28 March 2005 (gestation interval = 64 days). Despite multiple copulations in the other intensely monitored females, no other cubs were produced. Mean estrogen and progestin metabolite concentrations during pregnancy in the singleton female were 18.4 and 30.2 µg/g feces respectively, with the progestin concentrations no different than those seen throughout the year or in other non-pregnant females. There were no seasonal changes in testosterone metabolites in any of the adult males (overall mean, 0.7 ± 0.2 µg/g feces).

These results demonstrated that the female Iberian lynx is a seasonal breeder, with reproductive activity reflected in fecal estrogen, but not progestin metabolite profiles. The females of this species excreted much higher quantities of estrogen in the feces compared to other felid species studied to date. Contrary to estrogens, progestin metabolites (at least using standard felid assays) were a poor indicator of reproductive status in the Iberian lynx and even failed to fluctuate in either animals known to have copulated or in the single female that produced living young. The unusual endocrine profiles also extended to the males, which failed to exhibit fluctuations in excreted testosterone metabolites, even though the species seems to have a well defined (January to July) breeding season. Overall, this single milestone birth combined with an emerging database on endocrine profiles and reproductive behaviors provides encouragement that a scholarly and applied approach may be helpful in achieving successful captive breeding in this critically endangered felid.
THE REPRODUCTIVE BIOLOGY OF THE FOSSA (Cryptoprocta ferox): A PORTRAIT OF AN ENDANGERED SPECIES

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Abstract

The fossa is the largest carnivore on Madagascar and one of the numerous endemic species of this island. Though recent studies1,2 have increased the awareness of the peculiarity of this endangered species (IUCN, Red List), there is still little known about its reproductive biology. The aim of the present study was to describe the anatomy of the inner sexual organs and to provide further evidence for the seasonality of their reproduction.

Thirty-one (16.15) captive fossas were examined both during the reproductive season in spring and during the non-reproductive season in autumn. Ultrasoundographic examination of the reproductive organs, hormone analysis, semen evaluation, pheromone analysis, and a genetic assessment were performed.

Preliminary results allowed for the sonomorphologic description of the normal reproductive tract. However, a high number of individuals (2 of 16 males and 7 of 15 females) showed reproductive disorders and/or pathologies,3 such as cystic structures or poor development of the genital tract in females and unilateral cryptorchism in males. Results from the genetic studies will provide information, if the observed pathologies might be linked to inbreeding within the captive population. The seasonality of reproduction could be supported by hormone, semen5 and volatile4 analyses. Mean values of testosterone in male individuals (15.32 ± 8.05 ng/ml versus 0.73 ± 0.74 ng/ml) as well as estrogen in female individuals (0.47 ± 0.37 ng/ml versus 0.03 ± 0.01 ng/ml) were significantly higher in spring versus autumn. These findings were reflected by a higher semen quality during the breeding season versus the non-breeding season; characterized by the semen parameters volume (420 ± 496.06 versus 149.17 ± 96.15 µl), total sperm number (8.04 ± 18.69 versus 2.30 ± 2.54 × 10^6 cells/ejaculate) and motility (57.41 ± 8.72 versus 37.05 ± 12.71%). The volatile analysis revealed gender specific differences in volatile expression (total quantity and pattern of substances) that were apparent only in spring.

In conclusion, the reproductive organs of the fossa were described and additional proof for their reproductive seasonality was given. Further examinations will be performed to consolidate the data. A future aim is the comparison of the data obtained from the zoo population to that of the wild population.
ACKNOWLEDGMENTS

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LITERATURE CITED

EVALUATION OF TWO ANATOMIC LOCATIONS FOR MEASUREMENT OF INDIRECT BLOOD PRESSURE IN ANESTHETIZED AFRICAN LIONS (Panthera leo)

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Abstract

Indirect measurement of arterial blood pressure is being used increasingly in small animal practice and has potential for use in both anesthetized and conscious large zoo felids. Routine measurement of blood pressure in zoo felids may result in earlier detection of blood pressure abnormalities such as hypertension. This study was conducted on six sub-adult African lions (Panthera leo) to compare indirect oscillometric blood pressure measurement (NIBP) to invasive blood pressure measurement (IBP). Three male and three female lions with an average weight of 56 kg were anesthetized with a combination of medetomidine and either ketamine or tiletamine/zolazepam. A catheter was placed in the pedal or femoral artery to measure IBP in each lion. Oscillometric cuffs were placed around the base of the tail and around the front leg above the elbow to measure NIBP. Timed measurements from both NIBP cuffs were compared to the IBP measurement in each lion. When compared to IBP, NIBP measured oscillometrically on the front leg accurately reflected systolic arterial blood pressure (SAP) and diastolic blood pressure (DAP), but significantly overestimated mean arterial pressure (MAP). Compared to IBP, NIBP measured oscillometrically on the base of the tail reflected SAP relatively accurately, but underestimated DAP and MAP. Although further investigation is required, based on the findings of this study, measurement of systolic blood pressure using an oscillometric cuff around the front leg above the elbow or tail base appears to be a reasonably accurate method of monitoring blood pressure in lions.
HUMORAL IMMUNE RESPONSE OF AFRICAN WILD DOGS (Lycaon pictus) TO NOVEL CANINE DISTEMPER VACCINES

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Abstract

Modified live virus vaccines against canine distemper virus (CDV) have induced disease and mortality in several highly endangered carnivores, including the African wild dog (Lycaon pictus). The goal of our study was to determine the safety and efficacy of two alternative vaccines in African wild dogs: an experimental subunit vaccine (immunostimulating complex, CDV-ISCOM, Erasmus MC, Rotterdam, The Netherlands) and a recombinant vaccine (Purevax™, Merial, Duluth, Georgia 30096 USA).

We vaccinated 13 animals in the Netherlands with CDV-ISCOM, and 13 in Tanzania with Purevax™. The vaccine was administered three times with a 3-wk interval between each administration (1 ml, i.m.). Antibody titres to CDV were measured by enzyme-linked immunosorbent assay (ELISA) and virus neutralization (VN) in serum samples collected prior to each vaccination and 1 yr post vaccination. Based on published data of CDV infection in domestic dogs, we considered a VN or ELISA titer of 80 or higher to be protective.

Neither vaccine produced any adverse reactions. One year post vaccination, the percentage of animals with protective titres was higher in the Purevax™ group (85% by ELISA, 39% by VN) than in the ISCOM group (69% by ELISA, 8% by VN). Surprisingly, the mean titer in the Purevax™ group was higher than in the ISCOM group by VN (63 versus 3), but lower by ELISA (109 versus 246).

Overall, these results indicate that both vaccines are safe, and that the Purevax™ vaccine may be more efficacious in African wild dogs than the ISCOM vaccine, although a substantial percentage of animals in both groups no longer had protective titres 1 yr post vaccination. Titres following ISCOM vaccination were lower than those found in other non-domestic species.1 Reasons for this finding, and the discrepancies between VN and ELISA titres, remain unclear.

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Mkomazi Game Reserve, Tanzania; and Daphne Valk and the keepers of the African wild dogs in Artis (Amsterdam Zoo).

LITERATURE CITED

PHARMACOKINETICS OF A SINGLE INTRAMUSCULAR INJECTION OF AMOXICILLIN TRIHYDRATE IN TAMMAR WALLABIES (Macropus eugenii)

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Abstract

Though suggested dosages for antibiotic use in marsupials have been published, there is little pharmacokinetic information in the literature. Dose regimens are largely inferred from eutherian animal literature and/or response to treatment. However, the metabolism and elimination of drugs may differ in marsupials as they have a lower metabolic rate and body temperature when compared to eutherians.

Five tammar wallabies (Macropus eugenii) were injected with amoxicillin trihydrate (Betamox, Norbrook, New Gisborne, VIC, Australia; 10 mg/kg, i.m.), and blood samples collected at 0, 0.5, 1, 2, 4, 8 and 10 hr. Plasma concentrations of amoxicillin were measured using HPLC. Noncompartmental modeling estimated the variables (mean ± SD) for maximum plasma levels (Cmax) at 4.50 ± 0.70 μg/ml, time to maximum plasma levels (Tmax) at 2.00 ± 0 hr, area under the curve from time 0 to infinity (AUC0-∞) at 14.76 ± 4.15 hr.μg/ml, area under the first moment curve from time 0 to infinity (AUMC0-∞) at 62.24 ± 33.56 hr.hr.μg/ml, the terminal phase half-life (t½λz) at 1.88 ± 0.60 hr, and mean residence time (MRT) at 3.33 ± 0.32 hr.

Cmax, Tmax and AUC values attained in this pilot study are comparable to values attained with domestic species (dog, pig, sheep, goat) when amoxicillin trihydrate is given at similar doses and by the same route. The terminal phase half-life determined in this study is consistent with the elimination half-life in sheep and goats, however, no i.v. data were generated in the present study. These results could suggest a minimal depot effect in wallabies with amoxicillin trihydrate, necessitating a shorter dose interval.
TUBERCULOSIS DIAGNOSIS IN JAGUAR (*Panthera onca onca*) AND ADDRA GAZELLE (*Gazella dama ruficollis*) USING MULTIPLE ANTIGEN PRINT IMMUNOASSAY AND RAPID LATERAL FLOW TECHNOLOGY

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Abstract

Antemortem diagnosis of tuberculosis (TB) in wildlife has always proved challenging. Confirmation of TB as the disease process causing the clinical signs often occurs after a lengthy period of mycobacterial culture of diagnostic samples collected antemortem (e.g., tracheal wash) or postmortem (e.g., lesions in tissue). New diagnostic tools are needed to improve the ability to diagnose TB more quickly. Two novel serologic methods, Multi-Antigen Print ImmunoAssay (MAPIA) and lateral-flow technology (Rapid Test or RT) (Chembio Diagnostic Systems, Inc., Medford, New York 11763 USA) have been adapted for use in several species for the detection of Mycobacteria-specific antibody. With MAPIA, specific antigens are printed as horizontal stripes on a nitrocellulose membrane. Strips can be cut from this print-out and incubated with test serum samples as a Western blot with an anti-immunglobulin conjugate and color developer. Using this assay, an antibody response to mycobacterial antigens has been observed in sera from *Mycobacteria*-infected animals. Using selected mycobacterial antigens, RT was developed for rapid antibody detection that can use serum, plasma, or whole blood and provides results within 15 min for validated species. This technology is similar to in-clinic tests for FIV/FeLV detection (Snap FIV/FeLV Test, IDEXX Laboratories, Inc., Westbrook, Maine 04092 USA).

Elephants were the “proof of concept” species for the development of this test methodology. Although this methodology shows promise for use in other species, validation of each test is required with sera from individuals confirmed culture positive for mycobacterial infections. This report presents two species: addra gazelle (*Gazella dama ruficollis*) and jaguar (*Panthera onca onca*), previously not tested with MAPIA and RT and demonstrates their usefulness with clinical cases.

Case Studies

Addra Gazelle

A 15-yr-old female addra gazelle was euthanatized August 2002 due to severe weight loss and persistent hyperglobulinemia. Gross necropsy revealed a severe, diffuse granulomatous pneumonia and bronchial lymphadenopathy. Histopathology demonstrated extensive multifocal acid-fast positive granulomatous pneumonia, moderate multifocal erosive rumenitis, and moderate renal fibrosis and interstitial nephritis. Mycobacterial culture of the lung tissues grew...
*Mycobacterium tuberculosis.* Retrospective serum samples from several dates were submitted for RT and MAPIA.

While the globulins were elevated in this animal as early as May 1997, no specific indicators of mycobacterial disease were observed during that time on either test. However, RT and MAPIA appeared to detect mycobacterial reactivity (ESAT-6 and polyprotein ESAT-6/CFP10) as early as February 2002 with the serum sample dated 24 August 2002 demonstrating even more noticeable bands consistent with *M. tuberculosis* (ESAT6, CFP10, rMPB83, nMPB83, CFP10/ESAT6, F10 and Acrl/MPB83). These results support the presence of tuberculosis in the gazelle at least 6 mo before euthanasia and show an increasing immune response to the mycobacteria over time.

This herd of gazelle has historically had health issues with parasites, high prevalence to Johnes’ Disease, rumenitis and renal failure. Any of these conditions would allow an opportunistic organism such as *M. tuberculosis* to become an established and active infection. The remaining members of the herd were examined diagnostically with thoracic radiographs, bronchial lavage, intradermal skin testing, and ancillary testing on serum with RT and MAPIA. No clinical or serologic evidence of tuberculosis was found.

**Jaguar**

A 12-yr-old female jaguar was imported from Venezuela in July 1998. In October 2000, this animal presented with lethargy, inappetence and abdominal distension. One week following exploratory abdominal surgery for excisional biopsy of an infiltrative mass in the greater omentum, the animal died in November 2000. Gross necropsy showed multiple, infiltrative granulomas of the omentum and lymph nodes and hepatic abscessation. Histopathologic findings included multifocal necrogranulomatous peritonitis, hepatitis and lymphadenitis. The granulomatous lesions were acid fast positive and cultured *M. bovis*.

Serum samples (dated 15 October 1999 and 3 November 2000) were submitted for retrospective analysis by MAPIA and RT. Sera from four other jaguars in the same collection were submitted for assessment; two of these cats were imported with and exposed to the TB-positive jaguar. Also, sera from three jaguars under consideration for acquisition from Guyana were assessed. All jaguar samples were submitted without disclosure of history.

Both tests demonstrated reactivity to mycobacterial antigens in the serum samples from the *M. bovis*-positive cat (MPB83, nMPB83 and 16/83 zones) with a band pattern noted as suggestive of *M. bovis* infection. Both samples submitted from the TB-positive cat were similar in band pattern, although the first sample was collected during a normal physical examination. The serum samples from the other cats showed a complete lack of any band pattern suggesting no antibody formation and presumably a lack of exposure to mycobacteria.
Discussion

The addition of these two species to the demonstrated ability of RT and MAPIA to diagnose TB broadens the potential application of these testing methodologies. It is encouraging that these diagnostics did identify as positive the two mycobacteria culture-positive individuals. These tests will only have predictive value if truly no mycobacterial disease is present in the animals which test negative on the MAPIA and RT. Continuation of testing within these and other species using all available mycobacterial diagnostics will be important in validating these tests.

The band pattern of the MAPIA appears to correlate with particular *Mycobacteria* species and may have predictive ability as to the species of infecting organism. This information could allow exploration and investigation of the epidemiology of the disease in a more timely fashion than occurs with confirmatory culture results. Additionally, the gradual development of the intensity of the band pattern over time shows the individual’s growing immunologic response to the mycobacterial infection so the course of the disease process can be documented.

The imported jaguar likely arrived at the institution with the mycobacterial infection from ingestion of a mycobacteria-infected carcass at the originating institution where whole carcass feeding was common practice. Multiple diagnostics (e.g., hepatic biopsy for histopathology and mycobacterial culture, mycobacterial blood culture, and tuberculin skin testing) on the two other remaining Venezuelan-imported cats have failed to confirm any underlying mycobacterial disease. The hepatic biopsies in the male have shown granulomatous changes but acid fast organisms have neither been demonstrated nor *Mycobacteria* species cultured. Negative results from the MAPIA and RT are encouraging, but due to the insidious nature of the disease, these mycobacteria-exposed cats will continue to be monitored with the available diagnostics. This will allow for further validation of these new testing methodologies.

The ability to utilize the MAPIA and RT as non-invasive and relatively rapid turnaround tests will be of tremendous assistance in such clinical cases. Additionally, when other jaguars from Guyana were being considered for importation, they were assessed for tuberculosis prior to acquisition due to the problems experienced from the other imported jaguar. Based on the possibility of acquiring animals with pre-existing mycobacterial infections, especially when imported from tuberculosis-risk countries, it is encouraged that TB diagnostics be performed. RT and MAPIA can assist in expedient testing in such circumstances, as more species are validated.

Conclusion

The RT and MAPIA appear as very promising tools in the diagnosis of tuberculosis. As this methodology develops and the sensitivity and specificity of the tests are confirmed in other species, earlier detection of TB will be possible and result in earlier initiation of treatment or response. Additionally, positive MAPIA and RT results can help support that other diagnostics should be performed to identify the presence and location of mycobacterial disease in an individual.
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LITERATURE CITED

USE OF REAL-TIME PCR FOR DETECTION OF *Brucella* spp. IN MARINE MAMMAL TISSUES

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Abstract

Distinct strains of *Brucella* have been recognized in marine mammals worldwide since 1994. The distribution and potential health effects of these *Brucella* species on marine mammals and humans are under study, but progress is slowed by unreliability of traditional microbiologic and serologic diagnostic tests. Real-time, or quantitative, polymerase chain reaction (qPCR) assays are currently being employed in diagnosis of medical and veterinary cases of brucellosis, and this approach shows promise in the marine mammal context. To this end, a multiplex qPCR assay has been developed to screen tissues or blood from a wide range of marine mammals for the presence of *Brucella* spp. bacteria. This Taqman probe-based assay targets a 150 bp amplicon from an outer membrane protein gene (*bscp31*), which has been rigorously tested and reported in the literature as specific to the genus *Brucella*.1,2 The triplex assay also includes two internal controls: a conserved eukaryotic mitochondrial gene target for DNA quality control, and a plasmid-based internal control that detects endogenous inhibitors of PCR. Tests of the assay against a panel of common aquatic bacterial isolates demonstrated 100% specificity for *Brucella*. Assays of DNA extracted from pinniped and cetacean origin *Brucella* isolates show a limit of detection at or below three bacteria. Preliminary results testing field-collected harbor seal (*Phoca vitulina*) tissues show increased sensitivity of this assay compared to culture. Because this assay can be used with both ante-mortem or post-mortem samples, it shows promise as a useful screening tool for detection of marine mammal brucellosis.

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LITERATURE CITED

DIAGNOSTIC STRATEGIES FOR MONITORING STRONGYLE POPULATIONS IN EXOTIC HOOFSTOCK SPECIES IN DISNEY’S ANIMAL KINGDOM® COLLECTIONS

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Abstract

Endoparasites are a substantial health concern affecting ruminants, domestic and non-domestic, in Florida. Collections housed at Disney’s Animal Kingdom® have experienced notable morbidity and mortality in exotic artiodactylids due to the stomach worm, Haemonchus spp., which thrives in the state’s warm, humid climate.

Historically, parasite control programs in zoological institutions, including this collection, have relied heavily on empirical, anthelmintic rotations to decrease or eliminate parasite burdens. With the inherent challenges of orally and parenterally medicating zoological hoof stock species, sub-therapeutic dosing may produce a risk of drug resistance. Furthermore, costs of developing new drugs for domestic ungulates animals minimize new product development and marketing. In the domestic animal industry, anthelmintics alone can no longer be relied upon to control parasites. This concern impacts zoological collections both in terms of animal health and animal welfare, especially in parasite-rich environments.

Disney’s® Animal Programs has developed a comprehensive diagnostic and treatment strategy for Haemonchus and other strongyle spp. in hoofstock. The program was modeled after those developed for the domestic small ruminant industry in response to serious anthelmintic resistance issues. Components of this parasite control program include: quarterly McMaster’s fecal egg counts, annual fecal larval cultures and genus identification, fecal egg count reduction rates in association with anthelmintic treatment, in vitro larval development assays to determine anthelmintic sensitivity patterns and resistance issues, and quarterly pasture larval counts.
DIGITAL RADIOGRAPHY IN A ZOO SETTING

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Abstract

Digital radiography consists of two different technologies: computed radiography (CR) and direct digital radiography (DR). Although the two systems produce equal images, DR does not require cassettes or plates so it can be three times quicker than CR. This reduced processing time shortens anesthesia times. However, DR can be up to $25,000 more expensive than CR depending on the brand, model and options chosen.

In August 2005, this institution converted from a traditional radiography system (300HF Generator AMRAD Classic ST Stationary Table System) to a CR system donated by Fujifilm Medical Systems USA, which is used with the pre-existent machine. It consists of (1) the SmartCR unit with a compact reader unit for imaging plate scanning and erasure (FCR XG4); (2) the Flash Image and Information Processor console (Flash Lite IIP console) for patient ID, image preview, reprocessing and transmission for communication and archiving (PACS); (3) barcode reader; (4) 15” flat panel LCD display (1024 × 768); and (5) Fuji Type C cassettes. Most of the unit is located within the radiology suite and allows for a variety of image manipulations, including adjustment of brightness and contrast, magnification, inverting black and white and cropping of images. The workstation (Flash Lite IIP) is located in the adjacent treatment room and houses the central software (Synapse® 3.0-veterinary-specific PACS) where the patient database entry (accession number, species, name, primary clinician, body part imaged) is performed before the radiographic study is completed. The workstation has two 15” high-resolution flat-panel LCD displays in vertical position so the primary clinician can review the images during the procedure. A second workstation, consisting of two 17” high-resolution flat-panel LCD displays in horizontal position, is located in the hospital’s conference room where images are reviewed and discussed by all the clinicians. A Fuji Medical Dry Imager (DRYPIX 3000) prints hard copies of the digital images, which are useful when technical problems with the computer system arise.

Since the acquisition of the new system until March 2006, over 320 clinical cases have been radiographed, with a minimum of two images for each study. CR has reduced retakes due to overexposure or slight underexposure by using the image-management software to adjust the overall image. Because of this feature, bone and soft tissue detail can be obtained in the same image. However, as it is not possible to adjust a markedly underexposed image without repeating the image, a consistent increase in radiograph exposure intensity has been observed in this practice. This approach is a disadvantage when compared to traditional radiography where potential radiation dose to the patient and personnel can be collimated and controlled.
Prior to CR acquisition, each imaging required 7 min. With CR, 5 min is needed for each view. Before the imaging study, it is necessary to enter the patient information into the software which requires less than 1 min. The time from radiograph exposure to display on screen for manipulation is approximately 45 sec. Printing the image takes 2 min 23 sec. This total time is considered acceptable because radiographic studies are typically performed at the beginning of the anesthesia.

Another obvious advantage of CR when compared with traditional radiography is elimination of stocking and purchase of chemical developers. The system is therefore more environmentally friendly with less chemical disposal and ultimately, more cost-efficient per film.

Digital storage of CR has allowed easy review, retrieval, transferability via email (.jpg images) to consultants and reproduction of images. Although with this system all the images for one case can be compared, this system it is not capable of comparing images from different individuals of the same species on one screen.

Computer radiography offers substantial advantages to traditional radiology technology in a zoo setting. Although considered older technology than DR, the CR system is more affordable and can be used with existing radiographic equipment, decreasing the budget to digitally convert from a traditional radiography system.
URINALYSIS IN ASIAN ELEPHANTS (*Elephas maximus*)

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Abstract

Elephants have been reported with renal disease, and arthritic elephants are often maintained on long-term administration of non-steroidal anti-inflammatory drugs which have been associated with renal injury in other species Therefore, establishment of the reference values of normal urine would be a useful tool to elephant health care.

Routine urinalysis was performed on urine collected from healthy female adult Asian elephants (*Elephas maximus*, n=30). Elephants were included in the study if they had normal serum urea nitrogen and creatinine serum concentrations, no history of urinary tract disease, and had not received any medication within the past 3 mo. Urinalysis included gross description of urine color and clarity, measurement of pH and specific gravity, biochemical analysis and sediment evaluation. Trace bilirubin was detected in some samples. No ketonuria or proteinuria was found. Glucosuria, which has been reported as a transient and normal finding in captive elephants, was not detected in any samples.

LITERATURE CITED

DIAGNOSTIC IMAGING OF CHARISMATIC MICRO-INVERTEBRATES

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Abstract

Each captive-maintained animal taxon has experienced a development phase of veterinary medicine. Invertebrates comprise a sizeable and valuable part of many zoos and aquaria and are commonly kept as pets, educational animals, and research specimens.2,5 Diagnostic imaging presents a non-invasive, economically reasonable approach to understanding anatomy and diagnosing disease in any species, including invertebrates,1,3,4 although information pertaining to appropriate radiographic technique is scarce to nonexistent. Technique charts were established for common captive terrestrial invertebrates to include a representative omnivore (Madagascar hissing cockroach, Gromphadorhina portentosa), herbivore (millipede, Orthoporus sp.), and carnivore (Chilean rosehair tarantula, Grammostola spatulata). To limit unnecessary handling of specimens, whole body weight replaced linear measurements to optimize technique. Species, gender when known, body weight, radiographic film and screen types, and technique (kVp, mAs) were recorded (Table 1). Following survey radiography, contrast radiographs were obtained. Subjects were administered contrast media orally in a food item. Radiographs were taken at intervals until contrast agent was entirely voided to document gastrointestinal transit times.

LITERATURE CITED

Table 1. Whole body radiographic technique chart\textsuperscript{a} for the Madagascar hissing cockroach (*Gromphadorhina portentosa*), average body weight 6.5 g.

<table>
<thead>
<tr>
<th>Film Focal Distance</th>
<th>MAS</th>
<th>kVp</th>
<th>Technique as compared to optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>1</td>
<td>40</td>
<td>Underexposed</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>45</td>
<td>Slightly underexposed</td>
</tr>
<tr>
<td>24</td>
<td>3</td>
<td>45</td>
<td>Overexposed</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>40</td>
<td>Slightly overexposed</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>40</td>
<td>Underexposed</td>
</tr>
<tr>
<td>40</td>
<td>1</td>
<td>40</td>
<td>Very underexposed</td>
</tr>
<tr>
<td>40</td>
<td>6</td>
<td>40</td>
<td>Underexposed</td>
</tr>
<tr>
<td>40</td>
<td>8</td>
<td>40</td>
<td>Optimum: used for contrast studies\textsuperscript{b}</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Radiographic views were obtained using a non-grid technique (TREX TM40, TREX Medical Corporation, Broadview, Illinois 60153 USA, and 3M Veterinary Radiographic film, Ultra 2000, green sensitive film, 3M Animal Health Care Products, St. Paul, Minnesota 55144 USA).

\textsuperscript{b}Barium sulfate suspension (Liquid E-Z-Paque, E-Z-EM, Inc., Westbury, NY 11590 USA) and diatrizoate meglumine and diatrizoate sodium (Hypaque-76, Amersham Health Inc., Princeton, NJ 08540, USA) were both imaged in a food item (mashed banana), following ingestion at 30 min, and 4 hr after ingestion. Although no radiographic difference was observed between the food items containing each of the contrast agents, better consumption of the food item containing Hypaque-76 was noted.
THERMOGRAPHY-ASSISTED DIAGNOSIS OF A DISTAL PHALANX FRACTURE IN A RETICULATED GIRAFFE (Giraffa camelopardalis reticulata)

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Abstract

A 10-yr-old female reticulated giraffe (Giraffa camelopardalis reticulata) presented with an acute, severe, non-weight bearing lameness of the right forelimb. No swelling or deviations of the limb were noted in visual exam. The animal would not allow palpation of the limb distal to the cubitus. After 4 days of stall rest, no improvement in gait or any signs indicating location of an abnormality were seen. Examination of all legs using a thermographic camera (ThermaCam PM 675, Flir Systems, Wilsonville, Oregon 97070 USA) revealed an increased surface temperature of 0.9° C in the heel bulbs of the right forelimb particularly on the medial side.

Radiographs were obtained 10 days after the original lameness was noted. The animal had been trained to station for radiographs, including lateromedial (LM), dorsopalmar, oblique (dorsolateral-palmaromedial and dorsomedial-palmarolateral) and 45° dorsopalmar. A fracture through the body of the third phalanx of the medial digit was identified only on the LM projection. The fracture was a displaced, complete articular fracture in the frontal plane, dividing P3 into two large fragments. Of note on the radiographs were the sesamoids which are equivalent to 1/3 of the size of the distal phalanx.

The animal was managed with stall rest on a padded floor and treated with etodolac (Taro Pharmaceuticals, Hawthorne, New York 10532 USA; 2.8 g p.o. every 24 hr × 28 days). Occasional use of the leg started within 7 days of the original injury and improved gradually. Within 6 wk, the animal showed virtually no lameness. Follow-up radiographs at 6 and 20 wk showed increased opacification at the fracture line suggesting progressive healing.

Thermography is a method that measures surface temperatures via infrared emissions. Variations in skin temperature results from changes in tissue perfusion and blood flow in superficial veins. Increase in blood flow with produced heat are cardinal signs of inflammation. It is important in thermography to evaluate whole body images and contrasts in temperature between contralateral body parts. Both medical and industrial imaging instruments are capable of differentiating temperature changes of 0.1°C.
In domestic equines (*Equus caballus*), thermography is particularly useful in diagnosing conditions of the foot, such as laminitis and navicular disease. Due to the encasing effect of the hoof wall in horses and cattle physical examination is limited in sensitivity for diagnosis of foot diseases.

A lack of obvious swelling may have occurred in this case due to the thickness of giraffe skin and unique elasticity of the connective tissue. Cardiovascular dynamics in a giraffe are complex and high extra vascular tension must be needed in the distal limbs to maintain sufficient hydrostatic pressure to prevent pooling of fluid and adequate venous return.

In zoo and wildlife patients, palpation and other direct diagnostic techniques are frequently difficult. Sometimes close contact can be achieved with training; however, the process may be long. Diagnosis via remote, noninvasive methods such as thermography should be considered for any larger animal where size and behavior make management a challenge.

ACKNOWLEDGMENTS

We commend the Binder Park Zoo Animal Care staff for dedication to the giraffe operant conditioning program.

LITERATURE CITED

THE ROLE OF GABAPENTIN AS AN ANALGESIC: POTENTIAL APPLICATIONS IN ZOOLOGICAL MEDICINE

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Abstract

Originally developed as an anticonvulsant agent, gabapentin has recently become an attractive analgesic in the human medical field for the treatment of neuropathic and chronic pain. Although experience is limited, the drug has also shown promise in veterinary medicine. Gabapentin is a gamma-aminobutyric acid (GABA)-mimetic compound, although the drug has no direct GABAergic action and does not block GABA uptake or metabolism.8 The drug’s exact mechanism of action for both the anti-convulsant and analgesic properties is unknown. Research into antagonism of neuromuscular depolarizing agent receptors and blockage of calcium channels has shown the most supporting evidence for potential mechanisms of action. Evidence exists that the drug may exert effects both within the CNS and at peripheral sites.8

Gabapentin is available only as an oral preparation (Neurontin®, 100-800mg tablets and 50mg/ml oral solution, Parke-Davis, Pfizer, New York, New York 10017 USA). Bioavailability varies inversely with dose, with peak plasma levels obtained 3-3.2 hr after ingestion in humans.8 The drug is excreted unchanged in the urine with an elimination half-life between 4.8-8.7 hr in humans.8 Renal impairment will decrease clearance of the drug and dosages should be adjusted accordingly. Gabapentin appears to lack clinically significant drug interactions, although drugs that decrease renal glomerular filtration rate should be used with caution and certain gastrointestinal medications may interfere with absorption. Adverse effects reported in humans are minor, with somnolence, dizziness, ataxia, nausea, and fatigue being most commonly reported.8,9 Reports of massive overdoses have been documented without serious toxicity.8

Evidence from the human medical literature supports the use of gabapentin for a variety of neuropathic and chronic pain conditions. The drug is labeled for use in controlling postherpetic neuralgia (PHN) in people. Randomized, double-blind, placebo-controlled, multicenter studies have demonstrated a significant reduction in weekly mean pain scores in patients with chronic PHN pain and diabetic peripheral neuropathy when placed on doses of gabapentin titrated to maximum doses of up to 3600 mg/day.1,9 Additional studies in humans have supported the use of the medication for the treatment of neuropathic pain related to trigeminal neuralgia, multiple sclerosis, neuropathic pain in malignancy, spinal cord injury, and complex regional pain syndrome (CRPS).8 The drug has been used safely in combination with other analgesics in humans. Humans treated with a gabapentin-morphine combination were found to have more effective neuropathic pain control than with either agent alone.2
The use of gabapentin in veterinary medicine is largely extrapolated from human literature and research studies conducted in animal models. The drug has been used in anti-epileptic protocols and empirically in pain management. No studies specifically investigating the drug in a veterinary setting have been performed. However, numerous favorable anecdotal reports exist for dogs and cats with no documented major complications. In dogs, initial dosages ranging from 3 mg/kg/day to 5 mg/kg t.i.d. have been described. In cats, dosages of 2-10 mg/kg/day have been reported.

In a zoological setting, gabapentin may prove useful in a variety of cases where other therapy is impractical. Animals with chronic pain that has become refractory to current analgesic therapies may benefit from the addition of gabapentin to their treatment protocols. Animals likely to suffer detrimental side-effects associated with the long term use of other analgesics also present ideal cases for the use of gabapentin. The drug lacks significant sedative effects, which can make gabapentin an attractive option over other analgesic classes if it is effective. Gabapentin has been incorporated into analgesic treatment of several animals at the Saint Louis Zoo. Objective data on efficacy and safety is not available, but subjective success has been observed. The following cases are supplied as illustrations of potential applications.

Case 1

An 18-yr-old, male lion (Panthera leo) was diagnosed with mild arthritis and presumed intervertebral disk disease based on radiographically visible collapse of three thoracic disk spaces. The animal had become increasingly reluctant to move and had developed pressure sores as a result. Previous treatment consisting of etodolac and glucosamine was ineffective. Borderline renal insufficiency precluded increased NSAID doses due to potential nephrotoxicity. The animal was placed on gabapentin (3.7 mg/kg p.o. every 24 hr) in combination with the previous analgesics. Over the next several weeks, there was subjective improvement in the animal’s mobility and activity. The pressure sores also resolved within a few weeks, providing additional subjective support that the animal was more active and comfortable.

Case 2

A 44-yr-old, male orangutan (Pongo pygmaeus abelii) with chronic osteoarthritis and diffuse idiopathic skeletal hyperostosis (DISH) affecting multiple joints and the spine had become refractory to treatment with celecoxib, tramadol, and glucosamine. NSAID-induced gastric ulcers had also become a problem, necessitating alternate analgesic treatments. The animal was placed on increasing doses of gabapentin (maximum dose of 4.2 mg/kg p.o. b.i.d.) in addition to the celecoxib and glucosamine. Over the next several days, animal management staff viewed subjective improvement in the animal’s comfort, mobility, and activity.

The apparent lack of significant drug interactions and favorable safety margin make gabapentin a potential analgesic option in a wide variety of settings. The ability to incorporate the drug into existing analgesic protocols makes it an attractive option for multimodal treatment of pain, especially in cases where current therapy is ineffective. Additional research is warranted to demonstrate safety and efficacy, but the drug shows promise in veterinary medicine.
LITERATURE CITED


EVALUATION OF BUTORPHANOL AND CARPROFEN FOR ARTHRITIC PAIN IN PARROTS

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Abstract

Adequate pain control is an essential part of therapeutic intervention in acute and chronic pain for all animals, including birds. Multimodal analgesia through combined systemic administration of opioids and non-steroidal anti-inflammatory drugs (NSAIDS) is considered more effective than administration of either drug class individually, and although this approach is clinically applied to birds, it has not been experimentally evaluated. NSAIDS are characterized by their anti-inflammatory effects on peripheral tissues, and also have central antinociceptive effects. Opioids exert their actions by binding to specific membrane receptors that are distributed in neurologic tissue involved in transmission, modulation and sensation of pain. Opioids provide central analgesia at the spinal cord and the brain, provide peripheral analgesia, and also reduce peripheral inflammation. Our study measured the attenuation of tonic pain in parrots (n=19) following administration of a long acting opioid agonist and an NSAID. The four treatment groups, in a complete cross-over study, were as follows: (1) liposome encapsulated butorphanol (LEBT: 15 mg/kg s.c. once), (2) carprofen (2 mg/kg i.m. b.i.d. every 12 hr), (3) LEBT plus carprofen in combination, and (4) no treatment (control). Experimental monoarthritis was induced in each Hispaniolan parrot (n=19) by injection of 0.1 ml 8% urate crystals into the intertarsal joint. An incapacitance meter, adapted to perching, measured the weight load of each limb simultaneously. Weight bearing was evaluated prior to monoarthritis, and at 2, 6, 26, 30, 50, 54, 74, and 98 hr following interarticular injection of urate solution. When compared to baseline values, weight bearing was significantly decreased on the limb with monoarthritis at 2, 6, 26 and 30 hr. Using statistical analysis to compare the four groups, those treatments that included butorphanol were significantly different from the control birds, while the carprofen-treated birds were not significantly different from the controls.
MORPHINE, BUT NOT BUTORPHANOL, CAUSES ANALGESIA AND RESPIRATORY DEPRESSION IN RED-EARED SLIDER TURTLES (Trachemys scripta)

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Abstract

Pain management is a crucial component of clinical veterinary medicine. While analgesic drugs have been extensively examined in domestic species, 1,6 our clinical understanding of analgesic efficacy, pharmacodynamics, and opioid receptor binding characteristics is negligible in non-domestic species. 4,8 Relevant data are particularly lacking for reptiles, which are commonly maintained as companion animals, and heavily represented in zoological and scientific laboratory collections. Butorphanol tartrate, a mixed opioid agonist/antagonist with κ-agonist activity, is the most widely used analgesic drug in reptile medicine. 7 However, there are no clinical data to substantiate its analgesic effect in reptiles. In contrast, morphine, an opioid with μ-agonist activity, has been shown to attenuate behavioral responses to noxious thermal stimuli in anole lizards and crocodiles. 3,5 Opioid drugs can cause profound respiratory depression in many species. 6 For reptiles, μ-opioid receptor activation abolishes respiratory motor output in isolated turtle brainstems. 2 The objectives of this study were to: (1) determine the effects of morphine sulfate and butorphanol tartrate on nociceptive behaviors in adult, red-eared slider turtles (Trachemys scripta) using a thermal hind limb withdrawal latency test; and (2) evaluate effects of morphine and butorphanol on respiration in turtles.

Hind limb thermal withdrawal latencies were measured and compared in turtles (n=11) before and after subcutaneous administration of physiologic saline, butorphanol tartrate (2.8 or 28 mg/kg), or morphine sulfate (1.5 or 6.5 mg/kg). Hind limb thermal withdrawal latencies sampled at 1, 2, 4, 8, and 24 hr post injection were no different in turtles receiving saline or either dose of butorphanol. However, hind limb thermal withdrawal latencies increased significantly in turtles after administration of morphine sulfate, indicating that morphine sulfate provided analgesia in this species. Ventilation was measured in freely swimming turtles (n=7) before and after subcutaneous administration of physiologic saline, butorphanol tartrate (28 mg/kg), or morphine sulfate (1.5 mg/kg). Saline and butorphanol had no significant effect on ventilation, although turtles receiving butorphanol exhibited a trend toward ventilatory depression. Morphine, on the other hand, significantly depressed ventilation. Butorphanol tartrate, the most widely used analgesic in reptiles, may not provide adequate analgesia in turtles. However, morphine sulfate appears to be an effective analgesic in turtles, but may contribute to significant respiratory depression.
ACKNOWLEDGMENTS

This research was supported by a grant from the Morris Animal Foundation, Englewood, CO 80112. The authors gratefully acknowledge Robert Creighton for his excellent technical assistance, and Claudia Hirsch and the animal care staff at the Charmany Research Facility for animal care and logistical assistance.

LITERATURE CITED

PHARMACOKINETIC BASIS FOR DOSAGE RECOMMENDATIONS OF BUPRENORPHINE IN RED-EARED SLIDERS (Trachemys scripta elegans)

Maya Kummrow, Dr med vet* and Flo Tseng, DVM

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Abstract

Buprenorphine is a synthetic, mixed agonist-antagonist, opiate analgesic. Dosage recommendations for reptiles vary from 0.005-1 mg/kg.1 However, anecdotal observations are often the basis for the dosage used.2 In the current study, we did not perform a pain assessment study to evaluate the analgesic effect of buprenorphine in turtles but relied on the assumption that plasma levels of 1 ng/ml are analgesic, as has been reported for human surgery patients.5 We base this assumption on the fact that the opioid receptor genes are known to be highly conserved across multiple vertebrate orders.3,4

Fourteen red-eared sliders (Trachemys scripta elegans) were administered a single dose of 0.02 mg/kg of buprenorphine subcutaneously in the axillary area. Serial blood samples were collected immediately prior to administration and at 0.5, 1, 2, 4, 8, 12, 24, 48, and 72 hr after injection. The plasma level of buprenorphine was determined by radio-immunoassay (RIA) and standard pharmacokinetic values were calculated.

Our results suggest that in red-eared sliders (Trachemys scripta elegans), a dosage of 0.02 mg/kg buprenorphine subcutaneously results in a buprenorphine plasma level greater than 1 ng/ml for 18 hr.

LITERATURE CITED

EVALUATION OF AN OSMOTIC PUMP FOR DELIVERY OF FENTANYL IN DOMESTIC CATS (*Felis domesticus*): A MODEL FOR NON-DOMESTIC FELIDS

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Abstract

Providing adequate pain relief to non-domestic felids is challenging, and alternative methods are needed for reliable, non-stressful delivery of analgesics. Transdermal fentanyl patches have been used to provide pain relief to domestic cats, but their disadvantages include being easily removed and providing unreliable blood levels.1,2 Alzet® osmotic pumps (Fig. 1) have been used to deliver constant infusions of medications to laboratory animals and have potential for administration of analgesics to exotic cats.

As a model for non-domestic felids, eight domestic cats received either a transdermal fentanyl patch (25 μg/hr size; Fentanyl Transdermal System, Mylan Pharmaceuticals Inc., Morgantown, West Virginia 26505 USA) applied to the lateral thorax or an osmotic pump (10 μl/hr; Model 2ML1, Durect Corp., Cupertino, California 95014 USA, www.alzet.com) loaded with fentanyl (2.5 mg/ml; Fentanyl citrate, USP, Spectrum Chemical MFG Corp., Gardena, California 90248 USA) placed subcutaneously over the back. After a 3 wk wash-out period, each cat received the alternate treatment. Blood samples for radioimmunoassay (Coat-a-Count® Fentanyl, Diagnostics Products Corporation, Los Angeles, California 90045 USA) were collected periodically for 4 days, after which the pump/patch was removed.

Though inter-individual variation was observed using either method, the osmotic pumps resulted in higher fentanyl concentrations than those produced by the patches. The pumps were well tolerated by the cats, easy to place, and easy to remove. Though more studies are needed, Alzet® osmotic pump delivery of fentanyl may be appropriate for exotic felid post-surgical analgesia.

ACKNOWLEDGMENTS

This study was supported by a grant from the Morris Animal Foundation. The authors thank Tami Moyers and Nancy Zagaya for technical assistance and Joseph Bartges for the use of his research animals.

LITERATURE CITED

Figure 1. Cutaway section of osmotic pump.
USE OF THERMAL THRESHOLD TEST RESPONSE TO EVALUATE THE ANTINOCICEPTIVE EFFECTS OF BUTORPHANOL IN JUVENILE GREEN IGUANAS (*Iguana iguana*)

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Abstract

Butorphanol has been widely used as an analgesic in reptiles despite the lack of data on its antinociceptive effects. Six juvenile green iguanas, weighing 35-70 g, were used in this study. Animals were housed together until the night before the experiment, when they were weighed and moved to individual cages. On the morning of each experiment, a probe containing a temperature sensor and heating element was attached to the tail base with tape and attached to a long flexible ribbon cable connected to a thermal threshold tester. Skin temperature was recorded and the heater activated. When the iguana responded by kicking a hind leg, the temperature was recorded (thermal threshold; TT) and heating terminated. Three baseline measurements were recorded at 15 min intervals. Treatments were butorphanol (1 mg/kg i.m., quadriceps) or 0.9% saline given in a randomized cross-over design with at least 1 mo between tests. TT was tested every 15 min for 2 hr post injection, followed by 30-min intervals until 6 hr post injection, and then at 7 hr and 8 hr post injection. Three animals received both treatments with the human observer in view, and all six iguanas were tested after both treatments with the cage covered and the observer hidden but observing via a remote video camera. Skin temperature varied, therefore the difference between this and TT was recorded (ΔT). Data was analyzed by a split-plot repeated measures ANOVA.

There was a significant difference in ΔT when the tester was in view compared to when the tester was hidden; mean ± SD baseline of 14.2 ± 3.2°C and 8.8 ± 1.9°C respectively. There was no significant change in ΔT over time after saline or butorphanol under either test situation. This data suggests that the presence of a human increases ΔT in iguanas.

At this dose, butorphanol demonstrated no thermal antinociceptive effects. In other studies it had no anesthetic sparing effect. Butorphanol administered at 1 mg/kg is unlikely to alleviate pain in iguanas.

ACKNOWLEDGMENTS

This study was funded by the Morris Animal Foundation. The authors thank Dr. J. Hauptman for statistical analyses.
LITERATURE CITED


THE AMERICAN ZOO AND AQUARIUM ASSOCIATION (AZA) WILDLIFE CONTRACEPTION CENTER AND ITS PROGRAMS

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Abstract

Managing genetically and demographically healthy captive populations within relevant husbandry and welfare guidelines depends on a foundation of cooperation and shared information. Three services are seen as so essential to managing zoo populations they are all partially funded through the American Zoo and Aquarium Association (AZA): animal records and the development of the Zoological Information Management System (ZIMS); population analysis and the development of species master plans; and monitoring contraceptive use, advancing product development and providing contraceptive recommendations. In 1999 AZA folded the Contraception Advisory Group into the AZA Wildlife Contraception Center at the Saint Louis Zoo. The Contraception Center’s co-Directors, Dr. Cheryl Asa and Ingrid Porton, are employees of the Saint Louis Zoo while the Program Manager is currently funded through AZA. The Contraception Center is a readily available resource for contraceptive information and advice for the entire AZA community. We encourage all AAZV veterinarians and their staff to become familiar with the services and contraceptive products offered through the Center, provide input regarding unmet contraceptive needs and/or issues that require additional research, and consider participating in relevant research trials.

The Contraception Center’s website (www.stlzoo.org/contraception) is the most up-to-date source of contraception information available to the practicing veterinarian. The Contraception Recommendations, which are based on published research results from Center-sponsored research trails and analysis of the Contraception Database, are updated annually and published on the website in a searchable format. Details on how to obtain contraceptive products supplied through the Center or submit reproductive tracts to Dr. Linda Munson are included in the Recommendations. The Center maintains a “Contraceptive Hotline” (314-781-0900 ext. 384) and “Hot-Email Address” (contraception@stlzoo.org) for questions and issues not addressed in the published Recommendations. Additional useful and in-depth contraceptive information can also be found in the Center’s recently published book.1

The Center makes contraceptive products available to the zoo community through commercial partners, including Wildlife Pharmaceuticals, Peptech Animal Health, and Purina Mills. The Center then monitors contraceptive use and maintains a database in compliance with FDA regulations and to serve as a basis for FDA reports. MGA in implant form remains the most widely used contraceptive in U.S. zoos, but is also available incorporated in an herbivore diet or as a liquid for addition to the regular diet or to treats. These oral formulations are used predominantly in ungulates. Although MGA has been effective in almost all the species tested, it
and other synthetic progestins are associated with potentially severe side effects, especially in carnivores.

Alternatives to MGA and the other steroid-based methods include the zona pellucida vaccine, provided by Dr. J. Kirkpatrick and used primarily in hoofstock. The GnRH agonists such as leuprolide and deslorelin have the advantage of being potentially effective in males as well as females, and they are available as either a tiny implant or injectable implant. Trials to date indicate that these agonists can be effective contraceptives in females of perhaps all mammals species, but do not suppress reproduction in male ungulates or marsupials. Deslorelin is being used successfully in 23 carnivore species, 13 primate, and 4 ungulate, as well as dolphins, fur seals, and a single tree shrew.

One of the Center's main objectives is to foster communication and exchange of information with the people who manage and care for captive animals. Survey data are used to monitor various aspects of efficacy and to identify problems with application so that we can either correct the problems or search for alternative products. The Contraception Center is well positioned to integrate disparate contraceptive results and experiences that, together, can alert the zoo community to problems, early successes, or areas for further research. Veterinarians, animal managers and caretakers play a critical role in the success of the Center by responding to surveys and reporting their observations.

LITERATURE CITED

MANAGEMENT OF ELEPHANT POPULATIONS IN PRIVATE SOUTH AFRICAN GAME RESERVES WITH PORCINE ZONA PELLUCIDA VACCINE

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Abstract

Control of African elephant populations has become an absolute necessity in a number of game reserves in southern Africa. The two main methods used to control populations so far are culling and translocation. Culling, besides being regarded as inhumane and unacceptable in many quarters, is not suitable for smaller populations. It requires that whole family units are culled simultaneously which could mean that in reserves with 10 to 50 elephants a considerable portion, if not the entire population, is killed. As far as translocation is concerned, limited new space is available for elephants. The only alternative to the two above options is to control the rate of reproduction. The porcine zona pellucida (pZP) vaccine has been used to successfully contracept wild horses6,7,9 and other wildlife species.8 Work on the contraception of African elephants was initiated in the Kruger National Park in 1995 when the potential for using the porcine zona pellucida (pZP) was investigated.4 Subsequently the first field trials on wild elephants were carried out in Kruger and the results clearly showed that elephants could be contracepted with the pZP vaccine, although the efficacy achieved was 80%.5 During these field trials safety and reversibility were could be demonstrated.

In 2000 an elephant contraceptive program was initiated at Makalali Private Game Reserve, RSA, which has become the flagship model for immunocontrol in African elephants. The preliminary findings have been reported in three publications.1-3 During the first year, all 18 cows that were individually identified and older than 12 yr of age were treated. During the next 4 yr the number of cows contracepted increased to 23 as young animals were added to the program. The standard vaccination procedure during the first year consisted of a primary vaccination (600 μg or 400 μg pZP with 0.5 ml Freund’s modified complete adjuvant) followed by boosters (200 μg pZP with 0.5 ml Freund’s incomplete adjuvant) at 3 to 6-wk intervals. Annual boosters to maintain antibody titers and contraceptive effect followed. To date, the success rate on cows that have passed reserve-specific intercalving period of 56 mo has been 100%. The population stabilized within 3 yr by which time when all cows that had been pregnant at the time of first vaccination in 2000 had calved.1,3 Once again safety during pregnancy (14 cows pregnant at 2-21 mo gestation when first treated gave birth to normal healthy calves) as well as side effects that were limited to occasional lumps at the site of vaccination could be shown. Following ground darting, behavioral patterns returned to pre-darting status within 2 days. During 2003 and 2004 most boosters were administered from a helicopter; whereas,
previously they had been done from a vehicle or on foot. In all cases, drop-out darts were used. Time taken for vaccination from helicopter take-off to landing was about 30 min (1.5 min per cow; 30 min for total time). This required prior knowledge of the locations of family units or that an individual in each unit is radio-collared. Herds settled down much more quickly (1-2 days) than if darted from the ground.

Since then we have vaccinated another 107 elephant cows in eight game reserves. The cow populations have ranged from 4 to 43. In one of the reserves, Mabula, RSA, two of the four cows vaccinated have passed the mean intercalving intervals of the reserve with neither of them producing a calf. Treatment at the remaining reserves was initiated in 2004 or 2005 and it is too early to evaluate results. The most difficult reserve in terms of the vaccination process was Welgevonden, RSA, (35 000 ha) with 43 cows. The reserve is mountainous and heavily wooded. None of the elephants were collared and individuals could not be easily identified on the day of primary vaccination. The total flying time during which individuals were identified and vaccinated was 4.5 hr. Administration of the first booster took about 2 hr to locate and vaccinate each cow. Between the first and second booster the first rains occurred, followed by the spring flush of the vegetation. By the time the second booster was attempted late in November, the trees all had foliage. Only half the cows were located and darted because the elephants were very difficult to spot under the tree canopies. The valuable lessons we learned from this were: 1) that helicopter vaccinations should be performed when most trees are bare, and 2) when larger populations are vaccinated repeatedly during the first year, one cow in each family unit should be radio-collared. This makes rapid location of each unit possible and cuts down on the major cost factor that is flying time.

Elephant behavior is being monitored in all eight reserves where contraception is being applied. Because most of them have been contracepted recently, only the data from Makalali is available. The elephants at Makalali have been monitored intensively almost on a daily basis. To date, no anomalies in terms of aggressive or indifferent behavior with regards to nursing time, nursing behavior and calf proximity have been noted. No change in the cows’ social hierarchy has been noted. Since January 2003, a total of 15 heats were observed in 10 cows (nine in 2003 and six in 2004) with four mating episodes. For the same period, 38 musth occasions were seen in five bulls (26 in 2003 and 12 in 2004). These occasions include musth displayed in the same bull during consecutive days or within the same musth cycle. The greatest occurrence of musth was recorded in the largest, dominant bull. Bulls were not observed harassing or separating cows off from their herds or calves as a result of increased estrous frequency. Thus, the Makalali program demonstrates that pZP does not cause herd fragmentation, harassment by bulls, change in rank and other negative behaviors normally associated with hormonal contraceptives.

In conclusion we feel that it is important to emphasize the following points:
  • The pZP vaccine can be used successfully to contracept African elephants
  • The vaccine is safe during pregnancy and has no negative effect on birth or calf raising
  • It has no side effects other than occasional swelling at the site of vaccination
  • It is reversible
  • Other than an increased incidence of heat no behavioral side effects were seen
- Administration of the vaccine is carried out remotely by darting and does not require immobilization

LITERATURE CITED

REPRODUCTIVE EFFECTS OF A LONG-ACTING DESLORELIN IMPLANT OR INJECTION IN MALE AFRICAN WILD DOGS (Lycaon pictus): A PRELIMINARY REPORT OF THE FIRST SEVEN MONTHS POST TREATMENT

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Abstract

Long-acting GnRH analogues have been used for fertility control in domestic12-14 and wildlife species.1-7 However, dosing and efficacy differ between species and individual animals.8-11,13,14 A previously available 6-mg deslorelin implant reversibly contracepts male African wild dogs.2,3 This study examined pre- and post-treatment reproductive parameters of wild dogs administered a 4.7-mg deslorelin implant (Suprelorin®, Peptech Animal Health Pty, Australia; I, n=10), a 9.4-mg deslorelin injection (J, n=11) or a placebo injection (P, n=6). Treatment was administered during the non-breeding season (month 0), and dogs were assessed at months 3, 5, 6, and 7. Parameters evaluated included: serum and fecal testosterone, testicular ((πL × W × W)/6 per a testis) and prostatic (L ×W × H) volume, and sperm presence. Data were analyzed with ANOVA.

Post-treatment parameters of injection and placebo groups were similar. The average post-treatment serum testosterone of injection and implant groups differed (I: 0.25 ng/ml, J: 0.63 ng/ml, P≤0.10). However, post-treatment fecal testosterone did not differ between the groups. A significant post-treatment difference in testicular (I: 23.2 ml, J: 36.8 ml, P: 37.6 ml, P≤0.01) and prostatic volumes (I: 4.0 ml, J: 6.2 ml, P: 7.1 ml, P≤0.09) between implant and other groups existed. Of the eight azoospermic dogs, one was azoospermic pre and post treatment (1 I), four were azoospermic pre treatment and three later developed sperm (2 J, 1 I), and three had sperm at treatment but were azoospermic post treatment (3 I).

Seven months post treatment, the injection appears ineffective and the implant appears partially effective for male wild dog contraception.

ACKNOWLEDGMENTS

The authors would like to thank the staff of the De Wildt Cheetah and Wildlife Center, Nettie Englebrecht and Hettie Roussow of the Onderstepoort Physiology Laboratory, Reolf Greyling of the Onderstepoort Veterinary Institute Virology Laboratory, and Anne-Marie Human of the Onderstepoort Hormone Assay Laboratory for their technical assistance with this study.
LITERATURE CITED


THE APPLICATION OF IMMUNOCONTRACEPTION IN CAPTIVE NONDOMESTIC UNGULATES

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Abstract

Issues of carrying capacity and resource availability often limit captive propagation programs. Contraception can be used as a management tool to reduce, stabilize, or control the growth of animal populations. The use of PZP immunocontraception as a management tool for nondomestic ungulates was initiated at the San Diego Wild Animal Park in 2002 and continues to the present time. The overall goal is to reduce the number of births/herd/year while maintaining genetically viable populations. Most treated animals are housed in large mixed species field enclosures with multiple males and are vaccinated by remote delivery of a projectile dart. To date, 138 individuals of 26 different species have received a total of 351 doses of PZP. There has been no known mortality associated with the use of PZP in subadult or adult animals. Morbidity is rare but includes one femoral fracture, two lamenesses requiring hospitalization, and three sterile abscesses (which occurred in the same individual regardless of the adjuvant used). Since males are present in the herds year round, pregnancy status of an individual is not always known. A review of records indicates that animals were vaccinated during all stages of gestation. The use of PZP lengthened the interbirth interval in some species and reduced herd fertility rates (total number of births/total number of females in the exhibit in a given year). Herd fertility rates identify trends as there is constant population influx and efflux. Serum samples are saved opportunistically to measure anti-PZP antibodies. Duration of effectiveness of PZP varies on an individual and species basis. Prospective studies to document reversibility in the various taxa are needed.

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We thank Veterinary Services and the Mammal Departments of the San Diego Wild Animal Park for their assistance and support.
DEVELOPMENT OF AVIAN CONTRACEPTIVE TOOLS

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Abstract

Avian contraception is a nonlethal management tool that can be utilized for managing wild species associated with damage, or to manage reproduction in captive populations. Because management situations vary with respect to the management goal, species involved, location, and nontarget hazards, it is necessary to develop multiple contraceptive tools to allow management flexibility.

DiazaCon™ (Avitrol Corp, Tulsa, Oklahoma 74145 USA) and nicarbazin have already been developed at the National Wildlife Research Center (NWRC) as avian contraceptives. DiazaCon™ is a cholesterol mimic with nitrogen substitutions for the hydrocarbons at positions 20 and 25. It reduces cholesterol synthesis by inhibiting the conversion of desmosterol to cholesterol, thereby reducing production of reproductive steroid hormones. Nicarbazin is an anti-coccidial drug used routinely in the poultry industry. Through adverse effects on the vitelline membrane, nicarbazin prevents hatchability. At higher dose levels, nicarbazin also interferes with the deposition of egg yolk components, causing a reduction in egg production. Although both of these are promising contraceptive agents, more are needed for a wider variety of situations.

Past research at NWRC has focused on other cholesterol inhibitors, inhibitors of the P450 side chain cleavage enzyme, aromatase inhibitors, and melatonin. Future research will focus on natural products with contraceptive activity. These may include plant products containing high concentrations of phytosterols, phytoestrogens, saponins, and anti-gonadotropic compounds.

When choosing compounds to test as potential avian contraceptives, the ultimate goal of registration must be kept in mind. Adverse health effects, longevity in the environment, and secondary hazards must all be considered. Registration requirements should be kept in mind when designing efficacy studies.
LAPAROSCOPIC REPRODUCTIVE STERILIZATION OF WATERFOWL

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Abstract

Reproductive surgical sterilization in waterfowl has several potential uses but has rarely been attempted in zoological medicine. Laparoscopic surgery in wildlife species provides several benefits as compared to conventional surgery including less postoperative pain, faster healing times, and the ability to return the patient back to its environment more rapidly after the procedure. This project describes several surgical techniques that were developed and evaluated to perform orchidectomies and ovariectomies in mallard ducks (*Anas platyrhynchos*).

Introduction

Population control of captive wildlife is an important management tool in zoological institutions. Historically, methods of contraception in avian species have been limited. The goal of our project has been to investigate safe and effective methods of surgical sterilization in waterfowl.

At our institution, non-migratory mallard ducks are present in very high numbers and commonly brought to our hospital as orphaned ducklings, or with medical problems. In partnership with the Florida Fish and Wildlife Conservation Commission (FFWCC), and under jurisdiction of the United State Fish and Wildlife Service (USFWS), Disney’s Animal Programs has been surgically sterilizing mallard ducks for the last year.

Although castration (a.k.a. caponization or orchidectomy) has been routinely performed in young male poultry for many years, castration of other avian species in zoos is rarely done and has been associated with surgical complications including hemorrhage, and organ regeneration. Sterilization in female birds has usually been limited to salpingohysterectomy in pet avian species. In some avian species it is believed that removal of the uterus (shell gland) provides a feedback mechanism to the ovary, which limits follicular growth. However, in waterfowl, continued yolk release from the ovary after salpingohysterectomy may lead to yolk-related peritonitis.

Over the last year, approximately 200 mallard ducks were surgically sterilized. This number includes both juvenile and adult, and male and female birds. We evaluated several surgical approaches and techniques during this time. This paper describes some of the possible complications associated with each technique and describes our current method of choice for waterfowl sterilization.
Methods

Birds are given an injection of leuprolide acetate (Lupron Depot®, TAP Pharmaceuticals Inc., Lake Forest, Illinois 60045 USA), at 1 mg/kg i.m. from 7-14 days prior to surgery. For surgery, animals are placed under general anesthesia and intubated. The birds are placed in right lateral recumbency, feathers are plucked, and a surgical preparation is done from the 6th rib caudally to the pubis. In adult males, a bilateral approach is required for castration. In juvenile ducks, the sterilization can be done via two small laparoscopic incisions utilizing 3-5 mm cannulas. In mature adults, the more cranial incision will need to be large enough to place surgical clips and remove the gonad. The first incision is made just cranial and parallel to the femur. The underlying muscle bellies are bluntly separated using a hemostat, which is then utilized to penetrate into the coelomic space. The laparoscope is inserted into this incision, and the tip can be used to place a hole in the underlying air sac. A 6-mm incision is now made behind the caudal musculature of the femur (iliotibialis) and a straight blunt forcep is introduced in a craniodorsal direction until it can be visualized in the coelom via the laparoscope. A 3-5-mm cannula is then placed in this location for laparoscopic instrument use.

The following methods of hemostasis and gonad resection were evaluated: radiosurgery, harmonic scalpel, hemoclip application, carbon dioxide laser, Ligasure™ (Valleylab, Boulder, Colorado 80301 USA) unit coagulation, and segmental tissue resection followed by cryosurgery of remaining gonadal tissue.

Initially, our greatest surgical concern was hemostasis, and thus radiosurgery, the harmonic scalpel, and the Ligasure™ coagulation system were all utilized. Although these techniques did aid in hemostasis, we found that each one of these hemostasis techniques was associated with cardiac arrhythmias (severe tachycardia) and sometimes death. It is hypothesized that these methods induce some degree of collateral stimulation/irritation to the closely adjacent adrenal gland. It is believed that this stimulation of the adrenal gland may initiate catecholamine release, which in turn, causes cardiac arrhythmias and sometimes cardiac arrest. Initially, this theory was difficult to prove, but various degrees of tachycardia were observed repeatedly when any of these electrical systems were utilized adjacent to the adrenal gland. For this reason, these methods of gonad resection were discontinued.

In juvenile ducks, the current method of choice has been to utilize a 3 mm cupped laparoscopic biopsy instrument to remove the gonad piecemeal. This is done by grasping at the caudal pole of the gonad with the instrument and then gently rotating the piece of tissue continuously while withdrawing the instrument. This technique allows gentle traction and resection of that piece of the gonad. It is important to not use the biopsy forcep to cut through the tissue, but rather as a holding device for twisting. It is critical that the entire biopsy forceps be visualized, and that the vena cava or other major vessels not be compromised during this procedure. Immature males will require 3-6 extractions to remove all the tissue, and females may require 10-20 extractions depending on the size of the ovary and size of the pieces taken.

In general, the testis is well delineated and not as directly attached to the vena cava and adrenal gland. For this reason, it is much easier to perform a castration, and there is less chance of
leaving any gonadal tissue, which can regenerate. The ovary is much more closely associated with the adrenal gland and vena cava. In immature male ducks, both testes can often be visualized and safely removed from the left incision. A hole will need to be placed in the right abdominal air sac for visualization. If the testes cannot be fully visualized, it is better to close the left side and perform a bilateral approach.

The same technique of piecemeal gonadal tissue resection is utilized with the females. Our preliminary work showed that in several cases, it was impossible to see or safely remove all the ovarian tissue and that gonad regeneration was then a possible complication. For this reason, we currently utilize cryosurgical techniques after ovariectomy to devitalize any remaining tissue. A 3-mm insulated copper probe is placed into a dewar flask of liquid nitrogen. The frozen tip of the probe is then inserted through the instrument port and used to devitalize the remaining ovarian tissue. The tip is placed over the adrenal and vena cava sites for 2-3 sec in three separate freezing rotations. It is important to avoid causing necrosis of adrenal tissue or the vena cava. Preliminary studies have indicated this technique helps reduce the incidence of gonadal regrowth. We are currently involved in a study that will document the long-term efficacy of this technique.

Carbon dioxide laser surgery with a laparoscopic tip was also evaluated for efficacy. It was found that although this may be effective, it is difficult to safely direct the laser beam laparoscopically once inside the patient, and that inadvertent application to the vena cava or adrenal gland can lead to significant hemorrhage. Other forms of laser (e.g., diode laser) may be easier to precisely aim and may be useful in the future.

In mature male ducks, hemostasis cannot be accomplished with the previously described techniques and hemoclips must be utilized. Laparoscopic 5-mm clip applicers can be used, or a larger incision can be made and a 90º hemoclip applicer can be utilized. Typically, two clips are applied at the very base of the testes, ensuring that the vena cava and adrenal are not entrapped. Once the clips are in place a laparoscopic scissor is placed in the instrument port and the testes resected and removed. A bilateral approach is needed for an adult duck castration.

Closure is typically done in two layers, with the first incorporating the celomic serosa and associated muscles, and the second layer including subcutaneous tissue and skin.

Patients receive butorphanol (Torbutol,™ Fort-Dodge, Fort Dodge, Iowa 50501 USA) 2 mg/kg i.m. during their surgery for postoperative analgesia and meloxicam, (Metacam, Boehringer-Ingelheim, Vetmedica Inc., St. Joseph, Missouri 64506 USA) 0.1 mg/kg p.o. for two additional days after surgery. Incisions are evaluated at 4-7 days post surgery and if the animal is doing well, it is fitted with a USFWS band and released back to the wild.

Results and Discussion

Although there is some question about the use of leuprolide acetate in hormone regulation in waterfowl, this drug is given to help decrease the vascular supply to the gonads. A controlled study to evaluate its efficacy in waterfowl was not done. In poultry, keeping the birds in
complete darkness for an extended period of time is commonly practiced prior to caponization, and is believed to decrease the blood supply to the gonads.

Initially, hemorrhage was our biggest concern, but with careful manipulation in juveniles and the use of hemoclips in adults, hemorrhage was not a significant problem. In those cases where local hemorrhage occurred, hemostatic absorbable gelatin sponge foam (Gelfoam™ Upjohn Company, Kalamazoo, Michigan 49001 USA) and direct pressure were utilized to aid in stasis.

Cardiac arrhythmias were only seen when electronic devices were used in proximity to the adrenal gland. This was true in both male and female birds. Several drugs in mammals can be used to block catecholamine- induced arrhythmias, and their use was discussed, but not attempted. It is interesting to note that direct manipulation of the adrenal and collateral cryofreezing from the ovary were very rarely seen to induce arrhythmias.

It is our goal to be able to provide a safe, effective sterilization tool for zoo and wildlife professionals who work with avian species. Laparoscopy provided several advantages in this procedure, including small incisions, less postoperative pain, faster healing and less recuperative time before return to the wild. Laparoscopy also allows magnification of the surgical area of interest and is particularly important in juvenile animals with small gonads to ensure complete resection. In addition, laparoscopy allows excellent visualization in deep holes and facilitates the ability to perform a castration procedure from a single left-sided approach.

When we first began performing these surgeries, each procedure took well over 60-90 min. Currently, both male and female birds can be sterilized in 15-25 min.

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COMPLICATIONS ASSOCIATED WITH LONG-TERM CONTRACEPTION OF A MIXED SPECIES GROUP OF ARTIODACTYLS

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Abstract

Melengestrol acetate (MGA) has been used as an oral contraceptive agent in hoofed mammals at the Wildlife Conservation Society’s Bronx Zoo since 1991.2 It has been used in a total of 11 species at WCS facilities. It is milled into a pelleted hoofstock feed at the rate of 0.00015% and fed at a rate to deliver 1-2 mg of MGA per individual animal per day. A mixed species herd of barasingha (Cervus duvauceli), axis deer (Axis axis), and blackbuck (Antilopa cervicapra) are housed and exhibited together at the Bronx Zoo. They are generally managed as a single herd unit rather than as individuals, typically with multiple males of each species present at a given time. Challenges and complications associated with long term contraception in this herd of animals include failure of contraception due to competition for medicated feed; dystocias in primiparous females that matured while being fed medicated feed; mummified fetuses; prolonged interbirth intervals; endometrial hyperplasia; and mucometra. Barasingha, a large seasonally breeding cervid, have taken the longest periods of time to return to near pre-treatment fecundity levels. They are also the only of the three species to have had mummified fetuses and mucometria requiring surgical intervention. Axis deer and blackbuck will show signs of estrus within 2 days of discontinuing delivery of MGA and have a significant return to fertility at that time. Overall, the incidence of adverse effects associated with MGA administration has been low compared to the numbers of artiodactyls it has been fed to at WCS over the past 15 yr.1,2

ACKNOWLEDGMENTS

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LITERATURE CITED

IMMUNOCONTRACEPTION AND INCREASED LONGEVITY IN EQUIDS

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This study is pending publication in Zoo Biology.

Abstract

Intensive population management of wild equids by means of fertility control has been shown to change the age profile of the treated population.6 The primary change has been an increase in the number and percent of older animals, as expected, but also the appearance of new and older age classes. A similar increase in body condition scores and a decrease in mortality was also revealed within a population under intensive contraceptive management.2,6 An examination of direct effects of fertility control on individual animals in a herd of wild horses on Assateague Island National Seashore (ASIS), MD, over a 30-yr period, reveals a significant increase in longevity that is associated with contraceptive treatment and decreased pregnancies. Undetected neonatal losses were accounted for by means of remote pregnancy testing by means of urinary or fecal estrone conjugate and immunoreactive progesterone metabolites.3-5

The standard treatment protocol in the ASIS management plan applies initial contraception at 2 yr, and booster inoculations at age 3 and 4 yr. Previous studies demonstrated that ASIS mares treated for 3 yr consecutively would take anywhere from 1-4+ yr to become fertile again, based on current reversibility data,5 which would cause a significant decrease in foaling from age 5 to beyond 9 yr, which are the years of peak reproductive success. On ASIS, a study of 14 mares, all 3 yr or older, over an 8-yr period and prior to any contraceptive treatment, revealed that they produced a mean of 5.0 foals during that 8-yr period.1 Foals among a different set of 14 ASIS mares, all 3 yr of age or older and treated with PZP for varying periods of time, produced a mean of 0.5 foals during their lives.

The mean age at death (MAD) was calculated for 128 wild horses over a period of 19 yr for which precise birth and death dates were known, including 56 stallions, 42 untreated mares, 11 mares treated with a porcine zona pellucida (PZP) contraceptive vaccine for 1-2 yr, and 19 mares treated with the same vaccine for ≥3 yr. Results are given in Table 1.

The mean age at death (MAD) of stallions was not significantly different from the MAD of mares treated for <3 yr (P=0.973; t=0.032) but was significantly greater than that of untreated mares (P=0.0006; t=3.53), and significantly less than the MAD of mares treated for 3 yr or > (P=0.005; t=5.51).
The MAD of untreated mares was significantly less than that of mares treated for <3 yr \( (P=0.064; \ t=2.84) \), and significantly less than the MAD of mares treated for 3 yr or > \( (P=0.0001; \ t=9.67) \).

The MAD of mares treated for < 3 yr was significantly less than the MAD of mares treated for 3 yr or > \( (P=0.005; \ t=3.92) \).

**Conclusions**

The management of long-lived ungulate populations by means of contraception is possible, but there will be an increase in the longevity of the treated animals, and a significant change in the age profile of the herd. These changes must be accompanied by a concomitant adjustment of breeding strategies and/or de-accesssion plans if the herd numbers are to be kept constant.

**ACKNOWLEDGMENTS**

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**LITERATURE CITED**


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**Table 1.** Mean ages at death for Assateague horses as a function of length of PZP treatment.
A CALL TO AUTHORS FOR STANDARDIZATION OF DATA COLLECTION AND REPORTING RESULTS FOR STUDIES AND CASE PRESENTATIONS INVOLVING CHEMICAL IMMOBILIZATION AND REMOTELY DELIVERED ANESTHETIC AGENTS

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Abstract

Authors of investigative studies or case presentations describing techniques of chemical immobilization begin their discussions defining the measurement intervals or observation parameters utilized for data collection in their study. A literature review finds data collection and reporting to be unstandardized between authors.

Similar terms often have different definitions. The term, “Induction Time” has been defined as the period from injection of the immobilizing drugs until the animal is (a) immobile (either standing or recumbent), (b) recumbent (position unspecified), (c) in lateral recumbency, (d) head down (e) safe to handle or (f) reaches an anesthetic plane. “Down Time,” similarly has multiple definitions in the literature: (a) time from recumbency to standing, (b) time from induction to antagonist administration, (c) time from injection of the immobilizing drug until the animal becomes recumbent.

The goal of this paper is to propose the adoption of standardized data collection and reporting techniques, to afford more meaningful comparison between techniques and information involving chemical immobilization and remotely delivered anesthetic agents. A checklist of suggested definitions, measurement intervals, and observational parameters is provided as a standardized framework of reference. This checklist was developed using models presented in the published literature by various individuals, working with many species in multiple countries.

Capture, immobilization, and anesthetic procedures in animals unaccustomed to human contact have the potential for injury and mortality to animals and staff. It is our duty as practitioners to maximize the amount of information gathered and shared from these procedures, so that techniques can be fully emulated or undesirable impacts defined and avoided.
HOW MUCH TELAZOL® IS REALLY IN THE BOTTLE? INACCURATE LABELING OF TELAZOL FROM 1987-1998 AND THE IMPACT ON PUBLISHED LITERATURE

Keith Amass, DVM1*and Mark Drew, MS, DVM, Dipl ACZM1,2

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Abstract

Telazol® has been produced by pharmaceutical companies owned by the American Home Products Corporation (now Wyeth Corporation) since the products inception in 1987, with distribution in the USA under the A.H. Robbins label (AH Robbins, Richmond, Virginia, 1987-1992), and with previous and current distribution in the USA under the label of Fort Dodge Laboratories, Inc. and Fort Dodge Animal Health (Fort Dodge, Iowa, 1992-present). Telazol is a 1:1 combination of tiletamine + zolazepam supplied in freeze dried form (as a powder). From March 1987 until January 1998 Fort Dodge Telazol® was labeled to contain 500 mg of active drug per vial, with reconstitution instructions to add 5 ml of sterile water for injection to achieve a solution containing 100 mg/ml (50 mg/ml tiletamine + 50 mg/ml zolazepam). This reconstitution technique was confusing since upon addition of 5 ml of diluent the resulting total solution in the vial was approximately 5.7 ml due to the powder dissolving into solution and expanding the fluid volume, a phenomenon known as displacement. With 500 mg of total drug per vial and a total volume of 5.7 ml the resulting solution would only contain 87.7 mg/ml (43.85 mg/ml tiletamine + 43.85 mg/ml zolazepam). This dilemma: either the amount of total Telazol labeled to be in the vial was incorrect, or the resulting solution concentration with reconstitution with 5 ml of diluent was labeled to be incorrect.

In discussions with Fort Dodge the following information was obtained. Telazol® is produced by adding a target volume of 4.12 ml of 69.4 mg/ml tiletamine + 4.12 ml of 69.4 mg/ml zolazepam into each vial. The vial is then freeze dried producing powder in the vial totaling 285.93 mg tiletamine + 285.93 zolazepam or 571.86 mg of Telazol® (total combined drug per vial), if the exact target volumes are achieved.

Using the target values of 285.93 mg tiletamine + 285.93 zolazepam and a total reconstituted volume of 5.7 ml (taking into account displacement) the solution concentration of tiletamine is indeed accurate at 50 mg/ml and the solution concentration of zolazepam is also accurate at 50 mg/ml. With 571.86 mg of total Telazol® per vial and a total volume of 5.7 ml, the solution concentration of Telazol is again accurate at 100 mg/ml. Thus the actual amount of Telazol® per
vial is targeted to be 572 mg, and not 500 mg as was indicated on the 1987-1998 label, explaining the inconsistency.

After 1998 the Telazol® label and package insert were revised and no longer indicated the total amount of Telazol per vial, but only that reconstitution with 5 ml of diluent would provide a solution containing 100 mg/ml of active ingredient (50 mg/ml tiletamine + 50 mg/ml zolazepam). Understandably, since no alternative information has been presented, the misconception that Telazol® contains 500 mg of total drug per vial persists in the current literature despite label revisions by Fort Dodge Animal Health.18, 26

From 1987-1992 Telazol® was distributed under the AH Robbins label. With the exception of the replacement of sodium sulfate by mannitol as a buffering agent between 1992 and 1994, the production of Telazol® whether labeled as AH Robbins or Fort Dodge has been unchanged, and in the same facility or sister facilities since the inception of production in 1987.11 Thus, AH Robbins Telazol® distributed from 1987-1992, labeled to contain 500 mg of total active drug per vial, also actually contained a targeted fill volume of 572 mg total Telazol® per vial. CI-744, the precursor of the commercially released product Telazol® also was produced under the same target filling values.11

What is the Impact of The 1987-1998 “500 mg” Labeling on Published Species-Specific Dosages?

The impact of this inaccurate labeling will depend on the method of reconstitution used in the study. While some operators reconstitute Telazol® in the standard manner (5 ml diluent added), those working with remote injection often reconstitute Telazol® in a non-standard manner (less diluent added). This non-standard reconstitution produces a higher concentration formulation, affording a smaller injection volume if administered by hand injection or pole syringe, and if delivered remotely, allowing the use of smaller, lighter darts, which are less traumatic on impact.

Published species specific dosages (mg Telazol®/kg body weight) determined using the value of 500 mg total Telazol® in the vial, but using standard reconstitution volumes of 5 ml diluent, and basing their calculations on Telazol® at a solution concentration of 100 mg/ml are not effected by this incorrect labeling since the resulting solution did indeed contain 50 mg tiletamine + 50 mg/ml zolazepam, or 100 mg/ml Telazol® .

Published species specific dosages (mg Telazol®/kg body weight) determined using the value of 500 mg total Telazol® in the vial and non-standard reconstitution volumes are inaccurate, with an underestimate of the actual drug dosage by 14.4%.3,4,8,22,40,45

Telazol® production standards allow for a 10% (±) variance in each drug. Fort Dodge Animal Health “in house” standards are more stringent, striving to produce the medication at 102-103% of the production target values-producing solution concentrations between 49-53 mg/ml each tiletamine and zolazepam, with an average of 51 mg of each drug per ml and an average displacement of solution volume by powder dissolution of 0.6 ml.11
Conclusions

Readers should be cognizant of the amount of Telazol® referenced to be in the vial, and the reconstitution techniques utilized, when reviewing historic immobilization literature. Species specific dosages calculated and published using the incorrect Telazol® amount of 500 mg per vial and non-standard reconstitution techniques should be re-evaluated using the true value of 572 mg of Telazol® per vial. Future publications utilizing Fort Dodge Animal Health Telazol® should use 572 mg as the target filling weight of drug per vial, or weigh the contents of the vial to ensure the accuracy of calculated species specific dosage information.

Many publications using Telazol® do not provide information on reconstitution techniques and cannot be evaluated without acquiring this information through contact with the author. It is requested that whenever publishing case reports or studies using medications that require reconstitution, authors provide the drug name, manufacturer, production facility location, and a detailed description of the reconstitution techniques utilized.

ACKNOWLEDGMENTS

Thank you Dr. Jim Hall, Fort Dodge Animal Health for your efforts and assistance in researching historical technical information on the Telazol product, Nira Colonero and Maggie Beheler-Amass for assistance in compiling cited reference information, and Dr. Julie Smith for your time, efforts, and advice.

LITERATURE CITED


42. Telazol Product Insert: Fort Dodge Laboratories: Rev June 1994

COMPARISON OF TRUNK WASH RESULTS MATCHED TO MULTIANTEGEN PRINT IMMUNOASSAY (MAPIA) IN A GROUP OF CAPTIVE ASIAN ELEPHANTS (Elephas maximus)

Ray L. Ball, DVM,¹* Genny Dumonceaux, DVM,¹ John H. Olsen, DVM,¹ Mike S. Burton, VMD,¹ and Konstantin Lyashchenko, PhD²

¹Busch Gardens Tampa Bay, 3605 Bougainvillea Drive, Tampa, FL 33612 USA; ²Chembio Diagnostic Systems, Inc., Medford, NY 11763 USA

Abstract

Introduction

Between 1994 and June 2005, there were 34 confirmed cases of tuberculosis in elephants in the U.S. population. Thirty-one Asian (Elephas maximus) and three African (Loxodonta africana) elephants were affected. Mycobacterium tuberculosis was the etiologic agent in 33 cases and M. bovis in one case. Cases of tuberculosis caused by an unusual nontuberculous mycobacteria, M. szulgai have recently occurred as well.¹ Currently, TB in elephants remains a diagnostic dilemma. The sensitivity of trunk wash culture, the currently recommended test for diagnosis, is unknown. False negatives have been documented (trunk wash negative elephants that were subsequently found to be culture positive at necropsy). Other non-culture techniques for TB diagnosis include ELISA,² and PCR. A novel technology, MultiAntigen Print ImmunoAssay (MAPIA) and lateral-flow technology (Rapid Test)³ has been evaluated and used to diagnose tuberculosis in captive elephants with encouraging results.⁴ One concern with this serologic testing is the possibility of Mycobacterium other than tuberculosis (MOTT) cross-reacting with the antigen used in the Rapid Test or the MAPIA and leading to a false positive. With numerous MOTT routinely cultured from trunk washes, this is a valid concern.

Methods and Materials

A retrospective analysis was done at Busch Gardens Tampa Bay and Chembio, Inc. that matched trunk wash results to serum samples. All serum was collected within 7 days of the trunk wash and analyzed with the Rapid Test and MAPIA. Four Asian elephants with a total of 18 samples met this criteria and had serum submitted for testing.

Results and Discussion

Table 1 lists the results and the organisms cultured. While the sampling is limited in this pilot project, it appears that MOTT does not evoke a response when assayed with the Rapid Test or MAPIA. The recent cases of M. szulgai do demonstrate the potential usefulness for this test when a disease develops from MOTT. The usefulness of this new technology, taken in conjunction with other clinical data including trunk washes when indicated, is a valuable tool in the healthcare of captive elephants.
LITERATURE CITED


Table 1. Trunk wash mycobacterial culture with matched rapid test (RT) and multiantigen print immunoassay (MAPIA) results.

<table>
<thead>
<tr>
<th>Elephant</th>
<th>Serum Date</th>
<th>Trunk wash date</th>
<th>Mycobacterium cultured</th>
<th>RT</th>
<th>MAPIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15-Jul-2004</td>
<td>15-Jul-2001</td>
<td>M. avium complex</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>1-Sep-2001</td>
<td>21-Aug-2001</td>
<td>M. fortuitum</td>
<td>-</td>
<td>-</td>
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<tr>
<td>3</td>
<td>24-Feb-2003</td>
<td>6-Mar-2003</td>
<td>M. abscessus</td>
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<td>-</td>
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<td></td>
<td>20-Oct-2001</td>
<td>23-Oct-2001</td>
<td>M. avium complex</td>
<td>-</td>
<td>-</td>
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<tr>
<td></td>
<td>21-Aug-2001</td>
<td>21-Aug-2001</td>
<td>M. flavescens</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>21-Jun-2001</td>
<td>20-Jun-2001</td>
<td>M. mucogenicum</td>
<td>-</td>
<td>-</td>
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<tr>
<td></td>
<td>9-Apr-2001</td>
<td>9-Apr-2001</td>
<td>M. avium complex</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>5-Apr-2001</td>
<td>9-Apr-2001</td>
<td>M. nonchromogenicum</td>
<td>-</td>
<td>-</td>
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<tr>
<td>4</td>
<td>17-Feb-2003</td>
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<td>-</td>
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<td>17-Feb-2003</td>
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<td>M. intracellulare</td>
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<td>-</td>
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<td>21-Jan-2002</td>
<td>18-Jan-2002</td>
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<td>23-Aug-2001</td>
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<td>27-Jun-2001</td>
<td>20-Jun-2001</td>
<td>M. gordonae</td>
<td>-</td>
<td>-</td>
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<tr>
<td></td>
<td>3-Apr-2001</td>
<td>5-Apr-2001</td>
<td>M. simiae</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
DIET HYPERSENSITIVITY IN CAPTIVE WILDLIFE IN ZOOLOGICAL COLLECTIONS

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Abstract

Dietary hypersensitivity (food allergy) was documented in captive tigers (Panthera tigris tigris) and highly suspected in a case of anterior enteritis in an Asian elephant (Elephas maximus). This diagnosis was reached on the basis of clinical signs, specific IgE antigen food testing in model species, and resolution of signs with the correction of diet. Diet hypersensitivity should be considered as a possible underlying source of inflammation in such species as black rhinoceros, gorillas, pandas, cheetahs, and toucans.

Case 1

A diet trial was initiated in 1.1 Bengal tigers at Busch Gardens Tampa Bay. The tigers were 5 yr-old hand reared siblings, in good general health and chosen due to the relative ease of voluntary blood collections from the tail vein. The current commercial horsemeat diet (Diet A) was substituted with a beef based product (Diet B). In addition to being beef based, flaxseed oil was supplemented in this product. The diets were transitioned from Diet A to Diet B over a 9-day period so that on Day 10 the cats were on 100% of Diet B. Blood was collected prior to initiation of the trial and once the cats were established on the new diet. Acceptance of the new diet was fair but eventually 100% was taken. The weight of the food was kept the same and after 1 mo on the new food the female tiger had gained 10 pounds. This female had several bouts of regurgitation during this month and her coat had become dull and course. The diet was stopped and the tiger was returned to the original Diet A. Two more attempts were made to convert this tiger to Diet B with the same clinical presentation at each attempt. Food allergen testing has also been conducted at a commercial veterinary food allergen testing facility (Bio-Medical Services, P.O. Box 26600, Austin, Texas 78755 USA, www.bmslab.com). The male tiger was then transitioned to Diet B over 9 days. This diet was readily consumed but on Day 4 a considerable amount of vomitus was found from this tiger. This tiger was depressed and not responding to staff normally. The next morning the tiger was brighter and allowed blood collection form the lateral tail vein. Complete blood count and serum biochemistry panel were unremarkable. A food allergen profile was also conducted on this sample and two samples collected prior to the trial. The trial was stopped and Diet A was resumed. The male ate 100% of Diet A for 2 days and returned to normal. A food allergen profile suggested a hypersensitivity to flaxseed in the male and flaxseed and beef in the female (Table 1).
Case 2

A female Asian elephant (*Elephas maximus*), Studbook No. 32, DOB 1973, had a history of intermittent colic with regurgitation. The female also had voluminous, non-formed stools that had been accepted as normal for this individual. During these episodes the elephant typically had a stretched out posture and abducted elbows. Occasionally she would lie down but was not seen to be distended. There seemed to be a strong correlation with bran administration and/or stealing food from others with the onset of these episodes, especially with the most recent ones. Bloodwork typically would demonstrate a pre-renal azotemia. Therapy was symptomatic and consisted of analgesics, fluids, and fasting. A tentative diagnosis of anterior enteritis was made. A retrospective evaluation of food allergen testing was conducted at a commercial veterinary food allergen testing facility (Bio-Medical Services, P.O. Box 26600, Austin, Texas 78755 USA, www.bmslab.com). Three dates with clinical episodes are demonstrated with two dates pulled randomly from the serum bank in which no signs of gastrointestinal distress were noted (Table 2). Table 3 provides food allergen profiles from other female Asian elephants in the same herd. As a result of this testing, wheat bran has been removed from #32’s routine. Consideration should be given to the potential of chronic antigenic stimulation as an underlying etiology in other species.

Discussion

Food allergy is an adverse response to food or a food additive with a proven immunologic basis. A clinical presentation of food allergies in domestic carnivores typically involves the skin or gastrointestinal tract. In cats, specific adverse reactions have been documented to beef, dairy products, and fish. Diagnostic testing relies heavily on dietary elimination trials. Serologic testing is not considered reliable in animals. In the case of the tigers, a clinical response was seen after removal of the diet suspected of causing the clinical problems. Enzyme-linked immunosorbent assay (ELISA) using domestic cats as a model correlated well with the changes seen. The reactivity to flaxseed is noteworthy. Linolenic acid (C18:3 n-3) is required as 1-2% of the caloric intake in domestic cats and dogs. Flaxseed is an added component to Diet B and is reflected in the antigen profiles in both tigers and in the fatty acid profile of the diet analysis (Table 4). Cats appear to have a limited capacity in the production of the higher homologues of linolenic acid and this in fact may be responsible for the poor reproductive performance seen in domestic queens fed high vegetable fats diets. Excessive amounts of plant based omega 3 fatty acids in a strict carnivore may lead to adverse effects, possibly becoming an antigenic source for a reaction. The reaction to beef noted in the female tiger is consistent with what has been documented in domestic cats. Intake of fatty acid by grazing ruminants would be affected by the forage species consumed. This is also shown in Table 4. Antibiotic residues are also more likely to be relayed in domestic beef production versus commercial horse meat production and may provide a source of food allergy or food intolerance. Significant health problems in captive cheetahs have been greatly reduced in captive cats and recently-caught wild cheetahs by feeding venison and range-fed donkey (L. Marker, pers. comm., 2003).

In Case 2, there is a strong correlation to consuming excessive wheat bran and the clinical episodes of anterior enteritis. The food allergen ELISA suggests a hypersensitivity to wheat, a
commercial grain that would be considered novel to a grazing species like Asian elephants. The primary ingredient of the commercial elephant supplement fed is wheat middlings but none of the other animals in this herd have had any apparent issues related to this ingredient (Table 3). Given that this elephant had chronic loose stool for years, further investigation into wheat as a source of the problem is warranted and underway. Pruritis is the typical presentation to food allergens in horses. Wild oats, white clover, and alfalfa have been recognized as antigens in horses. The use of wheat bran as a laxative in captive elephants is common practice. The use of good quality grass hay will eliminate the need for this practice and may avoid any potential problems.

LITERATURE CITED


Table 1. Food allergen profiles of 1.1 Bengal tigers. Diet A samples were collected just prior to the start of the transition. (N=Negative ≤150, BL=Borderline 151-174, BL-P=Borderline-Positive 175-199, P=Positive 200-400, HP=Highly Positive >400).

<table>
<thead>
<tr>
<th></th>
<th>Beef</th>
<th>Flaxseed</th>
<th>Beets</th>
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<tbody>
<tr>
<td>Female</td>
<td></td>
<td></td>
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<tr>
<td>Diet A</td>
<td>172</td>
<td>170</td>
<td>122</td>
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<tr>
<td>Diet B</td>
<td>215</td>
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<td>128</td>
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<tr>
<td>Male</td>
<td></td>
<td></td>
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<tr>
<td>Diet A</td>
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<td>163</td>
<td>141</td>
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<tr>
<td>Diet B</td>
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<td>175</td>
<td>139</td>
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<tr>
<td>Diet B</td>
<td>144</td>
<td>178</td>
<td>149</td>
</tr>
</tbody>
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**Table 2.** Food allergen profile of Asian elephant in Case 2. Italics indicate sample taken during clinical episodes of colic. (N=Negative ≤150, BL=Borderline 151-174, BL-P=Borderline-Positive 175-199, P=Positive 200-400, HP=Highly Positive >400).

<table>
<thead>
<tr>
<th>Sample Date</th>
<th>11/13/95</th>
<th>12/05/05</th>
<th>09/03/96</th>
<th>06/05/04</th>
<th>05/08/05</th>
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<tbody>
<tr>
<td>Barley</td>
<td>161</td>
<td>101</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Soy Beans</td>
<td>132</td>
<td>108</td>
<td>122</td>
<td>133</td>
<td>119</td>
</tr>
<tr>
<td>Corn</td>
<td>148</td>
<td>155</td>
<td>150</td>
<td>116</td>
<td>171</td>
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<tr>
<td><strong>Wheat</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td><strong>207</strong></td>
<td><strong>182</strong></td>
<td><strong>178</strong></td>
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<td>111</td>
<td>144</td>
<td>126</td>
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<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
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<td>108</td>
<td>104</td>
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<td>100</td>
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**Table 3.** Food allergen profiles from November and December 2005 of five female Asian elephants in herd with elephant in Case 2. (N=Negative ≤150, BL=Borderline 151-174, BL-P=Borderline-Positive 175-199, P=Positive 200-400, HP=Highly Positive >400).

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<th>Elephant</th>
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<th>3</th>
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<td>12/05/05</td>
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NUTRITIONAL ANALYSIS OF BROWSE AND COMMON FEED ITEMS WITH AN EMPHASIS ON STARCH CONTENT

Ray L. Ball, DVM* and Celeste Kearney, MS

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Abstract

Introduction

There has been a recent awareness of the presence of soluble complex carbohydrates in animal diets. One particular aspect has been the use of starches in ruminant feeds. Starches have been implicated as a possible underlying factor in numerous medical issues in captive wild ruminants. Consumption of high levels of concentrates with high levels of starches, are a known cause of ruminal acidosis in domestic ruminants, affecting intake, feed digestibility, milk production, hoof health, and overall animal health. An experimental study in cattle was conducted in which starches were infused directly into the duodenum of cattle. Two of the four cattle became acutely ill with one animal needing to be euthanatized. The clinical signs were consistent with anaphylaxis. An experimental feed with less starch than a traditional zoo ruminant ration was shown to allow weight gain and decreased blood levels of non-esterified fatty acids in five of six captive giraffe. An evaluation of common feed items including browse items that included starches was performed. Representative feed items were shipped to a commercial feed lab (Dairy One Forage lab, 730 Warren Road, Ithaca, New York 14850 USA). Tables [CLKB10] 1, 2, and 3 [CLKB11] show the details of this analysis.

Discussion

Complex carbohydrates are not found in abundance in non-agricultural food items, with the exception of seeds, and hence many animals have not evolved appropriate measures for digesting them. As a result, various inflammatory problems may develop. One major manufacturer of zoo animal feeds has already recognized this and has begun integration of low starch feeds into their line of products. A recent workshop on Giraffe nutrition recommended starch levels of less than 5% be fed to giraffe. Starches can be found in many different feeds and the health care team at any zoological collection should be aware of the potential health problems this may cause. Other non-ruminant herbivores may also have the potential to develop health issues related to excessive dietary starches.
LITERATURE CITED


Table 1. Nutritional analysis of browse materials fed at Busch Gardens including starch and sugar analysis.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Hibiscus As Fed</th>
<th>Bamboo As Fed</th>
<th>Spanish Moss As Fed</th>
<th>Mulberry As Fed</th>
<th>Acacia w/ Stems As Fed</th>
<th>False Acacia w/ Stems As Fed</th>
<th>Water Hyacinth As Fed</th>
<th>Romaine As Fed</th>
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<td>Moisture (%)</td>
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<td>75.4</td>
<td>73</td>
<td>53.2</td>
<td>47.8</td>
<td>94.7</td>
<td>92.4</td>
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<tr>
<td>Dry matter (%)</td>
<td>18.7</td>
<td>24.6</td>
<td>27</td>
<td>46.8</td>
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<td>5.3</td>
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<td>15.7</td>
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<tr>
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<td>6.1</td>
<td>0.9</td>
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<td>10.4</td>
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<tr>
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<tr>
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<td>0.6</td>
<td>2.4</td>
<td>4.4</td>
<td>2.5</td>
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<td>3.4</td>
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<td>0.3</td>
<td>0.1</td>
<td>0.3</td>
<td>0.8</td>
<td>0.4</td>
<td>0.8</td>
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<tr>
<td>Sugar (%)</td>
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<td>3.3</td>
<td>6.9</td>
<td>5.2</td>
<td>4.6</td>
<td>4.3</td>
<td>2.8</td>
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<tr>
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<td>6.5</td>
<td>1.9</td>
<td>4</td>
<td>1.3</td>
<td>1.6</td>
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</tr>
<tr>
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<td>56</td>
<td>24</td>
<td>51</td>
<td>14</td>
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<td>0.1</td>
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<td>0.06</td>
<td>0.11</td>
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<td>0.1</td>
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<td>0.07</td>
<td>0.29</td>
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</tr>
<tr>
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<td>0.74</td>
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<td>281</td>
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<td>26</td>
<td>8</td>
<td>34</td>
<td>8</td>
<td>30</td>
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<tr>
<td>Copper (ppm)</td>
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<td>7</td>
<td>14</td>
<td>3</td>
<td>12</td>
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<td>9</td>
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<tr>
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<td>8</td>
<td>18</td>
<td>6</td>
<td>23</td>
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<td>18</td>
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<tr>
<td>Molybdenum (ppm)</td>
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<td>0.6</td>
<td>1.6</td>
<td>3.3</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Sulfur (%)</td>
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<td>0.3</td>
<td>0.1</td>
<td>0.38</td>
<td>0.03</td>
<td>0.12</td>
<td>0.06</td>
<td>0.2</td>
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<tr>
<td>Chloride ion (%)</td>
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<td>0.2</td>
<td>0.53</td>
<td>0.06</td>
<td>0.24</td>
<td>0.11</td>
<td>0.4</td>
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Table 2. Nutritional analysis of commercial feeds fed at Busch Gardens including starch and sugar analysis.

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<tr>
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<th>Leafcater</th>
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<td>As Fed DM</td>
<td>As Fed DM</td>
<td>As Fed DM</td>
<td>As Fed DM</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>9.0</td>
<td>12.0</td>
<td>10.9</td>
<td>8</td>
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<tr>
<td>Dry Matter (%)</td>
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<td>88.0</td>
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<tr>
<td>Crude Protein (%)</td>
<td>15.6</td>
<td>17.1</td>
<td>21.3</td>
<td>24.3</td>
</tr>
<tr>
<td>ADF (%)</td>
<td>26.3</td>
<td>28.9</td>
<td>12.9</td>
<td>14.6</td>
</tr>
<tr>
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<td>42.1</td>
<td>24.6</td>
<td>27.9</td>
</tr>
<tr>
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<td>4.8</td>
<td>4.0</td>
<td>4.6</td>
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<tr>
<td>NFC (%)</td>
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<td>5.6</td>
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</tr>
<tr>
<td>Sugar (%)</td>
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<td>14.2</td>
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<td>8.9</td>
</tr>
<tr>
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</tr>
<tr>
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<td>.93</td>
<td>.83</td>
<td>.94</td>
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<td>.345</td>
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<td>707</td>
<td>611</td>
<td>695</td>
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<tr>
<td>Copper (ppm)</td>
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<td>Manganese (ppm)</td>
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Table 3. Nutritional analysis of hay fed at Busch Gardens including starch and sugar analysis.

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<th>Bermuda</th>
<th>Orchard</th>
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<td></td>
<td>As Fed</td>
<td>DM</td>
<td>As Fed</td>
<td>DM</td>
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<tr>
<td>Moisture (%)</td>
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</tr>
<tr>
<td></td>
<td>8.9</td>
<td>8.6</td>
<td>7.7</td>
<td>8</td>
</tr>
<tr>
<td>Dry matter (%)</td>
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<td>92.4</td>
<td>92</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>14.2</td>
<td>15.5</td>
<td>6.5</td>
<td>7.1</td>
</tr>
<tr>
<td>ADF (%)</td>
<td>33.9</td>
<td>37.2</td>
<td>38.6</td>
<td>42.2</td>
</tr>
<tr>
<td>NDF (%)</td>
<td>44.5</td>
<td>48.8</td>
<td>60.9</td>
<td>66.7</td>
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<tr>
<td>Lignin (%)</td>
<td>8.6</td>
<td>9.5</td>
<td>5.8</td>
<td>6.3</td>
</tr>
<tr>
<td>NFC (%)</td>
<td>25.8</td>
<td>28.3</td>
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<td>22.2</td>
</tr>
<tr>
<td>Starch (%)</td>
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<td>0.9</td>
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<td>11.9</td>
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<tr>
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<td>1.7</td>
</tr>
<tr>
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<td>78</td>
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<td>0.19</td>
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<tr>
<td>Potassium (%)</td>
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<td>0.12</td>
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<td>0.11</td>
</tr>
<tr>
<td>Sodium (%)</td>
<td>2.47</td>
<td>2.71</td>
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<td>Iron (ppm)</td>
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<td>0.069</td>
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<td>0.004</td>
</tr>
<tr>
<td>Zinc (ppm)</td>
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<td>97</td>
<td>80</td>
<td>87</td>
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<tr>
<td>Copper (ppm)</td>
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<td>22</td>
<td>24</td>
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<tr>
<td>Manganese (ppm)</td>
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<td>9</td>
<td>9</td>
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<tr>
<td>Molybdenum (ppm)</td>
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<td>56</td>
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<tr>
<td>Cobalt (ppm)</td>
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<tr>
<td>Chloride ion (%)</td>
<td>0.12</td>
<td>0.13</td>
<td>0.08</td>
<td>0.09</td>
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</tbody>
</table>
MAINTENANCE OF WILD BORN WHITE RHINOCEROS \textit{(Ceratotherium simum simum)} ON FORAGE-ONLY DIETS IN CAPTIVITY

Ray L. Ball, DVM,* Jason Green, Derek Weatherford, and Kristin Forker

Busch Gardens Tampa Bay, 3605 Bougainvillea Drive, Tampa, FL 33612 USA


Abstract

Introduction

White rhinoceros are generally classified as hind-gut grazers. Wild diets typically consist of grasses with some low lying vegetation occasionally taken. In captivity, it is common to supplement commercially available hay with a pelleted concentrate. While generally hardy animals once acclimated to captivity, the lack of reproductive success prompted the staff at Busch Gardens Tampa Bay (BGT) to start investigating the possible role of nutrition in the lack of the F1 generation of white rhinoceros to breed successfully in captivity.

Methods and Materials

In May 2001, 1.2 white rhinoceros estimated at 5 yr of age, arrived at Busch Gardens Tampa Bay (BGT) from the Kruger National Park. After their capture they were held in bomas and adjusted to a diet of local grass hay for 6 mo prior to their arrival in Busch Gardens. Upon arrival to Florida they were housed together in a sand pen and fed a combination of timothy and alfalfa hays. The rhinoceros were trained within a few months for voluntary blood draws from the caudal surface of the ear and to stand on a platform for weights. A 5-day intake study was conducted in March 2003 prior to their relocation to a 15-acre mixed species display. Serum was stored and retrospectively analyzed for vitamin and mineral levels. Routine serum blood chemistries and complete blood cell counts were also examined periodically. Once moved, obtaining weights became routine. Two pregnancies have been confirmed and monitored. Milk was collected but was not analyzed for nutritional content as of this writing. A growth curve for the offspring has been established.

Results

The results of the intake study are summarized in Table 1. The three rhinoceros were treated as one individual and the totals summed per the protocol. Table 2 shows the weights of the adult rhinoceros. The first weight in October 2000 was at capture in Kruger National Park. Figure 1 shows the growth curve of the first calf born to female 61409. This calf averaged approximately...
1.5 kg per day growth during the first year of life. Table 3 shows the most recent vitamin and mineral serum analysis of the four rhinoceros on the forage-only diet.

**Discussion**

Alfalfa hay was limit fed and the rhinoceros always consumed it all. It was fed at the same time and is a preferred item over the timothy hay. The intake of 1.2% should be a good estimate as the rhinoceros still had plenty of palatable hay to consume if they chose. This figure represents a combination of timothy and alfalfa hay intake. Foose reports separate intake for grass hay (1.03%) and alfalfa hay (1.19%). Feeding 100% alfalfa is not advisable and was not looked at in this project. The combination hays fed here led to a similar intake of alfalfa by Foose and avoided the potential complications of feeding alfalfa exclusively to herbivores. The weight gains by the adults appeared reasonable and their overall condition is excellent (M. Hoftmyer, 2006. pers. comm.). The growth curve of the young female calf, 62638, shows a steady weight gain. This provides good evidence that the energy status of the dam was adequate. This female did lose some weight during this lactation period but her condition remained good and she has already conceived again. It can also be inferred that the protein level was adequate in this growing calf.

The only complications encountered so far have involved minerals. Table 3 compares the most recent serum vitamin and mineral analysis to published levels in free-ranging white rhinoceros. The zinc level was low in all animals and especially in 61409, the female with the calf. While lactating, this female developed a depigmentation of the skin on the withers. Biopsy revealed hyperplastic lesions consistent with zinc deficiency in domestic cattle. The zinc level at this time was 0.57 µg/dl with a reference level of 1.39 ± 0.2 µg/dl. Several browse and forages were looked at for zinc content and Spanish moss (*Tillandsia usneoides*) was chosen as a supplement. It is highly palatable and has a high level of zinc. High calcium diets also may lower zinc by competitive binding in the gastrointestinal tract. The amount of alfalfa was reduced to its current level and is now used only for husbandry and medical procedures. The serum zinc level improved as did the skin condition over several weeks. The reduction in calcium intake is believed to have been more useful as the supply of Spanish moss was exhausted soon. Other vitamin and minerals were within the range reported in wild rhinoceros with the exception of the iron in the calf 62638. The iron level at 12 mo of age was 1.59 µg/dl, well within the reference range. At 16 mo of age it had dropped to 0.89 µg/dl. This calf has no other health problems at this point but this aspect will be closely followed on the premise that this drop in iron is due to weaning.

With the notable exception of zinc, it appears that white rhinoceros can be successfully maintained and propagate on a forage-only diet. If this trend holds true it is hoped the F1 generation produced will be fed the same way. The addition of concentrates and commercial feed stuffs may be affecting reproduction possibly as an antigenic source and will be investigated. Close attention should be paid to all nutrients when conducting such trials. The emphasis on operant conditioning can not be underestimated in this trail.
LITERATURE CITED


Table 1. Five-day intake study of one male and two female white rhinoceros at Busch Gardens Tampa Bay. All weights are in pounds.

<table>
<thead>
<tr>
<th>Study Day</th>
<th>Feed</th>
<th>Fed</th>
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<th>Consumed</th>
<th>Total Hay Consumption</th>
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<td>130</td>
</tr>
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<tr>
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<td>50</td>
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<tr>
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<td>15</td>
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<td>120</td>
</tr>
<tr>
<td>4</td>
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<td>Timothy</td>
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<td>65</td>
<td>120</td>
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<tr>
<td></td>
<td>Alfalfa</td>
<td>55</td>
<td>0</td>
<td>55</td>
<td>120</td>
</tr>
</tbody>
</table>

Average Timothy Intake: 72
Average Daily Alfalfa Offered: 54
Average Daily Hay Consumption: 126
Total Body Weight: 10487
Hay Intake %BW/day: 1.2

Table 2. Weights (kg) of three adult white rhinoceros managed on forage-only diets at Busch Gardens Tampa Bay.

<table>
<thead>
<tr>
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<th>Animal ID 61408</th>
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<td>1160</td>
<td>1150</td>
</tr>
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Table 3. Representative vitamin and mineral profile of white rhinoceros at Busch Gardens Tampa Bay on forage diets.

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<th>62638</th>
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<td>31</td>
<td>25</td>
<td>23</td>
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<tr>
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<td>0.42</td>
<td>0.25</td>
<td>0.66</td>
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<tr>
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<td>70.51</td>
<td>88.14</td>
<td>58.98</td>
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<td>Calcium µg/ml</td>
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<td>112</td>
<td>105.6±15.5</td>
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<tr>
<td>Copper µg/ml</td>
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<td>Iron µg/ml</td>
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<td>Magnesium µg/ml</td>
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<td>26.1</td>
<td>22.8</td>
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<td>Phosphorus µg/ml</td>
<td>37</td>
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<td>29</td>
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<td>Zinc µg/ml</td>
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<td>0.7</td>
<td>0.81</td>
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Figure 1. Growth curve of female calf, 62638. Date of Birth: 12 October 2004.
FRONTAL SINUSITIS AND EPISTAXIS IN CAPTIVE BLACK RHINOCEROS (*Diceros bicornis*)

**Ray L. Ball, DVM,** *Mike S. Burton, VMD, Genny Dumonceaux, DVM, and John H. Olsen, DVM*

**Busch Gardens Tampa Bay, 3605 Bougainvillea Drive, Tampa, FL 33612 USA**

**Abstract**

Epistaxis in captive black rhinoceros is a common event with 20% of captive black rhinoceros in North America reported to have experienced this syndrome. Attempts to find the source can be frustrating, but if found are potentially amenable to cryosurgery. A 15-yr-old male black rhinoceros had several episodes of the clinical entities (weight loss, anemia, lameness, elevated fibrinogen, and elevated ferritin.) noted in black rhinoceros for several years. Clinical resolution was achieved with the use of 200 mg warfarin p.o. s.i.d for months and all parameters improved with the appetite and lameness returning to normal. Epistaxis developed and the warfarin was discontinued but with the clinical signs all returning. Several courses of warfarin were re-instituted but each attempt resulted in severe epistaxis even with clinical improvement. Standing radiographs of the sinuses was unproductive in identifying isolating the source of the epistaxis. The rhinoceros was euthanatized and upon necropsy, the frontal sinus was explored. Bony hyperplasia and a growth of *Aspergillus* sp. was documented. The remaining nasal passage was normal. This lesion was unreachable with a flexible endoscope and would have gone undetected had that diagnostic approach been used. Aspergillus has been well documented in captive black rhinoceros. Lesions have only been described in the lungs and trachea; it is uncertain if sinuses, particularly the frontal sinus was examined. Warfarin was a useful adjunct in the clinical management of this case and was chosen because it is believed that micro-emboli have a role in many of the clinical signs seen in captive black rhinoceros. The resolution of the lameness, presumably due to laminitis as seen in other black rhinoceros, supports this notion. Based on the lowering of the fibrinogen and ferritin, warfarin appears to be acting as an anti-inflammatory as well. Computed tomography of this skull has provided a basis for an ongoing retrospective evaluation of rhinoceros with epistaxis without a known source.

**LITERATURE CITED**

HYPERSENSITIVITY TO CAPTIVE DIETS AS A POSSIBLE UNDERLYING ETIOLOGY FOR CLINICAL SIGNS AND PATHOLOGY IN CAPTIVE BLACK RHINOCEROS (Diceros bicornis)

Ray L. Ball, DVM,* Mike S. Burton, VMD, Genny Dumonceaux, DVM, and John H. Olsen, DVM

Busch Gardens Tampa Bay, 3605 Bougainvillea Drive, Tampa, FL 33612 USA


Abstract

Black rhinoceros in captivity have been plagued by a host of clinical entities. These include superficial necrolytic dermatitis (SND), hemosiderosis, hemolytic and, non-hemolytic, anemia, and recently the idiopathic hemorrhagic vasculopathy syndrome (IHVS) has been described in a group of black rhinoceros. Secondary infections are also noteworthy and include salmonellosis, leptospirosis, tuberculosis, and aspergillosis. Information collected over the last several years have led to a theory that would potentially unite the pathologies and clinical conditions seen in captive black rhinoceros. A nutritional basis has long been suspected and the focus has tended to be on specific nutrients like iron or fatty acids. Another possibility is that captive diets may be an antigenic source and initiate a cascade of events that may lead to the pathologies and clinical conditions encountered in captive black rhinoceros.

Figure 1 summarizes the proposed pathophysiology with dietary hypersensitivity as the inciting cause for health issues seen in captive black rhinoceros. Differences exist in the level of inflammation between captive and wild black rhinoceros as evidenced with ferritin levels. The differences between wild rhinoceros and captive rhinoceros in regards to ferritin are well documented. While ferritin is used as a marker for tissue storage of iron, it is an acute phase inflammatory protein as well. Ferritin levels increase over time spent in captivity. This has been assumed to be to constant iron loading but a persistent inflammatory process could result in the same ferritin changes. A diet trial at Busch Gardens Tampa Bay (BGT) was undertaken in three adult male black rhinoceros (Diceros bicornis michaeli)(Studbook Nos. 518, 12-yr-old; 0786, 5-yr-old; 0864, 4-yr-old) in which a commercial browser pellet was substituted with a low starch, high physical effective fiber diet designed for giraffe. Basic hematology, serum chemistries, serum ferritin, and immune profiles were collected. Serum ferritin levels were checked (Kansas State Veterinary Diagnostic Laboratory, 1800 Dennison Avenue, D-117, Manhattan, Kansas 66506-5601 USA) at the beginning and ending of the trial and are listed in Table 2. The iron content of the new diet averages around 400 ppm but varies slightly between lots. The browser pellets contained was 370 ppm iron. Ferritin does spike with any inflammatory process, including immobilizations. On one occasion, rhinoceros 518 was immobilized for electroejaculation. Serum ferritin on that procedure was 5466 ng/ml. One week later it returned to “baseline” of
2443ng/ml. Lymphocyte proliferation\(^8\) was evaluated at Mote Marine Laboratory, (1600 Ken Thompson Parkway, Sarasota, Florida 34236 USA) at the beginning and end of the trial.\(^8\) Concanavalin A (Con A) and phytohemagglutinin (PHA) were used as mitogens to stimulate lymphocyte proliferation. Immune response was slightly less at the end of the 5-mo time period. The difference may not be statistically significant but the clinical significance may be real given other inflammatory mediators had been reduced. Antiphospholipid antibodies (APhL) have not been evaluated as of this writing. A reduction in serum ferritin in spite of a higher iron diet suggests something other than iron intake is taking place here and a change in inflammation is suspected. Antiphospholipid antibodies (APhL) have been examined in captive and wild black rhinoceros, as well.\(^1\) Wild black rhinoceros have lower levels of these antibodies compared to captive ones. A rising level can be seen when young captive rhinoceros are weaned onto solid foods.\(^1\) This rise in APhL parallels that seen in ferritin. APhL are commonly seen in inflammatory processes in people. It is believed that in black rhinoceros they are reflective of an increased inflammatory stimulus in captivity. Given the various conditions wild rhinoceros are often in regards to parasites and wounds, a reasonable deduction would be the diet in captivity could be inciting the inflammation.

Support for a dietary source of gastrointestinal inflammation also comes from recent field work. Eleven black rhinoceros were recently translocated from Hluhule-Imfolozi Wildlife Park in South Africa. At capture all rhinoceros had fecals collected for various projects. Fecal hemacult were analyzed using a commercial kit (Hemacult\(^\text{®}\), Beckman Coulter, Inc., 4300 N. Harbor Blvd., Fullerton, California 92834-3100 USA) animal side for the presence of fecal occult blood. All eleven samples were negative. Fecal hemacult test are always positive in all species of rhinoceros at BGT. This test is not considered reliable in horses as the hindgut can readily degrade large amounts of hemoglobin, hence masking gastric bleeding.\(^5\) While negative results can possibly be false negatives, a false positive seems very unlikely and suggest some bleeding in the gastrointestinal tract. Tannins or other porporyin containing substances that could potentially interfere with this assay seem much more likely to occur in wild rhinoceros consuming natural browse material. A recent epidemiologic project looking at the health issues in captive black rhinoceros listed diarrhea as the most common problem seen.\(^2\) Food allergen testing has also been conducted at a commercial veterinary food allergen testing facility (Bio-Medical Services, P.O. Box 26600, Austin, Texas 78755 USA, www.bmslab.com) on captive black rhinoceros at BGT and five wild black rhinoceros from Zimbabwe. There is a fair amount of variability in the profiles between food items in the captive rhinoceros but corn and wheat are consistently reacting as antigens on the assay. A young captive born rhinoceros (61115) showed an increase in the level of reactivity to several items over time with a large increase occurring after weaning. Most interesting is the large differences between the wild rhinoceros (Zim 1-5) and the captive rhinoceros. Persistence of these two inflammatory proteins, ferritin and APhL, may lead to problems directly. Antiphospholipid can cause microthromi and mimic problems seen in captive black rhinoceros.\(^1\) The problems with hemosiderosis are well documented in black rhinoceros.\(^6\)
ACKNOWLEDGMENTS

We would like to thank the Cathy Walsh at Mote Marine, Drs. Dave Cooper, Markus Hofmeyer, and Peter Buss in South Africa, Mary Port and Heather Henry at the Veterinary Hospital at BGT, and Jason Green, Kristin Forker, and Derek Weatherford and the entire rhinoceros crew at BGT.

LITERATURE CITED


Table 1. Food item hypersensitivity profiles on wild and captive black rhinoceros. (N=Negative ≤150, BL=Borderline 151-174, BL-P=Borderline-Positive 175-199, P=Positive 200-400, HP=Highly Positive >400). Dates from wild rhinoceros are approximates.

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Table 2. Beginning and ending serum ferritin (ng/ml) from diet trial on three adult male captive black rhinoceros.

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Figure 1. Proposed pathophysiology involving dietary hypersensitivity and gastrointestinal inflammation for the clinical and pathologic conditions in captive black rhinoceros.
COMPARISON OF ANTI-PHOSPHOLIPID ANTIBODIES BETWEEN WILD AND CAPTIVE BLACK RHINOCEROS (Diceros bicornis): IMPLICATIONS FOR HEALTH AND REPATRIATION

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1Busch Gardens Tampa Bay, 3605 Bougainvillea Drive, Tampa, FL 33674 USA; 2Warren Magnuson Clinical Center, National Institutes of Health, Bethesda, MD, 20892 USA; 3Veterinary Wildlife Services Kruger National Park Private Bag X402, Skukuza, 1350, South Africa; 4KZN Wildlife Veterinarian, Private Bag X01, St Lucia 3936 South Africa

Abstract

The antiphospholipid syndrome (APS) is defined as the occurrence of venous and arterial thrombosis, recurrent fetal losses, in the presence of the phospholipid antibodies (aPhL).5 This is a broad definition in a syndrome that can affect virtually any body system. Deep venous thromboses (DVT) and pulmonary embolism (PE) are among the most common clinical presentations of APS. The aPhL proteins result in anti-coagulant activity but actually cause a hypercoaguable state in vivo. The pathogenesis of APS is quite simply thrombosis regardless of the organ system involved.1,5 Black rhinoceros in captivity have been plagued by a host of clinical entities. These include superficial necrolytic dermatitis (SND),8 hemosiderosis,4,9 hemolytic,3,6,12 non-hemolytic,9,10 anemia and recently the idiopathic hemorrhagic vasculopathy syndrome (IHVS) has been described in a group of black rhinoceros.10 Comparisons between APS and black rhinoceros syndromes may not be obvious at first but there may be some parallels.2 Again the underlying pathogenesis for all the conditions may be thromboembolic events.

Methods

A black rhinoceros-specific IgG-aPL ELISA has been developed and validated under the direction of Dr. Sylvia Pierangeli at the Moorehouse School of Medicine in Atlanta. A standard human assay (APhL® ELISA Kit, Louisville APL Diagnostics, Inc., 3988 Flowers Rd. Ste. 620, Doraville, Georgia 30360 USA) was modified by substituting purified polyclonal black rhinoceros Ig-G for the human Ig-G conjugate. A standard ELISA reader was then utilized at a wavelength of 405 nm to measure the optical density (O.D.) of the wells. Controls were established by pooling the strongest reactors as the positive control and pooling the lowest reactors as the negative control. Readings of greater than 0.6 were considered to have a significant level of aPhL antibodies and considered positive. The assay was species specific and did not react with domestic horses or white rhinoceros serum.

Sera from wild black rhinoceros were collected during routine translocations in the Kruger National Park and from other South Africa National Parks (SAND). Eleven of the wild rhinoceros were captured in the Hluhluwe-Imfolozi Wildlife Park. Sera were stored in a -20C
Results and Discussion

To date 19/31 captive animals have tested positive. All 19 animals have some of the clinical signs associated with medical conditions in black rhinoceros. Of the 11 negative animals, 8 did not have any clinical signs. Several animals had increased titers with length of time in captivity. The age of positive animals ranged from 3 mo to adult. Three tendencies where noted in the captive samples: positives with O.D. above the cutoff of 0.6, animals with moderate levels of between 0.4 and 0.6 O.D., and those below 0.4 O.D. The majority of captive animals fell in the high or low ends. Wild caught rhinoceros have developed many of the problems as well once brought into captivity and demonstrated rising levels of aPhL antibodies as well. All 32 wild black rhinoceros tested at the Veterinary Science Services facility in the Kruger National Park had negative titers. The majority of these animals interestingly had levels in the middle range of 0.4-0.6 O.D.

Antiphospholipid antibodies are also elevated in generalized inflammatory conditions. Comparing the two populations of black rhinoceros, it is apparent that there is some inflammatory process that triggers an exaggerated response to APS antibodies in captive black rhinoceros. The wild rhinoceros all exhibited some clinical manifestations of inflammation (tick loads, wounds, and keratitis) but still had negative APS titers. This inflammation is believed to be reflected in the middle range of O.D. seen in the wild rhinoceros. An obvious difference between the two populations is the diet. It is not believed that captive black rhinoceros have primary antiphospholipid syndrome, rather the increase in antibodies to APS serves as an indicator of a generalized inflammatory state that does not exist in the wild state. This generalized inflammatory state may be contributory to a depleted immune system, thus allowing infection with opportunistic infections. This chronic generalized inflammatory state may also contribute to other conditions such as hemosiderosis. Future work at Busch Gardens Tampa Bay will focus on evaluating diet hypersensitivity and the physical form of the diet as the inciting causes. Planned evaluations include food allergy profiles during feeding trials with a browser diet consisting of a low starch and high physically effective fiber.

ACKNOWLEDGMENTS

We would like to thank all the participating facilities, Dr. Sylvia Pierangelli at Moerhouse School of Medicine and Jenny Joubert at the Veterinary Services laboratory at the Kruger National Park.

LITERATURE CITED

CHEMICAL IMMOBILIZATION OF BLUE WILDEBEAST (Connochaetes taurinus) WITH ETORPHINE-XYLAZINE OR FENTANIL-AZAPERONE-XYLAZINE

Mads Bertelsen, DVM, DVSc,¹* Torsten Møller, DVM,² and Bengt Röken, DVM, Dr.h.c.²

¹Center for Zoo and Wild Animal Health, Copenhagen Zoo, Roskildevej 38, DK-2000, Denmark; ²Kolmården Zoo, SE-618 92, Kolmården, Sweden

Abstract

Eight blue wildebeast (Connochaetes taurinus) were immobilized using a combination of either 0.006 mg/kg etorphine and 0.25 mg/kg xylazine or 0.055 mg/kg fentanyl, 0.2 mg/kg azaparone, and 0.2 mg/kg xylazine, delivered i.m. using a remote injection system. Animals (n=8) were immobilized twice in a random cross-over design. Induction and recovery times, heart rate, respiratory rate, rectal temperature, oxygen saturation, end-tidal CO₂ (ETCO₂), anesthetic depth, indirect blood pressure, and arterial blood gases were recorded. Wildebeast were not intubated and no supplementary oxygen was administered. Fifty minutes after induction, anesthesia was antagonized with naltrexone and atipamezole. Mean oxygen saturation was consistent with hypoxia in both the fentanyl group and the etorphine group. In both groups, but most pronounced in the fentanyl-azaparone-xylazine group, there was a gradual improvement in arterial oxygenation followed an initial depression. In both groups arterial pH decreased and partial pressure of carbon dioxide increased during anesthesia. These findings were consistent with respiratory acidosis and decreased ventilation. Values for respiratory rate, temperature, oxygen saturation, ETCO₂, blood gases, and blood pressure were similar for both groups at all time periods. In conclusion, both 0.006 mg/kg etorphine with 0.25 mg/kg xylazine and 0.055 mg/kg fentanyl with 0.2 mg/kg azaparone and 0.2 mg/kg xylazine provide reliable, light anesthesia in wildebeast. Ventilatory performance was compromised with both protocols and oxygen should be administered.

ACKNOWLEDGMENTS

The authors thank Karin Magnusson for excellent technical assistance.
OBSERVATIONS FROM A MIXED SPECIES DISPLAY OF EXOTIC HOOFSTOCK
AT BUSCH GARDENS TAMPA WITH Mycobacterium avium ss. paratuberculosis

Mike S. Burton, VMD,* Ray L. Ball, DVM, Genny Dumonceaux, DVM, and John H. Olsen, DVM

Busch Gardens Tampa Bay, 3605 Bougainvillea Drive, Tampa, FL 33612 USA

Abstract

Introduction

A 10-yr (1992-2003) retrospective analysis of Mycobacterium avium ss. paratuberculosis (MAP) on a 15-acre mixed species display at Busch Gardens Tampa Bay (BGT) was conducted. Nyala (Tragelaphus angasii), impala (Aepyceros melampus) and Thomson’s gazelle (Gazella thomsonii) all commingled on this display for many years until the herds were removed in 2002 for renovations and as a medical management tool to help control MAP.

Methods and Materials

Records were reviewed to estimate the running totals of herd numbers on the display from 1992 to 2003. As some records are incomplete, these are best estimates but should be fairly accurate. Fecals were collected routinely from these herds and submitted for culture to the Johne’s testing center at the School of Veterinary Medicine at the University of Wisconsin. In addition fresh and/or frozen tissues from necropsies were submitted for culture. Positive cultures are reported out as Mycobacterium spp. and the species confirmed by PCR probe. Acid fast stains were routinely performed on the following tissues: lymph nodes (submandibular, mesenteric and ileocecal junction), ileocecal valve, small intestine and large intestine. Blood was collected from 12 Thomson’s gazelles and submitted to evaluate IFN-gamma production by blood mononuclear cells in response to stimulation with mycobacterial antigens.

Results

Table 1 details the prevalence of animals MAP culture positive from the common display from 1992-2003. The youngest age for a positive fecal culture for each species was a Thomson’s gazelle at 19 mo, a nyala at 20 mo, and an impala at 23 mo. In one subset of 15 nyala that were culture positive on fecals, only six had positive cultures from tissues and none of them were positive by direct fecal PCR only. The most common place to find acid-fast organisms was in the lymph nodes, followed by small intestinal sections then large intestines and finally the ileocecal valve. In the same subset of 15 fecal culture positive nyala, 13 had acid fast organisms in lymph node tissue, 7 had acid fast organisms in small intestine, 2 in large intestines and 2 in the ileocecal valve. In a subset of 13 impala, seven were positive on both fecal and tissue culture, five animals were positive on tissue culture but negative on fecal culture and one was positive on fecal culture but negative on tissue culture. The results of the IFN-gamma testing indicated that...
the antibodies for cattle IFN-gamma do not detect gazelle IFN-gamma. (Ray Waters, DVM, PhD personal communication).

Discussion

Higher prevalence was found in impala and nyala than in Thomson’s gazelle even though all three species inhabited this display at the same time. Nyala are primarily browsers, Thomson’s gazelle are primarily grazers and impala are intermediate. As grazers Thomson gazelle seem more likely to ingest the MAP organisms. Thomson gazelle may have an inherent resistance to infection to MAP and that could be due to more exposure to the MAP organism. Nutrition could play a role in the difference in prevalence/incidence from one species to the other. A pelleted diet and forage were provided to all species in addition to pasture but there may have been a difference in what was selected by each species and how diets met requirements for the species. The smaller species, Thomson’s gazelle, was often excluded from feeding at communal troughs. Examples of socially dominant animals having nutritional deficiencies are not unheard of in captive settings. The impala and nyala were also noted to have hypocalcemia issues on a herd basis whereas the Thomson’s gazelle did not. This may have been from an imbalance in the concentrate to roughage ratio consumed by the two more dominant species. Animals with lowered calcium diets are at an increased risk of contracting MAP.¹ In the subset of 15 nyala histopathology was actually more sensitive at finding the organism than tissue culture. Table 2 demonstrates the relative risk (odds ratio) of developing Johne’s disease in reference to the species with the lowest incidence. Impala are approximately four times as likely to develop Johne’s disease given the same exposure while nyala are approximately five times as likely to, compared to Thomson gazelles. Continued investigation into a species-specific quantitative PCR for incorporation into a Johne’s-specific diagnostic is ongoing. The role of hypocalcemia in predisposing ruminants to Johne’s disease is also being looked at in the broader scope of overall ruminant health and nutrition.

LITERATURE CITED

Table 1. Prevalence of culture positive animals (fecal and tissue) 1992-2003.

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<th>Species</th>
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</tr>
<tr>
<td>Impala</td>
<td>95</td>
<td>32</td>
<td>33.7%</td>
</tr>
<tr>
<td>Thomson’s gazelle</td>
<td>106</td>
<td>12</td>
<td>11.3%</td>
</tr>
</tbody>
</table>

Table 2. Relative risk of having MAP culture positive sample between the three species on a common pasture at Busch Gardens Tampa Bay.

<table>
<thead>
<tr>
<th>Species</th>
<th>J Pos</th>
<th>J Neg</th>
<th>Odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impala</td>
<td>32</td>
<td>63</td>
<td>95</td>
</tr>
<tr>
<td>Thomson</td>
<td>12</td>
<td>94</td>
<td>106</td>
</tr>
<tr>
<td>Nyala</td>
<td>29</td>
<td>47</td>
<td>76</td>
</tr>
<tr>
<td>Thomson</td>
<td>12</td>
<td>94</td>
<td>106</td>
</tr>
<tr>
<td>Odds ratio</td>
<td>3.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NON-CHEMICAL RESTRAINT OF LOWLAND ANOA (*Bubalus depressicornis*) USING A CALF CHUTE SYSTEM

*Jason Chatfield, DVM*

*Peace River Center for Conservation, 4300 SW CR 769, Arcadia, TX 34269 USA*

Abstract

Lowland anoa (*Bubalus depressicornis*) are a small bovine species native to the island of Sulawesi. Anoa are small in comparison to their relatives the water buffalo, with a height of ~85 cm, body length ~180 cm$^1$ and weight of up to 300 kg.$^2$ Historically, chemical immobilization has been the method of choice for restraint of these small animals because of their size, strength and aggressive tendencies. Physical restraint has been all but impossible with healthy animals. By adapting a system employed by cattlemen for working domestic calves, veterinarians can perform routine exams and medical procedures without chemical immobilization.

At Peace River Center for Conservation (PRCC), 25 anoa were worked through a standard squeeze chute. Adult anoa housed at PRCC average 76 cm in height, 176 cm in length and weigh an average of 100 kg. The animals’ diminutive size necessitated some minor modifications of the procedure used for working domestic cattle. Anoa have horns that are angled awkwardly and can present a problem when the animal is restrained in the chute, thus, it is best that when the animal’s head is released, someone is there to catch the horns and hold the head still. Once the chute is “squeezed down” and the head caught, the animal is effectively and safely restrained for routine procedures. The majority of the animals worked through the chute were healthy and receiving annual exams which included vaccinations, blood collection and physical exams. Trans-rectal ultrasound was performed on several females to determine pregnancy status and progress. Lameness evaluation was also performed and included radiographs and hoof trims. Twice daily or three times daily treatments can be performed safely using the chute, whereas multiple chemical immobilizations in a 24-hr period would be unsafe. All procedures were accomplished with no injuries to staff or animals.

Lowland anoa are extremely endangered with less than 2500 (IUCN 2000) left in the wild. It is imperative that routine preventive health procedures and examinations be performed on captive animals without undue stress and risk to the animal. Chemical immobilization carries an inherent risk. By developing methods for manipulating the animals without the need for chemical restraint, husbandry and overall care for the animals is improved.

LITERATURE CITED

RESOLUTION OF A PITUITARY ADENOMA IN A WESTERN LOWLAND GORILLA
(Gorilla gorilla gorilla)

Jenifer Chatfield, DVM

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Abstract

Introduction

Pituitary adenomas are one of the most common causes of infertility in women. Because of the pituitary gland’s role in the regulation of prolactin secretion, a secretory adenoma (prolactinoma) adversely affects endometrial binding proteins and can result in chronic infertility or low fertility. These tumors can be clinically silent until becoming a space-occupying problem with impingement on the optic chiasm resulting in clinical blindness. Thus, the majority may go undiagnosed due to insignificant clinical symptoms. Treatment of pituitary microadenomas in women is performed medically with bromocriptine or cabergoline.

Case Report

A 17-yr-old primiparous western lowland gorilla was diagnosed with hyperprolactinemia following multiple failed embryo transfers. Serum prolactin was 302 ng/ml (normal range 1.9-25 ng/ml). An MRI was performed and revealed a pituitary microadenoma involving the pituitary stalk as well as the pituitary body. Treatment was initiated with cabergoline (Dostinex, Pfizer Inc., New York USA) p.o. twice weekly. A recheck of the serum prolactin at 3 mo still showed elevated levels, so the dose was increased. After 6 mo of therapy, a repeat MRI was performed and the tumor was notably smaller. Serum prolactin at this time was within normal limits and treatment was discontinued. Subsequently, the animal was seen breeding regularly and had a positive pregnancy test 6 mo later.

Conclusion

Hyperprolactinemia in women can be caused by physiologic disorders, medications, pituitary disorders, or hypothyroidism. In this case, hypothyroidism was ruled out based on normal TSH (3.16 ng/ml, ref. 0.4-4.0 ng/ml) in conjunction with elevated serum prolactin. Medical treatment for microadenomas is generally successful after 6-12 mo. In this case the animal was treated for 8 mo and a repeat MRI and serum prolactin indicated that the tumor had resolved. The subsequent pregnancy confirmed successful treatment.
ECTOPARASITIC AGENTS OF Desmodus rotundus (CHIROPTERA: PHYLLOSTOMIDAE) IN COSTA RICA

Andrés Rojas Chaves, DVM

School of Veterinary Medicine, the National University of Costa Rica, Heredia, Costa Rica

Abstract

There have only been a few studies concerning the ectoparasitic fauna of bats in Costa Rica, and for many years parasitologic studies of vampire bats have been almost non-existent. A descriptive study was carried out to determine the ectoparasitic fauna of the vampire bat Desmodus rotundus from 12 locations in Costa Rica and 8 ecologic life zones between 0 to 866 meters above sea level. A total of 420 ectoparasites were collected, of which 82.12% corresponded to the diptera species Trichobius parasiticus and 4.05% to the diptera species Strebla wiedemannii; 13.57% of the ectoparasites were represented by the Macronyssid mite species Radfordiella desmodi, and the Spinturnicid mite species Periglischrus herrerai, represented 0.24% (Table 1).

The bats were caught monthly over the course of 1 yr, using mist nets. In addition, the ecologic geography of the obtained ectoparasites was described using Geographical Information Systems. The study showed new geographic ranges for the Streblids batflies Trichobius parasiticus and Strebla wiedemannii. The presence of the Macronyssid mite Radfordiella desmodi and the Spinturnicid mite Periglischrus herrerai was reported for the first time in Costa Rica.

The greatest percentage of bat infestation was done by T. parasiticus (91.04%) and R. desmodi (19.40%) with an infestation intensity of 5.65 and 4.38 respectively per bat (Tables 2 and 3). T. parasiticus seemed to be the most frequent species found infesting vampire bats in their natural habitat and at the same time it appeared to be the ectoparasite with the largest geographic and ecologic distribution in Costa Rica, being found in eleven of the twelve locations and in all the life zones studied in this research. Similar results have been reported in other Latin American countries.

Maps were created to display the geographic location where each bat was caught. These maps showed that factors such as humidity, altitude, and average environmental temperature most likely influenced the ecologic distribution of the ectoparasitic species found.

ACKNOWLEDGMENTS

The author thanks the individuals that have provided samples and assistance with this research, including Mario Vargas, Manuel Zumbado, Marco Herrero, Virtor Hugo Sancho and Luis Villalobos.

LITERATURE CITED


Table 1. Ectoparasites obtained from *D. rotundus*.

<table>
<thead>
<tr>
<th>Ectoparasite</th>
<th>Number of males</th>
<th>Number of females</th>
<th>TOTAL</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diptera</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trichobius parasiticus</em></td>
<td>197</td>
<td>148</td>
<td>345</td>
<td>82.14</td>
</tr>
<tr>
<td><em>Strebla wiedemannii</em></td>
<td>9</td>
<td>8</td>
<td>17</td>
<td>4.05</td>
</tr>
<tr>
<td>Acarina</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Radfordiella desmodi</em></td>
<td>3</td>
<td>54</td>
<td>57</td>
<td>13.57</td>
</tr>
<tr>
<td><em>Periglischrus herrerai</em></td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.24</td>
</tr>
<tr>
<td>TOTAL</td>
<td>209</td>
<td>210</td>
<td>420</td>
<td>100</td>
</tr>
</tbody>
</table>

*aProtonymph of *P. desmodi*.*

Table 2. Infestation percentages of the species found.

<table>
<thead>
<tr>
<th>Ectoparasite</th>
<th>Number of bats</th>
<th>Infestation Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Trichobius parasiticus</em></td>
<td>61</td>
<td>91.04</td>
</tr>
<tr>
<td><em>Strebla wiedemannii</em></td>
<td>8</td>
<td>11.94</td>
</tr>
<tr>
<td><em>Radfordiella desmodi</em></td>
<td>19</td>
<td>19.40</td>
</tr>
<tr>
<td><em>Periglischrus herrerai</em></td>
<td>1</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Table 3. Infestation intensity averages of the ectoparasites found.

<table>
<thead>
<tr>
<th>Species of ectoparasite</th>
<th>Number of bats infested</th>
<th>Infestation intensity (Average)</th>
<th>Range of infestation</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Trichobius parasiticus</em></td>
<td>61</td>
<td>5.65 ± 6.1</td>
<td>0.00-11.75</td>
</tr>
<tr>
<td><em>Strebla wiedemannii</em></td>
<td>8</td>
<td>2.12 ± 0.76</td>
<td>1.36-2.88</td>
</tr>
<tr>
<td><em>Radfordiella desmodi</em></td>
<td>13</td>
<td>4.38 ± 1.73</td>
<td>2.65-6.11</td>
</tr>
<tr>
<td><em>Periglischrus herrerai</em></td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*aNot calculated as it was only one specimen.*
FIRST REPORT OF THELAZIOSIS (Thelazia anolabiata) IN A COCK OF THE ROCK (Rupicola peruviana)

Roberto Elias, DVM,1* Javier Mamani, DVM,1 Catalina Hermoza, DVM,2 and Mike Kinsella, PhD3

1Facultad de Veterinaria y Zootecnia, Universidad Peruana Cayetano Heredia, Av. Honorio Delgado 430, Lima 12, Peru; 2Parque Zoologico Huachipa, Lima, Peru; 3Department of Pathobiology, College of Veterinary Medicine, University of Florida, PO Box 110880, Gainesville, FL 32611 USA

Abstract

An adult male (235 g) cock of the rock (Rupicola peruviana) was found on the floor of its exhibit at a zoo in Lima, Peru. The bird was depressed, with the right eye closed, and was easily captured. On physical exam, the right eye exhibited blepharospasms, hiphema, and conjunctivitis. The eye was cleaned with a saline solution, and two nematodes, approximately 1 cm in length, were found on the surface of the cornea. They were collected and stored in 70% alcohol. A corneal ulcer was diagnosed near the medial canthus with the help of fluorescein (Fluoresceina®, Laboratorio Love Sudamericana) drops. The bird was treated with one dose of ivermectin (Biomisil 0.1%, Biomont, 0.2 mg/kg i.m), topical ciprofloxacin (Ciprolin®, Abeeef Bristol Myers Squibb, ophthalmic unguent) and an epithelium regenerator (Solcoceril®, Solco, ophthalmic gel) for 10 wk. Four weeks later, the bird had gained weight (255 g) and the cornea showed a scar.

The two nematodes were clarified in lactophenol for evaluation and measurement, and were identified as members of the genus Thelazia, one of two genera of nematodes reported in the conjunctive mucosa of birds, the other being Oxyspirura. The primary characteristics used to differentiate the species of Thelazia are the lengths of spicules and other morphologic characteristics such as the number of pre- and post-anal papillae, and the first annulations on the anterior part of the body. The spicules were 1770 microns long and there were eight pairs of pre-anal papillae. The first annulations were observed 45 microns posterior to the buccal capsule, all of these being characteristics of T. anolabiata. The specimens were deposited in the U.S. National Parasite Collection at Beltsville, Maryland with the accession number 096991. There is some controversy about the classification of this nematode as a possible synonym of T. digitata. By rDNA, the species T. gulosa, T. rhodesi y T. skrjabini were differentiated, proposing this as a new tool for epidemiologic studies and taxonomic classification.3 This is apparently the first record of the cock of the rocks as a definitive host of T. anolabiata, and the first clinical description of thelaziosis in this host.

LITERATURE CITED


RESTRAINT AND PHYSICAL EXAMINATION OF CAPTIVE FORMOSAN REEVE’S MUNTJACS (Muntiacus reevesi micrurus)

Joe J. C. Guo, BVM* and Jason S. C. Chin, DVM

Animal Medical Center, Taipei Zoo, Taipei 116 Taiwan

Abstract

To restrain animals safely is always a troublesome topic for wildlife researchers and veterinarians. The high mortality rate of Formosan Reeve’s muntjac (Muntiacus reevesi micrurus) after restraint and anesthesia has been perplexing. The Taipei Zoo has recently created protocols for health examinations of the Formosan Reeve’s muntjac to assist with disease prevention, establishment of animal identification, physiologic databases and other research requests. The purpose of this paper is to outline restraint methods and physical examination of these animals according to our experience. Seventy-two individuals were examined in 2003. These examination protocols included the following stages: animal management and working group/instrument preparation before operation; proceeding restraint/anesthesia and physical examination items during operation; observation, treatment and laboratory analysis post operation. We collected the following physiologic data during the procedures: body weight, breath rate, heart rate, blood oxygen ratio and immobilizing drugs according to gender and age. After establishing examination protocols, we were able to increase animal safety during procedures. We hope the restraint and physical examination protocols and physiologic analysis will not only provide assistance for animal management, medical treatment and research in captivity, but will be helpful for wild muntjac researchers.

LITERATURE CITED

COMPARISON OF ANESTHESIA OF AOUDADS (*Ammotragus lervia*) IN A CITY ZOO ENCLOSURE IN GERMANY WITH A FREE-RANGING GROUP OF AOUDADS IN A SAFARI PARK IN THE UNITED STATES AND REFERENCE HEMATOLOGIC DATA VALUES OF ONE OF THE PARKS

*Kerstin Jurczynski, DVM,1* Michael Flügger, DVM,2 and Modesto McClean, DVM3

1Tiergarten Heidelberg, Heidelberg, Germany; 2Tierpark Hagenbeck, Hamburg, Germany; 3Wildlife Safari, Winston, OR 97496 USA

Abstract

The anesthesia of aoudads (*Ammotragus lervia*) in an exhibit at Tierpark Hagenbeck in Hamburg, Germany was compared to a group of free-ranging aoudads at the Wildlife Safari in Winston, Oregon USA. Both methods of immobilization (xylazine-ketamine in Hamburg and xylazine-tiletamine-zolazepam in Winston) achieved a smooth induction and a very good immobilization. The reversal was carried out with a combination of yohimbine and atipamezole in Hamburg and only atipamezole in Winston. Both methods deliver a smooth recovery and enable the animal to be released into the herd within a few hours.

Introduction

Institution A: Tierpark Hagenbeck, Hamburg, Germany

Tierpark Hagenbeck in Hamburg has kept barbary sheep for many years. In general approximately 25 animals are kept in a 300 m² fenced-in area with a flooring of natural rock including climbing structures. Immobilizations are done on a regular basis, mainly for physical examinations, medical procedures or transports to other institutions.

Institution B: Wildlife Safari Winston, Oregon USA

Wildlife Safari keeps a large group of aoudads (about 40 animals) free-ranging in a drive-through area of 170 m², together with bison (*Bison bison bison*), alpaca (*Lama pacos*), mustangs (*Equus caballus*) and wapiti elk (*Cervus elaphus nelsoni*). The soil consists mainly of clay and the heavily wooded area contains ponds as well. The only solid structures are the drive-through paths for the vehicles which are randomly used by the aoudads.

The weather in Winston has more extremities as compared to Hamburg with its temperate climate with warm summers and mild cloudy winters. Hot summers and wet moderate winters are common in this region. Because of the high precipitation during the winter in Western Oregon the soil has a very soft consistency and the hooves cannot find the necessary abrasion. Massive overgrowth of the foot horn causes lameness and sometimes osteomyelitis. Therefore all animals are annually anesthetized for hoof trims and general examinations.
The anesthetic agent xylazine (2(2,6-dimethylphenylamino)-4-H-5,6-dihydro-1,3-thiazine hydrochloride) stimulates the \( \alpha_2 \)-receptors of the central nervous system and therefore inhibits the release of adrenaline and serotonin. In sufficient doses the sedative provides central muscle relaxation and analgesia.\(^1\) Often xylazine is used in combination with ketamine hydrochloride (2-(o-chlorophenyl)-2-methylamino cyclohexanone hydrochloride). Ketamine belongs to the dissociative anesthetic agents and produces catalepsia and analgesia.\(^1\) The combination of both drugs achieved good results in ruminants.\(^2,8\) Another possibility is the combination of an \( \alpha_2 \)-agonist with tiletamine and zolazepam (Telazol (tiletamine hydrochloride and zolazepam hydrochloride)). Tiletamine is a dissociative agent that is comparable but more effective than ketamine. Zolazepam is a Pyrazolodiazepinone and has been used as a tranquillizer and anticonvulsant. The combination of tiletamine and zolazepam (TZ) has been widely used to immobilize wild animals.\(^3,6\) To reduce the amount of TZ and decrease the risks of convulsion and excitation xylazine was added to the drug combination with good results.\(^7\) The sedative effect of xylazine can be reversed with \( \alpha_2 \)-adrenoceptor antagonists yohimbine hydrochloride or atipamezole (4-(2-ethyl-2,3-dihydro-1H-inden-2-y1)-1H-imidazole hydrochloride).\(^4\) Here both methods of immobilization are compared.

### Material and Methods

In Hamburg 31 aoudads were immobilized with a combination of xylazine and ketamine. 500 mg xylazine (Rompun® Dry Substance, Bayer) was mixed with 5 ml ketamine hydrochloride (Ketavet®, Pharmacia and Upjohn, 100 mg/ml) to receive a concentration of 100 mg xylazine and 100 mg ketamine per ml. The dosage was set up according to the age and appearance of the animal and the drugs were administered into the thigh muscles via dart delivered with a blowpipe. The body weight was estimated as <25 kg in the animals up to 1 yr of age, 25 – 40 kg for animals aged up to 4 yr and 50 kg (females) and 80-90 kg (males) for adults over the age of 4 yr. The induction time was measured from the time when the dart hit the animal until the aoudad became recumbent. The animal was then positioned in right lateral recumbency. In four animals a pulse oximetry probe was placed on the tongue or one of the ears and the pulse (beats/min) and the hemoglobin saturation (SpO\(_2\)) were recorded. During the anesthesia, blood was drawn from the jugular vein, injected into an EDTA-tube and a serum tube and sent off to a laboratory. After the procedure the anesthetic agents were antagonized with 1ml yohimbine (Yohimbine-HCl 1%)/20 kg BW and 1ml atipamezole (Atipamezolehydrochloride, Antisedan®, Pfizer, 5 mg/ml)/50 kg BW. The time between the injection and animal standing for the first time was recorded.

In Winston, aoudads have been anesthetized with a combination of xylazine, tiletamine and zolazepam. The body weight of the animal was estimated and the drugs were administered into the thigh muscles via dart (Pneudart®) delivered with a rifle (Dan-inject®). The dose used was 1.1 mg Telazol/kg BW and 1.0 mg xylazine/kg BW.

Five 1-yr-old females weighed between 27 and 36 kg. One male weighed 57 kg. Two 1-2-yr-old female animals weighed 57 and 68 kg, and two males of the same age group weighed 77-82 kg. Three female 2-4-yr-olds weighed 45-80 kg and five males weighed 77-114 kg. The body weight of the three over 4-yr-old adult female aoudads ranged from 57 to 68 kg and the 2.0
males weight 90 and 136 kg. The induction time was measured from the time when the dart hit the animal until the aoudad became recumbent or was found recumbent after being out-of-sight. Prior to the antagonism of the anesthetic agents the animal was placed in a wooden crate. 1mg Atipamezole (Antipamezolhydrochloride, Antisedan®, Pfizer, 5mg/ml) for every 10 mg of xylazine was injected intravenously and the catheter was removed. The time from reversal until the animal became sternal was recorded.

Results

Four adult female animals were connected to the pulse oximeter. It showed average values of 81.5% SpO2 and 72.5 bpm of pulse.

A reference list of hematologic and biochemical data of 7.7 animals aged 4-8 mo and 2.0 adult aoudads in Winston and Hamburg are given in Tables 1, 2 and 3.

Discussion

Inductions with both ketamine and xylazine (KX) and tiletamine, zolazepam and xylazine (TZX) were rapid and smooth at both institutions. Immobilization with the combination of xylazine and ketamine and xylazine, tiletamine and zolazepam has been reported as very efficient for ruminants in the literature for a long time. The effects of xylazine can be reversed with the α2-adrenoceptor antagonist yohimbine. The recommended dose for the antagonization is 0.125 mg-0.25 mg/kg body weight intravenously or intramuscularly. In Hamburg, atipamezole was added to yohimbine and revealed better recoveries than in the past. In Winston, only atipamezole was given and provided smooth and rapid recoveries. Jalanka and Roeken reported on the successful use of atipamezole as a reversal for xylazine in a dose of 1 mg of atipamezole for every 8-12 mg of xylazine used.

Conclusion

The comparison of anesthesias in both institutions led to the conclusion that both drug combinations are a valuable method to induce and maintain a safe immobilization in barbary sheep. The recovery with either yohimbine + atipamezole or only atipamezole showed no significant differences, therefore the use of yohimbine in combination with atipamezole apparently does not increase the efficiency.

LITERATURE CITED


Table 1. Institution A in Hamburg.

<table>
<thead>
<tr>
<th>Sex ratio</th>
<th>Age</th>
<th>Mean dosage (mg/animal)a,b</th>
<th>Average onset of anesthesia (min after darting)</th>
<th>Average procedure length (= antidote given)</th>
<th>Antidote (ml)c,d</th>
<th>Animal stands (min post antagonization) (p.a.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>3 mo</td>
<td>5 mg X + 25 mg K</td>
<td>8 min</td>
<td>41 min</td>
<td>0.5 Yo i.m.</td>
<td>10 min p.a.</td>
</tr>
<tr>
<td>3.4</td>
<td>4.5-7 mo</td>
<td>22.4 mg X + 51.43 mg K</td>
<td>12.14 min</td>
<td>31.29 min</td>
<td>0.93 Yo i.m.</td>
<td>1.86 min p.a.</td>
</tr>
<tr>
<td>1.2.0</td>
<td>8 mo</td>
<td>36.25 mg X + 165 mg K</td>
<td>10 min</td>
<td>41.25 min</td>
<td>1.13 Yo i.m.</td>
<td>5.75 min p.a.</td>
</tr>
<tr>
<td>3.6</td>
<td>1 yr</td>
<td>40 mg X + 164.44 mg K</td>
<td>9.33 min</td>
<td>32.56 min</td>
<td>1.94 Yo i.m.</td>
<td>13 min p.a.</td>
</tr>
<tr>
<td>1.3</td>
<td>2-3 yr</td>
<td>45 mg X + 160 mg K</td>
<td>8.75 min</td>
<td>49.5 min</td>
<td>2.5 Yo i.m.</td>
<td>10.25 min p.a.</td>
</tr>
<tr>
<td>0.3</td>
<td>4 yr</td>
<td>50 mg X + 200 mg K</td>
<td>14.67 min</td>
<td>33 min</td>
<td>3.67 Yo i.m.</td>
<td>9 min p.a.</td>
</tr>
<tr>
<td>2.1</td>
<td>&gt;4 yr</td>
<td>80 mg X + 253.33 mg K</td>
<td>15.33 min</td>
<td>41.33 min</td>
<td>4 Yo i.m.</td>
<td>6 min p.a.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.93 At i.v.</td>
<td></td>
</tr>
</tbody>
</table>

aX=xylazine.  
bK=ketamine.  
cYo=Yohimbine.  
dAt=Atipamezole.

Table 2. Institution B in Winston.

<table>
<thead>
<tr>
<th>Sex ratio</th>
<th>Age</th>
<th>Mean dosage (mg/kg body weight)a,b</th>
<th>Average onset of anesthesia after darting</th>
<th>Atipamezole (mg) (mg/kg body weight)</th>
<th>Animal sternal/stands (min post antagonization) (p.a.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>1 yr</td>
<td>60 mg T + 59 mg X</td>
<td>6.6 min</td>
<td>6 mg</td>
<td>2.2 min p.a.</td>
</tr>
<tr>
<td>1.0</td>
<td>1 yr</td>
<td>75 mg T + 75 mg X</td>
<td>4 min</td>
<td>7.5 mg</td>
<td>1 min p.a.</td>
</tr>
<tr>
<td>0.2</td>
<td>1-2 yr</td>
<td>75 mg T + 70 mg X</td>
<td>7.5 min</td>
<td>7 mg</td>
<td>1.5 min p.a.</td>
</tr>
<tr>
<td>2.0</td>
<td>1-2 yr</td>
<td>100 mg T + 95 mg X</td>
<td>7.5 min</td>
<td>9.5 mg</td>
<td>1.5 min p.a.</td>
</tr>
<tr>
<td>0.3</td>
<td>2-4 yr</td>
<td>75 mg T + 70 mg</td>
<td>8.3 min</td>
<td>7 mg</td>
<td>2.33 min p.a.</td>
</tr>
<tr>
<td>5.0</td>
<td>2-4 yr</td>
<td>90 mg T + 89 mg X</td>
<td>7.4 min</td>
<td>0.12 mg/kg</td>
<td>2.6 min p.a.</td>
</tr>
<tr>
<td>0.3</td>
<td>&gt;4 yr</td>
<td>83 mg T + 80 mg X</td>
<td>8 min</td>
<td>0.1 mg/kg</td>
<td>2.33 min p.a.</td>
</tr>
<tr>
<td>2.0</td>
<td>&gt;4 yr</td>
<td>75 mg T + 75 mg X</td>
<td>10.5 min</td>
<td>7 mg</td>
<td>2 min p.a.</td>
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</table>

aT=Telazol.  
bX=Xylazine.
<table>
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<th>Mean</th>
<th>Minimum value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>White blood cell count (x 10⁹/L)</td>
<td>9.25</td>
<td>5.3</td>
<td>13.7</td>
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<td>Red blood cell count (x 10¹²/L)</td>
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<td>Hemoglobin (g/dl)</td>
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<td>13.6</td>
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<td>Hematocrit (%)</td>
<td>30.78</td>
<td>26.3</td>
<td>34.4</td>
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<td>MCV (fL)</td>
<td>20.16</td>
<td>16.4</td>
<td>27.8</td>
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<td>MCH (pg/dl)</td>
<td>7.83</td>
<td>6.94</td>
<td>9.73</td>
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<tr>
<td>Segmented neutrophils (x 10⁹/L)</td>
<td>6.04</td>
<td>2.85</td>
<td>10.32</td>
</tr>
<tr>
<td>Lymphocytes (x 10⁹/L)</td>
<td>2.99</td>
<td>0.37</td>
<td>5.15</td>
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<td>Monocytes (x 10⁹/L)</td>
<td>0.10</td>
<td>0</td>
<td>0.41</td>
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<tr>
<td>Eosinophils (x 10⁹/L)</td>
<td>0.08</td>
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<td>0.37</td>
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<tr>
<td>Basophils (x 10⁹/L)</td>
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<td>0.24</td>
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<tr>
<td>Calcium (mMol/L)</td>
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<td>1.62</td>
<td>2.57</td>
</tr>
<tr>
<td>Phosphorus (mMol/L)</td>
<td>2.69</td>
<td>2.07</td>
<td>3.57</td>
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<tr>
<td>Sodium (mMol/L)</td>
<td>144.5</td>
<td>139</td>
<td>149</td>
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<tr>
<td>Potassium (mMol/L)</td>
<td>4.37</td>
<td>3.5</td>
<td>4.86</td>
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<td>Iron (umol/L)</td>
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<td>22.9</td>
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<td>Alkaline phosphatase (U/L)</td>
<td>271</td>
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<td>576.75</td>
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<td>810</td>
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<td>Aspartate aminotransf erase (U/L)</td>
<td>131.75</td>
<td>75</td>
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<tr>
<td>Alanine aminotransferase (U/L)</td>
<td>64.44</td>
<td>44</td>
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<td>Triglyceride (mg/dl)</td>
<td>25.31</td>
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<td>Cholesterol (mg/dl)</td>
<td>133.88</td>
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<td>227</td>
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<td>Total bilirubin (mg/dl)</td>
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<td>&lt;0.2</td>
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<td>Glucose (mg/dl)</td>
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<td>Urea (mg/dl)</td>
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<td>85</td>
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<tr>
<td>Creatinine (mg/dl)</td>
<td>1.52</td>
<td>1.21</td>
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<tr>
<td>Total protein (g/L)</td>
<td>58.98</td>
<td>47.7</td>
<td>69.9</td>
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COMPARISON OF ANESTHESIA OF BLACKBUCKS (*Antilope cervicapra*) IN A CITY ZOO ENCLOSURE IN GERMANY WITH A FREE-RANGING GROUP OF BLACKBUCKS IN A SAFARI PARK IN THE USA AND REFERENCE HEMATOLOGIC DATA VALUES OF ONE OF THE PARKS

*Kerstin Jurczynski, DVM,*1* Michael Flügger, DVM,2 and Modesto McClean, DVM3

1Tiergarten Heidelberg, Heidelberg, Germany; 2Tierpark Hagenbeck, Hamburg, Germany; 3Wildlife Safari, Winston, OR 97496 USA

Abstract

The anesthesia of blackbucks (*Antilope cervicapra*) in an exhibit at Tierpark Hagenbeck in Hamburg, Germany was compared to a group of free-ranging blackbucks at the Wildlife Safari in Winston, Oregon USA. Both methods of immobilization (xylazine-ketamine in Hamburg and xylazine-tiletamine-zolazepam in Winston) achieved a smooth induction and a very good immobilization. The reversal was carried out with a combination of yohimbine and/or atipamezole in Hamburg and only atipamezole in Winston. In Hamburg the best results were obtained by a combination of yohimbine administered intramuscularly and atipamezole intravenously. In Winston only atipamezole was used and delivered a smooth recovery. Both methods enabled the animals to be released into the herd within a few hours.

Introduction

Institution A: Wildlife Safari Winston, Oregon USA

Wildlife Safari keeps a group of free-ranging blackbucks in a drive-through area of 36.4 ha, together with yak (*Bos grunniens*), sika deer (*Cervus nippon pseudoaxis*), nilgai (*Boselaphus tragocamelus*), guanaco (*Lama guanicoe*), fallow deer (*Dama dama*) and ratites (*Dromaius novaehollandiae, Rhea americana*).

Institution B: Tierpark Hagenbeck, Hamburg, Germany

Tierpark Hagenbeck in Hamburg has kept blackbucks (*Antilope cervicapra*) for many years. Animals are frequently anesthetized for physical examinations, medical procedures, or transports to other institutions.

The anesthetic agent xylazine (2(2,6-dimethylphenylamino)-4-H-5,6-dihydro-1,3-thiazine hydrochloride) stimulates the α2-receptors of the central nervous system and therefore inhibits the release of adrenaline and serotonin. In sufficient doses the sedative provides central muscle relaxation and analgesia.1 Often xylazine is used in combination with ketamine hydrochloride (2-(o-chlorophenyl)-2-methylamino cyclohexanone hydrochloride). Ketamine belongs to the dissociative anesthetic agents and produces catalepsia and analgesia.1 The combination of both drugs achieved good results in ruminants.2,9 Another possibility is the combination of an α2-
agonist with tiletamine and zolazepam (Telazol (tiletamine hydrochloride and zolazepam hydrochloride)). Tiletamine is a dissociative agent that is comparable but more effective than ketamine. Zolazepam is a Pyrazolodiazepinone and has been used as a tranquillizer and anticonvulsant. The combination of tiletamine and zolazepam (TZ) has been widely used to immobilize wild animals.\textsuperscript{3,6} To reduce the amount of TZ and decrease the risks of convulsion and excitation xylazine was added to the drug combination with good results.\textsuperscript{8} The sedative effect of xylazine can be reversed with $\alpha_2$-adrenoceptor antagonists yohimbine hydrochloride or atipamezole (4-(2-ethyl-2,3-dihydro-1H-inden-2-yl)-1H-imidazole hydrochloride).\textsuperscript{4}

In the past there have been reports on the use of xylazine in combination with the antidote yohimbine in this species. Strauss described the inefficiency of anesthetizing five blackbucks with 4.4 mg/kg xylazine and trying to reverse it by using 2.0 mg/kg yohimbine.\textsuperscript{7} Unfortunately this was not a great success. On average the animals did not recover until approximately 251 min after yohimbine-injection.

**Material and Methods**

In Winston, blackbucks have been anesthetized with a combination of xylazine, tiletamine and zolazepam. The body weight of the animal was estimated and the drugs were administered into the thigh muscles via dart (Pneudart®) delivered with a rifle (Dan-inject®). The dosage used was 1.5 mg Telazol/kg BW and 1.6 mg xylazine/kg BW. The induction time was measured from the time when the dart hit the animal until the blackbuck became recumbent. Prior to antagonizing the anesthetic agents, the animal was placed in a wooden crate. 1mg Atipamezole (Antipamezolhydrochloride, Antisedan®, Pfizer, 5mg/ml) for every 10 mg of xylazine was injected intravenously and the catheter was removed. The time from reversal until the animal became sternal was recorded.

In Hamburg 52 blackbucks have been immobilized with a combination of xylazine and ketamine. 500 mg xylazine (Rompun® Dry Substance, Bayer) was mixed with 5 ml ketamine hydrochloride (Ketavet®, Pharmacia and Upjohn, 100mg/ml) to make a concentration of 100 mg xylazine and 100 mg ketamine per ml. The body weight of the animals were estimated and the drugs were administered into the thigh muscles via dart delivered with a blowpipe.

The induction time was measured from the time when the dart hit the animal until the blackbuck became recumbent. The animal was then positioned in right lateral recumbency. In thirteen animals a pulse oximetry probe was placed on the tongue or one of the ears and the pulse (beats/min) and the hemoglobin saturation (SpO$_2$) was recorded. After the procedure was completed the anesthetic agents were antagonized with different drugs and routes of administration.

Regarding the various antidotes and administration routes the animals in Hamburg can be divided into four groups: Group 1: 1.3 animals received an intravenous (i.v.) injection of only yohimbine (Yohimbin-HCl 1%). Group 2: 0.1 blackbuck was given atipamezole (Atipamezolehydrochloride, Antisedan®, Pfizer, 5 mg/ml) intramuscularly (i.m.). Group 3: 2.6 animals were reversed with a combination of yohimbine i.v. and atipamezole i.m.
Group 4: 16.23 animals were injected with a combination of yohimbine i.m. and atipamezole i.v. The time between the injection and animal standing for the first time was recorded.

Results

A reference list of hematologic and biochemical data of animals aged 4-8 mo and 2.0 adult blackbucks in Winston and Hamburg are given in Tables 1, 2 and 3.

Discussion

Induction with both ketamine and xylazine (KX) and tiletamine, zolazepam and xylazine (TZX) was rapid and smooth in both institutions. Immobilization with the combination of xylazine and ketamine and xylazine, tiletamine and zolazepam has been reported as very efficient for ruminants in the literature for a long time. Wiesner recommended 0.1 ml of the “Hellabrunner mix” in subadults to 0.4 ml in adults for anesthesia in blackbucks. One milliliter of the “Hellabrunner mix” contains 12.5 mg xylazine and 10 mg of ketamine. The effects of xylazine can be reversed with the α₂-adrenoceptor antagonist yohimbine. The recommended dose for the antagonist is 0.125 mg-0.25 mg/kg body weight intravenously or intramuscularly.

Strauss immobilized five blackbucks and antagonized the anesthetic effects with an average of 1.65 mg yohimbine/kg body weight. No desired effect occurred and therefore he concluded that yohimbine is not the recommended antagonist for a xylazine anesthesia in blackbucks. In group 1 at Tierpark Hagenbeck an average dose of 0.75 mg yohimbine/kg BW was injected intravenously and mean recovery time was 24-25 min. This was not very satisfying because the time of recovery should be as short as possible after procedures are done to get the animal back to the group. Jalanka and Roeken reported on the successful use of atipamezole as a reversal for xylazine at a dose of 1 mg of atipamezole for every 8-12 mg of xylazine. In group 2, 0.21 mg atipamezole/kg BW was used to reverse the immobilization of a 1.5-mo-old female. After 33 min the animal was able to stand for the first time. During the recovery the animal was struggling a lot. The animal was anesthetized previously and reversed with yohimbine and there was no struggling at that time. That lead to the conclusion that atipamezole alone was not a good reversal for a xylazine-induced anesthesia in these animals. This method was not further tested. In group 3 yohimbine and atipamezole were used at the same time. An average of 0.72 mg yohimbine/kg body weight was delivered intravenously and a mean dose of atipamezole at 0.12 mg/kg body weight intramuscularly. The mean recovery time for the entire group was 18.5 min. This was better than in the groups before but still too long and therefore the administration route had to be changed. In the last group at Hamburg the method that is used successfully at the Tierpark Hagenbeck today was established. Yohimbine was given i.m. in an average dose of 0.81 mg/kg BW and atipamezole at 0.12 mg/kg BW but this time intravenously. The amount of drug administered has not been changed significantly in the last two groups but the route of administration has made the difference. The average recovery time in 38 animals has been 3.92 min. In Winston atipamezole was given by itself and provided smooth and rapid recoveries.
Conclusion

The comparison of anesthesias in both institution led to the conclusion that both drug combinations are a valuable method to induce and maintain a safe immobilization in blackbucks. The recovery with either yohimbine + atipamezole or only atipamezole showed no significant differences, therefore the use of yohimbine in combination with atipamezole does apparently not increase the efficiency.

LITERATURE CITED

### Table 1. Institution A in Winston.

<table>
<thead>
<tr>
<th>Sex ratio</th>
<th>Age</th>
<th>Mean dosage (mg/kg body weight)</th>
<th>Average onset of anesthesia (min after darting)</th>
<th>Atipamezole (mg/kg body weight)</th>
<th>Animal sternal/stands (min post antagonization)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>&lt;7 mo</td>
<td>30 mg T + 32.5 mg X</td>
<td>4 min</td>
<td>3.25 mg</td>
<td>3.5 min p.a.</td>
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<td></td>
<td></td>
<td>2.24 mg T + 2.4 mg X</td>
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<td>0.24 mg/kg</td>
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</tr>
<tr>
<td>2.1</td>
<td>8-9 mo</td>
<td>50 mg T + 50 mg X</td>
<td>5 min</td>
<td>5 mg</td>
<td>3.7 min p.a.</td>
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<tr>
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<td></td>
<td>2.06 mg T + 2.06 mg X</td>
<td></td>
<td>0.21 mg/kg</td>
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</tr>
<tr>
<td>3.0</td>
<td>1 yr</td>
<td>40.67 mg T + 42.67 mg X</td>
<td>5.33 min</td>
<td>4.27 mg</td>
<td>3.67 min p.a.</td>
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<td></td>
<td></td>
<td>1.70 mg T + 1.78 mg X</td>
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<td>0.18 mg/kg</td>
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<td>2.0</td>
<td>2-3 yr</td>
<td>62.5 mg T + 65 mg X</td>
<td>5.5 min</td>
<td>0.17 mg/kg</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>1.78 mg T + 1.86 mg X</td>
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<td>0.18 mg/kg</td>
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<tr>
<td>0.7</td>
<td>&gt;4 yr</td>
<td>55 mg T + 55.7 mg X</td>
<td>5.14 min</td>
<td>5.57 mg</td>
<td>4 min p.a.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.81 mg T + 1.83 mg X</td>
<td></td>
<td>0.18 mg/kg</td>
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</table>

*T= Telazol.

*X= Xylazine.

### Table 2. Institution B in Hamburg.

<table>
<thead>
<tr>
<th>Sex ratio</th>
<th>Age</th>
<th>Weight</th>
<th>Mean dosage (mg per animal)</th>
<th>Average onset of anesthesia</th>
<th>Antidote (ml)</th>
<th>Animal stands (min post antagonization)</th>
<th>Mean pulse (bpm)</th>
<th>Mean SpO₂ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gr.1</td>
<td>0.1</td>
<td>1.5 mo</td>
<td>10 X + 30 K</td>
<td>5 min</td>
<td>0.5 Yo i.v.</td>
<td>51 min</td>
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<tr>
<td>baby</td>
<td>4.8 kg</td>
<td>2.08 X + 6.25 K</td>
<td>4 min</td>
<td>1.04 mg Yo/kg BW</td>
<td></td>
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<tr>
<td>sa</td>
<td>16-24 kg</td>
<td>1.49 X + 1.49 K</td>
<td>4 min</td>
<td>1.5 Yo i.v.</td>
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<td></td>
<td></td>
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<tr>
<td>Gr.2</td>
<td>0.1</td>
<td>1.5 mo</td>
<td>10 X + 30 K</td>
<td>4 min</td>
<td>0.2 At i.m.</td>
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<tr>
<td>baby</td>
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<td>2.08 X + 6.25 K</td>
<td>4 min</td>
<td>0.21 mg At/kg BW</td>
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<tr>
<td>Gr.3</td>
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<td>&lt;1 yr</td>
<td>37.5 X + 37.5 K</td>
<td>4.25 min</td>
<td>Yo i.v. + At i.m.</td>
<td>20.75 min p.a.</td>
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<tr>
<td>juv</td>
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<td>4.25 min</td>
<td>1.06 Yo + 0.38 At</td>
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<tr>
<td>sa</td>
<td>16-25 kg</td>
<td>1.87 X + 1.87 K</td>
<td>4.25 min</td>
<td>1.57 Yo + 0.5 At</td>
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<td>Gr.4</td>
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<td>2 yr 7 mo</td>
<td>40 X + 40 K</td>
<td>2 min</td>
<td>2.5 Yo + 0.6 At</td>
<td>13 min p.a.</td>
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<tr>
<td>ad</td>
<td>31 kg</td>
<td>1.29 X + 1.29 K</td>
<td>2 min</td>
<td>0.81 Yo + 0.10 At</td>
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<tr>
<td>Gr.4</td>
<td>0.1</td>
<td>1.5 mo</td>
<td>10 X + 30 K</td>
<td>7 min</td>
<td>Yo i.m. + At i.v.</td>
<td>7 min p.a.</td>
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<tr>
<td>baby</td>
<td>4.8 kg</td>
<td>2.08 X + 6.25 K</td>
<td>7 min</td>
<td>0.5 Yo + 0.25 At</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.10</td>
<td>&lt;1 yr</td>
<td>36.67 X + 36.67 K</td>
<td>5.57 min</td>
<td>1.14 Yo + 0.35 At</td>
<td>3.52 min p.a.</td>
<td>56.5 83.83%</td>
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<tr>
<td>juv</td>
<td>10-19 kg</td>
<td>2.76 X + 2.76 K</td>
<td>5.57 min</td>
<td>1.0 Yo + 0.14 At</td>
<td>(n=6) 83.83%</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>sa</td>
<td>22-28 kg</td>
<td>1.62 X + 1.62 K</td>
<td>5.57 min</td>
<td>0.93 Yo + 0.14 At</td>
<td>(n=1) 84%</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2.10</td>
<td>&gt;2 yr</td>
<td>41 X + 41 K</td>
<td>6.4 min</td>
<td>1.3 Yo + 0.38 At</td>
<td>7 min p.a.</td>
<td>49 84%</td>
<td></td>
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<td>30-38 kg</td>
<td>1.34 X + 1.34 K</td>
<td>6.4 min</td>
<td>0.50 Yo + 0.07 At</td>
<td>(n=6) 84%</td>
<td></td>
<td></td>
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</tr>
</tbody>
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*Sa= sub-adult.

*Ad=adult.

*T= Telazol.

*X= Xylazine.

*Yo= Yohimbine.

*At= Atipamezole.
**Table 3. Biochemical data.**

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>Minimum value</th>
<th>Maximum value</th>
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<tr>
<td>White blood cell count (x 10⁹/L)</td>
<td>9.25</td>
<td>5.3</td>
<td>13.7</td>
</tr>
<tr>
<td>Red blood cell count (x 10¹²/L)</td>
<td>15.6</td>
<td>10.3</td>
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</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>12.06</td>
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<td>Hematocrit (%)</td>
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<td>42.6</td>
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<td>6.04</td>
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<td>0.37</td>
<td>5.15</td>
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<td>Monocytes (x 10⁹/L)</td>
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<td>0.41</td>
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UNUSUAL NEOPLASMS IN TWO DIFFERENT SPECIES OF LEMUR

William Magnone, DVM,1,* Davide Guadagnini, DVM,1 Camillo Sandri, DVM,1 and Ernesto Pascotto, DVM2

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Abstract

Introduction

In the literature there is a lack of information about lemur medicine in captivity. There is scanty information concerning general medical aspects2−7,8 and there are very few reports on specific disease.9 Neoplasia in lemurs has been scarcely reported apart from some primary liver tumors4,5,13,22 and pulmonary tumors.13,19 We describe the clinical, anatomo-histomorphologic features of two unusual cases of neoplasia in two different lemurs hosted at Parco Natura Viva – Garda Zoological Park, Italy.

Case Report

Case 1: Lymphoma in Lemur catta

Clinical History

Prior to 2005 the 5-yr-old female ringtailed lemur did not show any clinical signs of illness. In March 2005 the animal was evaluated for depression, apathy, inappetence and a few episodes of regurgitation. She was thin (1.7 kg) and showed abdominal pain during palpation. Hematologic tests did not reveal any abnormalities; thus we started a medical treatment with carprofen (2 mg/kg) and joscina N-butilbromuro. Some weeks later, as no clinical improvement was noted, the lemur was anesthetized (medetomidine 0.05 mg/kg + ketamine 5 mg/kg) to perform a more detailed examination. A big firm mass was revealed in the epigas trium by the abdominal palpation and it was confirmed by radiographs: a large radiopaque mass about 3-4 cm in diameter. Two days later we decided to perform surgery: during laparotomy we found that the suspected neoplasm was completely inside the intestinal wall and the mass was removed through intestinal resection and anastomoses. The resected mass was submitted for histopathologic analysis. After ten days the lemur started to eat. However 1 mo later the same clinical signs reappeared: anorexia and several episodes of vomiting. The mass had regrown and was much bigger than before. The lemur was euthanatized due to poor prognosis.

Histopathology

The histologic evaluation of the first sample revealed heavy changes of the intestinal wall in the area of the ring inspissation. The intestinal wall was infiltrated by intense, multiphocal masses of
neoplastic lymphocitis. There was also a complete absence of the tonaca propria, a massive
degeneration of the submucosal tonaca and a strong and exuberant connectival new growth and a
partial destruction of muscular tonaca. The histologic feature revealed also different areas of
multifocal necrosis that was often punctiform.

At the edge of the ring lesion there was an interesting inflammatory feature similar to “gluten-
sensitive enteropathy” or “coeliac disease”: plasma cell and lymphocyte infiltration in the lamina
propria, impressive villous atrophy and crypt hyperplasia with decreased villous height-to-crypt
depth ratio and a pronounced increase in the number of intraepithelial lymphocytes. This
complex histologic feature is known as media cells intestinal lymphoma associated with enteritis
and is similar to “coeliac disease” of 3b level Marsh-Oberhuber. Tissue collected at necropsy
revealed similar lesions.

Case 2: Leiomyosarcoma in Eulemur macaco macaco

Clinical History

In January 2005 a 9-yr-old female black lemur was evaluated for a swelling in the left lower lip.
Despite that, the lemur ate regularly and did not show any other clinical signs.

Twenty days later the neoplasm was so big (about 5 cm of diameter) that the lemur had difficulty
eating normally. The animal was anesthetized to remove the neoplasm with a combination of
medetomidine and ketamine i.m. and then intubated and maintained on isoflurane. This surgery
was complicated because the neoplasm was so firmly attached to the tissue that it was impossible
to remove the tumor entirely. Tissue was submitted for histologic examination. After 15 days the
left lower lip had a deviated profile. Over the next 3 mo the neoplasm recurred three times and
thus in April 2005 the animal was humanely euthanatized.

Histopathology

Histopathology revealed a homogeneous neoplastic proliferation organized in a mass with very
irregular edges and different degrees of local invasiveness. This neoplastic proliferation did not
look ulcerative even if it deeply penetrated so that it involved abundantly the striate portion of
buccinator muscles and labial glands. Some portions of the surface showed epidermic
hyperplasia with serious invagination of the epidermis. This aspect is common in neoplasms like
histiocytoma of the dog and equine sarcoid. Moreover the inside part of the mass looked well-
vascularized apart from different necrotic centers with hemorrhagic phenomenon. Structural and
cytologic characteristics suggest that the mass was a cutaneous leiomyosarcoma originating with
the piloerector muscles (pyeloleiomyosarcoma).
Discussion

Case 1

In literature there are few studies about lymphoma in primates and reports of this tumor in lemur are very rare. Thus this case is important because it gives information about lymphoma in *Lemur catta* and it is also interesting because in this case the tumor is associated with a similar “coeliac disease.” Furthermore different authors underline that there is a higher risk to develop small-bowel non-Hodgkin’s lymphoma in human with coeliac disease. This report indicates that perhaps further investigation into the link between these two diseases in lemurs are warranted.

Case 2

Skin tumors of non-striated muscles are unusual both in domestic carnivores and in humans. In particular leiomyosarcoma is rare: it represents about 2-3% of human dermal mesenchymal tumors and less of 1% of dermal tumors of domestic carnivores. This neoplasm occurs more frequently in dogs and ferrets. To the authors’ knowledge in non-human primates there is only one previous report of a skin tumor in a Peruvian squirrel monkey. The present paper represents an interesting integration to the existing literature. It is important to underline that the clinical and histologic features of the described neoplasm seem to be more aggressive than those seen in other species. It is also noteworthy that the tumor originated from the piloerector muscle as this is not very often seen.

LITERATURE CITED

PRURIGINOUS ALOPECIA IN TWO YOUNG CHIMPANZEES (Pan troglodytes)

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Abstract

Introduction

Many captive animals show forms of pelage loss that are absent in wild or free-living conspecifics, which result from grooming or plucking behavior directed at themselves or at other individuals. For instance, dorsal hair loss in primates results from excessive hair-pulling or over-grooming by cage-mates. Occasionally this behavior appears to be associated with stress, however, captive non-human primates frequently suffer from sarcoptic mange, psorergatic mange (caused by Psoralgidae mites) and pulmonary acariasis due to lung mites (Pneumonyssus spp.). The pathogenesis and concordant clinical symptoms of mange might depend on the immune status of the host. Naïve, immunocompromised or anergic animals that are unable to evoke hypersensitivity responses might develop an extensive epidermal hyperkeratosis with a chronic dermal inflammation. The following case reports describe an unusual dermatologic disease and its regression in two hand-reared young chimpanzees (Pan troglodytes) at Parco Natura Viva, Garda Zoological Park, Italy.

Case Report

Over a period of the last 2 yr two young hand-reared chimpanzees (one male and one female) showed a particular form of complete pruriginous alopecia spread over the whole body. The female is an 8-yr-old female chimpanzee. She was hand-reared in a human family context for the first year of her life and after that period she was housed alone for 2 yr in the chimpanzee enclosure at Parco Natura Viva, Garda Zoological Park, Italy. When she was 3 yr old her brother was housed with her in the same enclosure for 1 yr and then two other young hand-reared chimpanzees were put in the enclosure.

The chimpanzee enclosure had two different areas: an outside area and an inside one with four different cages. The small group of four young chimpanzees was housed in the biggest round cage whereas the adult group was housed in the other three cages and the outside area. The juvenile chimpanzees were allowed into the outside area for a few hours each day while the adults were kept inside.

Over the first 3 yr the female had no clinical problems and her development was normal except for a localalized dermatitis on hands and feet which was resolved with antimycotics (itraconazole). However, when she was 4 yr old she developed a pruriginous dermatitis on her back that spread rapidly over her whole body. Initially the problem was thought to be a parasitic infection of a simple food allergy and was treated with ivermectin p.o. and antihistamine at the
human dose. No clinical improvement was seen. During this time her brother started to present with similar pruritus and dermatologic problems. In September 2003, the skin condition worsened in both chimpanzees. Clinical signs progressed to depigmentation, depilations, round erosions/ulcers, crusty keratin flakes and papules. Antibiotic treatment (Clavamox 25 mg/kg) for a pyodermatitis was initiated, but was ineffective. Corticosteroids were also prescribed and seemed improve the pruritus. After 3 mo treatment was discontinued and the chimpanzees started to scratch again.

Herpetiform dermatitis caused by a food allergy to gluten was considered as a differential diagnosis as it has been reported in humans.\textsuperscript{13} Gluten was removed from the diet for 1 mo, but no clinical improvement was seen. Repeated skin scrapings and fecal examinations were negative throughout the treatment period.

In January 2004, treatment with doramectin (Dectomax\textsuperscript{®}) p.o. once per week for 2 mo was initiated. In January 2004 the chimpanzees were anesthetized and blood collected for viral and hematologic tests and skin biopsies performed. All results were within normal limits. Tests were negative for the simian T-lymphotropic virus (STLV), SIV and \textit{Herpesvirus}. Moreover, serologic examination for \textit{Leishmania} was negative.

The biopsy results were dermatitis peri-vascular superficial comprising eosinophilus granulocyte associated to hyperkeratosis of the epidermis. Since the contact allergy could not be ruled out by the biopsy the straw was removed from the inner enclosure from the beginning of July 2004. In August 2004 we performed a second biopsy on all four chimpanzees in the group: that revealed for two of them (the borther and sister described here) chronic hyperplastic and hyperkeratotic perivascular dermatitis with focal band like/interface dermatitis in the female and with minimal eosinophilic infiltration in the male. It is important to underline that even if mites and/or eosinophilic infiltration were not found in the biopsy, scabies could not totally be ruled out.

The following differential diagnoses had to be considered: atopy, psychogen dermatitis, food allergy, drug reaction. In October 2004 the chimpanzees were anesthetized for the third time in order to perform serologic RAST test and PRICK test to check any food, inhalatory and contact allergy. The RAST test is an allergen-specific IgE antigen test to screen for an allergy (a type I hypersensitivity) to a specific substance or substances. The PRICK test is used to identify the causative allergens in an atopic individual. The test depends on the introduction of allergen extract into the dermis resulting in an IgE-mediated response that looks like a local erithema and skin swelling. A skin culture was also performed. The female was positive for \textit{Staphylococcus aureus} and a hemolytic bacillus whereas the male was positive for \textit{Klebsiella pneumoniae}; both were negative for mycotic culture and enterobacteriaceae. The Prick allergic test revealed a high reaction to milk and milk by-products and RAST test showed sensitivity to some vegetables (pineapple, tomato, apricot, peer, grapefruit), peanuts, nuts, almonds and also rice, bread and milk. According to these results the diet of the two young chimpanzees was changed and the above food items were avoided. Anti-inflammatory or antihistaminic drugs were given when serious episodes of pruritus occurred. Even with these treatments, the clinical picture did not improve. In spring 2005 the two chimpanzees and two other young chimpanzees were introduced into the group of eight adult individuals. The introduction of the two chimpanzees was slow
especially because they had already exhibited some stereotypic behaviors (finger sucking, rocking, etc.) related to problems with their earlier care. After that, they developed a strong bond with one of the keepers who was with them for the last 4 yr. In general, hand-reared chimpanzees form a strong bond with their human caregiver that substitutes for the natural mother.\textsuperscript{7} Once the introduction was complete, the pruritis and other clinical symptoms decreased and then disappeared. The skin lesions resolved as well. Currently, the alopecia has completely regressed and the two chimpanzees are fully haired.

Discussion

This case report demonstrates the possibility that factors other than the traditional parasitic causes can be involved in severe, chronic pruritis and alopecia in chimpanzees. Once introduced into the group of adults, not only were the other chimpanzees not infected, but also the disease of the two chimpanzees disappeared. The facts strongly suggest the existence of factors (prior or concurrent to mite infestation) that predisposed these chimpanzees to scabies and allowed the progression of the disease. Predisposing factors in children include neurologic and immunologic disorders, psoriasis, and various diseases (including parasitoses) that result in immunosuppression, (i.e., measles, pneumocystosis, candidiasis).\textsuperscript{1,2,11} Furthermore, in immunocompetent and immunocompromised children, topical therapy usually fails to cure crusted scabies.\textsuperscript{6,11} As young chimpanzees are highly social, the experience of abandon and isolation had made the chimpanzees’ psychologic development complicated and difficult. This is supported by the fact that their disease was solved only when they were introduced into the group of adults in a social context. In conclusion, our data suggest that alopecia in chimpanzees could be a highly complex multifactorial disorder.

ACKNOWLEDGMENTS

We thank Donata Grassi and Caterina Spiezio for providing their expertise in chimpanzees behaviour; Maria and Ruth for their dedication to the chimpanzees and for telling us Camilla and Tommy's story.

LITERATURE CITED

EVALUATION AND CONSERVATION OF INDIAN DOUBLE HUMPED CAMEL

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National Research Centre on Camel, PB No. 07, Bikaner, Rajasthan 334001 India

Abstract

Bactrian camels are reared under traditional zero input management system. Camels propagate naturally, roaming and grazing in the rangeland all the year round, without any supplementary feeding and housing except for the few working animals and females at the time of parturition. Breeding is seasonal and occurs during the winter (December to March) months. Females reach maturity at the age of 3-4 yr and the reproductive life may continue up to 16-18 yr of age. Usually calving occurs once every 2 yr. Males reach maturity at 5 yr of age and continue to breed up to 15 yr of age. No hair clipping is done in Bactrian camels; shedded wool is collected by the owners from April to June. In working camels a wooden nose peck is inserted at around 3 yr of age and then camels are trained for work. Before the arrival of winter working camels are used for transportation of fodder, fuel, wood, stones and manure etc. for a period of about 1 mo.

Hair is one of the important products from Bactrian camel, which is extensively used for manufacture of various items like shawls, coats, caps, sweaters and hand gloves etc. in the village cottage industry of this region. The average annual hair production per camel ranges from 2.5 to 4.0 kg depending upon age. Fifty-six hair samples from 16 calves (below 6 mo of age) and 40 adult bactrian camels (above 3 yr) were collected and analyzed for fiber quality attributes such as staple length, fiber diameter, and fiber diameter of different types of fiber (pure, hetero, hairy). The staple length was recorded by 10 measurements from each hair sample. Before recording of other parameters, hair samples were processed by washing for 12 hr in benzene and dried in NaOH desiccators for 24 hr. The slides were prepared using liquid paraffin and examined under 500× magnifications in the earmascope for estimating fiber diameter and percentage of different fiber types based on medullation. Three hundred observations were recorded from each slide to minimize the error. The data were analyzed by using Mixed Model Least Squares and Maximum Likelihood Programme.

Comparison of different sites (shoulder, mid-side, hump, neck and thigh) indicated significant differences (P<0.01) among most of the hair quality attributes but the differences were non-significant between the sex. The staple length was found to be highest at the hump site 13.25 ± 1.03 cm followed by neck 10.45 ± 1.15 cm, shoulder 8.38 ± 1.29 cm, mid-side 5.37 ± 1.16 cm and thigh 3.15 ± 1.44 cm. The mean fiber diameter was lowest at thigh 14.56 ± 3.56 μ, mid-side 16.38 ± 2.88 μ, shoulder 26.41 ± 3.19 μ, neck 28.90 ± 2.86 μ and hump site having the highest fiber diameter of 30.74 ± 2.54 μ. The mean fiber diameter of pure, hetero and hairy type followed the similar trend. The higher percentage of pure fiber was found in the mid-side 72.31±3.76, followed by thigh 67.41 ± 4.64, shoulder 60.52 ± 4.16, hump 59.94 ± 3.31 and neck 56.56 ± 3.73.
Comparison between two age groups revealed that the staple length of calves (below 6 mo of age) was slightly higher $8.92 \pm 1.63$ cm than the adults (above 3 yr) $7.32 \pm 0.58$ cm but mean fiber diameter was lower ($P<0.01$) $15.82 \pm 3.67$ μ in calves as compared to $30.97 \pm 1.77$ μ in adults. The staple length and mean fiber diameter indicated superiority of calf's fibre as compared to adult. The fiber characteristics of Bactrian camel such as fineness and staple length can be considered best as per the specification given by ISI. Bactrian camel produces superior quality hair in comparison to dromedary camel.

Indian double humped camels are compact, short in height with well-built robust muscular body and the body color varies from light brown to dark brown.

Biometric data were recorded in double humped camel covering 13 parameters, the Least – square means of various biometric parameters are presented in Table 1. Significant difference in body length ($P<0.05$), height at wither ($P<0.01$), face length ($P<0.05$), leg length ($P<0.01$), distance between eyes ($P<0.01$), hump circumference [front] ($P<0.01$) and muzzle diameter ($P<0.05$) were observed between the sexes. The biometric parameters will be helpful in selection of male studs as well as for breed characterization programs.

In attempt to study the adaptive mechanism of double humped camel blood samples were collected from nine dromedary (Camelus dromedarius) and six Bactrian (Camelus bactrianus) camels. Hematologic parameters include hemoglobin (Hb), erythrocyte sedimentation rate (ESR) and differential leukocyte count (DLC). Blood hematologic parameters were studied by using standard laboratory methods. Macro and micro-minerals studied were calcium (Ca), phosphorus (P), magnesium (Mg), zinc (Zn), iron (Fe), copper (Cu), cobalt (Co), manganese (Mn) and molybdenum (Mo) by atomic absorption spectrophotometer (Perkin Elmer, Norwalk, USA). Data were analyzed by student t-test. The results presented in Table 2 indicate high Hb in Bactrian camels and significant differences ($P<0.01$) in ESR between single ($1.73 \pm 0.09$mm/hr) and double humped ($2.47 \pm 0.15$mm/hr) camels. The differences were significant ($P<0.05$) for percent eosinophils and lymphocytes.

The serum Ca in dromedary camels ($9.73 \pm 1.12$ mg/dl) was significantly ($P<0.05$) lower than double humped camels ($15.09 \pm 2.26$ mg/dl. The difference in serum P was also significant ($P<0.01$) between dromedary ($5.55 \pm 0.53$ mg/dl) and double humped ($8.54 \pm 0.86$ mg/dl) camels. The level of Mg was found to be similar in single and double humped camels. The concentration of micro-minerals Zn, Fe and Cu was significantly ($P<0.01$) higher in Bactrian camels ($197.75 \pm 16.75$; $145.00 \pm 5.12$ and $187.00 \pm 7.80$ μg/dl) as compared to dromedary ($113.60 \pm 10.52$; $118.50 \pm 4.53$ and $123.00 \pm 5.33$ μg/dl) camels. No significant difference was observed in the levels of Co and Mn between dromedary and Bactrian camels. Mo could not be detected in these samples.

Higher level of Hb and Fe are likely to be associated with adaptive mechanism of the double humped camel to withstand the harsh climate of high altitude. Camel Hb has a greater affinity for oxygen than the Hb of other animals resulting in more oxygen being taken up per unit volume of red cells. The increased affinity for oxygen is a definite advantage for the animal exposed to a relative shortage of oxygen. The types of feed/ fodder available in the area also play an important role.
role as it may influence intestinal absorption and utilization of nutrients. Nutrition, environmental conditions, metabolism and genetics also influence serum mineral profiles.6,7

High mortality is being observed (1:3) in newborn Bactrian calves due to drowning in the Shayok river while crossing. This appears to be the major problem affecting the population to some extent. The camel keepers are following no specific health care practices. The important diseases are actinobacillosis, pneumonia, eye diseases associated with corneal opacity, hydropericardium and ectopic pregnancies. A total of 200 fecal samples examined were found negative for any helminthic infections. Thirty blood samples examined did not revealed any hemoprotozoan infection. As found in dromedary camel, ectoparasitic and skin diseases are not a major problem in Bactrian camels.

Bactrian camels can carry loads up to 100 kg as baggage and can work for 6-8 hr daily. Male camels are being regularly used as baggage animals in the month of October and November for transportation of fuel, wood, stones, bags and manure from agricultural fields to village houses.

Due to rapid expansion of roads, the rearing and maintenance of small population of double humped camel became unprofitable and the survival of this species in this region was endangered. The efforts must be made to conserve this endangered species.

ACKNOWLEDGMENTS

The authors thank to Indian Council of Agricultural Research, New Delhi for funding this research project.

LITERATURE CITED

Table 1. Least squares means (cm) of certain biometric parameters of Bactrian camels.

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<th>Parameters</th>
<th>Male (n=3)</th>
<th>Female (n=12)</th>
<th>Overall (n=15)</th>
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<td>Body length</td>
<td>174.00±3.80</td>
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<td>162.04±2.12a</td>
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<td>Height at wither</td>
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<td>Heart girth</td>
<td>201.66±7.22</td>
<td>196.66±3.61</td>
<td>199.16±4.03</td>
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<td>Neck length</td>
<td>95.66±4.85</td>
<td>93.75±2.42</td>
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<td>128.83±2.20a</td>
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<td>25.08±0.76</td>
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<td>46.95±1.07b</td>
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<td>Hump circumference (front)</td>
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<td>81.33±2.06</td>
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<td>Hump circumference (rear)</td>
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<td>Distance between humps</td>
<td>17.00±2.82</td>
<td>19.08±1.41</td>
<td>18.04±1.57</td>
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</table>

aSignificant $P<0.01$.
bSignificant $P<0.05$.

Table 2. Hematologic and minerals profile of dromedary and Bactrian camels.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Single humped (n=9)</th>
<th>Double humped (n=6)</th>
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<tbody>
<tr>
<td>Hb(g/dl)</td>
<td>10.75 ± 1.08</td>
<td>12.50 ± 1.17</td>
</tr>
<tr>
<td>ESR (mm/hr)</td>
<td>1.73 ± 0.09A</td>
<td>2.47 ± 0.15B</td>
</tr>
<tr>
<td>Neutrophils (%)</td>
<td>53.44 ± 0.72a</td>
<td>56.50 ± 0.57b</td>
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<td>Eosinophils (%)</td>
<td>4.12 ± 0.20A</td>
<td>6.17 ± 0.28B</td>
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<td>Lymphocytes (%)</td>
<td>35.22 ± 0.62a</td>
<td>33.00 ± 0.74b</td>
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<td>Monocytes (%)</td>
<td>3.78 ± 0.49</td>
<td>4.17 ± 0.28</td>
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<td>Calcium mg/dl</td>
<td>9.73 ± 1.12A</td>
<td>15.09 ± 2.26b</td>
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<td>Phosphorus mg/dl</td>
<td>5.55 ± 0.53A</td>
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<td>Magnesium (Mg) mg/dl</td>
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<td>3.08 ± 0.86</td>
</tr>
<tr>
<td>Zinc (Zn)µg/dl</td>
<td>113.60 ± 10.52A</td>
<td>197.75 ± 16.75B</td>
</tr>
<tr>
<td>Iron (Fe)µg/dl</td>
<td>118.50 ± 4.53A</td>
<td>145.00 ± 5.12B</td>
</tr>
<tr>
<td>Copper (Cu)µg/dl</td>
<td>123.00 ± 5.3A</td>
<td>187.00 ± 7.80B</td>
</tr>
<tr>
<td>Cobalt (Co) µg/dl</td>
<td>1.18 ± 0.47</td>
<td>1.06 ± 0.31</td>
</tr>
<tr>
<td>Manganese (Mn) µg/dl</td>
<td>18.43 ± 2.33</td>
<td>17.86 ± 3.26</td>
</tr>
<tr>
<td>Molybdenum (Mo)µg/dl</td>
<td>Very low</td>
<td>Very low</td>
</tr>
</tbody>
</table>

A,B $P<0.01$.
a,b $P<0.05$. 
LYMPHOSARCOMA IN A TOCO TOUCAN (Ramphastos toco)

Catalina Hermoza, DVM,1 Roberto Elías, DVM,2 Javier Mamani, DVM,2* and Gerry M. Dorrestein, DVM, PhD2

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Abstract

An adult, male, 450-g toco toucan (Ramphastos toco) bred in captivity was suspected of food intoxication. On physical examination, the bird was depressed, anorectic, and incoordinated. The hematology results were RBC 4.6 ×10^{12}/L, Hb 16.5 g/dl, PCV 47%, WBC 56 × 10^9/L, heterophils 9%, lymphocytes 73%, monocytes 2% and eosinophils 16%. After 10 days of treatment the bird died. At the necropsy the liver was friable with rounded edges and multiple coalescing yellow irregular foci visible on the surface. The spleen was enlarged and had similar yellow foci. Histologic examination of the liver revealed proliferation of neoplastic lymphoid cells, which expanded along the sinusoids and formed lymph nodule-like structures with a necrotic center. There was also bile duct hyperplasia. In the spleen, similar neoplastic lymphoid infiltrates with extensive necrotic areas were present.

Lymphoid neoplasia has been reported in exotic and domestic birds,1,2,4,5 and some of them have been associated with retroviruses.3,4 This is the first report of a lymphoid neoplasm in a toucan.

LITERATURE CITED

SECONDARY AMYLOIDOSIS IN A CAPTIVE ONCILLA (Leopardus tigrinus)

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Abstract

An adult female oncilla (Leopardus tigrinus) bred in a zoo was suspected of having renal insufficiency. The animal died after 7 days of treatment. On physical examination, the animal was depressed, dehydrated, and had ulcers in the oral cavity. The hematologic findings were anemia and leukopenia. The urine results were: pH 6, glucose +, bilirubin +, protein +++ and blood ++++. The serum biochemistry results were: urea 300 mg/dl and creatinine 2.5 mg/dl. At necropsy, both kidneys were enlarged, pale brown, with fine miliary whitish-yellow foci visible on capsular surface. The cut surface had similar miliary foci as well as straight whitish-yellow striations within the deep cortex. The stomach was edematous and hyperemic.

Buffered formalin-fixed tissues were stained with hematoxilin-eosin (H-E) and Congo red (CR). After determination of spiral-shape structures, the stomach was stained with Warthin-Starry stain. Kidney examination with H-E and CR revealed multifocal deposition of amyloid in the peritubular interstitium associated with tubular coagulative necrosis. The stomach had mild lymphoplasmacytic and neutrophilic gastritis with intraglandular and intraparietal cell argentophilic spiral-shape bacteria.

Secondary amyloidosis occurs in a wide variety of domestic2 and wild3,4 animals. It has been associated with chronic inflammation, infection, or neoplasia.5 Chronic lymphoplasmacytic gastritis was associated with secondary amyloidosis in cheetahs.3 Helicobacter spp. was found in cheetahs and Bengal cats with and without gastritis1,6. Secondary amyloidosis is a common cause of morbidity and mortality in cheetahs and controlling conditions such as chronic gastritis is recommended.3 This oncilla was diagnosed with secondary amyloidosis associated with mild lymphoplasmacytic and neutrophilic gastritis with Helicobacter-like organisms.

LITERATURE CITED

COMPARATIVE SERUM GLUCOSE LEVELS IN SEDATED SUIDAE AND TAYASSUIDAE

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Abstract

Introduction

Wild pigs have become more commonly exhibited in North American zoos. The suborder Suina contains two families, the Suidae and the Tayassuidae. There are thirteen species in five genera belonging to the family Suidae with members found in Europe, Asia, East Indies and Africa. The family Tayassuidae is formed by three species in two genera found exclusively in the American continent. Different protocols for chemical immobilization in these two families have been described elsewhere. The use of midazolam, butorphanol, and medetomidine (MBM) for routine sedation of pigs and peccaries has provided overall good consistent results in the greatest number of swine species at the San Diego Zoo and is one of the recommended protocols for routine chemical restraint suggested by the TAG veterinary advisor. However, hypoglycemia has been reported with the use of this anesthetic protocol. Other protocols reported for Suidae and Tayassuidae species have not reported this effect on glucose blood levels in sedated specimens, pigs or peccaries. Hypoglycemia is a problem that requires immediate attention during a sedation episode; one wild pig anesthetized with the MBM protocol died after recovery from significant hypoglycemia. Hypoglycemia is a response not expected with the use of α-2 adrenergic agonists, since they tend to inhibit the insulin release from pancreatic β cells, resulting in a reduced glucose uptake in tissue and decreased glycogen production and storage in liver (hyperglycemia). This study compares the blood glucose levels in different species of anesthetized wild pigs in captivity at the San Diego Zoo, identifies those species that are susceptible to hypoglycemia and establishes the reliability of a field diagnostic method for blood glucose.

Materials and Methods

Anesthesia reports were reviewed from 2000 to 2005 for glucose levels. Only complete records were selected for this study (convenience sample). A complete record was selected when blood glucose was reported by two measurement techniques: In-house Laboratory (hexokinase, “in-house”) with Ciba-Corning Express Plus (Diamond Diagnostics©, 333 Fiske Street, Holliston Massachusetts 01746 USA) and field testing with FreeStyle™ (“field”) glucometer (Abbott Laboratories, Abbott Park, Illinois 60064 USA) in the same anesthetic event, and where the anesthetic protocol employed was MBM. A total of N = 92 anesthetic events were selected for the study, including the following species: European wild boar (Sus scrofa, n=7), Visayan warty pig (Sus cebifrons, n=19), Bornean bearded pig (Sus barbatus, n=10), red river hog (Potamochoerus porcus, n=33), African bush pig (Potamochoerus larvatus, n=5), South African
Warthog (Phacochoerus africanus sundevalliis, n=10) and Chacoan peccary (Catagonus wagneri, n=8). Reported normal blood glucose values in domestic swine are 85-150,\(^4\) for this study blood glucose of <70 mg/dl was considered hypoglycemic. Descriptive central tendency and dispersion parameters of blood glucose levels were obtained for both measurements techniques. Kruskal-Wallis one-way ANOVA was used for determination of difference in blood glucose levels among species and a Wilcoxon rank sum test was used to identify those differences (In-Lab results). These same analyses were repeated for the blood glucose results using the Freestyle™ glucometer. A paired-t test was performed between in-house laboratory results and Freestyle™ blood glucose results in order to determine reliability of the field blood glucose method. Minitab® statistical software (Minitab Inc., Quality Plaza 1829 Pine Hall Rd, State College, Pennsylvania 16801-3008 USA) was used for the analyses.

**Results**

Table 1 shows the descriptive values for blood glucose in the different species of pigs. Kruskall-Wallis one-way ANOVA results were significantly (\(P \leq 0.05\)) different among the different species with both diagnostic methods. The Wilcoxon rank sum test identified red river hogs and African bush pigs as having blood glucose values significantly lower (\(P \leq 0.05\)) than the established minimum and different from other species of wild swine using the in-house laboratory diagnostic method while red river hogs, African bush pigs, Visayan warty pigs and South African Warthogs were found to be significantly lower than the minimum using the field technique. The in-house and field techniques were statistically different in some wild swine species (see Table 1). It is important to note that the sample populations did not follow a normal distribution, requiring the use of nonparametric statistical analyses.

**Discussion**

Hypoglycemia was seen consistently using both blood glucose diagnostic methods in two species of African wild swine belonging to the same genus (Potamochoerus sp.); red river hogs and African bush pigs. Two other species were considered susceptible to hypoglycemia using the Freestyle™ (field) glucometer; one from Africa (Phacochoerus africanus sundevalli) and one from Asia (Sus cebifrons). The findings found in the Potamochoerus sp. are consistent with clinical observations during several years of anesthetic procedures. The differences in the results using both diagnostic methods in Phacochoerus spp. and Sus cebifrons may be attributed to the small sample size and distribution curves. In these two species there was no detectable hypoglycemia using the in-house laboratory diagnostic but hypoglycemia was detected with the FreeStyle™ glucometer. This could suggest that different calibration is required for the field technique in these species. Care should be taken when interpreting results in the field for these two species. Our results rejected the hypotheses that Visayan warty pigs will also be susceptible to hypoglycemia using both methods. However, based on our clinical observations, they should still be considered susceptible until further studies with larger sample sizes are conducted. Hyperglycemia has been seen in medetomidine-ketamine treated animals, and similarly increasing the xylazine dose in tigers produced higher glucose levels. There is no physiologic explanation for why members of the genus Potamochoerus sp. suffer from hypoglycemia instead of hyperglycemia as in other species of animals.
Conclusion

Wild swine of the genus *Potamochoerus* sp. should be considered highly susceptible to develop hypoglycemia under anesthesia using the MBM anesthetic combination. The use of a field technique (Freestyle™) for the assessment of blood glucose seems to be reliable in the genus *Potamochoerus* sp. but care should be taken when interpreting results in other wild swine species. Further studies are needed to understand how glucose metabolism is influenced by anesthetic drugs. In addition, other potential factors such as individual, behavioral and environmental stressor prior to anesthesia may be affecting blood glucose during anesthesia. Current studies are being performed in red river hogs and Visayan wart pigs in order to better characterize this phenomenon. When these species are anesthetized it is strongly recommended that blood glucose levels be monitored closely in the early stages of the procedure. If hypoglycemia (<70 mg/dl) is noted, administration of 0.5-0.75 g/kg of dextrose i.v. bolus (slowly) should correct the deficit. Recheck the blood glucose hourly or just prior to recovery. Following anesthetic recovery, a small meal high in glucose-rich food items (grapes, melons, other fruits) should be offered to prevent a secondary hypoglycemic episode.

ACKNOWLEDGMENTS

Laura Keener and the staff from the Clinical Pathology laboratory, the veterinary and animal management staff at the San Diego Zoo for their help in developing anesthesia protocols for wild suina and for assistance in collecting data, Scott Larsen for reviewing statistical analyses used in this report, and Deborah Lancman, Kay Munduate and Donna Vader for assistance with medical records reviews.

LITERATURE CITED

Table 1. Description and comparison of blood glucose values obtained by in-house and FreeStyle™ glucometer in seven different species of wild swine anesthetized with medetomidine-butorphanol and midazolam at the San Diego Zoo from 2000-2005.

<table>
<thead>
<tr>
<th>Species</th>
<th>In-house laboratory (hexokinase) blood glucose results</th>
<th>Freestyle™ glucometer blood glucose results</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Min</td>
</tr>
<tr>
<td>European wild boar</td>
<td>143</td>
<td>22.4</td>
<td>95</td>
</tr>
<tr>
<td>Visayan warty pig</td>
<td>83</td>
<td>31.5</td>
<td>43</td>
</tr>
<tr>
<td>Bornean bearded pig</td>
<td>96.5</td>
<td>29.2</td>
<td>45</td>
</tr>
<tr>
<td>Red river hog</td>
<td>53.6</td>
<td>27.2</td>
<td>32</td>
</tr>
<tr>
<td>African bush pig</td>
<td>36</td>
<td>9.1</td>
<td>22</td>
</tr>
<tr>
<td>Chacoan peccary</td>
<td>74.9</td>
<td>44.1</td>
<td>47</td>
</tr>
<tr>
<td>Chacoan peccary</td>
<td>104.8</td>
<td>35.5</td>
<td>57</td>
</tr>
<tr>
<td>n=92</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aP≤ 0.05 significant difference between both blood glucose measurements.
CAPTIVE ANTEATER SURVEY IN BRAZIL

Flávia Regina Miranda, DVM,1* Rodrigo Hidalgo Teixeira, DVM, MS,2 and Catia Dejuste de Paula, DVM, MS1

1Anteater Project and São Paulo Zoo Foundation, São Paulo, Brazil; 2 Anteater Project and Sorocaba Zoo, Sorocaba, Brazil

Abstract

The anteaters belong to the Xenarthra order and are characterized by the absence of teeth, extra joint surfaces between the vertebrae and reproductive tracts and circulatory systems that are unique among mammals. There are four species of anteater and they exist only in the New World. Brazil has three of the existing species: giant anteater (Myrmecophaga tridactyla), lesser anteater (Tamandua tetradactyla) and the pygmy anteater (Cyclopes didactylus). All of these species are suffering population declines due to human growth, habitat loss, and the impact of fire, hunting and car collisions. There is an urgent need to improve in situ and ex situ conservation of these species.

In Brazil, there has been little data about the captive population. A survey was distributed to the institutions that have captive anteaters. The objective was to improve collaboration between these institutions, produce a management guide, and improve the ex-situ conservation. The survey contained questions about the species present, number of animals, management, type of animal identification, reproduction, nutrition and geographic origin. The questionnaire was sent via fax or email to 15 institutions, members of the Brazilian Zoo Association, from which 87% answered. From the questionnaire, we were able to determine that the number of captive animals in 2003 were 39 giant anteater (20 males, 18 females and 1 undetermined) in 12 institutions and 23 lesser anteaters (12 males, 10 females, 1 undetermined) in nine institutions. There are no pygmy anteaters maintained in captivity, although it is a common free living animal in Brazil’s northern regions. Pygmy anteaters are difficult to maintain in captivity.

The main form of identification is transponders, and almost 40% of the institutions use no identification. The giant anteaters are maintained mainly in pairs; only one institution has succeeded maintaining a group. Some animals are maintained alone due to the lack of a mate. The lesser anteater is maintained equally alone, in pairs or in groups. The number of birth was 06 giant anteater and 04 lesser anteaters. The mortality in the first year is very high, about 65% of the giant anteaters and 50% of the lesser anteaters. Some of the animals where hand raised and the diet used was mainly composed of cow’s milk or milk used to hand raise domestic pets, egg yolk and diverse supplements. There is no commercially formulated diet for adult anteaters in Brazil so the institutions developed a liquid diet that differs from each place and the main components are dog food, bovine meat, egg, termites, honey, milk, and fruit like banana and papaya. Others components vary greatly between the institutions. The zoos usually receive animals from the wild with health problems or for hand rearing.
In 2004, seven giant anteaters and 13 lesser anteaters were brought into zoos. There was no significant distinction between seasons. At the end of 2004 there were 39 giant anteaters (21 males, 17 females and 1 undetermined) and 25 lesser anteaters (15 males, 10 females). The veterinary management was very poor. Little data was collected such as diagnosis of diseases and cause of deaths.

This questionnaire was only done for 2004, but will be continued annually. Although it was done for only 1 yr, we were able to see that the anteater populations didn’t have a significant increase, the infant mortality was high, and there are a lot of wild animals coming into the captive population. Management and veterinary care were also deficient. This study will continue to be done but it is already clear that there is a need for professional collaboration, research and conservation actions with the anteaters in Brazil.
Toxoplasma gondii IN AN AFRICAN CRESTED PORCUPINE (Hystrix cristata)

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Abstract

An adult female crested porcupine (Hystrix cristata) was evaluated for an acute onset of head tilt, circling, and ataxia. She was found dead in animal holding 2 days after exhibiting clinical signs of a neurologic disorder. Histopathology of brain tissue revealed protozoal cysts indicating that a protozoal encephalitis was the cause of death. Immunohistochemical staining of brain tissue for Toxoplasma gondii was strongly positive. The adult male in the same enclosure has demonstrated similar clinical signs for the past 3 yr. T. gondii has not been reported in this species to date.
ANALYSIS OF HUMORAL RESPONSE TO PROPHYLACTIC INOCULATION OF A H5N2 VACCINE IN EXOTIC AVIAN SPECIES IN THE UNITED ARAB EMIRATES

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Abstract

As a prophylactic measure against the threat of avian influenza in the Middle East, 130 healthy birds, representing five orders (Anseriformes, Ciconiiformes, Charadriiformes, Galliformes and Gruiformes) and 11 species were inoculated using a commercially available inactivated H5N2 vaccine. Pre- and post-vaccination titres were determined using hemagglutination inhibition technique towards H5N2 antigen. In addition, five non-vaccinated animals were used as controls throughout the study.

Two doses of the vaccine were administered subcutaneously in all animals: at day 0 and day 30. Serology at day 0 confirmed that all birds were negative prior to inoculation. Post-vaccination antibody titres were subsequently evaluated at day 30 and day 60. Vaccine doses administered were weight dependent: birds with a body weight less than 400 g received a dose of 0.25 ml, birds between 400 g and 2 kg were given 0.5 ml, whereas heavier individuals received 1 ml.

In some species, one dose proved sufficient to produce 100% seroconversion, although the second booster stimulated higher antibody titres. Stone curlews (Burhinus oedicnemus) were the only species that failed to show good levels of seroconversion. Although the reason for this is not readily apparent, an unidentified immunosuppressive factor(s) is suspected.

Neither adverse reactions to the vaccine employed, nor vaccination related mortality were reported during our trial.

Although post-vaccination experimental live virus challenge of birds in this study was not possible, one can surmise that the attained titres are protective owing to the fact that they compare favourably to established protective titres in domestic poultry.
CONDITION SCORING OF THE EUROPEAN HARBOUR PORPOISE USING DIRECT AND INDIRECT TECHNIQUES

Helen Provan, BVM&S MSc MRCVS,* Matthew W. Perkins, BSc,2 R. Deaville, BSc,3 and Paul D. Jepson, BVMS, PhD, MRCVS4


Abstract

The United Kingdom has few short-term and no long-term facilities for the treatment and rehabilitation of stranded cetaceans. As a result, clinicians and rescue teams must rely purely on clinical examination and, when available, simple diagnostic tests at the scene of a stranding. Condition (nutritive) scoring can be a valuable prognostic indicator but is generally subjective. Provided references are available, the implementation of ultrasound to measure blubber thickness would help to standardize condition scoring. The Lean Meater Back Fat Ultrasound machine is compact and easy to use and therefore ideal for stranding situations of small cetaceans where bulky equipment would be unpractical. Calibration of this machine was investigated by measuring the level of agreement between blubber thickness measured directly and the thickness measurements obtained with the ultrasound machine on fresh cetacean carcasses examined at the Institute of Zoology (Zoological Society of London). Reference ranges of dorsal, lateral and ventral blubber thickness were calculated for UK-stranded harbour porpoises (Phocoena phocoena) using a dataset of standardized blubber measurements and other findings from postmortem examinations of UK-stranded porpoises conducted between 1990 and 2004. The reference ranges took into account age, gender, season and location of stranding and cause of death (as determined by post mortem).

ACKNOWLEDGMENTS

The authors thank British Divers Marine Life Rescue for the Donation of the Renco Lean Meater ultrasound machine and the Whale and Dolphin Conservation Society for their assistance with funding.
SEGMENTAL INTESTINAL ATRESIA IN HELMETED GUINEAFOWL (*Numida meleagris*) CHICKS

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**Abstract**

Atresia or stenosis of the intestinal tract is uncommon in mammalian species and rarely reported in avian species.1 Atresia is the complete occlusion of the lumen and stenosis implies incomplete occlusion. Atresia is further classified as membrane atresia, in which the obstruction is formed by a simple membrane; cord atresia where the blind ends of the intestine are joined by a cord of connective tissues; and blind end atresia that has a completely missing segment of intestine and possibly the mesentery. Segmental ischemia from a mechanical lesion of the blood supply (ischemia) such as from a volvulus, intussusception, or malrotation is purported to be the primary cause.1,2 This etiology has been supported by experiments done in lambs, dogs, rabbits, and chickens where a persistent occlusion of the blood supply of a fetal intestine results in atresia.3 In domestic mammals, atresia is most commonly described in equine, bovine, and porcine species. In some of these cases, there is a suggestion of a heritable condition, as atresia can be identified back along common breeding lines.2

With the exception of the experimentally induced lesions of chickens, no other reports are found of intestinal atresia of avian species.3 One, and possibly two, breeding pairs of helmeted guineafowl (*Numida meleagris*) produced several clutches of chicks that have died shortly after hatching. These chicks, three of which were examined, had segmental intestinal atresia at various levels. One had a focal colonic atresia at the level of the cloaca. There was no connection between the end of the large intestine to the cloaca. The intestinal section was greatly dilated. In this chick, the large intestinal atresia resulted in extensive damage to the kidney, most likely due to the enlarging mass of the intestine. A second guinea fowl had the lesion within the cloaca, where the closure was within the cloaca close to the level of the vent (coprodeum). The large intestinal blind end into the cloaca was lined with mucosal epithelium and submucosal tissue. There is no opening or connection through the vent. The cloaca had developed and a bursa of Fabricius was recognized. Again, the intestinal sections were greatly dilated with intraluminal amorphous material. A third guinea fowl chick had a lesion most suggestive of cord atresia, with a connection from the cloaca to the vent by a thin remnant of muscular tunic connecting the coprodeum and the proctodeum. In this chick, there was also no connection between the ventriculus and small intestine. On this third chick, there was also an apparent cardiac lesion in that the cardia atria were bilaterally dilated. No specific lesions were noted of the heart with the exception of the atrial dilation. No further cases have been identified in the next breeding season.
LITERATURE CITED

DISSEMINATED LYMPHOSARCOMA IN A GIANT ANTEATER (*Myrmecophaga tridactyla*)

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Abstract

The giant anteater (*Myrmecophaga tridactyla*) is a typical neotropical mammal, and in spite of being maintained in captivity in zoos in South America and other parts of the world, captive populations are small, and medical knowledge of the species is scarce.

This paper reports a case of disseminated lymphosarcoma in an adult male giant anteater from the City Zoo of Curitiba, State of Parana, Brazil. The animal came from the wild as an adult and lived in the zoo for 3 yr.

No clinical signs were noticed prior to death, except for slight inappetence. The animal was necropsied immediately after death and pale yellow or white masses of various sizes were found in the heart, liver, and lymph nodes. The most significant gross lesion was found in the heart. Samples of the affected tissues were collected and preserved in a 10% formalin solution. After fixation the tissues were routinely processed for microscopic examination using hematoxylin plus eosin.

In the heart, the histologic examination revealed multifocal areas of neoplastic cells, with a high nucleus/cytoplasm ratio and evident nucleoli, gross nuclear cromatin, and one to three mitotic figures in each microscopic field. The cells were infiltrated between the cardiac muscle fibers, without the presence of a fibrous capsule. Proliferation of two lymphoid cell populations was identified, with moderate pleomorphism between them – histiocytic and lymphoblastic. The same kind of neoplastic tissue was present in samples of liver and lymph nodes.

Disseminated lymphosarcomas are well documented in domestic animals, but this is the first Brazilian report in a giant anteater (*Myrmecophaga tridactyla*).
VITAMIN D₃ LEVELS IN WILD AND CAPTIVE TUATARA (Sphenodon punctatus): A CASE STUDY ON THE MANAGEMENT OF HYPOCALCEMIA IN PREGNANCY

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Abstract

Introduction

Tuatara are the last extant members of the suborder Sphenodontia. They are now limited to a few off shore islands in New Zealand where they live in burrows in coastal forests or scrub. They are most active between the temperatures of 15°C and 18°C. While they have been seen foraging at 7°C, they can cease feeding, retreat below ground and become torpid. In the wild, diet consists of mixed invertebrate and small vertebrate prey items.¹

Tuatara become sexually active between approximately 11-13 yr of age. Females of this species lay clutches of an average of 11 eggs roughly every 4 yr. Vitellogenesis takes many months, mating occurs in autumn and egg laying occurs about 2 mo following emergence from torpor in the spring.¹

While appearing morphologically similar to lizards, comparatively little is known about their physiology. This study was undertaken in response to two clinical cases of hypocalcemia in gravid tuatara housed at Chester Zoo, UK.

Case Report

A group of young tuatara was donated to Chester Zoo in 1994 (five female and three male). From 1994 to 2004 they were housed in an indoor enclosure and were exposed to natural daylight, through a UV opaque roof. Diet consisted of invertebrate prey, gut-loaded and dusted with a proprietary calcium supplement and occasional whole rodent prey items. No ultraviolet (UV) lights or vitamin D supplementation were used.

Eggs were found in the enclosure for the first time in summer 2004 indicating that at least one of the females had become sexually mature. Age range of females at this time was 17-20 yr.

In early winter 2004, one female exhibited poor muscle tone and appeared to be moribund. Radiography revealed shelled eggs and mild to moderate osteomalacia. Blood calcium was low: 0.69 mmol/L (ref range 2.18-5.79 mmol/L¹). Demeanor and muscle tone improved rapidly with parenteral administration of calcium borogluconate and a presumptive diagnosis of hypocalcemia precipitated by egg production was made.
The remaining animals were also radiographed and blood sampled. Sample volume was limited therefore levels of total blood calcium and the vitamin D₃ metabolite 25-hydroxycholecalciferol (25(OH)D₃) were prioritized (see Table 1). All but one of the females were found to be gravid and one showed signs of weakness and muscle fasciculations that resolved on parenteral administration calcium borogluconate.

The asymptomatic animals were given a prophylactic dose of calcium glucobionate (200 mg/kg) orally and returned to their burrows to continue hibernation/torpor. The remainder were kept warm and given oral calcium and vitamin D supplementation for 2 mo before being allowed to return to torpor.

All four gravid females laid their eggs without problems between May and June 2005. Radiographic evaluation and blood sampling was repeated during summer 2005 (Table 1). Calcium levels were within normal range for tuatara¹ and to date all the animals remain in good health.

Discussion

Hypocalcemia associated with egg production is well documented in reptiles. The affected animals usually have marginal access to calcium and the demands of vitellogenesis can precipitate a hypocalcemic crisis.³

Tuatara nutrition at Chester Zoo was reviewed. Using requirements for other reptiles as a guide, dietary calcium and phosphorus levels were felt to be adequate and vitamin D deficiency was suspected.

The serum obtained in winter 2004 and summer 2005 were analyzed for 25(OH)D₃ levels at Manchester Children’s Hospital. Unfortunately this laboratory was unable to handle very small sample sizes and results were obtained for only half of the animals (Table 1).

In the absence of published values from wild tuatara this data were difficult to interpret. Mean serum 25(OH)D₃ values for reptiles kept in their natural environments can vary widely between suborders ranging from 8.12 ng/ml in the desert tortoise (Gopherus agassizii) to 150 ng/ml in green iguanas (Iguana iguana).⁴

Serum from six adult male and six adult female animals sampled in the field during the summer months were obtained from Victoria University, Wellington, New Zealand. These were analyzed at Steroid & Immunobiochemistry Unit, Canterbury Health Laboratories, New Zealand and data are presented in Table 2.

There was a trend towards slightly lower vitamin D levels in our captive tuatara in summer when compared to their wild counterparts at the same time of year, however this difference was not significant. By contrast, the captive winter values were significantly lower than both wild and captive summer levels (P<0.05). In the absence of wild winter values, the serum levels <1.5
ng/ml seen in the captive animals in winter are difficult to interpret but could be consistent with a vitamin D deficiency.

The marked increase in 25(OH)D₃ levels seen between winter 2004 and summer 2005 in the captive animals must have been the result of vitamin D obtained from the whole vertebrate prey as no UV light or artificial vitamin D supplementation were given and invertebrate prey is deficient in this vitamin. Our data thus provides evidence that tuatara can use oral sources of vitamin D. Tuatara are know also to be capable of maintaining adequate calcium homeostasis without access to oral sources of vitamin D. UV and calcium supplementation alone is the treatment of choice for young tuatara with nutritional secondary hyperparathyroidism that are being fed a exclusively invertebrate diet.²

Conclusions

The first data on 25(OH)D₃ levels in wild tuatara are presented here. It is expected that levels will vary with season as is seen in captive tuatara and hence further studies including data from torpid tuatara are needed. While these would be difficult to achieve in truly wild populations data from animals kept in naturalistic enclosures in New Zealand would be welcomed.

Comparisons of winter (torpid) and summer (active and feeding) vitamin D levels in this study and successful treatments of nutritional secondary hyperparathyroidism using calcium supplementation and UV light alone, demonstrates that tuatara can use both sources to achieve calcium homeostasis.

Egg production however can produce a significant threat to calcium homeostasis. Clinical signs were apparent at blood calcium levels below 2.0 mmol/L. In two out of five study animals, the dietary D₃ obtained by feeding occasional vertebrate prey was insufficient to allow for reproductive demands.

A combination of increased dietary D₃ and access to UV light should prevent this occurring in the future.

ACKNOWLEDGMENTS

Thanks to Prof. Charles Daugherty, Nicola Nelson & Sue Keall of Victoria University (Wellington) New Zealand for providing the serum from the wild tuatara, Brett Gartrell, wildlife veterinarian at Massey University (Palmerston North), and Janine Shaw, Section Leader, New Zealand Veterinary Pathology Laboratory, (Palmerston North) for arranging and performing the analysis. Isolde McGeorge, Team Leader reptile section Chester zoo for care and information on the Chester group, and Steve Unwin, veterinary officer Chester Zoo, and Richard Jakob-Hoff, senior veterinarian Auckland Zoo, for their help and advice.

LITERATURE CITED

Table 1. Total serum calcium and 25(OH)D₃ level for each tuatara both for the winter and summer.

<table>
<thead>
<tr>
<th>Captive Tuatara</th>
<th>November 2004 (winter – torpid)</th>
<th>June 2005 (summer – active/feeding)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total serum calcium (mmol/L)</td>
<td>25 (OH)D₃ (ng/ml)</td>
</tr>
<tr>
<td>Tomatoᵃ</td>
<td>0.69</td>
<td>n/a</td>
</tr>
<tr>
<td>Redᵇ</td>
<td>0.88</td>
<td>n/a</td>
</tr>
<tr>
<td>Marmite</td>
<td>2.09</td>
<td>&lt;1.5</td>
</tr>
<tr>
<td>Pixie</td>
<td>2.11</td>
<td>1.5</td>
</tr>
<tr>
<td>Mustard</td>
<td>2.11</td>
<td>&lt;1.5</td>
</tr>
<tr>
<td>Titch</td>
<td>2.60</td>
<td>n/a</td>
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<tr>
<td>Mean Standard</td>
<td>1.75</td>
<td>&lt;1.5</td>
</tr>
<tr>
<td>Deviation</td>
<td>0.77</td>
<td>n/a</td>
</tr>
</tbody>
</table>

ᵃDenotes animals showing clinical signs. Range for serum calcium of wild females in summer 2.18-5.69 mmol/L (n=10).

Table 2. 25 hydrocholicalciferol (25(OH) D₃) serum levels in wild tuatara taken in summer.

<table>
<thead>
<tr>
<th>Wild Tuatara</th>
<th>Mean (ng/ml)</th>
<th>Range (± 2 SD)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females (n=6)</td>
<td>56.8</td>
<td>25.2 – 88.8</td>
<td>15.9</td>
</tr>
<tr>
<td>Males (n=6)</td>
<td>40.9</td>
<td>19.6 – 62.4</td>
<td>10.7</td>
</tr>
<tr>
<td>Both sexes (n=12)</td>
<td>48.8</td>
<td>18.0 - 78.8</td>
<td>15.4</td>
</tr>
</tbody>
</table>
USE OF ORAL HYPOGLYCEMIC DRUGS FOR THE MANAGEMENT OF DIABETES MELLITUS IN PROSIMIANS

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Abstract

Three ring-tailed lemurs (Lemur catta) and one Bengal slow loris (Nycticebus coucang bengalensis) were diagnosed with diabetes mellitus. The diet of each animal was modified to reduce sugar content. For management reasons, animals were treated with oral hypoglycemic drugs rather than exogenous insulin. Drugs used alone, or in combination, included glipizide (GlipiZIDE, Sandoz, Inc., Broomfield, Colorado 80020 USA; 0.38 – 2 mg/kg p.o. b.i.d.), metformin hydrochloride (Mutual Pharmaceutical Company, Inc., Philadelphia, Pennsylvania 19124 USA; 48 mg/kg p.o. b.i.d.), and acarbose (Precose®, Bayer Pharmaceuticals Corporation, West Haven, Connecticut 06516 USA; 1.9 – 3.7 mg/kg p.o. b.i.d.). Parameters used to evaluate glycemic control included urine glucose, blood glucose, serum fructosamine, glycosylated hemoglobin,1 serum insulin, and serum insulin-to-glucose ratio (I:G). Routine monitoring of glycemic control and alteration of drug therapy for each animal is ongoing.

During treatment with glipizide, glycemic parameters improved in the loris and Lemur 1 (initial I:G of 31 and 28, respectively). However, glycemic parameters did not improve in Lemur 2 and Lemur 3 (initial I:G of 1 and 5, respectively) when treated with glipizide, metformin, and/or acarbose. Monitoring serum insulin and I:G in diabetic prosimians may be valuable for predicting response to certain classes of hypoglycemic drugs. Oral hypoglycemic drugs that stimulate insulin release and/or improve peripheral insulin sensitivity will be most effective in patients with adequate endogenous insulin and normal or high insulin-to-glucose ratio (Lemur 1 and loris). Normal reference ranges for fructosamine, insulin, and I:G in prosimians would be helpful in managing clinical cases of diabetes in these species.

LITERATURE CITED

COLLABORATIVE VETERINARY TRAINING: HEALTH MANAGEMENT AND CAPACITY BUILDING FOR AFRICAN PRIMATE SANCTUARIES

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Abstract

The Pan African Sanctuary Alliance

The Pan African Sanctuary Alliance (PASA), founded in 2000, is committed to providing the best facilities and care possible to captive African primates in Africa, while working towards the protection and conservation of the species in the wild.

Many sanctuaries operate in or protect national parks in Congo, Gabon, Nigeria, Uganda, Guinea, Sierra Leone and Gambia, while others in Cameroon, Zambia, Kenya and DRC coordinate with authorities to enforce wildlife protection laws. Each sanctuary is community based and dedicated to local employment and enterprise, and PASA members invest a combined $US 2.51 million into local economies each year through salaries, health care, education and the purchase of goods and supplies. As a result, PASA members enjoy a reputation for quality animal welfare and conservation that factors in the needs and concerns of the human community.

Increasing Sanctuary Veterinary Capacity: Building a Bridge Between Rehabilitation, Welfare, Reintroduction and Conservation

PASA sanctuaries offer a ‘portal’ into the wild under captive situations - a unique opportunity to assess and manage disease outbreaks before they spread, and this opportunity can only be maximized by collaboration with others working in the field. In addition, PASA sanctuaries are developing plans to reintroduce animals into the wild.

Current partners in this Initiative are: Pan African Sanctuary Alliance (PASA), North of England Zoological Society (NEZS), Zoological Society of London (ZSL), Great Ape Health Monitoring Unit (GAHMU), Liverpool School of Tropical Medicine (LSTM), Davee Centre for Epidemiology and Endocrinology, Lincoln Park Zoo.

PASA, in cooperation with NEZS, ZSL and most of the other project partners have already developed other project components including:

(2) Creation of a Primate Veterinary Healthcare Manual in both English and French, hardcopy and on CD, freely available to anyone working with primates in Africa

(3) Conducting field pilot programmes in disease investigations with GAHMU and LSTM, as a basis for a larger scale project

(4) Organisation of Defra-funded African Primate Reintroduction Workshop, held in April 2006, with IUCN, to review and refine specific protocols for release of rehabilitated primates from PASA sanctuaries

(5) Individual sanctuaries involved with local communities in ongoing dialogue regarding reintroduction plans

(6) NEZS has operated staff education exchanges (veterinary and husbandry) with PASA sanctuaries since 2003.

This new initiative aims to build on this work to establish high quality, local veterinary capacity in Africa to support the reintroduction of primates by:

- Building capacity by recruitment and extensive training to African wildlife veterinarians in preventive health, disease investigation, health monitoring and risk assessment techniques in wild and captive primates as part of reintroduction programs.
- Developing non-invasive monitoring techniques for significant and emerging infectious diseases of both animals and human staff in sanctuaries, in pre-release quarantine and for post-release monitoring.
- Developing an information sharing process between PASA sanctuaries, international research institutions, zoos and national wildlife administrators to improve procedures for reintroductions.
- Establishing sanitary guidelines to be implemented within sanctuaries in preparation for reintroduction programmes.

This project introduces new elements such as the Great Ape Health Monitoring Unit (GAHMU), which is housed at the Robert Koch Institute in Germany. GAHMU was established in 2004 in order to provide veterinary and diagnostic support to great apes projects through Africa and Asia. Even though GAHMU is focused on health problems in wild great apes, it offers diagnostic support to this PASA initiative and has been involved in previous veterinary training done within PASA including workshops, individual sanctuary diagnostic programmes etc. GAHMU operates in co-operation with the Wildlife Conservation Societies ‘Field Veterinary Programme’ and the ‘Mountain Gorilla Veterinary Project’. This network aims at understanding diseases and disease transmission in wild great apes.
The responsibilities of the various partners will be:

(1) NEZS will be project leader and central co-ordinator for all parties; including arranging and co-ordinating advertising for employment of two Veterinary Co-ordinators; consultation on selection, instruction, and assessment of six Veterinary Trainees;

(2) GAHMU will be running routine laboratory diagnostics and outbreak investigation.

(3) ZSL will provide logistic and technical project support; consult on selection, instruction and assessment of Veterinary Co-ordinators and Veterinary Trainees.

(4) PASA will supervise drafting and implementation of the Management Plan for Sanctuary Reintroductions in cooperation with IUCN in April 2006. They are involved in all stages of this project, including purchasing of veterinary equipment, implementation and running of annual veterinary workshops, coordination between sanctuaries and liaising with regional and national governments. An existing relationship with Davee Centre for Epidemiology and Endocrinology at Lincoln Park Zoo (Chicago, Illinois USA) will contribute to in situ training of epidemiology and disease risk analysis.

PASA members in Cameroon and Democratic Republic of Congo (DRC) will serve as host organizations; others will provide diagnostic samples, logistic support, and veterinary staff, where available. The 14 sanctuaries based in the eight host countries are:

- Limbe Wildlife Centre (Cameroon) – veterinary hub, workshop host
- Lola Ya Bonobo Sanctuary, (Kinshasa, DRC) – veterinary hub, workshop host
- HELP-Congo, Tchimpounga (Rep. Congo), Tacugama (Sierra Leone), CWAF, Sanaga Yong (Cameroon), Pandrillus, CERCOPAN (Nigeria), Centre for Chimpanzee Conservation (Guinea), Ngamba Island (Uganda), Projet Protection des Gorilles (Gabon and Rep Congo), Chimpanzee Rehabilitation Association (Gambia)
- PASA members in other countries will play a support role.

(5) Liverpool School of Tropical Medicine will provide in-situ parasitologic analysis of collected blood and fecal samples, plus in-situ training in these techniques to the veterinary trainees. They will also provide a logistic support and advisory role.

Conclusions

The transformation of PASA sanctuaries over the last 5 yr from rehabilitation and welfare centres for orphaned African animals, to catalysts for conservation in their regions has been impressive and successful. The current project is seen as one of the most important components of the increased conservation role PASA is playing on most of its sites.
THE EFFECT OF BEHAVIORAL TECHNIQUES TO PROMOTE THE RESUMPTION OF OVARIAN CYCLICITY IN A FEMALE CAPTIVE CHIMPANZEE (Pan troglodytes)

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Abstract

Environmental and behavioral enrichment techniques used with captive wild animals have become important for improving the quality of life and the reproductive performance of several species. The evaluation of the techniques should be done combining behavioral and hormonal parameters. The best way to measure hormones for this purpose is to use non-invasive techniques such as fecal hormone analysis. The aim of this work was to apply enrichment techniques to treat an acyclic captive female chimpanzee (Pan troglodytes) kept at the Sao Paulo Zoo, and to monitor the effects through the analysis of behavioral, hormonal and physical (perineal tumescense) aspects. The first phase lasted 60 days and included 80 hr of behavioral observations through ethograms obtained by the focal sampling method and simultaneously collecting daily fecal samples in order to measure the levels of cortisol and estradiol. The perineal tumescense was subjectively scored. The aim of this phase was to characterize the current hormonal, behavioral and perineal patterns before the introduction of the enrichment techniques. The second phase was characterized by the introduction of the enrichment techniques followed by another 80 hr of the same analysis of behavioral, hormonal and perineal aspects previously described. The second phase also lasted 60 days. The results of the first phase showed a clear behavioral dysfunction with a high frequency of stereotypic (abnormal) behaviors associated with high levels of cortisol and low levels of estradiol followed by the absence of the ovarian cycle. In the second phase the results showed a marked reduction in the frequency of stereotypic behaviors after the introduction of the enrichment techniques, followed by the resumption of the ovarian cyclic activity demonstrated by the perineal tumescense patterns and fecal estradiol profile. In this phase the fecal levels of cortisol presented an initial rise followed by a marked reduction to significant and sustained lower levels. In conclusion, our results strongly suggested that the enrichment techniques were efficient to treat the non-cyclic condition of this female chimpanzee, promoting a reduction of the stress level and resumption of the ovarian cyclicity.
SURGICAL TREATMENT OF ACUTE LENS RUPTURE BY PHACOEMULSIFICATION IN A PATAS MONKEY (Erythrocebus patas)

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Abstract

A 22-yr-old female captive Patas monkey (Erythrocebus patas) (6.08 kg) presented with an acute onset of unilateral, left sided, bluish ocular lens discoloration. After 6 days of observation, the clinical signs progressed into a hypermature cataract, vomiting, ocular discomfort and abnormal head movement. The monkey would place the left side of its face against the wall or floor, and apply pressure onto it by tipping its body forward.

The monkey was anesthetized with a ketamine (KetaVed, Phoenix Scientific Inc., St. Joseph, Missouri 64503 USA) medetomidine (Domitor, Pfizer Animal Health, Exton, Pennsylvania 19341 USA) combination and maintained on isoflurane (IsoSol, Vedco Inc, St. Joseph, Missouri 64507 USA, 2-3%). The monkey was diagnosed with spontaneous equatorial lens rupture of the left eye. Diagnostic techniques included measuring the intraocular pressure with a Tonopen tonometer and dilating the pupil to observe the lens with a slit lamp and a binocular indirect ophthalmoscope. Due to expulsion of lens protein, the left eye developed secondary cataract, glaucoma, and uveitis. The monkey’s right ocular lens contained a few small microscopic opaque lesions, but these were insignificant findings. Temporary relief was given by applying dorzolamine hydrochloride (Trusopt, Merck Sharp & Dohme, Whitehouse Station, New Jersey USA; 2% solution, 1-2 drops into left eye, b.i.d.).

The following day the monkey was treated with a standard phacoemulsion procedure1 as blood samples and radiographs were negative for other systemic disorders. The lens capsule was left in place, as it would not decrease vision. The monkey was given meloxicam (Metacam, Boehringer & Ingelheim, St. Joseph, Missouri 64506 USA; 0.1 mg/kg p.o., s.i.d.) injected into grapes for 2 days for pre-surgical pain removal. During anesthesia the monkey was given lactated ringer’s solution (Lactated Ringer, Hospira Inc, Lake Forest, Illinois 60045 USA) and ampicillin (Ampicillin, American Pharmaceutical Partners Inc., Schaumburg, Illinois 60173 USA; 19.9 mg/kg i.v., s.i.d.) as a tracheal lesion was made by the endotracheal tube. As the monkey is not trained to receive injections, the monkey was continued on topical neomycin polymyxin B sulphate (Bausch & Lomb Incorporation, Tampa, Florida 33637 USA; 2 drops topically, b.i.d.), and amoxicillin trihydrate (Amoxicillin, Ranbaxy Pharmaceuticals Inc., Jacksonville, Florida 32216 USA; 11 mg/kg, p.o., b.i.d.). Both were given for 7 days. The monkey stayed 4 wk in postoperative solitary confinement to prevent traumatization of the eye and ocular wound. As previous signs of discomfort disappeared, the meloxicam treatment which had begun 2 days before surgery was discontinued on day 22 post surgery. Treatment considerations included age (geriatric monkey), recovery time, and additional postoperative
treatment. Enucleation was not chosen as it would not have allowed her to regain her left eyes function, thereby decreasing the monkey’s comfort level within its group. Future complications include intractable glaucoma and retinal detachment.

ACKNOWLEDGMENTS

The author would like to thank the Simonyi Foundation for his scholarship at Woodland Park Zoo, Dr. Tom Sullivan for his support of Woodland Park Zoo, and Dr. Darin Collins and Kelly Helmick for knowledge and guidance on the subject matter.

LITERATURE CITED

PROPHYLACTIC TREATMENT OF REPTILE AMOEBIASIS WITH METRONIDAZOLE

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Abstract

Entamoeba invadens is the etiologic agent of amoebiasis in reptiles. This parasite has a direct life cycle (fecal-oral) and is very pathogenic with high morbidity and mortality, although this may vary according to the reptilian species involved. The present report describes the successful prophylactic use of a particular dosage regimen of metronidazole in order to control reptile amoebiasis in the Zoo of Antwerp.

Materials and Methods

For many years, the Royal Zoological Society of Antwerp (RZSA) has been housing reptiles with a significant number of deaths by amoebiasis (Table 1). In all cases a standardized necropsy protocol has been carried out. Macroscopically, lesions consisted of necrotizing enteritis and/or liver abscesses, and in wet or histopathologic preparations of these lesions the amoebal vegetative form or cysts could be observed. Data in 1994 demonstrated that the problem of amoebiasis was increasing. Therefore, prophylactic treatment of snakes started on 8 February 1994 and similar observations 4 yr later led to the start of medical prophylaxis in the other reptiles (tortoises, varanes, other lizards) on 1 April 1998.

For practical reasons a system with two different capsules (A and B) was used. Capsule A contains 100 mg metronidazole (Flagyl – Aventis Pharma, Pleinlaan 9, 1050 Brussels, Belgium) and 67 mg CaCO₃, and capsule B 20 mg metronidazole and 83 mg CaCO₃. Capsules A are administered to big snakes and capsules B to all other reptiles. The dosage regimen is given in Table 2.

For statistical analysis a generalized linear model with binomially distributed error term is fitted to the yearly number of deaths given the number at risk, including as covariate a binary variable expressing whether the year appeared before or after treatment commenced. The year when treatment started is not included in the analysis.
Discussion and Conclusion

Amoebae can be found in fecal material of reptiles without any clinical or pathologic symptoms (e.g., *Entamoeba invadens* is only occasionally pathogenic in turtles⁵). However, the patients described in this study showed gross necropsy lesions in which amoebae were demonstrated.

For the treatment of clinical amoebiasis many authors describe metronidazole dosages ranging from 25-275 mg/kg body weight once or for 1 to 7 days, with repetitive intervals of 1-3 wk for 2-3 treatments.¹-⁴,⁷ On the other hand, data on chemoprophylaxis are scanty. According to Soulsby,⁶ tetracycline at 400-800 mg/m body length has prophylactic activity.

Since metronidazole has proven activity against amoebae, we decided to develop a practical regimen that could be effective in the long run. The calculated dosages per kg body weight lie in the range of the therapeutic ones described by the different authors, only the prophylactic treatment intervals differ (Table 2). The death rate by amoebiasis decreased markedly 1 yr after the prophylactic treatment started and remains very low after 10 and 6 yr of chemoprophylaxis in snakes and other reptiles respectively.

The ratio of the odds of deaths before and after treatment equals 10.45 (95% CI : 4.11-26.53) for the snakes and 10.76 (95% CI : 2.55-45.44) for the other reptiles. Both odds ratios are significantly higher than 1 and indicate that for both groups animals were more likely to die from amoebiasis before prophylactic treatment started.

Obviously, chemoprophylaxis has to be strengthened by strict hygiene. Since the same hygienic measures had been implemented during the entire duration of the present study, it can be concluded that the metronidazole prophylactic treatment played a key role in the control of clinical and lethal amoebiasis.

LITERATURE CITED

### Table 1. Number of snakes and other reptiles and the respective number of deaths due to amoebiasis at the Royal Zoological Society of Antwerp.

<table>
<thead>
<tr>
<th>Year</th>
<th>Snakes</th>
<th>Other reptiles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Amoebias</td>
</tr>
<tr>
<td>1987</td>
<td>80</td>
<td>5</td>
</tr>
<tr>
<td>1988</td>
<td>71</td>
<td>5</td>
</tr>
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<tr>
<td>2004</td>
<td>48</td>
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### Table 2. Prophylactic regimen of metronidazole in reptiles at the Royal Zoological Society of Antwerp.

<table>
<thead>
<tr>
<th>Reptiles and body weight</th>
<th>Metronidazole (mg)</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big snakes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2 kg</td>
<td>100</td>
<td>Monthly</td>
</tr>
<tr>
<td>2-4 kg</td>
<td>200</td>
<td>Monthly</td>
</tr>
<tr>
<td>4-6 kg</td>
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<tr>
<td>6-7 kg</td>
<td>400</td>
<td>Monthly</td>
</tr>
<tr>
<td>&gt;7 kg</td>
<td>500</td>
<td>Monthly</td>
</tr>
<tr>
<td>Small snakes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>per 0.2 kg</td>
<td>20</td>
<td>Monthly</td>
</tr>
<tr>
<td>Kingsnakes, milksnakes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>per 0.5 kg</td>
<td>20</td>
<td>Monthly</td>
</tr>
<tr>
<td>Other reptiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>per 1 kg</td>
<td>20</td>
<td>Twice per month</td>
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</tbody>
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A TOXICOLOGIC PATHOLOGY STUDY OF THE THYROIDS AND COCHLEAE OF HARBOUR PORPOISES (*Phocoena phocoena*) EXPOSED TO ORGANOCHLORINES IN BRITISH WATERS: QUALITATIVE MORPHOPATHOLOGY, HISTOMORPHOMETRY AND BIOANALYSIS

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Abstract

A five-phase investigation was conducted to test the hypothesis; that there was a significant causal relationship between thyroid lesions and organochlorine concentrations in harbour porpoises (*Phocoena phocoena*) from British waters; stranded during 1991 and 1995. Double blind studies were performed on the thyroid sections of 8 out of 28 porpoises; phase I-III. During phase I, qualitative histopathologic evaluations were conducted. Severe diffuse chronic fibrotic thyroiditis was diagnosed from the thyroid tissue sections of two porpoises. For phase II, computer assisted light microscopic histomorphometric (CALMHIM) studies, employing the SEESCAN image analysis system, were conducted on the thyroid sections from three harbour porpoises. The CALMHIM/SEESCAN derived data were analyzed by the SPSS statistical software; phase III. From the pooled data of the three porpoises, follicular types were defined as:

Megafollicle; inner follicular area (A<sub>f</sub>) = 70489.8 ± 91906.22 μm<sup>2</sup>; [n=29];
Inner follicular perimeter (ρ) = 1651.4 ± 1093.52 μm; [n=29];
Macrofollicle; A<sub>f</sub> = 18122.52 ± 17664.8 μm<sup>2</sup>; [n=92]; ρ = 870.4 ± 116.26 μm; [n=92];
Midminifollicle; A<sub>f</sub> = 7149.1 ± 1464.42 μm<sup>2</sup>; [n=77]; ρ = 413.9 ± 361.96 μm; [n=77];
Microfollicle; A<sub>f</sub> = 2976.5 ± 1332.51 μm<sup>2</sup>; [n=97]; ρ = 283.6 ± 317.82 μm; [n=97].

There was a cubic relationship between the follicular area and follicular perimeter. A statistically significant difference existed between the dimensions of the megafollicle, macrofollicle and microfollicle. There was a negative dose-response relationship between the degrees of fibrosis and colloid depletion, and potentially endocrine disruptive chlorinated biphenyl (CB) concentrations for five porpoises.

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LITERATURE CITED


Figure 1. A summary of the diagnoses of the etiologies of mortalities for 234 harbour porpoises stranded in the coastal zones of England and Wales; between September 1990 and September 1995. The largest percentage of diagnoses were due to the etiologies of by-catch. The non-established diagnoses were the second largest in percentage. Neoplasia in cetaceans has been linked to environmental pollution in the St Lawrence River, Canada. The endocrine disruptive effects of the CBs would have most likely contributed to a dysthyroid condition in any of these porpoises and contributed to the etiologies of by-catch, physical trauma, starvation and live stranding.
Figure 2. The incidence of thyroid lesions in harbour porpoises which were pathologically evaluated between 1991 and 1995 at the London Zoo Hospital. The number of harbour porpoises examined in 1991 was 41. In 1993, 16 harbour porpoises were examined and in 1995, 20 harbour porpoises were evaluated (n for 1991 = 41; n for 1993 = 16; n for 1995 = 20).
MOLECULAR SEXING OF NICOBAR PIGEONS (*Caloenas nicobarica*) FROM FEATHER RACHIS

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Abstract

Identifying the sex of a bird is important to ensure successful breeding strategies and effective conservation programs, especially for endangered species. Sex can be identified from the intron size of the CHD1 gene located in avian sex chromosomes Z and W. Most birds are vulnerable to stress during sampling, however, so obtaining a sufficient amount of genomic DNA while causing the least amount of harm is a critical issue.

The Nicobar pigeon (*Caloenas nicobarica*) is a CITES I, highly threatened species distributed in south-east Asia. The major threat to its persistence is stress, especially from disturbance during breeding.

With cut feathers as samples, we successfully determined the gender of Nicobar pigeons. We found that the rachis segment of a cut feather contained sufficient amounts of DNA for determining sex. This indicates that cutting instead of plucking the feather is feasible; a cut feather including the rachis can be a superior method because it decreases stress on the examined birds and is accomplished easily. Further, feather tips are also a favorable DNA source for identification of avian leukosis and Marek’s disease pathogens. This sampling method thus simultaneously facilitates screening for these important avian tumorigenic diseases.

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LITERATURE CITED

IMMUNIZATION AND ANTIBODY PERSISTENCE TO CANINE DISTEMPER AND RABIES VACCINATION IN CAPTIVE AFRICAN WILD DOGS (*Lycaon pictus*)

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Abstract

The goal of the project was evaluation of vaccination protocols and antibody persistence to canine distemper and rabies vaccination in captive African wild dogs (*Lycaon pictus*) (AWD). Although vaccination offers the best protection against canine distemper virus (CDV), morbidity and mortality from suspected modified-live virus vaccine-induced canine distemper has been reported in captive AWD litters.2,3,5 This species is also highly susceptible to rabies virus, where high mortality rates have occurred in captive, re-introduced, and wild packs in southern and east Africa with and without rabies vaccination.4,7 Vaccine recommendations for domestic dogs have substantially changed over the past 5 yr. Routine annual vaccinations are no longer recommended, rather antibody concentration monitoring is suggested to determine duration of immunity from specific vaccination schedules.1,6 Currently, however, annual vaccination is practiced for many species of exotic carnivores due to unknown efficacies of vaccines in species where challenge studies are not practical and lack of serologic studies to determine antibody titers after vaccination.

U.S. institutions that house AWD were contacted requesting vaccination and banked serum records. Analysis of records from participating institutions were used to request specific serum samples for CDV antibody titer via serum neutralization and for rabies antibody testing by the rapid fluorescent focus inhibition test method. Results from this study will assist in establishing vaccine protocols similar to that of revised domestic canine vaccine recommendations. The expectation is that risk will be reduced due to less frequent vaccinations considering the documented sensitivity of this species to the modified-live CDV vaccine.

LITERATURE CITED

BRAIN REMOVAL IN CHARISMATIC MEGA-VERTEBRATES: A NOT-SO-CHARISMATIC CHORE.

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Introduction

Examination of the central nervous system, both grossly and histologically, is an important component of a complete necropsy. Cerebral nematodiasis, West Nile Virus infection, rabies, distemper, and organophosphate toxicity are just a few of the possible diseases with serious herd and public health significance which may only be diagnosed by careful analysis of the brain and/or spinal cord. Removal of the brain is strongly suggested for a complete necropsy, and though it may appear a daunting task, a few guidelines and power tools will allow efficient removal of the brain and a complete necropsy.

It is usually preferred that the brain be removed whole by removal of the skull cap. This technique has been well documented in necropsy texts and is commonly taught in veterinary schools. Briefly, after skinning the skull, a saw or ax may be used to cut on either side from the foramen magnum and the occipital condyles cranially and dorsally in a circular pattern (Fig. 1). This technique is useful to examine the brain in situ and remove it whole, but unfortunately requires skinning of the head, can be time-consuming, and is almost impossible to complete in rhinoceros and elephants. There are many alternative approaches to brain removal, but the author has found the following methods using commonly available tools are quick, leave a relatively intact skull, and the brain itself is removed in two parts. Certainly, the techniques presented here can be adapted to the individual preferences of the prosector and to other similar species. If nothing else, a discussion of brain removal techniques will reinforce the importance of collecting a complete set of tissues during a post-mortem examination.

Tools: Some recommended tools:
1) A scalpel or small necropsy knife
2) A large buck or bow saw (ideally, with a blade designed to cut bone)
3) A carpenter’s electric reciprocating saw (Milwaukee Sawzall®, or similar with a supply of 9” wood/nail-cutting blades)
4) A Jarvis Wellsaw
5) A generator to use power tools in remote locations and field conditions
6) A hand keyhole or jigsaw can be used in the field.
7) An ax or hatchet can also be used, but the brain may be damaged and the physical effort required is much greater.
8) A thin long metal spatula for removing the brain from the brain case.
Equids

After removing the tongue, trachea, and esophagus (the “pluck”) from the oral cavity and neck region, the neck should be over-extended, exposing the spinal cord ventrally through the atlanto-occipital joint and the cord severed by a stab incision with a knife or scalpel. The skin on the head is cut in a line parallel to the caudal margin of the mandibular ramus through a point 1 cm cranial to the ear canal (see Fig. 2, line marked A). Then using a saw, the head is cut transversely all the way through. The calvarium is now open and the brain is in two pieces. Using a thin metal spatula, a knife, or gloved finger, the brain can be separated from its attachments in the skull and pulled free. The bony tentorium may need to be broken down with a knife to remove the cerebellum. If the cut is accurately made, the pituitary gland should be immediately adjacent to the cut in the cranial half.

Artiodactylids

A similar technique as that described for equids can be used in many artiodactylids (Fig. 2). This is particularly useful when antlers or horns make removal of the skull cap impossible. The precise division of the brain may vary in different species.

Rhinoceros

Rhinoceros brain removal can be challenging, particularly since many institutions want to display the skull after the necropsy. The following technique (Fig. 3) was successfully used to remove the brain of a white rhino, but would likely work for other species of rhino.

The skin should be removed from the dorsum of the head. Make 2 transverse cuts in the skull as diagramed (Fig. 3, A). The first cut should be in a transverse plane drawn through the ear canal. The second cut is made in a parallel plane 14 cm cranial to the first and approximately 15 cm caudal to the eye. These cuts are in an arc so as to minimally damage the brain and extend laterally to a point 4 cm ventral to the longitudinal plane through the ear. Two lateral cuts in the longitudinal plane then connect the ends of the two transverse cuts. It is easiest to start these cuts with the Stryker saw to get a groove in which to place the blade of a larger saw. Before the brain can be removed from this access, the spinal cord must be severed at the atlanto-occipital joint, either by removing the head or with a knife through the ventral dura at the joint.

Elephant:

Due to their massive size and the remarkable bony sinuses overlying the elephant skull, the brain is especially difficult to remove. However, the following procedure has produced good results and can be performed with either power tools or hand tools in the field.

The elephant should be in lateral recumbency to best proceed with brain removal. Remove all the skin from the neck to the eyes and over the top of the head. Cut down to the atlanto-occipital junction from the ventrum after removing the pluck. Once the atlanto-occipital joint is found, the head can be rolled forward slightly to open the gap between the atlas and the occipital condyles. Drive a sharp knife into this gap to sever the spinal cord to prevent further histologic stretch.
artifacts in the brainstem and spinal cord and make the brain easier to remove. The atlanto-occipital joint can be completely cut at this point. Clean all the muscle from the caudal aspect of the skull so that only bone is exposed approximately 15 cm dorsal and 10 cm lateral to the foramen magnum. Using the saw, make the following cuts (see Fig. 5):

a. From the ventral lateral aspect of the foramen magnum, cut dorsally 15 cm at a 30° angle from the ventral midline on both sides.

b. Connect the dorsal extent of both cuts with a third cut. In order to cut through the bone, it is best to lay the saw flat on the surface of the bone until it cuts through into the cranium. Then the cut can be extended laterally to connect with the first two cuts. The bone fragment can now be removed. A pry bar may be used if necessary to separate the bone if the cuts are not complete.

d. If the resulting opening is not wide enough to remove the brain, two additional cuts may be used to widen it. Cut laterally from the base of the foramen magnum approximately 8 cm. Then cut from the cranial-most aspect of the previous cuts ventrally to the end of these two lateral cuts (essentially cutting off the occipital condyles).

The cerebellum and brainstem are now exposed. Reach in with the knife or a scalpel and separate the cerebellum and brainstem from the cerebrum. The cerebellum can now be removed carefully, cutting cranial nerves as it is elevated. The cerebrum can be extracted by reaching in with a scalpel or simply a gloved hand, carefully separating the brain from its dural adhesions, and delivering it through the widened foramen magnum (much like delivering a baby). It may be necessary to separate the two hemispheres. Usually the pituitary gland remains and can be removed by carefully lifting it by the dural attachments with forceps and using a scalpel to peel it from the underlying bone.

**Brain fixation**

Like all tissues, the brain is best preserved in 10% NBF at a 10:1 ratio (formalin:tissue). Some pathologists, however, fix large brains in 40%. Unless the gross morphology is critical, it is best to separate the cerebral hemispheres and fix them and the cerebellum separately. Even though the brain may be autolyzed or accidently macerated, it should be preserved in formalin and examined. Many diagnoses can still be made from these tissues. If rabies is a differential diagnosis, the brain should be submitted fresh to the local or state laboratory. Fixation will make rabies testing impossible (although select samples may be fixed for histology when the brain is first removed).

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I thank Dr. Rob Fairley for introducing me to the technique of brain removal in horses and Drs. Linda Lowenstine and Linda Munson for their advice and support during many long elephant necropsies. I also thank Drs. Murray Fowler, Susan Mikota, and Dick Montali for their kind permission to reprint diagrams from their textbook.

**LITERATURE CITED**


**Fig. 1:** Equid skull. To remove the brain whole, it is necessary to cut the skull cap from the occipital condyles cranially and dorsally to the frontal bone on both sides, remove the cap, and dissect out the brain.

**Fig. 2.** Diagram of the intact head and skull of an equid (left) and bovid (right). A single saw cut through the skull parallel and just caudal to the margin of the ramus of the mandible (immediately cranial to the ear canal) will expose the brain. After breaking down the bony tentorium separating the cerebrum and cerebellum and cutting the spinal cord with a stab incision through the ventral atlanto-occipital joint, the brain can be manually removed.
Fig. 3. Head and skull of a White Rhino. Using a reciprocating saw, cuts are made transversely (A) through the ear canal and through a point 14 cm cranial (approximately halfway between the eye and the ear). The ventral extension of these cuts can then be connected (B) on either side and the cap removed exposing the brain below.

Fig. 4. Caudal view of an elephant skull. Using a reciprocating saw, cut from the base of the foramen magnum dorsally and cranially on each side for approximately 10 cm (a). Connect the dorsal aspect of both lateral cuts (b). If necessary, the remaining occipital condyles can be removed so that the brain can be more easily reached. (Reprinted with permission from Biology, Medicine and Surgery of Elephants. Fowler and Mikota (Eds). 2006).