A RETROSPECTIVE STUDY EVALUATING VITAMIN E SUPPLEMENTATION IN PELICANS AND PLASMA α-TOCOPHEROL CONCENTRATIONS IN PELICANS, STORKS, AND FLAMINGOS

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Abstract

A retrospective study was conducted to evaluate the effectiveness of two vitamin E supplement forms in pink-backed pelicans (Pelecanus rufescens). The forms were a paste supplying 100 IU vitamin E daily or a capsule supplying 10.5 IU vitamin E daily. Baseline blood α-tocopherol concentrations were 7.15 µg/ml in 1998. After 10 mo of receiving vitamin E in the capsule form, the α-tocopherol concentrations increased by 28% (P = 0.046), but were similar to the pink-backed pelicans receiving the supplement paste (P = 0.17). There were significant year to year variation in the α-tocopherol concentrations of eastern white pelicans (Pelecanus onocrotalus), marabou storks (Leptoptilos crumeniferus), and greater flamingos (Phoenicopterus roseus), although some of the variation may be due to a change in analytic laboratories. The pelicans, storks, and flamingos, regardless of supplementation strategy, had average α-tocopherol concentrations with ranges for other piscivorous birds.

Introduction

Due to lack of supplementation, rancid feed, and over supplementation, both vitamin E deficiencies and toxicity has been documented in captive pelicans.2,8,10 Proper vitamin supplementation and food handling can prevent deficiencies and Baer and Allen (1989) suggested using a water soluble supplement to prevent the over-supplementation of vitamins in piscivorous species.1 Two flocks of pink-backed pelicans (Pelecanus rufescens) at Disney’s Animal Kingdom (DAK) and Disney’s Animal Kingdom Lodge (DAKL) were recently combined. These flocks were receiving vitamin E and thiamin supplementation in the form of a paste or a capsule added to fish. Determining which supplement strategy to continue in the combined flock was the justification of a retrospective study to evaluate the method of vitamin E supplementation to pelicans and to look at the blood α-tocopherol concentrations of other piscivorous birds.

Methods

A flock of (8.8) wild born pink-backed pelicans were received in May 1998 at Disney’s Animal Kingdom. A flock (8.6) was placed on exhibit in October 1998. Six birds (3.2) were removed
from the main flock in February 2001 to create a new breeding group at DAKL. The flocks were recombined at DAK in October 2004. Three birds (0.3) were deaccessioned between 1998 and 2000. The pink-backed pelicans were fed a diet consisting of a variety of fish including rainbow trout (Oncorhynchus mykiss), lake smelt (Osmerus mordax), short spotted croaker (Ophioscion punctatissimus), and mullet (Mulgi spp.). The current diet consists of 50% trout and 50% lake smelt by weight (Table 1). Initially, all birds received 1 g of a vitamin E/thiamin paste (1 g contained 100 IU of α-tocopherol acetate and 50 mg of thiamin mononitrate; Thiamin-E, Stuart Products, Inc., Bedford, TX 76021) in one fish daily. In November 2002, the DAKL flock started to receive a gelatin capsule (No. 2, Eli Lilly and Co., Indianapolis, IN 46285) containing 10.5 IU vitamin E (Rovimix E 20, DSM Nutritional Products, Inc. Parsippany, NJ 07054) and a ¼ of a of thiamin mononitrate tablet (Thiamin B-1; 50 mg tablet; Rugby Laboratories, Inc. Duluth, GA 30097) for each bird to be inserted into one fish daily prior to feeding.

Blood samples were collected during routine exams from the pink-backed pelican flock in May 1998, the DAK flock in March 2002, the DAKL flock in August 2003, and from six birds in the recombined flock in March 2005. Eastern white pelicans (Pelecanus onocrotalus), storks and flamingos had blood collected during routine exams between 1999 and 2005. Plasma or serum was harvested, stored at -80 °C (< 6 mo) and analyzed for vitamin E (α-tocopherol) at commercial laboratories (Animal Health Diagnostic Laboratory, Michigan State University, Lansing, MI 48909; Wildlife Conservation Society, Department of Nutrition, Bronx, New York 10460).

Within each pink-backed pelican vitamin supplement group, blood α-tocopherol concentration was analyzed as a repeated measure using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). Additionally for bird species when serial blood samples were collected, trends were analyzed as a repeated measure using the GLM procedure of SAS. For the greater flamingo (Phoenicopterus roseus) flocks, where only a subsample of the birds had blood collected, the GLM procedure of SAS was used with least square means separated using the PDIFF ADJUST=TUKEY option. In species when serial blood samples were not collected, the mean, standard deviation, minimum and maximum were determined.

**Results and Discussion**

Changing the form of vitamin E supplementation from a paste to a capsule resulted in a decrease in the total daily amount offered (Table 1). Vitamin E dietary recommendations for exotic birds range from 100 to 500 IU/kg DM which is considerably higher than 5 to 28 IU/kg DM for domestic poultry. Therefore, the two forms of supplementation were at the extremes of the suggested dietary requirements. Additionally, although a vitamin E supplemented fish was prepared for each bird daily, there were some days that the birds did not consume this fish or may have consumed two.
The pink-backed pelicans’ initial blood α-tocopherol concentrations in 1998 (Table 2) averaged 7.15 µg/ml. The pink-backed pelicans which received the vitamin E supplement paste had similar α-tocopherol concentrations in 1998 and 2002. When the pink-backed pelicans were switched from the supplement paste to the vitamin E capsules for 10 mo, the blood α-tocopherol concentrations increased 28% ($P = 0.046$). The α-tocopherol concentrations were similar between pink-packed pelicans in 2002 and 2003 ($P = 0.17$). The subsample of pink-backed pelicans sampled in March 2005, had blood α-tocopherol concentrations within the range of the previous years.

Ullrey et al. (1995) suggests that there is a large amount of variation in blood α-tocopherol concentration within an animal group and can vary 1.5 – 2 fold, with each individual having its own characteristic concentration range. This variation is evident in the eastern white pelicans at DAK (Table 3). Their blood α-tocopherol concentrations have fluctuated from year to year without changing the use of the vitamin E paste. Additionally, there may have been an impact on α-tocopherol concentrations due to a change in commercial laboratory. Given the variation in α-tocopherol concentration observed in both free-ranging and captive piscivorous birds (Table 4), both species of pelicans fell within these reference ranges.

The blood α-tocopherol concentrations for the storks, ibis, and spoonbills at DAK and DAKL (Table 3) are within the reference ranges for piscivorous birds listed in Table 4. These birds are not as piscivorous as the pelicans. In addition to fish supplemented with the vitamin paste, these birds receive small rodents and carnivore meat containing supplemental vitamin E (170 IU vitamin E/kg DM, TorontoZoo Carnivore Diet, Milliken Meat Products LTD, Scarborough, Ontario Canada M1V 3F1). There was one scarlet ibis (Eudocimus ruber) that had a blood α-tocopherol concentration of 0.83 µg/ml, which was below the others in its group and may be considered deficient.

The American and greater flamingo (Phoenicopterus ruber and $P. roseus$, respectively) flocks (Table 3) had α-tocopherol concentrations within the reference ranges (Table 4). There was a significant increase ($P < 0.05$) in α-tocopherol concentrations of the greater flamingo flock in 2004 and 2005 compared with early years. Although this increase coincides with a change in laboratories, this magnitude of change is not represented in other recent α-tocopherol analyses and can not be explained by a change in the greater flamingo diet.

Although the use of the vitamin paste or capsule provided different daily vitamin E supply, vitamin E status as measured by blood α-tocopherol concentrations seem unaffected. Additionally, there was a reduction in cost when capsules were used to supplement vitamin E. There were year to year fluctuations in blood α-tocopherol concentrations that were not due to supplementation strategy. Alpha-tocopherol concentrations of piscivorous birds were greater than reference values for domestic poultry and can vary greatly within and between piscivorous species. Additional information is needed on the dietary requirements and blood α-tocopherol concentrations of piscivorous birds.
ACKNOWLEDGMENTS

The authors would like to thank Sarah Putman for data entry, Mark Adkins at the Animal Nutrition Center for his assistance in tracking down information for this paper, and also the Animal Medical Records team of Crystal Pancake, Deb Crenshaw, and Meredith McCoy for their supply of information.

LITERATURE CITED

### Table 1. Current ingredients and estimated vitamin E content of the diet supplemented with a vitamin paste or capsule and fed to pink-backed pelicans (*Pelecanus rufescens*).

<table>
<thead>
<tr>
<th>Item</th>
<th>DM, %</th>
<th>Daily diet offered</th>
<th>Vitamin E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>As-fed, kg</td>
<td>DM, kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>mg/kg DM mg/day</td>
</tr>
<tr>
<td>Lake smelt&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.4</td>
<td>0.511</td>
<td>0.114</td>
</tr>
<tr>
<td>Rainbow trout&lt;sup&gt;b&lt;/sup&gt;</td>
<td>24.3</td>
<td>0.511</td>
<td>0.124</td>
</tr>
<tr>
<td>Unsupplemented diet, total</td>
<td>23.4</td>
<td>1.022</td>
<td>0.238</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>51.58 13.82</td>
</tr>
</tbody>
</table>

Vitamin E content of the diet supplemented with paste or capsules

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Paste, 1 g/day&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
<td>478.23 113.82</td>
</tr>
<tr>
<td>Capsule, 1/day&lt;sup&gt;d&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
<td>102.18 24.32</td>
</tr>
</tbody>
</table>

<sup>a</sup>*Osmerus mordax.*
<sup>b</sup>*Oncorhynchus mykiss.*
<sup>c</sup>Vitamin paste supplement (1 g = 100 IU of α-tocopherol acetate and 50 mg of thiamin mononitrate).
<sup>d</sup>Vitamin capsule supplement (10.5 IU of α-tocopherol and 12.5 mg thiamin mononitrate).

### Table 2. Influence of vitamin E supplement form on blood α-tocopherol concentration in pink-backed pelicans (*Pelecanus rufescens*).

<table>
<thead>
<tr>
<th>Flock</th>
<th>Supplement form</th>
<th>Analysis date</th>
<th>n</th>
<th>α-tocopherol, µg/ml serum or plasma</th>
<th>Mean ± SE</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mean ± SE</td>
<td>SD</td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>DAK&lt;sup&gt;a&lt;/sup&gt; (5.3 birds)</td>
<td>Paste&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1998</td>
<td>8</td>
<td>7.04 ± 0.60&lt;sup&gt;x&lt;/sup&gt;</td>
<td>1.71</td>
<td>3.95</td>
<td>9.84</td>
<td></td>
</tr>
<tr>
<td>DAKL&lt;sup&gt;b&lt;/sup&gt; (3.2 birds)</td>
<td>Paste&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1998</td>
<td>5</td>
<td>7.32 ± 0.87&lt;sup&gt;y&lt;/sup&gt;</td>
<td>1.94</td>
<td>5.12</td>
<td>9.59</td>
<td></td>
</tr>
<tr>
<td>Combined (4.2 birds)</td>
<td>Paste&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2005</td>
<td>6</td>
<td>7.21 ± 0.63&lt;sup&gt;x&lt;/sup&gt;</td>
<td>1.21</td>
<td>5.79</td>
<td>8.82</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Disney’s Animal Kingdom.
<sup>b</sup>Disney’s Animal Kingdom Lodge.
<sup>c</sup>Vitamin paste supplement (1 g = 100 IU of α-tocopherol acetate and 50 mg of thiamin mononitrate).
<sup>d</sup>Vitamin capsule supplement (10.5 IU of α-tocopherol and 12.5 mg thiamin mononitrate).

<sup>x</sup>Means within location with unlike superscripts differ *P* < 0.05.
Table 3. Vitamin E (α-tocopherol) concentrations of piscivorous bird species housed at Disney’s Animal Kingdom and Disney’s Animal Kingdom Lodge.

<table>
<thead>
<tr>
<th>Species</th>
<th>Analysis date</th>
<th>n</th>
<th>α-tocopherol, µg/ml serum or plasma</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mean ± SE</td>
</tr>
<tr>
<td>Eastern white pelicans</td>
<td>1998</td>
<td>7</td>
<td>11.87 ± 1.03</td>
</tr>
<tr>
<td>(Pelecanus onocrotalus)</td>
<td>2002</td>
<td>7</td>
<td>8.00 ± 1.09</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>7</td>
<td>14.48 ± 1.61</td>
</tr>
<tr>
<td>Marabou stork</td>
<td>2003</td>
<td>7</td>
<td>9.47 ± 0.94</td>
</tr>
<tr>
<td>(Leptoptilos crumeniferus)</td>
<td>2004</td>
<td>7</td>
<td>12.71 ± 1.79</td>
</tr>
<tr>
<td>Abdim’s stork</td>
<td>2003</td>
<td>3</td>
<td>8.77 ± 1.90</td>
</tr>
<tr>
<td>(Ciconia abdimii)</td>
<td>2004</td>
<td>3</td>
<td>8.58 ± 1.00</td>
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<tr>
<td></td>
<td>2005</td>
<td>2</td>
<td>9.05</td>
</tr>
<tr>
<td>Saddle-billed stork</td>
<td>2004</td>
<td>7</td>
<td>28.01</td>
</tr>
<tr>
<td>(Ephippiorhynchus senegalensis)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Bald ibis (Geronticus calvus)</td>
<td>2003</td>
<td>4</td>
<td>15.93</td>
</tr>
<tr>
<td>Scarlet ibis (Eudocimus ruber)</td>
<td>2003/2004</td>
<td>8</td>
<td>44.89</td>
</tr>
<tr>
<td>African spoonbill (Platelea alba)</td>
<td>2003/2004</td>
<td>3</td>
<td>36.12</td>
</tr>
<tr>
<td>Roseate spoonbill (Ajaia ajaja)</td>
<td>1999/2003</td>
<td>3</td>
<td>41.39</td>
</tr>
<tr>
<td>American flamingo</td>
<td>2001</td>
<td>9</td>
<td>13.12</td>
</tr>
<tr>
<td>(Phoenicopterus ruber)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater flamingo</td>
<td>1999</td>
<td>12</td>
<td>9.15 ± 0.76</td>
</tr>
<tr>
<td>(Phoenicopterus roseus)</td>
<td>2000</td>
<td>12</td>
<td>16.69 ± 1.21</td>
</tr>
<tr>
<td></td>
<td>2001</td>
<td>3</td>
<td>7.34 ± 0.13</td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>4</td>
<td>11.11 ± 1.71</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>13</td>
<td>51.45 ± 7.86</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>13</td>
<td>41.13 ± 1.75</td>
</tr>
</tbody>
</table>

*aLinear effect P = 0.17, quadratic effect P = 0.003.
*bLinear effect P = 0.95.
*cLinear effect (2003 to 2004) P = 0.087.
*dMeans within species with unlike superscripts differ P < 0.05.
Table 4. Reference values for blood vitamin E (α-tocopherol) concentrations of domestic and piscivorous birds.

<table>
<thead>
<tr>
<th>Species</th>
<th>α-tocopherol, µg/ml serum or plasma</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickens</td>
<td>0.100 – 0.350</td>
<td>Puls, 1994</td>
</tr>
<tr>
<td>Quail and turkeys</td>
<td>0.300 – 1.400</td>
<td>Puls, 1994</td>
</tr>
<tr>
<td>Free-ranging birds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gentoo penguins (Pygoscelis papua)</td>
<td>30.8 – 50.7</td>
<td>Monroe, 1993</td>
</tr>
<tr>
<td></td>
<td>8.3 – 32.6</td>
<td>Ghebremeskel et al., 1992</td>
</tr>
<tr>
<td></td>
<td>16.3 – 22.3</td>
<td>Williams et al., 1989</td>
</tr>
<tr>
<td>Humboldt penguins (Spheniscus humboldti)</td>
<td>5.15 – 29.64</td>
<td>Wallace et al., 1996</td>
</tr>
<tr>
<td>Macaroni penguins (Eudyptes chrysolophus)</td>
<td>8.0 – 71.0</td>
<td>Ghebremeskel et al., 1992</td>
</tr>
<tr>
<td>Magellanic penguins (Spheniscus magellanicus)</td>
<td>6.1 – 23.3</td>
<td>Williams et al., 1989</td>
</tr>
<tr>
<td>Rockhopper penguins (Eudyptes crestatus)</td>
<td>22.3 – 40.8</td>
<td>Monroe, 1993</td>
</tr>
<tr>
<td>Captive birds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humboldt penguins</td>
<td>5.35 – 66.4</td>
<td>Crissey et al., 1998</td>
</tr>
<tr>
<td>Boat-billed herons (Cochlearius cochlearius)</td>
<td>7.9 – 14.2</td>
<td>Dierenfeld, 1989</td>
</tr>
<tr>
<td>Saddle-billed storks</td>
<td>2.2 – 17.7</td>
<td>Dierenfeld, 1989</td>
</tr>
<tr>
<td>Flamingo (Two Phoenicopterus spp.)</td>
<td>10.7 – 34.0</td>
<td>Dierenfeld, 1989</td>
</tr>
</tbody>
</table>
COMPLICATIONS ASSOCIATED WITH DIET MANIPULATION IN CALLIMICO (Callimico goeldii)

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Abstract

The diet traditionally fed to Callimico goeldii in North American institutions has included a canned, nutritionally complete food combined with fruits, vegetables and insects. There has been a long-standing question as to whether the diet could be contributing to health issues in this species, particularly renal disease. Although, no direct correlation between the diet and renal disease has been documented, a primary concern continues to be the high levels of vitamin D that have historically been formulated into their diets. More recent clinical and post-mortem findings, hepatic and gastrointestinal disease in addition to renal disease, suggest that there may be other dietary issues besides the quantity of vitamin D that may be influencing the longevity and health of this species in captivity.

To investigate these concerns, information regarding diets offered at various Species Survival Plan Program (SSP) and European Endangered Species Programme (EEP) facilities (particularly the University of Zurich) was collected. Based on information gained through this process, changes to the existing Callimico diet were made. Efforts concentrated on formulating a diet that would be better accepted and improve stool quality. The reformulated diet contained less protein and vitamin D (in an attempt to lower the incidence of renal disease) and still met National Research Council (NRC) requirements. After 1 yr on this new diet, several cases of rickets in infants and poor growth in adolescent Callimico were identified. This is the first report of nutritional disease caused by a vitamin D deficiency in this colony of Callimico in over 20 yr of maintaining this species at Brookfield Zoo.
CHOLESTEROL CONCENTRATIONS IN FREE-RANGING GORILLAS (Gorilla gorilla gorilla AND Gorilla beringei) AND BORNEAN ORANGUTANS (Pongo pygmaeus)

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1Lincoln Park Zoo, Chicago, IL 60614 USA; 2University of Missouri, Experiment Station Statistics, Columbia, MO 65211 USA; 3Mountain Gorilla Veterinary Project, Maryland Zoo in Baltimore, Baltimore, MD 21217 USA; 4Division of Comparative Medicine, School of Medicine, Johns Hopkins University, Baltimore, MD 21205 USA; 5Field Veterinary Program, Wildlife Conservation Society, Bronx, NY 10460 USA

Abstract

Cholesterol concentrations in captive gorillas and orangutans vary widely within species and average approximately 244 mg/dl for gorillas and 169 mg/dl for orangutans as previously published. The International Species Inventory System reports higher concentrations of 275 and 199 mg/dl for gorillas and orangutans, respectively. It is unknown if these values were typical and/or were influenced by captive management. To answer this question, banked serum samples from free-ranging mountain gorillas (Gorilla beringei), western lowland gorillas (Gorilla gorilla gorilla), and Bornean orangutans (Pongo pygmaeus) were analyzed for concentrations of total cholesterol, triglycerides, high density lipoproteins, and low density lipoproteins. Free-ranging mountain gorillas did not differ significantly from free-ranging lowland gorillas in cholesterol, triglyceride, high density lipoprotein, or low density lipoprotein concentrations, suggesting that mountain gorilla values could be used as a model for lowland gorillas. Free-ranging gorilla cholesterol and low density lipoprotein concentrations were significantly lower (P < 0.05) than in captive groups. Free-ranging male and female orangutans differed significantly (P < 0.05) in cholesterol, high density lipoprotein, and low density lipoprotein concentrations. Captive orangutan cholesterol concentrations were only different (P < 0.05) from the free-ranging female orangutans, while captive orangutan low density lipoprotein concentrations were significantly higher (P < 0.05) than both free-ranging male and female orangutans. The higher cholesterol and low density lipoprotein concentrations in captive apes may predispose them to problems with cardiovascular disease and might be attributed to diets, limited energy expenditure, and genetics.
NUTRITIONAL AND BACTERIOLOGIC EVALUATION AS PART OF A RAW MEAT QUALITY CONTROL PROGRAM

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Abstract

Six lots of raw horsemeat diet (Zoo Carnivore Diet, Dallas Crown, Inc., Kaufman, TX 75142 USA) were analyzed in triplicate for selected nutritional and bacteriologic components. Aliquots of frozen meat were submitted to a commercial laboratory (Dairy One, Inc., Ithaca, NY 14850 USA) to determine proximate composition, mineral levels, and gross energy. Additional aliquots were thawed at 10°C for 44 hr, and then maintained at 37°C for an additional 24 hr. Positive control samples were created by adding lyophilized microorganism preparations (Epower™ Microorganisms, MicroBioLogics, Inc., St. Cloud, MN 56303 USA) to aliquots. During thawing (T = 0, 24, 44, 68 hr), the samples were screened for Salmonella spp. using an enzyme-linked immunosorbent assay (Reveal®, Neogen® Corporation, Lansing, MI 48912 USA), and numbers of Escherichia coli and coliform bacteria were determined using a ready-made culture medium system (3M™ Petrifilm™ E. coli/Coliform Count Plate, 3M™ Microbiology Products, St. Paul, MN 55144 USA).

Mean percentages of crude fiber and moisture were below guaranteed maximum values for each lot. However, mean levels of crude fat, sodium, calcium, and phosphorus for each lot were below the guaranteed minimum values. Mean crude protein levels were below the guaranteed minimum values in four of six lots.

One aliquot was weakly positive for Salmonella spp. at T = 0, but negative at all subsequent time points. Frozen meat samples had low numbers of E. coli and coliform bacteria. Coliform bacteria typically increased with length of thaw, but changes in E. coli numbers over time were less predictable.

ACKNOWLEDGMENTS

This project was supported by funds from the Sacramento Zoo and a grant from the Columbus Zoo and Aquarium Fund for Conservation. The authors thank Neogen® Corporation, 3M™ Microbiology Products, and MicroBioLogics, Inc. for donation of some of the products used in this research.
SURVEY OF NUTRIENT CONCENTRATIONS IN THE DIET, SERUM, AND URINE OF GIRAFFE MAINTAINED IN NORTH AMERICAN ZOOS

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Abstract

In order to elucidate the causes of urolithiasis in giraffe, a comprehensive survey was initiated in September 2004 of giraffe within North American zoological institutions. Giraffe feeding practices and medical histories were examined, and holding institutions were recruited to submit samples of feeds, water, serum, urine and feces, and asked to participate in a feeding trial. Currently, 37 out of the 95 institutions contacted through the giraffe American Zoo and Aquarium Association Species Survival Plan Program have responded. Nineteen of the 37 institutions have agreed to provide samples of feeds, water, serum, urine or feces. Preliminary serum and urine analyses from three giraffe from one zoo have been completed (Table 1). Serum concentrations were similar to previously published values, with slightly elevated Ca and blood urea nitrogen (BUN) and high glucose (GLU). Average urine concentrations were within acceptable ranges (Table 1) with an average pH value of 9. Further efforts will continue to focus on comparisons of serum and urine chemistries between zoos and include comprehensive dietary analyses to gain further insight into the nutritional factors that may incite urolithiasis in captive giraffe.

LITERATURE CITED

Table 1. Comparison of serum and urine chemistry data for giraffe (mean ± SEM) with published serum data (mg/dl).

<table>
<thead>
<tr>
<th></th>
<th>Magnesium</th>
<th>Calcium</th>
<th>Phosphorus</th>
<th>Glucose</th>
<th>Blood urea nitrogen</th>
<th>Creatinine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum</td>
<td>2.3 ± 0.16</td>
<td>8.6 ± 0.46</td>
<td>9.5 ± 0.72</td>
<td>255 ± 39.6</td>
<td>29 ± 1.6</td>
<td>1.9 ± 0.14</td>
</tr>
<tr>
<td>Urine</td>
<td>70.1 ± 10.89</td>
<td>11.4 ± 3.40</td>
<td>6.2 ± 0.9</td>
<td>na²</td>
<td>na</td>
<td>373 ± 37.6</td>
</tr>
<tr>
<td>Jansen and Nijboer, 2003</td>
<td>1.2</td>
<td>5.0</td>
<td>9.3</td>
<td>138.7</td>
<td>na</td>
<td>1.8</td>
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<td>ISIS, 2001</td>
<td>3.9 ± 4.5</td>
<td>8.0 ± 0.80</td>
<td>10.9 ± 2.8</td>
<td>105 ± 62.0</td>
<td>22 ± 4.0</td>
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<td>Kearney, 2005</td>
<td>2.7 ± 0.6</td>
<td>8.6 ± 0.29</td>
<td>10.9 ± 0.60</td>
<td>99 ± 8.1</td>
<td>21 ± 0.7</td>
<td>1.7 ± 0.06</td>
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<tr>
<td>Bush et al., 1980</td>
<td>na</td>
<td>4.8 ± 0.14</td>
<td>10.0 ± 2.7</td>
<td>179 ± 54.0</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

²Not applicable.
AN UPDATE ON GIRAFFE (Giraffa camelopardalis) RESPONSE TO DIETARY FIBER FORM AND CARBOHYDRATE PROFILE: IMPLICATIONS FOR ANIMAL HEALTH

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Abstract

An experimental coarse browser supplement (EF) and a mixture of 75% Mazuri Browser Breeder and 25% Omelene 200 (GF) were used to evaluate the effects of dietary physical form and carbohydrate profile on six non-lactating adult female giraffe (Giraffa camelopardalis reticulata) in a modified reversal study using seven 21-day periods. Individually housed giraffe were fed ad libitum alfalfa hay, water, and supplement (EF or GF) each period. Blood collected via jugular venipuncture (day 21) was analyzed for complete blood count and chemistry profile. Observed behavior was recorded every 60 sec (days 13 through 15). Intake of individual feeds was measured days 15 through 21. The statistical model for data analysis included animal, period, and diet. Significance was set at $P < 0.10$. Dry matter intake did not differ between treatments, but varied greatly among animals. When consuming EF vs. GF, animals consumed less starch and more neutral detergent-soluble fiber, had lowered blood glucose and blood urea nitrogen, greater neutral detergent fiber organic matter digestibility, and a 2.29 times increase in time spent consuming supplement. Increased eating time may increase salivary rumen buffering. Weight gain and decreased blood levels of non-esterified fatty acids occurred in five of six animals when consuming EF. The overall picture suggests a possible shift in ruminal fermentation toward a high acetate:low propionate profile as documented in wild giraffe. Extended investigations with a larger population are warranted.

ACKNOWLEDGMENTS

We thank Busch Entertainment Corporation and the Busch Gardens management and staff for their support and assistance.
EVALUATION OF ZOOLOGICAL HOOFSTOCK SUPPLEMENTS

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Abstract

Traditionally, U.S. zoos have fed two types of forage to exotic hoofstock species, primarily a legume (usually alfalfa, Medicago sativa) or grass hay(s). In addition to the forage, a grain supplement is added primarily as a carrier for vitamins and minerals, but also for supplemental energy. This has been the diet of choice for most ruminant and non-ruminant species with varying amounts and types of forage matched with grain to meet physiologic needs. Other than the occurrence of specialized versions of browser diets, that feeding regime has been the mainstay of U.S. zoos for hoofstock species. In addition to crude protein differences, the content of several macrominerals found in alfalfa and grass hays varies significantly. The recent occurrence of urinary calculi in a petting zoo pygmy goat brought that reality to mind at the Denver Zoo. Legume hays such as alfalfa have high levels of calcium in proportion to phosphorus, often a 4-6:1 (Ca:P ratio) in addition to higher crude protein. Likewise grass forages tend to have lower calcium levels in proportion to phosphorus, running from 1-2:1 (Ca:P ratio), and lower crude protein. Within the last few years, the equine industry has implemented a feeding strategy of feeding supplements according to forage type. Supplements lower in calcium and crude protein complement alfalfa, while supplements higher in calcium and crude protein improve the profile of grass hay-based diets more closely. Following this mindset, the nutrient profile of hoofstock supplements at the Denver Zoo have been modified to better match the needs of hoofstock species.
Bamboo is a rapidly renewable, nutritionally stable, and in most cases, evergreen forage. Although only rivercane (*Arundinaria gigantica*) is native to North America, bamboo enthusiasts have imported hundreds of varieties adapted to a wide range of climates and growing zones. We have conducted macronutrient analysis on eleven temperate species collected across all seasons and have analyzed for dry matter, ash, acid-insoluble ash (AIA), crude protein (CP), crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, crude lipid (ether extract, EE), and acid detergent fiber crude protein (ADFCP) and gross energy (GE). We have detected no nutritionally significant seasonal changes in nutrient composition.

Bamboo leaves, averaging 14.26 ± 1.75% CP, 10.68 ± 2.36% EE, 71.29 ± 3.08% NDF, 34.21 ± 2.25% ADF, 8.21 ± 3.22% lignin and 10.99 ± 2.03% ash are similar in composition to many grass hays, although there is a greater amount of EE in bamboo leaves than in most grasses. Bamboo culms, at 1.71 ± 1.21% CP, 6.21 ± 1.29% EE, 90.08 ± 2.76% NDF, 62.43 ± 6.45% ADF, 15.75 ± 1.35% lignin, and 1.90 ± 0.63% EE are most similar chemically to the woody “twigs” of many browse species such as grapevines, mulberry and several willow species. Like many other grasses, bamboo contains appreciable quantities of silica and may contain secondary plant compounds of unknown toxicity. However, because of its evergreen nature, bamboo can be used as a readily available browse species during winter months when other species are unavailable.
OVERVIEW OF AMERICAN ZOO AND AQUARIUM ASSOCIATION GOVERNMENT AFFAIRS AND ANIMAL HEALTH

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Abstract

The AZA Government Affairs Committee and staff track numerous legislative and regulatory initiatives each year which directly and indirectly affect AZA institutions and, in particular, animal health and veterinary programs. This paper will update conferees on the legislative and regulatory issues that are monitored by AZA. This will include status reports on legislation such as the Marine Mammal Protection Act, the Horse Slaughter bill and the Pet Primate Safety Act and regulatory efforts such as CWD, Captive Wildlife Safety Act, and monkeypox. The paper will also explore how the AZA Government Affairs staff works within the Federal framework to represent AZA and its member institutions and how AAZV can be more active in AZA government affairs activities.

Introduction

Prior to the late 1950s, few restrictions existed, allowing zoos and aquariums to collect those animals they wished to display and operate their facilities as they saw fit. In the late 1950s, the U.S. Department of Agriculture (USDA) initiated the first major restriction by a federal agency to affect zoos. The Animal and Plant Health Inspection Service (APHIS) implemented the APHIS Authorization Act to protect animals in the United States against infectious or contagious diseases.

In the mid 1960s, the AZA adopted its own “Endangered Species Act”: a membership-imposed restriction against the trafficking of such animals as the Javan and Sumatran rhinoceros, golden lion tamarin, and Galapagos tortoise. AZA members were active in these worldwide conservation efforts several years before the federal government.

The American public began visiting animal exhibits in unprecedented numbers, which caused an increase in the number of roadside zoos. Troubled by what they saw in roadside zoos, the public and other organizations called for humane treatment of captive animals. In 1970, Congress passed the Animal Welfare Act of 1966 (AWA) to regulate animals used in research facilities, for exhibition purposes, and as pets to ensure they are provided with humane care and treatment.
In 1972, amidst great public outcry over the incidental “take” of dolphins by tuna fishermen, the Marine Mammal Protection Act of 1972 (MMPA) was enacted to protect all species of whales, dolphins, seals, polar bears, walrus, manatees, and sea otters. The term “take” is broadly defined to mean: harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill an endangered species. The MMPA created a moratorium on the taking of marine mammals without a permit, but it does provide for the issuance of public display and scientific research permits.

Early in 1973, representatives from 80 nations met in Washington, D.C. to consider the plight of endangered species of flora and fauna throughout the world. This resulted in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)—the first major international treaty to protect species globally by regulating their import and export.

In late 1973, the Endangered Species Act of 1973 (ESA) was enacted to restrict activities involving native and foreign endangered and threatened animals and plants to help ensure their survival. The ESA prohibits the take of these species unless authorized by a permit, but certain exceptions apply to captive-bred wildlife. The ESA defines an endangered species as any species in imminent danger of extinction and a threatened species as any species likely to become endangered in the foreseeable future.

Pressed to impose stricter laws regarding the importation of wildlife, the Department of the Interior amended the Lacey Act to prohibit the importation, exportation, transportation, sale, receipt, acquisition, or purchase of any fish or wildlife taken or possessed in violation of any law, treaty, or regulation of the United States, any Native American tribe, or any foreign country. Permits are available to import otherwise prohibited wildlife for zoological, educational, medical, or scientific purposes.

The Wild Bird Conservation Act was enacted in 1992 to promote the conservation of wild exotic birds by prohibiting the importation of wild-caught birds. There are four exceptions to the prohibition, including zoological breeding or display programs.

The Migratory Bird Treaty Act implements four separate treaties that the United States is a party to with Great Britain (on behalf of Canada), Mexico, Russia, and Japan. The Act states that no person shall take, possess, import, export, transport, sell, purchase, barter, or offer for sale any migratory bird, or the nests or eggs of such birds, except as authorized by a valid permit.

The Public Health Service Act (PHSA) regulates imports to prevent the introduction, transmission, or spread of communicable diseases from foreign countries into the United States. The PHSA covers turtles, tortoises, terrapins (excluding sea turtles), and non-human primates.
Cause and Effect of Zoo and Aquarium Legislation

Any profession or industry must closely monitor all draft legislation (bills) impacting it. It must examine the reasons behind a bill's introduction, and analyze that bill's effects. It must then establish positions to take on the bill.

Often it is more difficult to determine what causes the introduction of a bill than what the effects of such legislation might be. This is one of the reasons legislative representation in Washington is valuable. Since 1975, AZA has been very active in the legislative and regulatory arena, providing members with continuous legislative information.

Why Should Zoo and Aquarium Employees Be Familiar with Current Wildlife Laws?

It is absolutely essential for persons involved in the capture, shipment, receipt, sale, transportation, or display of exotic wildlife to be familiar with existing local, state, federal, and international wildlife laws. Ignorance of the laws and assumptions of compliance will not withstand legal challenge. For example, the Lacey Act makes the receiver of illegally taken or transported wildlife as guilty as the shipper, even if the receiver had no knowledge that the wildlife in question was either illegally taken or transported, or that the container holding such wildlife was improperly marked.

The AZA Legislative Program

The AZA provides numerous legislative services to its members including legislative representation in Washington, D.C., daily monitoring of the Federal Register, and continuous review of the Congressional Record. The Government Affairs Committee assists in responding to draft legislation and regulations which will impact zoos and aquariums. Finally, the AZA Government Affairs Department sponsors Legislative Conferences in Washington, D.C. to give members the chance to meet with their representatives on Capitol Hill.

Conclusion

The AZA Government Affairs Committee and staff track numerous legislative and regulatory initiatives each year which directly and indirectly affect AZA institutions and, in particular, animal health and veterinary programs. This paper will update conferees on the legislative and regulatory issues that are monitored by AZA (as noted above). This will also include status reports on new legislative initiatives such as the Horse Slaughter bill and the Pet Primate Safety Act and regulatory efforts such as CWD, Captive Wildlife Safety Act provisions, APHIS bird standards and monkeypox. The paper will also explore how the AZA Government Affairs staff works within the Federal framework to represent AZA and its member institutions and how AAZV can be more active in AZA government affairs activities.
PREVENTING IMPORTED ZOONOSES

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Abstract

The Division of Global Migration and Quarantine of the Centers for Disease Control and Prevention (CDC) of the United States Department of Health and Human Services has been delegated responsibility for preventing the introduction, transmission, or spread of communicable diseases from foreign countries into the United States and from one state or possession into another. Regulations for preventing the introduction, transmission, or spread of communicable diseases, including certain zoonotic diseases, are found in federal regulations at 42 CFR Part 71.

Current CDC foreign quarantine regulations contain specific information on the importation of the following species: dogs, cats, turtles and nonhuman primates. In addition, under 42 CFR 71.54, a person may not import into the United States, nor distribute after importation, any etiologic agent or any arthropod or other animal host or vector of human disease unless accompanied by a permit issued by the CDC Director. Under this authority, non-native species of bats only may be imported by obtaining a permit. CDC also currently prohibits the importation of African rodents, civets, and birds from certain areas in Southeast Asia. CDC’s regulatory authority also may be used to regulate the importation of other animals that may introduce, transmit, or spread communicable diseases to humans.

In situations where a public health risk is identified, as were the cases with monkeypox, severe acute respiratory syndrome (SARS), and avian influenza, the CDC Director may take immediate action to prevent the introduction, transmission, or spread of communicable diseases, including prohibiting the importation of certain species of animals.
THE MINOR USE AND MINOR SPECIES ANIMAL HEALTH ACT OF 2004: ITS HISTORY AND IMPLEMENTATION

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Abstract

The Minor Use & Minor Species Animal Health Act of 2004 (the MUMS Act) was made law in August of that year. It was the culmination of years of effort on the part of a coalition made up of professional societies, producer groups, and representatives from the regulated industry, as well as those providing technical assistance within the FDA, and members of the US Congress. The purpose of the law is to increase the legal availability of new animal drugs for use in minor species (all species other than horses, dogs, cats, cattle, swine, chickens, and turkeys) and for minor uses in the major species (uses that are for diseases that occur infrequently or in limited geographic areas and in small numbers of animals annually). To achieve these ends, the law provides new incentives to drug sponsors and new processes to facilitate drug availability.

The MUMS Act establishes three new programs: (1) Conditional Approval, (2) the Index of Legally-Marketed Unapproved New Animal Drugs (the Index), and (3) Designation. Conditional approval is an option for sponsors to get their drug to market early after completing all manufacturing and safety information required for FDA approval, but prior to completing the effectiveness component. Conditional approval must be renewed annually and may be in effect for a maximum of 5 yr, during which time the effectiveness component must be completed to full FDA standards. Indexing is limited to minor species and is intended to make available drugs for claims that cannot reasonably be approved by the standard process. This includes zoo animals, aquarium fish, pocket pets, exotic birds, and other similar groups. The FDA will allow legal marketing of these drugs based largely on the report of expert panels. Designation is the veterinary equivalent of orphan drug status in human medicine. A drug claim that is designated will be eligible for grants to support studies needed to demonstrate safety and effectiveness of the drug. It also will be eligible for 7 yr of exclusivity (protection from competition) beginning on the date of approval or conditional approval.

The law specifies that Conditional Approval and Designation go into effect immediately. However, the grants program must wait until publication of final regulations in August of 2006. Indexing may not be implemented until final regulations are published in August of 2007.
The MUMS Act also established a new Office of Minor Use and Minor Species at FDA’s Center for Veterinary Medicine to implement and manage some of these new processes and to continue liaison work with existing programs and minor use/minor species stakeholders. Specific questions can be addressed to the Office Director, Dr. Andrew Beaulieu (abeaulie@cvm.fda.gov) or Dr. Meg Oeller (moeller@cvm.fda.gov).
REGULATORY PERSPECTIVE ON THE GAME MEAT TRADE

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Abstract

The game meat industry has seen rapid growth in recent years as consumer demand increases for alternate food products or foods reminiscent of home countries. Both domestically produced and imported game meats are subject to U.S. federal, state, and local regulations that address public health, animal health, and may include wildlife conservation issues. The illegal bush meat trade impacts these same health and conservation areas and presents concerns for potentially serious public health consequences associated with the consumption of these products. The FDA and other federal regulatory agencies having jurisdiction over laws protecting public health, animal health, and wildlife conservation each have some authority regulating game meats. This can present a challenge to providing cohesive implementation of these regulations and enforcing violations of illegal game meat (bush meat) trade.

Introduction

Game meats are from non-domesticated, free-ranging and farm-raised wild animals and birds that either are legally hunted for personal consumption or reared, slaughtered, and commercially sold for food. Although individuals have hunted and eaten these species for years for personal consumption, animals killed in the wild that are processed to enter the U.S. commercial food supply must comply with applicable state and federal food safety regulations. The farmed game animal industry is diverse and has seen unprecedented growth since the 1970’s. Its rapid growth in recent years is largely due to consumer demand for low-fat products and interest in alternative food products. In 2003, the North American Elk Breeders Association’s estimated that there were about 110,000 elk on 2,300 U.S. farms valued at more than $150 million dollars. The National Deer Farmer’s Association reported in 2003 that there were approximately 550,000 deer on 11,000 U.S. farms with an estimated value of $1 billion. The National Bison Association reported that there were more than 1,100 American bison farms by 1999.

The growth of these game meat industries highlights the importance of having regulations addressing disease control, interstate movement of animals, animal identification, slaughter inspection, and food processing practices which are similar to the regulations for traditional livestock production. However, the industry may be regulated either by the state agriculture department, the state wildlife agency, the state public health department, or by shared responsibilities between the state agencies, causing a lack of consistent regulations among states.
Also state agriculture departments generally have regulations or policies for importation into the state of game animals and their products but may not continue to regulate these products once they are in intra-state commerce. The federal agencies have regulations for inter-state commerce designed to ensure the health and welfare of these animals, as well as the safety of the food products derived from them.

**Federal Regulatory Responsibility**

There are four federal agencies that protect human and animal health, food safety, and wildlife conservation through their respective regulatory authorities of domestic and imported game meat. They are the U.S. Department of Agriculture’s Animal and Plant Health Inspection Service (APHIS) and Food Safety Inspection Service (FSIS), the U.S. Fish & Wildlife Service (USFWS), the Centers for Disease Control and Prevention (CDC), and the U.S. Food and Drug Administration (FDA). APHIS has jurisdiction under the Animal Health Protection Act and animal quarantine laws, such as those listed in Title 9 in the Code of Federal Regulations (9 CFR 94), to inspect, detain, quarantine, seize, and destroy animals, meat, and meat products in interstate commerce or those being imported into the U.S. that pose a risk of introducing a pest or foreign animal disease to U.S. domestic livestock and poultry.

USFWS has regulatory authority under the Endangered Species Act (ESA), the Lacey Act, and the Wild Bird Conservation Act, and enforces the Convention on International Trade of Endangered Species (CITES) within the U.S. to prohibit the importation of wild animals and any wildlife products that may be injurious to native wildlife (by introduction of foreign disease, for example), that violate federal, state, or local wildlife laws, that threaten species conservation, or that violate the CITES treaty which is based on sustainable use and management of wildlife to prevent decline of wild animal populations.

CDC has authority under the Public Health Service Act (PHSA) to prohibit the importation of animals and animal products and to regulate foreign quarantine to prevent introduction of communicable diseases that threaten public health. Currently, CDC bans the importation of all non-human primates (NHP), African rodents, civets, and Asian birds and products from these animals to protect the public against Ebola, simian immunodeficiency virus, monkeypox, severe acute respiratory syndrome, and avian influenza.

FDA is responsible for protecting consumers against impure, unsafe, and fraudulently labeled food covered under the Federal Food, Drug, and Cosmetic Act (FFDCA). This includes products not covered by the USDA-FSIS’s Poultry Products Inspection Act (PPIA) and Federal Meat Inspection Act (FMIA). Meat from game animals and birds are not covered by those acts and are regulated by FDA under the FFDCA. Game meat produced domestically, as well as shipped from other countries, must meet the same safety standards applied to all foods domestically produced and offered for entry into U.S. interstate commerce. Additionally, if offered for sale as a consumer commodity, they also must meet the requirements of the Fair Packaging and
Labeling Act (FPLA). Domestic and international food shipments found not to comply with the provisions of the FFDCA must be brought into compliance, destroyed, or if from other countries, may be re-exported. FDA also has authority under the PHSA to prohibit interstate commerce of animals and animal products to prevent transmission of communicable diseases affecting human health.

**Smuggled Bush Meat Trade: An Emerging Problem**

Bush meat is a term for game meat from wild animals that are hunted and slaughtered for personal consumption traditionally in the bush of Africa and elsewhere in the world. Although this term was originally associated with the great apes and monkeys it also includes many species of wild ruminants, carnivores, rodents, reptiles, and birds. Many of these animals are threatened or endangered species protected by international wildlife laws and treaties such as CITES, and may make commercial harvest and trade as food illegal and a violation of the treaty. Consumption of meat from these animals also may pose a public health risk because the health of these hunted animals is unknown and many species may harbor diseases that could infect people.

Unfortunately, the amount of illegal, smuggled bush meat entering commerce has increased markedly in recent years coincident with the increased demand for farmed game meats. Historically, the consumption of bush meat was primarily confined to the poorer, rural communities in Africa, Asia, the Middle East, and South America that hunted local wildlife for personal consumption as an inexpensive source of protein in their diets. Now, however, consumption is substantially increasing in Europe and the United States. Much of this meat, which is being sold in street markets and ethnic restaurants, is illegally smuggled into countries such as the United States. Sometimes it is hidden in passenger’s suitcases and sometimes in commercial cargo shipments that are intentionally mislabeled. This practice is disconcerting as there are potentially serious health consequences associated with the consumption of these products. According to the USFWS and Department of Homeland Security- Customs Border Patrol (CBP) the amount of bush meat entering the United States each year is unknown, however, CBP estimates that they may be intercepting only a fraction of what is being illegally imported. Similarly, the Department of Food and Rural Affairs (DEFRA) in the United Kingdom (U.K.) estimates that nearly 12,000 tons of smuggled bush meat enters the U.K. annually. DEFRA believes that some of this meat may be contaminated with FMD virus which would pose disease risks to U.K. livestock. According to reports from the Zoological Society of London and the Bush Meat Crisis Task Force, as much as 5 million tons of bush meat is extracted from the vast Congo basin and Central African Republic each year putting many wild animal populations at risk of extinction.

**Public Health Concerns**

While most game meats are produced from healthy animals, some game meats have raised public health concerns because the meat may harbor infectious agents that are not destroyed by
smoking, salting, or brining preparations, and could cause human disease. There also are some public health concerns about chronic wasting disease (CWD), a transmissible spongiform encephalopathy (TSE), or prion disease, which has been identified in both wild and farm-raised mule deer, white-tailed deer, and Rocky Mountain elk. While consumption of beef contaminated with bovine spongiform encephalopathy (BSE) is thought to be responsible for the variant form of Creutzfeldt-Jakob disease (vCJD) in people, consumption of CWD contaminated cervid meats is not known to cause disease in people or domestic livestock. Nonetheless, research is ongoing to determine if interspecies transmission of CWD agent to humans and domestic livestock is possible.

Smuggled bush meat likely presents the greatest public health risk. Among the diseases that may be transmitted to humans from bush meat are those caused by viral agents of Ebola, HIV/SIV, Monkeypox, Herpes B, Rift Valley Fever, and Rabies; bacterial agents of tuberculosis (Mycobacterium bovis, M. tuberculosis), anthrax, salmonellosis, shigellosis, brucellosis; and parasitic agents of trichinelllosis, cystercercosis, and toxoplasmosis.

**Conclusion**

FDA’s mission is to ensure the safety of the foods it regulates, whether they are traditional products like milk, grain products, and eggs, or the more esoteric game meats and game meat products. FDA takes very seriously the risks to public health of illegally imported foods like bush meat harvested from wild animal populations that may harbor dangerous zoonotic diseases. Similarly, FDA and CDC are looking carefully at the potential public health risks that may be associated with CWD-contaminated meat and have recommended refraining from consuming meat and other products from CWD-positive deer and elk until more information is available to understand how CWD is transmitted within the same species of deer or elk and if it could be transmitted to people. The FDA will be working to identify manufacturers and processors involved in the importation and interstate commerce of game meats and game meat products in an effort to establish inspection plans to evaluate on-farm and slaughter facility sanitation practices. As well, the FDA will continue to work together with other federal agencies to develop better guidelines and procedures to facilitate interagency cooperation to prevent illegal bush meat from entering the United States.¹

**LITERATURE CITED**

METHODS OF EUTHANASIA REPORTED IN THE ZOOLOGICAL MEDICINE LITERATURE

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Abstract

Euthanasia guidelines for domestic animals are well developed because of requirements specified by the Animal Welfare Act (United States Code, Title 7, Sections 2131-2159; as amended, 1990). Equivalent euthanasia guidelines for many non-domestic species are not required by federal regulation. The instructions to authors of the Journal of the American Veterinary Medical Association, American Journal of Veterinary Research, and Veterinary Pathology, specifically require that investigations were in compliance with federal guidelines on humane animal care and use; therefore, methods of euthanasia are routinely reported. In order to assess the frequency and comprehensiveness of reporting methods of euthanasia in the zoological medicine literature, 60 recent (within the last 5 yr) articles each from the Journal of Zoo and Wildlife Medicine (JZWM) and the Journal of Wildlife Diseases (JWD) were reviewed. In the JZWM, 377 articles were reviewed to identify 60 articles involving euthanasia, with 15 of the 60 (25%) articles specifying the method of euthanasia. In the JWD, 176 articles were reviewed to identify 60 articles involving euthanasia, with 40 of the 60 (67%) articles specifying the method. Most of the methods of euthanasia reported in this subset of JZWM and JWD articles would be classified as acceptable or conditionally acceptable by the guidelines provided in the 2000 Report of the AVMA Panel on Euthanasia.1

LITERATURE CITED

NUTRITIONAL CHALLENGES ASSOCIATED WITH FEEDING A MULTISPECIES EXHIBIT: A SERIES OF CASE STUDIES

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Abstract

Feeding multi-species exhibits can be challenging in many ways. The first is ensuring that each species, as well as, each individual has access to a diet without excessive competition from another species. The second is ensuring that animals with different nutrient requirements are able to consume the appropriate diet. The third is to ensure that animals do not consume a diet which may be balanced for one species but predispose another to health problems.

The most practical solutions are including adequate feeding stations or stratifying feeding station based on exhibit niche.2 Although stratification is effective, there have been suspected cases of nutrient toxicity in terrestrial animals that consumed food refused and dropped by the arboreal species in the exhibit.1

More difficult scenarios occur when animals in an exhibit have access to all the diet, some of which may lead to health problems. Such examples include, psittacines that began to consume a meat or fish-based diet intended for piscivorous or carnivorous birds, attempts to hand feed selected birds and altering diet presentation and feeding times decreased the quantity of meat consumed by the psittacines. When the cause of death of a Grant’s zebra (Equus burchelli boehmi) was associated with enterolithiasis, it was determined that the group of zebras was consuming the remaining alfalfa hay intended for the black rhinoceros (Diceros bicornis) in the exhibit. In the southwest United States, consumption of alfalfa hay is strongly associated with enterolith formation in domestic horses; therefore, the black rhinoceros diet was changed deleting the alfalfa hay from the diet. In other cases, animals have to be removed from the exhibit as a preventive health measure. While some nutritional challenges of a multi-species exhibit are easily corrected, others require creative techniques to ensure all the animals are receiving the balance diet intended for them.
LITERATURE CITED


EPIDEMIOLOGY OF SELECTED INFECTIOUS DISEASES IN ZOO UNGULATES: SINGLE SPECIES VERSUS MIXED SPECIES EXHIBITS

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Abstract

The study analyses the epidemiology of selected infectious diseases of 65 different species within the four families of bovids, cervids, camelids and equids in one Czechoslovakian and nine German zoos. It is based on a survey of all epidemiologic data since 1998. Furthermore 900 blood samples taken between 1998 and 2005 are screened for the presence of antibodies against selected viral and bacterial pathogens. The results are linked to the epidemiologic data.

Introduction

The concept of mixed species exhibits increasingly becomes important in European zoos. It is an important form of behavioral enrichment, it optimizes the use of space and it is of great educational value for visitors, giving them an impression of ecological connections. But until now it has not been elucidated whether the kind of exhibit may lead to an increase in the prevalence of specific infections.

The aims of this study are to evaluate the exposure of zoo ungulates to a variety of disease pathogens that can be transmitted between different species and to assess the epidemiology of mixed exhibits.

We are interested in the following questions:
1. Which selected infectious agents are zoo ungulates exposed to?
2. What is the seroprevalence against these agents?
3. Is there a correlation between seroprevalence and the following factors:
   - animal exhibition system (single species / mixed species exhibit)
   - population density and animal movements
   - interspecific contact rates
4. Do specific agents in mixed exhibits appear only in single or in all of the involved species?

In this paper we report preliminary results of a serologic survey performed in ten different zoos. The seroprevalence of selected pathogens of bovids, cervids, equids and camelids are evaluated for single and mixed species exhibits.
Materials and Methods

We collected data on both single and mixed species exhibits on
- group composition (exhibit system, number of animals, their origin, birth date, sex)
- veterinary data (quarantine, vaccinations; serologic and post mortem findings)
- epidemiologic data (size and design of the enclosures; quantity and quality of interspecific contact; other animals looked after the keeper; temporary separation during birth; cleaning intervals; contact with neighbor animals etc.)

Blood samples are being tested for evidence of exposure to the following pathogens:
1. Bovine herpesvirus 1 (BHV 1)
2. Caprine herpesvirus 1 (CHV 1)
3. Cervide herpesvirus 1 (HVC 1)
4. Malignant catarrhal fever virus (MCFV)
5. Bovine viral diarrhea virus (BVDV)
6. Chlamydophila psittaci
7. Coxiella burnetii
8. Mycobacterium avium ssp. paratuberculosis

Blood samples were obtained by zoo veterinarians during immobilization when animals were examined or transported. They represent 42 species of bovids, 11 species of cervids, 6 species of camelids and 6 species of equids. The sample set is assembled from blood banks from 1998 through 2002 (sera) and own sampling from 2003 through 2005 (plasma, buffy coat). None of the animals examined were vaccinated against any of the above mentioned pathogens.

The study is conducted at the following zoological gardens:
1. Berlin Tierpark Friedrichsfelde
2. Berlin Zoo
3. Dortmund Zoo
4. Dvůr Králové Zoo, Czech Republic
5. Gelsenkirchen Zoo
6. Hagenbeck Tierpark, Hamburg
7. Hanover Zoo
8. Karlsruhe Zoo
9. Leipzig Zoo
10. Wilhelma Zoological / Botanical Garden, Stuttgart

Plasma is stored at -20°C, buffy coats at -80°C until use. Serologic tests are performed by:
- Virus-neutralization test to detect antibodies against BHV 1, CHV 1, HVC 1 and different BVDV stains.

- Enzyme linked immunosorbent assay to detect antibodies against Chlamyphila pittaci, Coxiella burnetii, M. avium ssp. paratuberculosis and OvHV 2 antigen.

**Preliminary Results**

The exhibits were classified with regard to the cohabiting animals as follows:

1. single species exhibit: one family, one species
2. mixed species exhibit: one family, minimum two species
3. mixed species exhibit: min. two families, minimum two species
4. petting zoo

Table 1 shows that among the tested bovids, cervids and camelids only four individuals were positive to BHV-1, three of them living in a single species exhibit. Two of them were also positive to CHV-1 and to HVC-1. In total, 141 individuals are seropositive reactors for MCFV, 80 of them living in single species exhibits, 38 in mixed species exhibits and 23 in the petting zoo.

**Discussion**

Our preliminary results show that neither BHV-1 nor CHV-1, HVC-1 or BVDV appear to be widespread in the zoos investigated. 27% of the animals showed antibodies against MCFV. Out of 46 bovid species 20 were positive, out of 12 cervid species 3 were positive and out of 4 species of camelids none was positive. There seems to be no association between the number of seropositive reactors for MCFV and the exhibit system. Whether there is a correlation with population density, animal movements or interspecific contact rates has still to be proved.

Presently, the seroprevalence against *Chlamyphila psittaci*, *Coxiella burnetii* and *M. avium* ssp. *paratuberculosis* is not yet investigated.

**ACKNOWLEDGMENTS**

Special thanks to H. Li (Washington State University) for providing the ELISA test kits for OvHV 2, and H. Klöös (Berlin Zoo) for financial support and all the zoo veterinarians for providing blood samples.
**Table 1. Preliminary serologic results of bovids, cervids, and camelids of ten different zoos.**

<table>
<thead>
<tr>
<th>Exhibit category</th>
<th>Number positive/ number tested</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bovine herpesvirus 1 (BHV 1)</td>
</tr>
<tr>
<td>1: Single species exhibit</td>
<td>3/269</td>
</tr>
<tr>
<td>2: Mixed species exhibit</td>
<td>0/38</td>
</tr>
<tr>
<td>3: Mixed species exhibit</td>
<td>1/218</td>
</tr>
<tr>
<td>4: Petting zoo</td>
<td>0/27</td>
</tr>
</tbody>
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SO YOUR DIRECTOR WANTS A FARM IN THE ZOO

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Abstract

It seems that humans have always craved animal contact. Even at a zoo, a place designed for wild animals, visitors want and even expect to be able to touch an animal. Petting corrals, touch tanks, feeding stations, etc. are the most popular exhibits at a zoo, especially for families with young children. Contact areas can provide a valuable educational experience as well as satisfy visitors’ ever-growing desire for entertainment. A farm in the zoo is often proposed to fulfill these needs. Zoos contemplating this type of exhibit need to consider a variety of issues including: goals and educational message; type of operation and the level of medical and management assistance required; protection of the public and the remainder of the zoo’s collection from infectious disease; and public perceptions.

A Farm in the Zoo

A working farm is not a petting zoo. A number of factors should be considered in the selection of species and operations for the farm, the most important of which are the goals of the exhibit and its concomitant interpretive program. The overall goal of the Minnesota Zoological Garden’s (MZG) farm exhibit was to represent working Minnesota farms—past, present, and future. This led to the selection of species and operations typical of a small Minnesota family farm. Many breeds were chosen from the American Livestock Breeds Conservancy in keeping with the conservation role of zoological institutions. A critical component of species/breed selection is how exhibit animals will be acquired and replaced (see Biosecurity). The operations chosen largely dictate the type of facilities, the level of staff expertise, and the type and level of medical and management assistance required.

Dairy Cattle

Dairy operations create the greatest demands for facilities (milking parlor, milk storage, housing type, exercise area, examination stocks, feed storage, bedding), staff (skilled milkers; routine husbandry procedures such as castration, dehorning, vaccination), services (artificial insemination), nutrition (ration balancing for stage of lactation), and veterinary care for common conditions (pregnancy diagnosis, ketosis, hypocalcemia, metritis, mastitis, abomasal...
displacement, and lameness). Feeding for low to moderate milk production can decrease, but not eliminate common production conditions. Enlistment of the aid of a nutritionist from the local feed co-op is highly recommended to help maintain a balanced feeding program through all stages of lactation and to help evaluate feed quality. Establishment of a reliable feed and bedding source can be a challenge, particularly when storage is limited. Bulls, if included, require separate housing with double fencing for security. A head gate and chute with access to both sides of the bull should be included in the bull housing area. Calves should be protected from contact with the public due to the risk of disease transmission such as Cryptosporidium.

Beef Cattle and Sheep

Beef and sheep operations are generally lower intensity than dairy operations. Appropriate pasture with solid fencing, a wind break, reliable clean water access, and a feed bunker are minimal housing requirements in most climates. A chute and stock system is necessary for veterinary procedures in beef cattle. Routine husbandry procedures (beef – as for dairy; sheep – tail dock, castrate, sheering) may be managed by trained staff, contract help (sheering), or veterinarians. Requirements for ration balancing and feed storage are minimal compared to dairy operations. Nutritional management is less complex and production related diseases are uncommon. Breeding may be done naturally or by artificial insemination (trained staff or contract service). Beef bulls may run with the herd if pasture fencing is adequate for public safety.

Goats

Goat operations may be dairy, non-dairy, or a combination. A decision to have a full dairy operation dictates the breeds to be included and increases the facility and staff training needs slightly. Routine husbandry procedures in goat kids (dehorn, castrate) require more complete analgesia than for calves and lambs, often requiring anesthesia, and should be performed by a veterinarian. Production goats have fewer production related diseases than dairy cows, although careful attention to feeding practices is important. Breeding is generally natural and requires separate housing for a male until breeding season.

Swine

Swine operations may either be free-ranging, confinement, or a combination. Use of farrowing crates is recommended for farrowed sows to protect the young piglets. Routine husbandry procedures (tail dock, clip eye teeth, castration) can be performed by trained staff or veterinarians. Breeding may be natural or by artificial insemination. Pregnancy diagnosis is best done with trans-abdominal ultrasound.
Poultry

Poultry, like swine, may be free-ranging or under confinement management. If poultry are confined, there needs to be adequate nesting boxes for the laying hens and roosting space for all birds. In cold weather, supplemental heat may be needed. Either automatic waterers or other watering devices with heaters may be used. An outside area is desirable so birds have access to sunshine and an area for scratching. Some type of food may be spread on the area to give birds enrichment. If birds are free ranging they need some type of shelter and possible confined space for overnight to guard against predators.

Equine

Horse operations, like dairy operations, require a high level of management. Horses may serve a function on the farm and demonstrate their role in past or current farms. The MZG uses their draft geldings to pull a tram that brings visitors to the farm for several hours a day. Minimal housing requirements include a well fenced pasture with several stalls for management of individual animals that require confinement for treatment or separation from other horses. A set of stocks is strongly recommended for treatment and routine procedures. Husbandry requires trained staff or contract skilled labor (hoof trims, shoeing) or veterinary staff (castration, dental care). Lameness, dental disease, wounds, and colic are common problems that may require a veterinarian with equine experience. Nutritional management is critical and affiliation with a nutritionist through your local feed co-op is highly recommended. Breeding may be natural (all breeds) or by artificial insemination (some breeds). Due to the risk of injury, stallions are not generally allowed to run with the herd but are introduced to the mare only when she is in heat. Handling of a stallion requires highly experienced staff.

Rabbits

Rabbits require an appropriate hutch. Males and females require separate housing. Nesting boxes and heaters for water will be needed in cold climates. These animals may be used for educational classes and demonstrations as well.

Dogs and Cats

Dogs and cats are regulated by USDA. A “farm dog” requires a kennel or similar space. Adequate housing, shade, and food and water need to be available. Will it be a working dog, a pet, or used for something else? Regular vaccinations and standard preventive medicine protocols are necessary. A friendly, tolerant breed would be best. Cats help control rodents on typical farms but also present a significant source of disease transmission between animals and between animals and people; inclusion should be carefully considered.
Other Considerations

Farms are inspected by the American Zoo and Aquarium Association (AZA) during accreditation inspections. There are several requirements for animal contact areas including the proximity of hand washing stations, food service in the area, and staff presence. The AZA’s Animal Disposition Policy for surplus domestics allows for disposition consistent with acceptable farm practices. The USDA Animal Welfare Act also has many areas applicable to farms including inspection of most species, staff presence, and public feeding. Public feeding enhances animal contact for the public, but increases the difficulty of maintaining a balanced diet. Lastly, a working farm requires much more veterinary time than a comparably sized and stocked exotic animal exhibit even when the majority of husbandry procedures are performed by trained staff or contract professionals.

Biosecurity

Biosecurity begins by establishing good working relationships with local public health and animal health boards. These local authorities can be invaluable for customizing protocols which must take into account local disease prevalences, zoonoses, voluntary or required state monitoring programs, etc. At a minimum, the following protocols for each species will need to be developed: preshipment testing (site of origin); quarantine testing (on zoo site); parasite testing (quarantine and ongoing); parasite control (quarantine and ongoing); serologic testing (quarantine and ongoing); routine vaccinations (quarantine and ongoing); husbandry procedures for production products (milk, eggs, offspring); treatment procedures for production diseases; neonatal care; processing of colostrum; prevention of drug residues, and human bite/injury. Copies of the MZG protocols are available upon request.

Zoonotic Disease

The general public is now more aware of the potential for “becoming ill” from an animal because of all the press reports of infectious disease outbreaks associated with traveling petting zoos and fairs. The 2005 Compendium of Measures to Prevent Disease Associated with Animals in Public Settings states that hand washing is the single most important prevention step for reducing the risk for disease transmission. Therefore farms need easily accessible hand washing stations with abundant signage. The reports goes on to recommend education of exhibitors and visitors, among others, regarding the risk for disease transmission with animal contact. Therefore it is incumbent upon the veterinary staff to educate themselves, keeper staff, volunteers, and the general public in regards to preventing zoonotic disease. An often overlooked source of infection is contact with parturition fluids given that the birth process is extremely popular with the public.
Protection of Non-Farm Exhibits

Zoonotic diseases are easily prevented with proper hand washing techniques and education along with reasonable quarantine and testing programs. But zoos also need to protect the remainder of their collection from infectious disease originating in livestock. Collection protection begins with acquiring animals for a farm exhibit from a “clean” herd; not always an easy task. Farmers typically do not test their animals for many of the disease entities which are tested for as part of surveillance programs in zoological collections. Although state and federal programs mandate some testing programs for animals transported across state lines, including tuberculosis, brucellosis, pullorum, and scrapie, other disease testing programs are voluntary (paratuberculosis) or nonexistent.

Obtaining herd disease history and preventive medicine history from the farm of origin is essential to the biosecurity of the farm exhibit. Specific breed registries can help to locate farms for specific breeds to start your search. State Boards of Animal Health can be contacted to obtain the herd health status of a particular herd in regards to mandated and voluntary testing programs. Dairy Herd Improvement Association records can be obtained for a dairy farm as an indication of the mastitis history of the herd. It is extremely important to talk to the veterinarian providing care to the farm to obtain disease history information and, if possible, inspect the farm.

Once you are satisfied the farm of origin does not pose any undue disease risk, you can begin testing of the animal(s). It is far more valuable from a disease surveillance perspective if the animals come from a regularly monitored herd in which a substantial proportion of the herd is routinely tested. This is more typically the case in larger production herds and it is not difficult to obtain a Holstein cow from a Johne’s test level 4 herd or a pig from a large production facility that routinely tests for porcine reproductive and respiratory syndrome, mycoplasma, and brucellosis. However, less common domestic breed species are typically available from smaller facilities which usually don’t have as extensive a disease surveillance program.

After animals are decided upon, contact the farm’s veterinarian and discuss what preshipment testing will be performed on the animal(s). Expect to pay the veterinary clinic directly for the testing and examination of the animals. Some of the bloodwork and tests such as complete blood counts, chemistry panels, paratuberculosis cultures, fecal parasitology, and fecal pathogen cultures can be sent directly to various laboratories by the farm veterinarian. In some cases, samples can be obtained by the zoo’s veterinary clinic and processed. In some situations, animals may be isolated from other conspecifics until test results are obtained and animals shipped. Depending on the age of animals required, it is also possible to have neonates removed from their dams at birth and bottle-fed to greatly reduce the potential transmission of diseases such as paratuberculosis and caprine arthritis and encephalitis.

Tests are typically repeated when animals are received in to quarantine. Note, you will need a quarantine facility designed and specific for farm animals. Minimal quarantine lengths are 30
days, but 60 days are required for ruminant species to allow time for paratuberculosis fecal culture results. Start planning early to allow animals to clear quarantine if planning an opening for a new exhibit or if animals are needed for a specific purpose. Much of the above can be avoided once you are able to raise your own replacement animals, but once again, plan ahead—it takes 2 yr to raise a calf to replace a milking cow.

Biosecurity also mandates continued testing of on-site animals for infectious diseases including fecal screening for parasites, serology, and scheduled vaccinations.

As with any quarantine situation, separate quarantine keepers should ideally care for the farmstock while they are under quarantine. If this is not feasible, quarantined farmstock should be cared for after nonquarantine animals. Separate clothing, cleaning utensils and vehicles should be utilized when caring for the animals in quarantine. Animal wastes and bedding can be placed into dumpsters and disposed of off site. Alternatively, proper composting of organic waste will destroy most pathogens if proper mixing and temperatures are obtained in a compost pile. These parameters need to be monitored. A separate area should be set up on the compost pad for quarantine animal waste. When all testing has been completed and animals are released from quarantine, the quarantine animal waste can then be mixed with the rest of the compost material.

Because a small herd of cattle in combination with a few pigs produce fairly large volumes of waste, organic waste material from the farm is handled at a separate composting facility from that used for the rest of the zoo animals. This also decreases the potential for cross-contamination of domestic and nondomestic animal areas. For this reason farmkeepers and other zookeepers utilize separate vehicles as well.

Public Perceptions

Many zoo visitors lack an accurate understanding of domestic animals in regards to husbandry practices, food production, potential for injury or disease, etc. Education is vital to avoid negative perceptions. Facilities must be designed to diminish the possibility of public-animal disease and injury. Abundant hand washing signs as well as “Stay Off The Fence” or “Animals Will Bite” are necessary. Regardless, people will be surprised and angry when they or their child are injured.

Decisions about animal husbandry and turnover must be made early in the decision process. Food animals and animal products are, by intent, sold for consumption. The “message” of the connection between farm animals and the food chain should be developed and communicated to all personnel. This can be difficult for volunteers who often become attached to individual animals. You need a plan to deal with visitors, volunteers, and the press.
Modern farm animal husbandry practices involve procedures that the general public does not encounter in the care of their dogs, cats, and horses, including long term confinement and surgical procedures without general anesthesia. Will the public be allowed to view routine husbandry or medical procedures? If so, what will be communicated to the public and how? This is not unlike the current fad of having the zoo’s veterinary clinic on display. It has been noted that constant, informed communication is required to prevent adverse impressions. If these practices are not going to be on public display, additional behind the scenes facilities will be necessary for restraint and procedures.
COLITIS IN CAPTIVE TAMARINS DISPLAYED ON SEMI-NATURAL MIXED SPECIES EXHIBITS IN A NORTH AMERICAN ZOO

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Abstract

Callitrichids have long been kept in zoological exhibits and in laboratory colonies. They are considered to be difficult to maintain and breed in captivity. Most of the species are considered to be endangered, threatened or vulnerable. Some causes of morbidity and mortality include inappropriate housing and diet, disease and trauma related to social stress, wasting marmoset syndrome, infectious diseases and other factors.

Colitis is an important cause of morbidity and mortality among captive cotton-top tamarins (Saguinus oedipus) kept in research laboratories. Other species such as mustached tamarins (S. mystax) and white lipped tamarins (S. labiatus) have been reported as susceptible. Previously the disease has been only reported in laboratory conditions, and the disease is considered absent in wild populations of cotton-top tamarins. Low temperatures, mal-adaptation to captivity, diet, genetic predisposition, and infectious diseases have been implicated to be causal for the development of this problem. There are few reports of the disease in zoo collections in the USA; it has been considered that more natural conditions give in zoo collections could be a reason why this disease is not highly prevalent.

A 10-yr (1993-2003) retrospective study of histopathology records (40 total) was performed; we observed 17 cases with lesions compatible with colitis (42.5%). The disease was present in five different species of tamarins (S. oedipus, mystax, geoffroyi, midas, fuscicollis) with a gender ratio of 12:5 (male: female), All tamarins were exhibited in the Laid Jungle Building, eight cases (47.0%) came from tamarins that were exhibited with other species of primates (Callitrichidae or Cebidae), five (62.5%) were displayed in open island exhibits, one case from a glass closed display (12.5%) and two were displayed in both type of exhibits (25%).

The open island exhibits display birds of different species that could be limited to roam in the exhibit or species of birds that could roam free inside the Laid Jungle Building, South-American
rodents such as agouties have also been exhibited during the period of research. Aquatic turtles and different species of fish have direct and indirect contact with the island. Tamarins displayed in closed glass exhibits had contact with pigmy marmosets (*Callithrix pygmaea*) or red handed tamarins (*S. midas*). There are reports of sporadic observations of rodents in both types of displays, but it is considered that they are more prevalent in the open-island exhibit.

This is the first report of colitis in tamarins other than cotton-top (*Saguinus oedipus*), outside laboratory conditions in the USA and presented in multiple species of tamarins that are kept in semi-natural exhibits and in contact with other species in a zoo collection. More studies such as factors of association, etiologic agent or transmission (if exists), are necessary to understand the pathogenesis of the disease in order to develop adequate husbandry and management measures for tamarins in captivity. We ignore if the disease has been prevalent previously in zoo collections or the disease has been under look since it has been considered to be more prevalent mainly in one species of tamarin (cotton-top) kept under laboratory conditions. We encourage the surveillance for colitis in tamarins in zoo collections.

**LITERATURE CITED**

MEDICAL CONSIDERATIONS WHEN EXHIBITING MULTIPLE TAXA IN LARGE AQUARIUM SYSTEMS

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Abstract

Large multi-taxa aquatic systems are often challenging for both husbandry and veterinary personnel. A wide variety of diseases can afflict entire systems with potential medical considerations for all exposed taxa.

Largely for logistic reasons, the most common method of disease treatment is the addition of chemotherapeutics directly to the aquatic environment. However, the potential for species-specific toxicoses associated with some treatments exists. This can limit the choice of therapeutics used if the animals are to remain in the system during the treatment period. Consequently, it is of paramount importance that additional animal holding areas are available, and that separate water filtration and water treatment options be included in the planning of any multi-taxa system. A critical review of the collection plan, with disease concerns being included as part of the discussion, will help prepare the staff for future system health concerns.

At the Living Seas Pavilion at Epcot in Walt Disney World, a single large 21.6 million liter main tank (MT) maintains teleost fish, elasmobranchs, sea turtles and marine mammals. In addition, interactive guest programs are offered that expose human beings to the aquatic environment. Understanding which diseases are likely to occur among the various animal groups and how each situation should to be addressed, is critical to the success of the exhibit, as well as to animal and human health.

Historically, morbidity and/or mortality necessitating full system treatment at the Living Seas facility have been associated with external parasitism by protozoal organisms such as Cryptocaryon irritans and monogenes such as Neobenedenia sp. Copper sulfate is commonly considered the industry standard for both protozoal infestations and also has efficacy against monogenes. From 1985-1997, copper sulfate and organophosphates were the primary agents used for treatment of monogenes in the MT exhibit. More recently, Praziquantel (Sigma®, P.O. Box 14508, St. Louis, MO 63178) has become the treatment of choice for monogenes.

System treatment with either copper sulfate or organophosphates in multi-species exhibits can lead to significant morbidity and mortality. This is especially true with elasmobranchs (sharks, rays, chimeras and skates), which have a very low tolerance threshold for these chemical
treatments. Even among the different species of elasmobranchs, there is wide variation in what concentration of copper sulfate or organophosphate may cause toxicity. In general, all elasmobranchs should be removed from the system being treated. When this is not practical, it is important to know which species are most susceptible to toxicity.

In most cases, elasmobranchs are not susceptible to the same parasites that infest teleosts, and therefore can be removed from the system and isolated from other teleosts during treatment. These animals can then be returned to the exhibit when treatment is completed without risk of reintroducing parasites. There have been some concerns that while elasmobranchs cannot serve as permanent hosts for these parasites, they may harbor certain parasites and should potentially be sampled and/or given a fresh water dip treatment prior to being placed back in the exhibit.

Praziquantel has been successfully utilized in large multi-taxa systems with no known toxicity in teleosts, elasmobranchs, herptiles and mammals. A sustained low dose (2 ppm bath for 5-15 days) appears to be both efficacious and safe.

It should be noted that due to the large number of animals that are treated when chemotherapeutic agents are added to the system, we have developed several safety measures to ensure appropriate dosing and communication throughout the treatment. Members of the husbandry, veterinary and water quality team must all be involved with system treatments. Once a drug and concentration has been determined, the amount of drug being weighed out and added to the system is double checked by members of the veterinary or water quality teams. Appropriate communication between teams during treatment will ensure filtration modifications are made and that animals can be closely observed for any deleterious effect.

In order to keep therapeutic levels of different chemical treatments in the water, the following filtration modifications are commonly made:

- Remove all activated carbon from the system.
- Turn off all ozone to the system.
- Sand filtration systems are kept in operation during the treatment period. It should be noted that in some situations, copper treatments have been associated with stagnation and even degradation of the biologic filtration. When copper is being used, plans should be made to re-seed the biologic filtration and potentially add ammonia-binding agents, such as sodium hydroxymethanesulfonate (AmQuel®, Novalek, Inc., 2242 Davis Court, Hayward CA 94545-1114), or add nitrifying bacteria.

Suggested treatment protocols:

1. Protozoal Infestation (e.g., Cryptocaryan sp.)
   - Remove elasmobranchs from the system under treatment. Depending upon the species and size, manual or chemical restraint is commonly utilized.
   - Remove any activated carbon from the system.
• Do not use ozone during treatment.
• Treat the system with copper sulfate (target concentration of 0.18-0.2 ppm).

Note: Species-specific toxicity of copper sulfate in teleost fish is not uncommon. Closely monitoring levels of copper in the water is critical, along with removing copper sensitive teleosts as needed. System treatment with copper sulfate is complex and requires constant management. Maintaining levels in the therapeutic range (>0.18 ppm) without going into the toxic range (>0.2 ppm) can be very challenging. This is particularly true when the system has a large amount of substrate for the copper to bind with. A system with variations in other water quality parameters (e.g., pH) can also cause significant changes in copper concentration. Multiple water samplings and dosing each day are often required for a successful treatment regime. This intensive sampling and dosing is critical and cannot be overemphasized.

• Closely monitor water quality parameters for indications of problems with the biologic filtration.
• Consider decreasing feeding of the animals during treatment and monitor for changes in ammonia levels.
• Teleost fish should be monitored for any evidence of secondary bacterial infections. These can be caused by immunosuppression associated with copper therapy, previous parasitism, or damage to the integument associated with increasing ammonia levels.
• At completion of the treatment, utilize activated carbon to remove copper sulfate from the system. The carbon may need to be changed several times in order to remove all the copper sulfate from the water. Expect an initial large reduction in copper levels over the first 48 hr followed by a persistent low level (0.02-0.04 ppm) as the copper is slowly released from the substrate.
• Monitor the system for evidence of protozoa or monogenes for several weeks to ensure efficacy of treatment before elasmobranchs are placed back into the exhibit.
• In general, elasmobranchs are not returned to the system until copper sulfate has been reduced to levels below 0.03 ppm. Exact safe levels for elasmobranchs have not been determined, and appear to be species specific.

2. Monogene Infestation
• Remove activated carbon, foam fractionator and ozone filtration prior to treatment.
• Since no toxicity has been reported with praziquantel at low dose continuous bath regime (2 ppm), all animals can be maintained in the system during treatment.
• Praziquantel, if used as a single treatment, has been known to be stable in the system for 7-18 days.
• Due to the life cycle of many monogenes, several treatments may be required.
• Resume ozonation and activated carbon filtration once the praziquantel treatment is complete.
ACKNOWLEDGMENTS

The authors are indebted to Disney’s Animal Programs Animal Husbandry, Life Support and Veterinary Hospital teams for their assistance and dedication to excellence in aquatic animal health.
HEPATOCYSTITIS IN BABOONS (Papio sp.)

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Abstract

Hepatocystis infection in baboons and old world monkeys can lead to hematologic, gross and histologic changes. Even though the disease is subclinical the changes may lead to diagnostic confusion. The common hematologic, gross and histologic lesions and their significance are illustrated and discussed.

Introduction

Hepatocystis kochi and H. simiae are malarial-type protozoa that are endemic in Old World nonhuman primates including baboons. Transmission is by insect vectors and the parasites are considered to be nonpathogenic.

Methods

Blood samples were collected from baboons introduced into quarantine. Tissue samples with lesions were obtained at necropsy from animals that died of a variety of causes.

Results

Clinical Pathology: Early gametocytes appeared as a vacuole in erythrocytes. In 4-5 days these developed into mature gametocytes, which were slightly larger than a normal erythrocyte and contained green-black pigment.

Gross Lesions: Multiple 1.0 – 5.0 mm yellow-white foci were present on the surface and throughout the hepatic parenchyma of affected baboons.

Histologic Lesions: These varied from early changes (intracellular granules in hepatic parenchymal cells) to multilocular merocysts. An inflammatory response and eventually fibroplasia and scar formation were also seen.

Discussion

Parasites can be found in the peripheral blood and do cause gross and histologic lesions, which could lead to confusion during physical/laboratory examination or during necropsy. This paper
discusses and illustrates the hematologic, gross and histologic lesions seen in baboons with *Hepatocystis* infection.

**LITERATURE CITED**

AN INVESTIGATION OF MOOSE MORTALITIES IN ALASKA

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Abstract

In 2004-2005 we undertook an investigation to determine the causes of death in moose found dead in Alaska. Intact moose carcasses that were found by department personnel or reported by the public that were not obviously due to human-induced trauma, underwent detailed post mortem examinations and histopathology. Additionally, moose with radiocollars that were detected in mortality mode were investigated when predation was not the proximate cause of death. Fifty-four moose were examined and a variety of diseases or parasites, some not previously reported in Alaskan moose, were discovered. A late winter cluster of mortalities, mostly in calves, had gross and histologic lesions of vasculitis and fibrinopurulent peritonitis. Other notable diagnoses include: meningoencephalitis, peracute clostridial septicemia, metastatic malignant melanoma, mesothelioma, meningoencephalitis, fungal pneumonia, and pyometra with uterine rupture, severe pathology associated with rumen flukes in debilitated moose, copper deficiencies, degenerative myopathy/granulocytic myositis, granulomatous steatitis and perineuritis.
TRANSITIONAL CELL CARCINOMA IN FISHING CATS (*Prionailurus viverrinus*): PATHOLOGY AND EXPRESSION OF CYCLOOXYGENASE-1, -2, AND P53

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Abstract

A high incidence of urinary bladder transitional cell carcinoma (TCC) has been noted in captive Fishing cats (*Prionailurus viverrinus*), small primarily piscivorous felids native to Southeast Asia and Indonesia. Of the 91 adult (>1 yr) deaths between 1995 and 2004, 12 (13%) were attributed to TCC. In contrast, the incidence of urinary TCC in domestic cats is <1%.

To help elucidate possible mechanisms for bladder carcinogenesis in fishing cats, archival sections of urinary bladder from 12 fishing cats were examined histologically and by immunohistochemistry for expression of p53, cyclooxygenase (COX)-1, and COX-2. Eight cats had TCC and four were unaffected. Affected fishing cats (5.3) were all captive-born with an average age of 10.8 yr (range 7.5 – 16 yr). Unaffected cats were all captive-born, males with an average age of 10.5 yr (range 8 – 13.5 yr).

The majority of fishing cat TCCs (7/8) were histologically characterized by extensive mural infiltration. A subset of these tumors (4/7) also had luminal papillary components. A single case consisted of carcinoma in situ. Squamous metaplasia, necrosis, and lymphatic invasion were prominent features in most tumors. Metastasis was documented in two individuals.

p53, a gene involved in control of the cell cycle and apoptosis, is frequently mutated in human cases of TCC. In the fishing cats, only 2/8 TCCs had significant positive immunoreactivity for p53. In the remaining six tumors, positive staining was detected in rare, widely-scattered cells, comparable to that noted in sections of normal bladder. Therefore, mutation of the p53 gene did not appear to be an essential component of bladder carcinogenesis in fishing cats.

Cyclooxygenase enzymes are involved in the production of prostaglandins. The COX-2 isoform is induced by a variety of inflammatory mediators and overexpression has been detected in several types of epithelial neoplasms. COX-2 immunoreactivity was detected in all eight TCCs with staining limited to the infiltrative portions of the tumors. In contrast, only 1/4 normal bladders had rare individual immunoreactive cells. COX-1 immunohistochemistry was uniformly negative in all eight tumors. COX-2 overexpression suggested that prostaglandin-mediated mechanisms of carcinogenesis are important in this species and treatment with
cyclooxygenase-inhibiting, nonsteroidal anti-inflammatory drugs (NSAIDs) could be of therapeutic benefit.

ACKNOWLEDGMENTS

We would like to thank Stacy Schultz, Jane Chladny, and the University of Illinois histology laboratory for technical assistance and slide preparation. We’d also like to thank Dr. Bill Swanson and Linda Curtis for providing the Fishing Cat International Studbook and helping to identify the fishing cat TCC cases. Finally, we’d like to acknowledge the veterinarians and staff at the San Diego Zoo and Wild Animal Park, Cincinnati Zoo and Botanical Gardens, Memphis Zoo, Capron Park Zoo, and Audubon Zoo for their contributions of case materials.

LITERATURE CITED

LINKING STRESS WITH ALTERED GASTRIC IMMUNE RESPONSES IN CAPTIVE CHEETAHS (Acinonyx jubatus)

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Abstract

Captive cheetah (Acinonyx jubatus) populations worldwide are plagued by debilitating diseases that are rare in free-ranging cheetahs exposed to the same infectious agents. The prototype disease is Helicobacter gastritis because of striking differences in prevalence of moderate to severe disease between captive (64%) and free-ranging (3%) cheetah populations infected with the same Helicobacter types. Captive cheetahs also have adrenal cortical hyperplasia and higher corticoids than free-ranging cheetahs, suggesting chronic stress. Corticoids have many complex effects on the immune system including altering gene expression of some cytokines, inflammatory mediators, and cell receptors that determine the host's response to infectious agents. Specifically, corticoids are known to decrease expression of interleukin (IL)-1, 2 and interferon (IFN)γ genes, thereby suppressing cell-mediated immunity and shifting the immune system toward antibody-dominant responses. The lesions that captive cheetahs develop to many infectious agents are largely plasmacytic, typical of antibody-dominant responses, suggesting modulation by elevated corticoids.

To determine if elevated corticoids in captive cheetahs have altered the local gastric immune response, concentrations of IL-1, IL-2, and IFNγ mRNA were measured in the gastric mucosa of 30 cheetahs infected with Helicobacter, 15 captive cheetahs with moderate to severe gastritis, and 15 free-ranging cheetahs without gastritis. RNA for tumor necrosis factor (TNF)α and MHC II, which are generally expressed in inflammation, were also quantified in the same samples in order to further characterize the inflammatory response. RNA was measured by quantitative real time reverse transcriptase polymerase chain reaction (RT-PCR) using cheetah specific primers. Concentrations of MHC II and TNFα, general inflammatory mediators that are not known to be affected by corticoids, were appropriately higher in cheetahs with gastritis. In contrast, concentrations of IFNγ and IL-1, general inflammatory cytokines whose expression can be suppressed by corticoids, were not elevated in cheetahs with gastritis suggesting an inappropriately suppressed expression in these cheetahs. Additionally, IL-2, an inflammatory cytokine normally present at low levels but known to be suppressed by corticoids, could not be detected in captive cheetahs with gastritis. These results suggest that higher levels of corticoids in captive cheetahs have inappropriately altered local gastric cytokine expression. Because
relative levels of these cytokines determine the character and drive the immune response, this altered cytokine expression in captive cheetahs has likely modulated the normal immune response towards an intense plasmacytic inflammatory reaction and immune-mediated damage to the gastric mucosa. Further research should evaluate whether immune responses in captive cheetahs are similarly modulated in response to other infectious agents.

ACKNOWLEDGMENTS

The authors wish to thank the Cheetah Conservation Fund, The Living Desert, Sacramento Zoo, White Oak Conservation Center and Wildlife Safari for contributing samples for this research. The authors also wish to thank Ms. Stacy Schultz and Dr. Brian Aldridge for technical assistance, the Brookfield Zoo and the Loyola University Molecular Core Facility. This study was generously funded by the Morris Animal Foundation.

LITERATURE CITED

CORRELATION BETWEEN PLASMA URIC ACID LEVELS AND HISTOLOGIC RENAL CHANGES IN SELECT SPECIES OF REPTILES

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Abstract

The accuracy of uric acid levels in the diagnosis of specific renal diseases in reptiles has not been fully explored. This paper will review histologic renal changes of emerald tree boa (Corallus caninus), green tree python (Chondrophyton viridis), Asian water dragon (Physignathus cocincinus) and inland bearded dragon (Pogona vitticeps) and correlate them with antemortem plasma uric acid levels from blood taken within 3 days prior to death.

Introduction

Kidney disease is a common problem in reptiles. The etiology of renal disease is multi-factorial and includes inappropriate husbandry, poor nutrition, toxic injury, bacterial and parasitic infection, neoplasia, and possibly senescence. Ante-mortem diagnosis is difficult because the symptoms may be mild and nonspecific, including anorexia, lethargy, and dehydration. Also, the hematologic changes are not consistent, although increases in uric acid and phosphorus and decreases in total calcium have been reported in iguanas and hyperuricemia has been associated with severe renal disease and gout in several species of reptiles.

Uric acid is the primary catabolic end-product of protein, nonprotein nitrogen, and purines in reptiles. Of the total nitrogen excreted, 80 to 90% is in the form of uric acid in terrestrial reptiles. Plasma uric acid does not appear to be a sensitive test for renal disease in reptiles and elevations above normal values most likely require loss of two-thirds of the functional renal mass. Also, plasma uric acid is not a specific test for renal disease. Urinalysis is not a validated tool for use in the diagnosis of renal disease in reptiles. Renal disease categories are poorly defined in reptiles and the relationships between histologic changes, clinical signs, and laboratory values are not clearly established.

Methods

Animals chosen for this retrospective study had both histologic renal changes at the time of death and bloodwork taken within 3 days prior to death. Reptiles at the National Zoological Park (NZP) that filled these criteria included two emerald tree boas (Corallus caninus), two green tree pythons (Chondrophyton viridis), two Asian water dragons (Physignathus cocincinus) and two
inland bearded dragons (*Pogona vitticeps*). Blood was obtained during clinical diagnosis of various renal and non-renal diseases and the reference range utilized for uric acid was that previously established in the Clinical Pathology Laboratory in the Department of Pathology of NZP. Histologic sections of kidneys were all stained with hematoxylin and eosin and changes within the glomeruli and tubules were evaluated for extent and severity.

**Results and Discussion**

The reference range for plasma uric acid at the National Zoological Park for the studied species are as follows: 5.2 – 12.2 mg/dl for green tree python, 12.8 – 12.8 mg/dl for Asian water dragon and 1.5 – 1.5 mg/dl for inland bearded dragon. No reference range has been established for emerald tree boas at the NZP clinical pathology laboratory.

As is shown in Table 1, both emerald tree boas had uric acid levels within assumed normal limits but both had moderate, acute and subacute changes in the glomeruli, tubules and interstitium. The green tree python that died due to renal failure (GTP1) had normal plasma uric acid values in bloodwork taken the day of death. Green tree python number 2 had very high levels, but only moderate glomerulosclerosis.

Both Asian water dragons had uric acid levels within normal limits, but both had a moderate amount of renal changes within the glomeruli, tubules and interstitium, including renal adenocarcinoma. Among the inland bearded dragons, animal number 1 had high uric acid levels but mild tubular degeneration. Inland bearded dragon 2 had intact renal tubules, mild glomerulosclerosis, and normal uric acid levels.

Histologic renal changes in these eight reptiles were generally mild to moderate and did not correlate consistently with uric acid levels determined within 3 days of death. Additionally, the animal with the worst histologic renal changes (GTP1) had normal uric acid levels. This supports the thought that plasma uric acid is not a sensitive test for renal disease in reptiles as was already suggested by some authors. Results of this study indicate that ante-mortem diagnosis of renal disease based on uric acid levels alone is not possible in reptiles. Conversely, normal levels of uric acid should not rule out renal disease, especially in green tree pythons.

Blood urea nitrogen values are also unhelpful in the diagnosis of renal disease because reptiles are primarily uricotelic. Additionally, creatinine is generally very low in reptiles and is only elevated in severe cases of dehydration and/or renal disease.

Urinalysis is considered by some authors to be an unhelpful tool in the diagnosis of renal failure in reptiles. Urates may move retrograde from the cloaca into the colon and small intestine. It is possible, though not thoroughly studied, that fermentation or resorption of components of the urine may occur in the intestinal tract, altering the composition of the excreted product.
In conclusion, uric acid levels alone are a poor indicator of renal disease in reptiles. The evaluation of renal function in snakes and lizards should employ a full chemistry panel and assessment of clinical signs, with renal biopsy as the most valuable ancillary diagnostic tool.

LITERATURE CITED

Table 1. Light microscopic changes in selected reptiles with uric acid levels determined within 3 days ante-mortem.

<table>
<thead>
<tr>
<th>Species</th>
<th>Animal number</th>
<th>Uric acid level (mg/dl)</th>
<th>Light microscopic findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerald tree boa</td>
<td>ETB1</td>
<td>3.7</td>
<td>Mild glomerulosclerosis, moderate gouty tophi, mild tubular pigmentation, mild tubular dilation, moderate interstitial lymphoplasmacytic inflammation, moderate interstitial edema</td>
</tr>
<tr>
<td>Emerald tree boa</td>
<td>ETB2</td>
<td>4.7</td>
<td>Mild glomerulosclerosis, moderate tubular pigmentation, mucinous interstitial change, mild lymphoplasmacytic inflammation and leukemia</td>
</tr>
<tr>
<td>Green tree python</td>
<td>GTP1</td>
<td>3.5</td>
<td>Moderate glomerulosclerosis, moderate tubular pigmentation, moderate interstitial pigmentation, moderate interstitial edema</td>
</tr>
<tr>
<td>Green tree python</td>
<td>GTP2</td>
<td>72.5</td>
<td>Moderate glomerulosclerosis</td>
</tr>
<tr>
<td>Asian water dragon</td>
<td>AWD1</td>
<td>6.3</td>
<td>Moderate glomerulosclerosis, mild tubular mineralization, moderate tubular pigmentation, moderate interstitial pigmentation, interstitial fibrosis and mild lymphocytic and heterophilic interstitial inflammation and renal adenocarcinoma</td>
</tr>
<tr>
<td>Asian water dragon</td>
<td>AWD2</td>
<td>8.3</td>
<td>Moderate glomerulosclerosis, mild tubular degeneration, mild tubular mineralization, gouty tophi, moderate tubular pigmentation, mild interstitial edema, fibrosis and heterophilic inflammation and multilocular cysts</td>
</tr>
<tr>
<td>Inland bearded dragon</td>
<td>IBD1</td>
<td>20.1</td>
<td>Mild tubular degeneration and moderate interstitial fibrosis and mild lymphoplasmacytic interstitial inflammation</td>
</tr>
<tr>
<td>Inland bearded dragon</td>
<td>IBD2</td>
<td>4.4</td>
<td>Mild glomerulosclerosis, moderate tubular pigmentation, moderate interstitial heterophilic and lymphocytic inflammation, moderate interstitial fibrosis and edema</td>
</tr>
</tbody>
</table>
SUSPECTED HYPOVITAMINOSIS A IN CAPTIVE TOADS (Bufo spp.)

Allan P. Pessier, DVM, Dipl ACVP,1* Michael Linn, DVM, Dipl ACVP,2 Michael M. Garner, DVM,3 Dipl ACVP, James T. Raymond, DVM,3 Dipl ACVP, Ellen S. Dierenfeld, PhD,4 and Wendy Graffam PhD5

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Abstract

“Short tongue syndrome” (STS) is an acquired condition first recognized in the endangered Wyoming toad (Bufo baxteri). Despite vigorous efforts, toads with STS have a diminished ability to apprehend prey and may eventually require hand feeding. Histologically, a commonly observed change is transformation of mucus-producing lingual epithelium to stratified squamous keratinizing epithelium (squamous metaplasia). In other cases, there are significantly decreased amounts of cytoplasmic mucus in lingual epithelial cells without overt squamous metaplasia. Review of necropsy records submitted to the Wyoming toad SSP between 1999-2003 showed that 22/41 (54%) animals in which tongue was examined histologically had some degree of lingual squamous metaplasia. Because squamous metaplasia of mucus-producing epithelia is commonly associated with hypovitaminosis A in other species, investigation of vitamin A status in affected toads was pursued. Captive Wyoming toads with squamous metaplasia (n=11) had significantly decreased hepatic retinol (mean 1.6 μg/g) when compared to free-ranging Wyoming toads (n=10; mean 104.6 μg/g). The combination of squamous metaplasia and decreased hepatic retinol is highly suggestive of hypovitaminosis A. Similar clinical signs and histologic changes have subsequently been observed in other captive toads including Rocky Mountain boreal toads (Bufo boreas boreas) and Woodhouse’s toads (Bufo woodhousii). Possible contributory factors to the development of hypovitaminosis A include inadequate supplementation of insect-based diets, use of outdated supplements and unique species requirements for vitamin A or vitamin A precursors.
A RETROSPECTIVE STUDY OF DISEASES OF SEA DRAGONS

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1Northwest ZooPath, 654 West Main, Monroe, WA 98296 USA; 2University of Connecticut, Department of Pathobiology and Veterinary Science, 61 N. Eagleville Road #U-3089, Storrs, CT 06269 USA; 3Cleveland Metroparks Zoo, 3900 Wildlife Way, Cleveland, OH 44109 USA; 4New England Aquarium, Central Wharf, Boston, MA 02110-3399 USA

Abstract

Leafy (Phycodurus eques) and Weedy sea dragons (Phyllopteryx taeniolatus) are related to seahorses and pipefish, and are found in reefs and sandy underwater regions of Western Australia, South Australia and further east along the coastline of Victoria, Australia. These fish are protected under Australian law, and have become popular recently for aquarium exhibits in the United States. With the exception of a few parasites and vibriosis,1-6 little is known of the pathogens or other disease processes of sea dragons. The report summarizes the pathologic findings in 148 weedy sea dragons (WSD) and 97 leafy sea dragons (LSD) submitted to Northwest ZooPath from 1994 to early 2005, and the Connecticut Veterinary Medical Diagnostic laboratory from 1999-2005.

Table 1 summarizes the disease processes diagnosed in LSD and WSD. Thirty-four disease processes were identified in WSD and 28 disease processes were identified in LSD. Some fish had multiple disease processes. Diseases commonly seen in both species were ciliated protozoan infections, mycobacteriosis, and various forms of dermatitis. Emaciation and no pathologic changes were also common diagnoses in WSD. Some important infectious diseases that occurred in WSD but not in LSD were myxozoanosis, intestinal coccidiosis, and branchial epitheliocystis-like inclusions.

ACKNOWLEDGMENTS

The authors thank the following institutions for contributing cases: Tennessee Aquarium, Monterey Bay Aquarium, National Aquarium (Baltimore), Aquarium of the Pacific (Long Beach), Aquarium of the Americas, Dallas World Aquarium, Waikiki Aquarium, Texas State Aquarium, Pittsburgh Zoo and Aquarium, Underwater Adventures, the Toledo Zoo, Point Defiance Zoo & Aquarium, Indianapolis Zoo, The Seattle Aquarium, Henry Doorly Zoo, and the New Jersey State Aquarium (now Adventure Aquarium).

LITERATURE CITED


<table>
<thead>
<tr>
<th>Disease</th>
<th>Weedy sea dragon, 148 cases (%)</th>
<th>Leafy sea dragon, 97 cases (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciliates</td>
<td>26 (18)</td>
<td>16 (16)</td>
</tr>
<tr>
<td>Dermatitis(^a)</td>
<td>25 (17)</td>
<td>23 (24)</td>
</tr>
<tr>
<td>Myxozoanosis</td>
<td>25 (17)</td>
<td>0</td>
</tr>
<tr>
<td>Emaciation</td>
<td>22 (15)</td>
<td>8 (8)</td>
</tr>
<tr>
<td>No lesions</td>
<td>21 (14)</td>
<td>7 (7)</td>
</tr>
<tr>
<td>Mycobacteriosis</td>
<td>15 (10)</td>
<td>27 (28)</td>
</tr>
<tr>
<td>Cestodes</td>
<td>13 (9)</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Chromomycosis</td>
<td>11 (7)</td>
<td>8 (8)</td>
</tr>
<tr>
<td>Nematodes</td>
<td>8 (5)</td>
<td>5 (5)</td>
</tr>
<tr>
<td>Branchitis</td>
<td>7 (5)</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Myopathy</td>
<td>7 (5)</td>
<td>6 (6)</td>
</tr>
<tr>
<td>Trematodes</td>
<td>6 (4)</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>6 (4)</td>
<td>9 (9)</td>
</tr>
<tr>
<td>Renal tubular necrosis</td>
<td>4 (3)</td>
<td>0</td>
</tr>
<tr>
<td>Coccidiosis</td>
<td>4 (3)</td>
<td>0</td>
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<tr>
<td>Epitheliocystis</td>
<td>4 (3)</td>
<td>0</td>
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<tr>
<td>Branchial atrophy</td>
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<td>Skin protists</td>
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<td>Steatitis</td>
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<td>Unidentified intestinal parasite</td>
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<tr>
<td>Trauma</td>
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<td>4 (4)</td>
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<td>S.b. hypoplasia</td>
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<td>Islet cell hyperplasia</td>
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<tr>
<td>Mineralization</td>
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</tr>
<tr>
<td>Urolithiasis</td>
<td>0</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>11 (7)(^b)</td>
<td>8 (8)(^c)</td>
</tr>
</tbody>
</table>

\(^a\)Includes cases of ulceration, erosion and underlying cellulites.

\(^b\)Weedy sea dragons had additional single case diagnoses of stomatitis, unidentified parasite granulomas, ammonia toxicosis, cataract, osmoregulatory disturbance, bacteria nephritis, mineralization, hepatic necrosis, diatoms, mycotic stomatitis, and probable viral branchitis.

\(^c\)Leafy sea dragons had additional single case diagnoses of renal tubular dilatation, osmoregulatory disturbance, hematopoietic depletion, goiter, flagellates, amoeba, nephrosclerosis, and biliary mucolith.
SURVIVAL ANALYSIS OF BLACK RHINOCEROSES (Diceros bicornis) IN CAPTIVITY IN THE UNITED STATES

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Abstract

A survey was conducted to identify disease-related risk factors associated with decreased survival in the captive black rhinoceros population in the United States. This study surveyed 40 of the 43 (93%) facilities and included 296 of the 334 black rhinoceroses (88.9%) ever in captivity between the years 1930 and 2001. The data consisted of information collected on 270 black rhinoceroses housed in captivity in AZA accredited zoos between the years 1930 and 2001. Information on the animals was collected until the animal’s death or completion of the survey. Survival analysis, using the Cox proportional hazards model, was performed to study the effects of disease parameters on survival. The dependent variable was the age of the animal at time of death or censoring. A black rhino was considered censored if it was alive at the time of the survey, with censoring occurring on the date of the survey visit. This study identified several risk factors associated with decreased survival time, including the presence of skin lesions, hypercalcemia, dental calculus, neurologic signs, jaundice, muscle necrosis or rhabdomyolysis, and signs consistent with idiopathic hemorrhagic vasculopathy. The finding of this study with the most serious implications for management of captive black rhinoceroses is that being housed at more than one institution is associated with an almost two-fold increase in the likelihood of death in a given time period as compared to animals housed only at one institution.
UPDATE ON SEROLOGIC DETECTION OF *Mycobacterium tuberculosis* INFECTION IN ASIAN ELEPHANTS

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Abstract

Tuberculosis has become an important disease in captive elephants, particularly Asian elephants (*Elephas maximus*). Diagnosing tuberculosis in elephants has been problematic as many tests have inadequate sensitivity or specificity.2-4 A multiple-antigen enzyme-linked immunosorbent assay (ELISA) was previously investigated for detecting infection in Asian elephants and African elephants (*Loxodonta africana*); this test had excellent sensitivity and specificity, but needed further evaluation.1

 Modifications to the multiple-antigen ELISA panel have since been made. Valuable antigens were retained, other antigens were removed, and new ones were added. This modified ELISA was re-evaluated, using serum from 68 Asian elephants. Sixteen had *M. tuberculosis* -positive trunk cultures, while 52 were either culture negative at necropsy or had a history of negative trunk cultures and no contact with infected elephants. Seven elephants were evaluated over time.

The test was 100% (95% CI; 95-100%) specific and 94% (95% CI; 79-100%) sensitive using two of the six antigens (*M. bovis* strain AN5 culture filtrate and *M. tuberculosis* early secretory antigenic target 6). “Effectively-treated” elephants had decreasing seroreactivity, but those that were culture-positive post-treatment were more consistently seroreactive. Although “effectively-treated” elephants had declining seroreactivity, they still usually had higher values than animals that had never been infected.

Serology continues to show great promise in detecting tuberculosis in elephants, often detecting infection months-to-years sooner than trunk wash culture. Advances in techniques may soon make serology even more practical. While serology should not replace trunk-wash culture, it is a useful adjunct for early detection of infection in elephants and for monitoring treatment.

ACKNOWLEDGMENTS

We thank the many veterinarians, owners, caretakers, and managers of elephant-owning institutions that participated in this investigation, as well as Drs. Michele Miller and Susan Mikota for helping to coordinate sample collection. We also thank Kimberly Deines and other laboratory personnel who processed ELISA samples. The study was
partially funded by a grant from USDA, CSREES to Colorado State University Program of Economically Important Infectious Animal Diseases.

LITERATURE CITED


APPLICATION OF MAPIA (MULTIPLE ANTIGEN PRINT IMMUNOASSAY) AND RAPID LATERAL FLOW TECHNOLOGY FOR TUBERCULOSIS TESTING OF ELEPHANTS

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Abstract

Tuberculosis (TB) remains a serious re-emerging disease in wildlife and zoo animals. Mycobacterium tuberculosis has been isolated from 30 captive Asian elephant (Elephas maximus) within 14 herds in the United States (1994-2004) and Mycobacterium bovis has been isolated from one African elephant (Loxodonta africana) (Mikota, pers. comm.).3 There are several challenges with elephant TB diagnosis. Culture of trunk wash has relatively poor sensitivity and is subject to contamination. Skin test is not validated in elephants and there is little reliability in these results.4 Serologic tests are appealing because samples can be stored for future analysis, archived samples can be analyzed, various assay platforms can be directly compared, and these assays are amenable to serial analysis (e.g., to monitor therapy). There is currently a multiple antigen ELISA test available for experimental use in elephants.1

To improve tuberculosis control, new diagnostic tools should be rapid, accurate, and host species-independent. Two novel serologic methods, MultiAntigen Print ImmunoAssay (MAPIA) and lateral-flow technology (Rapid Test), have been adapted for use in white-tailed deer, European badger, cattle, and Asian and African elephants for the detection of TB-specific antibody. Serologic markers of diagnostic importance have been identified for each host tested so far. With MAPIA, a machine prints specific antigens horizontally on a nitrocellulose membrane which can be cut into strips and used in Western blot.2 Strips are incubated with test serum samples, then an anti-Ig conjugate and color developer. Using this assay, an antibody response to multiple mycobacterial antigens has been observed in sera from M. tb-infected elephants. No antibody response was detected to any antigens in non-infected elephant sera. Additionally, the kinetics of antibody responses by elephants undergoing antibiotic therapy indicates that the MAPIA could be used for monitoring treatment and to determine recrudescence of infection.

Using selected antigens, a lateral-flow test was developed for rapid antibody detection that can be used in multiple species. The Rapid Test can use serum, plasma, or whole blood and provides results within 15 min. These tests are similar to in-clinic tests for FIV/FeLV detection (snap test, IDDEXX). If a band is present in the test strip, it indicates a positive reaction (antibody present).
A panel of sera from healthy and TB infected elephants showed good correlation between the MAPIA and the rapid test (Table 1).

In summary, it appears that TB-infected elephants produce a robust antibody response that can be detected in serologic assays. Of special significance is the kinetics of the response, which may permit earlier detection of infection than current diagnostic methods. While initial results are promising, additional studies are required to validate these two assays. A relatively small set of serum samples from documented infected and non-infected elephants was used, and more samples are needed to further validate the tests. MAPIA has been used to optimize antigen selection in order to make the most sensitive and specific Rapid Test. This strategy may also allow for identification of “treatment-sensitive” antigens that could be used in the MAPIA format to monitor TB therapy. While elephants will be used as an initial “proof of concept” species for test development, additional samples from other species will also be evaluated to determine applicability to other species (i.e., a host species-independent test), thus benefiting other groups such as primates, rhinos, cervids, etc.

ACKNOWLEDGMENTS

The authors thank the zoos and individuals that have provided samples and assistance with this research, including Ray Ball, Carol Buckley, Jenifer Chatfield, Genny Dumonceaux, Javan Esfandiary, Rena Greenwald, Scott Larsen, Susan Mikota, Torsten Moller, Dick Montali, Mike Richards, Heidi Riddle, Mo Salman, Scott Terrell, and many others. This research was supported by Chembio Diagnostics, Inc.

LITERATURE CITED


<table>
<thead>
<tr>
<th>Health status</th>
<th># Elephants</th>
<th># Rapid test positive</th>
<th># MAPIA positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy</td>
<td>63</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TB infected</td>
<td>17</td>
<td>17</td>
<td>16</td>
</tr>
</tbody>
</table>
FATAL ENTEROCOLITIS IN TWO ASIAN ELEPHANTS (*Elephas maximus*) CAUSED BY *Clostridium difficile*

Mads F. Bertelsen, DVM, DVSc,¹,²*, Miki Bojesen, DVM, PhD,³ and Katharina E. P. Olsen, MSc, PhD⁴

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Abstract

Altered behavior, anorexia and listlessness were observed in four of five adult captive female Asian elephants (*Elephas maximus*). Two animals recovered, while two died after 2 days. The dead elephants were subjected to post mortem examination including histopathology, demonstrating fibrinonecrotic enteritis and colitis.

*Clostridium difficile* was isolated from both dead elephants and from the feces of the two surviving affected animals, and identified by selective cultivation and PCR identification. All isolates had the *tcdA* and *tcdB* toxin genes and were positive in a toxigenic culture assay. *C. difficile* toxin from the intestinal content of one of the fatal cases was demonstrated using cell-culture based cytotoxin assays.

*Clostridium perfringens* type A and *Clostridium septicum* were also isolated from both dead animals. Although *C. perfringens* has been associated with ulcerative enteritis in an elephant,¹ in this case these isolates likely are incidental, as *C. perfringens* enterotoxin was not demonstrated, and as *C. septicum* is well known for producing rapid post mortem overgrowth.

Amplified fragment length polymorphism typing, showed that the *C. difficile* isolates recovered from the outbreak, all had the same fingerprint profile, indicating that all four elephants were affected by the same bacterial clone.

These findings appear to be the first to demonstrate that *C. difficile* may cause enterocolitis in elephants. The results emphasize the need to regard this organism as potentially dangerous for elephants. Although there was no prior exposure to antibiotic agents in this case, caution is recommended when treating elephants with antibiotics, as this may trigger *C. difficile* induced enterocolitis in other species, most notably humans and horses.²
LITERATURE CITED

COMPARISON OF RADIOGRAPHS VERSUS COMPUTED TOMOGRAPHY FOR EVALUATION OF THE DISTAL LIMB IN AN ASIAN ELEPHANT

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Abstract

Feet problems are the most commonly seen ailment in captive elephants. In the field of zoo and wildlife medicine, radiographs are the accepted standard of skeletal evaluation of the distal limb of elephants, to show changes in bone density and conformation.1 Although radiographs are considered reliable to show severe degenerative change in the distal phalanges, it is difficult to assess detail of the carpus and tarsus due to the anatomy and superimposition of the large carpal and tarsal bones.

Radiographic images of the distal limbs of a geriatric, female Asian elephant, were compared with postmortem computed tomography (CT) images. This animal had a long history of clinical nail disease treated for many years with diligent foot care and aggressive paring of multiple nails. Arthritis of the carpi, tarsi and/or digits was suspected and had been treated with non-steroidal anti-inflammatory medications. Serial radiographs from several years showed obvious degenerative change in multiple digits, especially those most severely affected clinically at the nail. Osseous detail in the carpi and tarsi was suboptimal on radiographs even when postmortem specimens were radiographed with a stationary, high capacity radiograph machine designed for large animal radiology. CT images of the distal limbs revealed degenerative skeletal changes that were not readily apparent on radiographs. Most degenerative change was noted in the periosteal areas of the carpal and tarsal bones, particularly at articular surfaces.

Realizing that CT of feet and distal limbs of live elephants is impractical, if not impossible, this comparison of radiographs and CT demonstrates that radiographs may not reveal all abnormalities present in joints of the distal extremities. Comparative CT images of younger or clinically normal animals were not available, so it has not been possible to determine the clinical significance of the apparent degenerative changes noted on these radiographs and CT images at the time of this publication. Nonetheless, consideration should be given for the lack of detail when evaluating radiographs of elephant feet.
When radiographic changes are noted in the distal limbs of elephants suffering from arthritis with a history of nail disease, the attending veterinarian may consider prophylactic antibiotic therapy to treat possible osteomyelitis in the bones of the distal limb. Also, in animals with arthritic change on radiographs and no nail disease, implementation of appropriate anti-inflammatory drugs and/or joint supplements should be considered. Hydrotherapy, acupuncture, limb exercise and other topical therapies may be warranted, depending on each individual case and the clinical signs exhibited. Routine and diagnostic radiographs should be taken from several angles, including oblique views, to assure the most accurate assessment of bony change in the distal limb and to give the best overall images for retrospective comparison. Radiographs should include the carpus and tarsus if the radiograph machine has the capacity for the bone density of that region.

ACKNOWLEDGMENTS

Thanks to the State Veterinary Diagnostic Laboratory, Auburn University College of Veterinary Medicine Department of Radiology for all of their time, expertise and contributions to this study. Also, thanks to Marcia Riedmiller and the pachyderm care staff at the Birmingham Zoo.

LITERATURE CITED

PHARMACOKINETICS OF INTRAVENOUS AND INTRAMUSCULAR BUTORPHANOL IN ASIAN ELEPHANTS (Elephas maximus)

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Abstract

Captive Asian elephants (Elephas maximus) are susceptible to lameness resulting from foot and joint pain.1 In the past, opioid analgesics, such as the agonist-antagonist butorphanol, have been used clinically for pain management. However, dosages used in treating elephants were often extrapolated from data in horses, with the risk of administering either a sub-efficacious dose or an overdose, both of which are undesirable.

In this study, six adult captive Asian elephants (five female, one male) were administered butorphanol intravenously (i.v.) and intramuscularly (i.m.) in a cross over design. The dose was 0.015 mg/kg for both routes with at least 21 days between administrations. Serial blood samples were collected immediately prior to butorphanol administration and at 5, 10, 20, 40 min, 1, 1.5, 2, 3, 4, 5, 6, 8, 10, and 24 hr after injection. The samples were collected into Li heparin vacutainer tubes and centrifuged to obtain plasma. The plasma was separated into cryovials and frozen at -70°C until analyzed using a validated LC/MS assay with a LOQ of 0.025 ng/ml.

The dosage selected for this pharmacologic study in elephants is within the recommended analgesic butorphanol dose range for horses.2 Following i.v. administration the median pharmacokinetic values that were calculated include: Vd, Clp, MRT, and half life (t½). After i.m. injection the median Cmax, Tmax, and bioavailability (F) were calculated. The Vd data used for extrapolation from published literature on five domestic mammalian species correlated with the values found for elephants. Thus, Vd may be useful to extrapolate an efficacious dose in Asian elephants. Our preliminary results suggest a dosage of 0.015 mg/kg may provide analgesia without evidence of severe sedation. Further studies are necessary to determine the quality and duration of analgesia from the administration of butorphanol in elephants at this recommended dose.

LITERATURE CITED

TREATMENT OF PEDAL OSTEOMYELITIS AND INFECTIOUS ARTHRITIS IN AFRICAN HOOFSTOCK: MEDICAL AND SURGICAL OPTIONS, SALVAGE PROCEDURES AND THEIR SEQUELAE

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Abstract

Trauma to the ungulate foot may result in microbial invasion of its soft tissues and compromise of pedal circulation, conditions that can lead to osteomyelitis of the distal phalangeal bone, and/or infectious arthritis of the distal interphalangeal joint. Early diagnosis of foot injuries with complete delineation of soft tissue wound margins is essential to successful treatment.

Some of these injuries involve infection with multiple pathogens that differ in their patterns of antimicrobial sensitivity. Lack of pharmacokinetic data for African hoofstock species, inconsistent consumption of oral antibiotics by these animals, and the difficulties inherent in delivering drugs to them repetitively via parenteral routes may prevent ideal case outcomes. Use of regional intravenous antibiotic perfusion, antibiotic impregnated polymethylmethacrylate beads, and portable, battery-powered drug infusion pumps are among the various strategies that can be used to combat foot infections in these species.2-4,6,8 Cases progressing to osteomyelitis and infectious arthritis are addressed with surgical debridement and lavage therapy.

Some animals with infectious arthritis and/or osteomyelitis do recover with our assistance. When infection is cleared, formation of “false joints” and osseous proliferation may still occur as part of the animal’s natural attempt to support its weight with compromised joint and skeletal structures.

Treatment failure occurs in some of these cases despite aggressive management and numerous immobilizations of the animal. Euthanasia is certainly a humane option when therapy fails. In our experience, salvage procedures such as joint fusion and amputation of the distal phalanx give temporary reprieve to the animal and to zoo staff reluctant to terminate the animal’s life. However, lameness frequently recurs due to abnormal weight-bearing that produces conditions such as proliferative osteopathy and tendinous calcification in the originally affected or contralateral foot. Quality of life issues become legitimate concerns. Continued work on early diagnosis and monitoring of osteomyelitis plus pharmacokinetics in African hoofstock will increase our chances for success in these cases.1,5,7
LITERATURE CITED

DENTAL EXAMINATION OF EQUIDS

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Abstract

Presentation of Equidae with dental disease is one of the most common problems that the equine practitioner will encounter. Disease may be in the form of simple enamel points to fractured teeth.

The process by which the veterinarian approaches the disease will greatly enhance their probability for success. The most important aspect of diagnosing and managing any dental disease is obtaining an accurate history. The history of a dental case can change depending on whom you talk to. What are the eating habits of the equid? Does the equid eat slowly? Does the equid turn his head to one side or the other when eating? If necessary, the practitioner should watch the animal while it eats to detect subtle abnormalities. Is the meal consumed within a reasonable time? What supplements is the equid getting?

Weight lost is one of the common reasons geriatric equids are presented for dental examinations. Ask about parasite control. Do a fecal examination. I often find parasite eggs in equids that are ‘wormed’ on a regular basis.

The floating history is extremely valuable to me. When was the equid last floated? By whom? Was that the first time that the equid was floated in years? Did the problem improve or get worse? What types of floats were used? Is there a dental record from the referring veterinarian to examine?

The dental record is without question a must for any equid under going a dental examination or dental procedure. The record should have an individual number for filing and include all necessary information to identify the individual equid. The dental record should also include the history of the equid and the presenting complaint.

Body condition may be a good indicated of the type of problem(s) you may be dealing with. If all the equids on the farm/zoo are thin then it most likely is a nutritional or management problem and not a dental problem. Take time to look around and you will learn a lot about the equid’s environment and the people you are dealing with.
The dental examination process always should include visual and tactile examinations, and in some cases ancillary diagnostic aids are necessary. The visual examination is best done first at a distance, noting the symmetry of the animal’s head and its demeanor. Closer inspection of the head should be performed to identify asymmetry, bumps, swellings, and draining tracts. External palpation of the equid’s head can also aid the practitioner in detecting subtle changes in the anatomy and sharp enamel points on the upper cheek teeth by palpating the external cheek. The lips and lip commissures should be inspected for any scars, cuts, or ulcers. Subsequently, the incisor arcade can be inspected for any abnormalities including broken, missing and/or malaligned teeth. Upon completion of the visual examination, the equid’s breath should be smelled for a fetid odor characteristic of tooth infection or impacted feed material.

The tactile examination can be done with or without a mouth speculum, but a full-mouth speculum is required to palpate the caudal molars. In addition to the teeth, the buccal surface of the cheeks and the tongue should be palpated for abnormalities.

Radiography can be an essential component of the examination process and satisfactory radiographs can be obtained in the field. A portable x-ray unit capable of producing 80-100 kVp with exposure times up to 0.5s will provide satisfactory x-rays in most cases. Rare-earth 400-speed film provides the best results. The practitioner should always take four views (lateral, dorsoventral, and two obliques) of the skull when evaluating Equidae with suspected dental disease. The injection of contrast media into draining tracts will often aid in the identification of the affected tooth. Indications for radiography include: tooth eruption, impacted teeth, fractures of the teeth or skull, abnormal dental wear patterns, tooth abscesses, foreign objects, and missing, malaligned, sinusitis or supernumerary teeth.

Ultrasonography can be used to detect pockets of fluid, (e.g., abscesses) in the oral cavity and near the base of the tongue or cheek. The ultrasound probe is placed in the intermandibular space or against the cheek if the equid is presented with a history of a localized swelling and/or dysphagia especially if the equid had a history of a previous floating or oral trauma.
CHILDREN’S ZOO ANIMALS MADE EASY

Peregrine L. Wolff, DVM

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Abstract

Many zoological institutions have a children’s or petting zoo. These exhibits contain primarily domestic animals. Zoo veterinarians focus their efforts on staying current with the medical care of exotic species. This presentation provides an overview of the preventive care (vaccinations, foot care, parasite control and dental), anesthesia drugs and dosages, and common clinical conditions, and zoonotic diseases of llamas, alpacas, sheep, goats and pot-belly pigs.

New World Camelids, Llamas and Alpacas

Preventive Care

Toe nail trimming: Trim flush with the plantar surface of the “slipper”.

Annual vaccinations: Clostridium and tetanus. West Nile virus infection has occurred in camelids and the vaccination recommendations are 1 ml every 3 wk for three doses, then an annual booster.

Annual shearing: Should be done to prevent heat stress, especially in climates with excessive heat and humidity. Shear in spring when night time temperatures will remain above 10ºC (50ºF). Try to use an experienced shearer. Iatrogenic burns over the dorsum have been reported.

Parasite control: Deworming strategies should be based on fecal results. Nematodirus or Trichuris species have caused problems in camelids, and are noted to be variably shed in the feces. Even one to two eggs identified on a fecal exam should prompt treatment of the animal. Parelaphostrongylus tenuis affects camelids in susceptible areas. Recent research has shown that the intermediate host snails emerge from hibernation uninfected and accumulate the parasite over the summer. The majority of the clinical cases in camelids have occurred between September and March. Current recommendations to avoid resistance are to deworm with avermectins from September through December and to also focus on environmental control.

Teeth evaluation and trimming: Incisor teeth will grow to replace the worn portion and in a normal animal will contact the dental pad. Mild to moderate superior brachygnathism is not uncommon and the incisor teeth may need to be trimmed. Male camelids also have six (two...
upper, one lower) fighting teeth, that should be cut or blunted to prevent injury to other animals or handlers. Retained deciduous incisors are frequently seen and should be removed.³

Anesthesia

See sedation and general anesthesia drug dosages Tables 1 and 2. Intubation for gas anesthesia can be achieved using the proper laryngoscope blade. A 12-inch Miller blade simplifies intubation of camelids (A.M. Bickford, Inc., 800-795-3062).

Common Medical Problems

Skin diseases: Vague, often unsightly, alopecic skin conditions are common in camelids. Many skin problems are idiopathic and colloquially referred to as “munge.” Common locations are the bridge of the nose, periaural, inguinal, axilla, perianal and ventral abdomen. Differential diagnoses are similar to other large animal species. Chorioptes mange is not an uncommon cause of alopecia and is most reliably diagnosed by skin scrapings performed in the interdigital area or axilla. Zinc-responsive dermatosis has been described and supplementation with zinc is reported to be of benefit in a number of dermatosis in camelids. Two to four grams of zinc methionine orally per day has been noted to be beneficial. Topical or systemic corticosteroid therapy is useful, but has been anecdotally linked to abortions in camelids.⁵

Tooth root abscesses and lumpy jaw: Tooth root abscesses are primarily in the mandible, with M1 and M2 most commonly involved and seen in animals anywhere from 2 – 22 yr of age. Diagnosis requires radiographs. Medical treatment with long term antibiotics may be effective. Surgical removal of the affected tooth or teeth with long term antibiotics has been 100% curative. A lateral alveolar plate resection is the surgical approach of choice to avoid causing a mandibular fracture. Antibiotics of choice are Ceftiofur and Florfenicol.²

Lumpy jaw is also fairly common. Actinomyces bovis has been variably cultured from these lesions.²,⁴ Long term antibiotics, including penicillin-G procaine, 22,000 IU/kg, s.i.d. along with oral organic iodide powder mixed with dextrose and administered at 3 – 5 gm, s.i.d. for 3 wk.⁴

Goats and Sheep

Preventive Care

Hoof trimming: Overgrown hooves are common and can be a significant cause of lameness in sheep and goats.

Annual vaccinations: Clostridium and tetanus. Rabies vaccines are approved for use in sheep.
Parasite control: Deworming strategies should be based on fecal results. *Haemonchus* is the most significant parasite. Goats and sheep probably need higher dosages of anthelmentics than cattle. Anecdotal reports suggest that Ivermectin be dosed at 300 µg/kg and only be administered orally.⁸

Anesthesia

See sedation and general anesthesia drug dosages (Tables 1 and 2) and comments under New World camelids.

Common Medical Problems

*Caprine arthritis-encephalitis virus (CAE) and ovine progressive pneumonia (OPP):* Both diseases are caused by nononcogenic retroviruses. The majority of animals infected with CAE or OPP are asymptomatic. CAE can cause four clinical syndromes, arthritis, mastitis, leukoencephalomyelitis, and interstitial pneumonia. Progressive arthritis is the most common clinical presentation. It occurs primarily in the carpal joints, and is seen in goats as young as 6 mo. OPP usually causes disease after years of infection. Pneumonia, mastitis and chronic arthritis are the clinical syndromes seen. In both diseases, affected animals are infectious to others. Serum AGID tests are available for both CAE and OPP.¹⁰

*Inappropriate Lactation Syndrome:* Does develop an enlarged udder (in some instances to the extent that it will impair locomotion) with no history of being bred. A thin milky to straw colored fluid may be milked from the udders. There are no clinical signs of mastitis. Ovarian and pituitary abnormalities have been reported with this condition. If the doe is not pregnant, administration of PGF2α (10 mg i.m.) can be given to rule out pseudopregnancy. Recommended treatment is udder amputation.¹¹ OVH in kids may prevent this syndrome.

*Urolithiasis:* Extremely common in castrated goats. Also seen in all small ruminants and pot-belly pigs. Determining the presence of normal urination is the most important physical exam finding in the sick wether. Surgical correction via tube cystotomy or cystotomy with urethral hydropulsion along with urethrotomy can carry a good long term prognosis and quality of life. Prevention can be achieved by dietary manipulations. Feed a grass hay ad libitum and no grain. Encourage water consumption by providing fresh water and gradually adding sodium chloride to achieve 3 – 5% of daily dry matter intake. Ammonium chloride at 0.5 – 1% of the daily dry matter intake will acidify the urine.¹² However, ammonium chloride is extremely unpalatable and alternative acidifiers such as Biochlor and Soychlor may be used. (personal communication through American Association of Small Ruminant Practitioners forum, www.aasrp.org)
Pot-belly Pigs

Preventive Care

Hoof trimming: Overgrown toes and dew claws are very common. Trimming can be done in an awake animal, but is usually more successful and quieter with anesthesia.

Annual vaccinations: Erysipelas and tetanus are recommended in adult pigs.

Parasite control: Deworming strategies should be based on fecal results.

Teeth evaluation and care: Males have continuously growing canine teeth (tusks) that must be regularly cut. Use Gigli wire or a dental drill. Females have much smaller tusks, that may become sharp and should be blunted. Dental exams and cleanings should be performed annually. Calculus, periodontal disease and tooth loss are common in adult pigs.

Anesthesia

See sedation and general anesthesia drug dosages (Tables 1 and 2). Intubation for gas anesthesia can be achieved easily using the proper laryngoscope blade (see New Worlds camelids).

Common Medical Problems

Uterine tumors and pyometra: Common in older sows. Pigs present with firm, distended abdomen, and/or vaginal bleeding and purulent discharge. Both malignant and benign tumors have been diagnosed (unpublished data through Veterinary Information Network, www.vin.com); however, gross evidence of metastasis seems low. Surgical removal is straightforward. All female pigs should be spayed. The uterus is easy to locate and remove.

Tusk abscesses: Appears to only affect lower tusks and primarily seen in older males. Clinical signs are soft tissue swelling around the jowls, and/or fistulous tracts and foul odor from the face or mouth. Multiloculated soft tissue abscesses are common. Radiographs show profound loss of bone around the affected tusk root. Removal is possible, if the oral portion of the tusk is loose, otherwise, long term treatment with clindamycin or amoxicillin/clavulanate is the treatment of choice.

Osteoarthritis: Seen in almost all adult pot-belly pigs. Primary sites are fetlocks, pasterns and elbows. Proper hoof care, weight management and housing on surfaces other than concrete may help delay onset or slow progression of the condition. Long term use of NSAIDS marketed for osteoarthritis in canines or prednisone (20 mg, p.o. b.i.d. every other day) appear to be beneficial.
Zoonotic Disease Considerations

All you need to know is contained in the Center for Disease Control and Prevention’s (CDC) Compendium of Measures to Prevent Disease Associated with Animals in Public Settings, 2005. This is found at http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5404a1.htm.

LITERATURE CITED

Table 1. Sedation and general anesthetic dosages in New World camelids, sheep, goats and pot-belly pigs.

<table>
<thead>
<tr>
<th>Sedation</th>
<th>Llamas (mg/kg)</th>
<th>Alpacas (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Butorphanol</strong></td>
<td>0.07 - 0.1 i.m.</td>
<td>0.07 - 0.1 i.m.</td>
</tr>
<tr>
<td>Xylazine</td>
<td>0.2 - 0.3 i.v.</td>
<td>0.1 - 0.2 i.v.</td>
</tr>
<tr>
<td>“Ketamine stun” (i.v./i.m.) (xylazine, ketamine, butorphanol)</td>
<td>Xylazine (0.2 - 0.3) + ketamine (0.2 - 0.3) + butorphanol (0.07 - 0.1) (i.v.)</td>
<td>Same as llamas</td>
</tr>
<tr>
<td></td>
<td>Xylazine (0.2 - 0.5) + ketamine (0.2 - 0.5) + butorphanol (0.05 - 0.1) (i.m.)</td>
<td></td>
</tr>
<tr>
<td><strong>Butorphanol, ketamine, xylazine (i.v.)</strong></td>
<td>1.0 - 2.0 ml of mixture (i.v.)</td>
<td>0.5- 1.5 ml of mixture i.v., as needed.</td>
</tr>
<tr>
<td>Ketamine (1gm) + xylazine (100 mg) + butorphanol (10 mg)</td>
<td>Xylazine (0.3) + ketamine (3.7) + butorphanol (0.037) or 1 ml/50 lb + 1ml</td>
<td></td>
</tr>
<tr>
<td><strong>General anesthesia</strong></td>
<td>Xylazine (0.22 i.m.) wait 10 min then ketamine (11 i.m.) Note: Have also given half dose i.v.</td>
<td>Xylazine (0.22 i.m.) wait 10 min then ketamine (10 - 15 i.m.)</td>
</tr>
<tr>
<td>Butorphanol, ketamine, xylazine (i.m.)</td>
<td>Telazol (5.5 i.v.) + butorphanol (0.1 i.v.) for additional time</td>
<td>Telazol (5.5 i.v.) + butorphanol (0.1 i.v.) for additional time</td>
</tr>
<tr>
<td><strong>Telazol (i.v.)</strong></td>
<td>4.0 i.m. 2.0 i.v., up to 45 min duration</td>
<td></td>
</tr>
<tr>
<td><strong>Sedation</strong></td>
<td>Goats (mg/kg)</td>
<td>Sheep (mg/kg)</td>
</tr>
<tr>
<td><strong>Xylazine and butorphanol</strong></td>
<td>Xylazine (0.1 - 0.2 i.v.) Butorphanol (0.01 - 0.02 i.v.) deep sedation for 60 min</td>
<td>Xylazine (0.1 - 0.2 i.v.) Butorphanol (0.01 - 0.02 i.v.) deep sedation for 60 min</td>
</tr>
<tr>
<td><strong>Medetomidine</strong></td>
<td>0.001 - 0.007 i.v. 0.01 - 0.04 i.m.</td>
<td>0.001 - 0.007 i.v. 0.01 - 0.04 i.m.</td>
</tr>
<tr>
<td><strong>General anesthesia</strong></td>
<td>Ketamine (0.1 ml/10 lb) + detomidine (0.01 ml/10 lb i.v.) add butorphanol (0.4 i.v.) for added analgesia</td>
<td>Ketamine (0.1 ml/10 lb) + detomidine (0.01 ml/10 lb i.v.) add butorphanol (0.4 i.v.) for added analgesia</td>
</tr>
<tr>
<td>Ketamine and detomidine (personal communication through AASRP, unpublished data)</td>
<td>Reversal: Half dose of detomidine as atipamezole i.m.</td>
<td>Reversal: Half dose of detomidine as atipamezole i.m.</td>
</tr>
<tr>
<td><strong>Xylazine and ketamine</strong></td>
<td>Xylazine (0.22 i.m.) wait 10 min then ketamine (11 i.m.) Note: Have also given half dose i.v.</td>
<td>Xylazine (0.22 i.m.) wait 10 min then ketamine (10 - 15 i.m.)</td>
</tr>
<tr>
<td><strong>Telazol</strong></td>
<td>Telazol (5.5 i.v.) + butorphanol (0.1 i.v.) for additional time</td>
<td>Telazol (5.5 i.v.) + butorphanol (0.1 i.v.) for additional time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sedation</th>
<th>Pot-belly pigs (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General anesthesia</strong></td>
<td>Butorphanol (0.1 - 0.4) + ace (1 - 3 mg) i.m.</td>
</tr>
</tbody>
</table>
Table 2. Reversal agents used in New World camelids, sheep, goats and pot-belly pigs.

<table>
<thead>
<tr>
<th>Reversal agents</th>
<th>Dose</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yohimbine⁷,⁹</td>
<td>0.125 mg/k i.m. or half dose i.v.</td>
<td></td>
</tr>
<tr>
<td>Tolazoline⁷,⁹</td>
<td>1 – 2 mg/kg i.m.</td>
<td>Use with caution i.v. in camelids</td>
</tr>
<tr>
<td></td>
<td>Give 50% of initial dose slow i.v. or i.m.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and then determine if more is needed.⁹</td>
<td></td>
</tr>
<tr>
<td>Atipamezole⁷,⁹</td>
<td>0.1 – 0.2 mg/kg slow i.v. or i.m.</td>
<td></td>
</tr>
</tbody>
</table>
CHRONIC RENAL FAILURE AND NEPHROLITHIASIS IN A TWO-TOED SLOTH (Choloepus didactylus)

Julia E. Napier, DVM\textsuperscript{1} \textsuperscript{*} and Tiffany A. Moore, DVM\textsuperscript{2}

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Abstract

A 9-yr-old, female two-toed sloth (Choloepus didactylus) presented with acute illness and expired within 24 hr. On necropsy, two nephroliths were located in the renal pelvis of the right kidney. The bladder walls were dark and thickened. The right ureter was enlarged and filled with a mucopurulent substance. Histologically, the diagnosis was chronic renal disease with marked chronic interstitial nephritis and severe gastric mucosal mineralization. The composition of the kidney stones was determined to be struvites. Previous exams of this animal that included radiographs and bloodwork were unremarkable. Urinalyses had not been performed. Performance of routine physical exams, bloodwork, radiographs and urinalyses may be important tools for ante-mortem diagnosis of renal disease and/or stones in this species. Evaluation of husbandry and diet provided for captive two-toed sloths may illuminate causes for increased incidence of this disease in these animals.

Introduction

Chronic renal failure (CRF) is a common diagnosis in many species.\textsuperscript{5} As shown in a recent retrospective study, this clinical problem is a leading cause of death in two-toed sloths (Choloepus sp.).\textsuperscript{6} Replacement fibrosis of the renal parenchyma that occurs with CRF often obscures the specific etiology of end-stage kidney disease regardless of species.\textsuperscript{5} Sloths have an alkaline urine pH that contributes to formation of crystals and urinary tract stones, conditions that can set the stage for renal failure. Clinical signs in sloths with renal failure may be non-specific such as weakness, dehydration, anorexia, and weight loss. Many sloths with CRF die acutely, showing little indication of disease. Routine physical exams are often not performed on captive sloths and little data exists for sloth urinalysis in normal or diseased states.\textsuperscript{6}

Case Report

Abnormally thickened, viscous saliva was noted in a 9-yr-old female two-toed sloth. This animal displayed acute anorexia and exhibited difficulty in clinging to tree branches. Physical exam revealed a body temperature of 33.3°C, heart rate of 85 bpm and respiratory rate of 12 brpm. Emergency treatment under manual restraint consisted of enrofloxacin (Baytril, Bayer Corporation, Agriculture Division, Animal Health, Shawnee Mission, KS 66201 USA) 2.5
Dexamethasone (Dexamethasone Solution, Phoenix Pharmaceuticals Inc. St. Joseph, MO 64506 USA) 1 mg/kg i.m. and LRS (Lactated Ringer’s, USP, Abbott Laboratories, North Chicago, IL 60064 USA) 200 ml s.c. The sloth was placed in a crate with a heat source underneath it and was closely monitored. It did not respond to supportive care and died 24 hr after initial clinical signs were observed.

A cystocentesis completed immediately post-mortem showed urine pH of 8, specific gravity of 1.013, trace blood, the presence of 1-2 triple phosphate crystals per hpf, 4+ bacteria and 3+ protein (DiaScreen Reagent strips, Hypoguard, Minneapolis, MN 55439 USA). Urine culture was not performed. At necropsy, the entire bladder wall appeared thickened and black. The right ureter was approximately twice the size of the left ureter and filled with a mucopurulent substance. Two nephroliths were found in the right kidney. On analysis, the stones were composed of magnesium ammonium phosphate hexahydrate (struvites). Chronic renal disease with lymphoplasmacytic interstitial nephritis and severe gastric mucosal mineralization was diagnosed histologically. Gastric mineralization has been documented as a secondary finding in other sloths with end stage renal disease.

Radiographs taken 11 mo prior to the animal’s death did not indicate a difference in kidney size and nephroliths were not visualized. Serum chemistry at that time was unremarkable relative to ISIS values for this species. However, serum calcium was 10.4 mg/dl, showing an increase to the high normal range as compared to a serum calcium measured approximately 2 yr prior to the animal’s death (8.2 mg/dl). A urinalysis had not previously been performed.

**Discussion**

An understanding of normal excretory processes in the sloth is important when considering potential causes of urinary tract disease in this species. Sloths urinate and defecate simultaneously, usually when they start their daily activity. Elimination occurs every 3 to 10 dy. The bladder of a sloth can hold up to 1.5 L and sloths generally expel anywhere from 800 – 1200 ml of urine at a time. Sloth urine tends to be dilute and alkaline based on limited urinalyses results currently available.

The causes of nephrolith and urolith formation in the sloth are likely multifactorial. Uroliths composed of calcium, magnesium, ammonium, phosphorous, magnesium phosphate hydrate, and carbonate apatite are associated with an alkaline urine and appear to be the predominant stone type documented in this species.

Bacterial cystitis may contribute to urolith and nephrolith formation as it increases organic debris available for stone formation. Urease positive bacteria such as *Staphylococcus* sp., *Streptococcus* sp., *Klebsiella* sp., and *Proteus* sp. can contribute to formation of struvites. Urinary tract infections were reported frequently in the retrospective study. Little information regarding results of urine cultures in this species exists. *Klebsiella* sp. was cultured from a two-toed sloth.
with struvites. Further studies of sloth culture results as correlated with urinary tract infection and stone formation are needed.

Diets offered to captive sloths may also contribute to the development of stone formation and kidney disease. Dietary protein and mineral levels may be important concerns for sloths as high protein diets are believed to contribute to stone formation and kidney disease in companion animals. Commercially produced low protein diets have been instrumental in reducing the occurrence of both diseases.

Current domestic animal research is also directed at determining if foods high in magnesium and phosphorus predispose dogs and cats to uroliths and renal failure. Most commercially produced low protein diets are also lower in phosphorus, magnesium, and calcium. Foods highest in phosphorus content are proteins like meat. Legumes such as squash, zucchini, broccoli, mustard greens, cabbage, and asparagus also have a high phosphorus level.

In the wild, studies indicate sloths eat primarily foliage including leaves, blossoms, shoots, green stems, and fruit. Speculation exists that sloths eat animal matter when it is easily available yet this practice has not been documented.

Captive sloths have proven to be fairly indiscriminate as regards dietary preference. They are fed a combination of fruits, vegetables and greens in varying amounts, as well as some source of protein such as a feline diet, dog kibble, eggs, primate canned diet and/or biscuits.

Two sloths presenting with cystic calculi underwent cystotomy for stone removal and were placed on a different diet such that their intake of protein, phosphorus, and magnesium was reduced. Their original canned primate diet (Zu/Preem Primate Diet and Zu/Preem Marmoset Diet, P.O. Box 2094, Mission, Kansas, 66202, USA) was replaced with Hill’s S/D (Hill’s Pet Products, Inc. Topeka, Kansas 66601, USA) and stones did not reoccur. A study on the correlation between the amount or type of protein and minerals in the diet as it relates to renal disease and stone formation in the two-toed sloth is being pursued at this time.

This case demonstrates the need for performance of regular physical exams and clinical diagnostic tests to detect urinary tract disease in sloths. As seen in this case, two-toed sloths can quickly become ill and die before underlying renal disease is detected. It can be difficult to note a change in activity such as lethargy in these animals because they are sedentary by nature and are often in exhibits where they are not easily observed. Regular evaluation of changes in routine urine results including pH, protein levels, bacteria levels, and the amount of crystals in the urine may illuminate an animal’s predilection towards urinary tract infections, stone formation, and subsequent kidney problems. Sloths can be difficult to catheterize yet cystocentesis can be performed with relative ease. Free catch urine samples may be collected regularly for analysis of basic parameters and trends in urine composition.
Yearly blood chemistry values may reveal azotemia although this abnormality is not consistently seen in this species, as was the case with this sloth. Regular radiographs may reveal such abnormalities as visceral mineralization as has been documented for end stage renal disease.\(^6\)

Therapeutically, urine acidifiers may be considered to address urinary tract disease in sloths although there is no published information regarding their use in this species. The fact that two-toed sloths have a rumen-like gastrointestinal system might affect the viability of these acidifiers.

ACKNOWLEDGMENTS

I would like to thank Laura Arriaga, the veterinary technician at the Potawatomi Zoo, for performing the necropsy and taking the pictures for this presentation. Thanks also to Dr. Ivan Rubiano, Dr. Deidre Fontenot, Dr. Rudy Wedlarski, Dr. Vicki Clyde, Judy Aviarios, Dr. Jackie Gai and Dr. Beth Hammond for contributing the diet information from their respective institutions.

LITERATURE CITED

MORTALITY OF THE THREE-TOED SLOTH (Bradypus variegatus) IN CAPTIVITY

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Abstract

The three-toed sloth (Bradypus variegatus) is highly coveted in the Columbian illegal fauna trade, especially during vacation periods, when animals are sold to tourists as pets. However, rescued wild-caught three-toed sloths often die of unknown causes. In addition, maintenance of this species in captivity has been reported as difficult.1-4 It is speculated that the mortality rate of this species in captivity is related to its very specialized feeding habits.4 Increased knowledge about causes of morbidity and mortality of this species will promote effective rescue strategies for sloths.

Morbidity and mortality information for twelve three-toed sloths acquired from the illegal fauna trade in Columbia were reviewed. Additional clinical studies of these animals aided the recognition of sick sloths. Post-mortem research of these cases improved understanding of the gross and microscopic characteristics of normal and diseased tissues in this species. It was established that sloths experiencing stress develop digestive, cardiovascular, and respiratory dysfunctions leading to multiple organ system failure, shock, and death. Circulatory alterations ultimately cause the animal’s demise.

LITERATURE CITED

HUMORAL IMMUNE RESPONSE TO NOVEL CANINE DISTEMPER VACCINES IN EUROPEAN MINK (Mustela lutreola)

Joost Philippa, DVM,1,2* Tiit Maran,3 Marco van de Bildt, BSc,1 Thijs Kuiken, DVM, PhD, Dipl ACVP,1 Willem Schaftenaar, DVM,2 and Ab Osterhaus, DVM, PhD1

1Institute of Virology, Erasmus MC, dr Molewaterplein 50, 3015 GE, Rotterdam, The Netherlands; 2Rotterdam Zoo, P.O. Box 532, 3000 AM Rotterdam, The Netherlands; 3Foundation Lutreola, Tallinn Zoo, Paldiski Road 145, Tallinn 13522, Estonia

Abstract

All families of the order Carnivora are susceptible to infection with canine distemper virus (CDV), a ubiquitous and potentially fatal disease.1,2 Domestic dogs are vaccinated with a modified live (ML) vaccine for protection against this disease. However, these ML vaccines have induced disease and death in several non-domestic carnivore species, including the highly endangered European mink (Mustela lutreola).3 Safer alternatives are inactivated virus vaccines, subunit vaccines, or recombinant vaccines. Recombinant vaccines have proven to be safe and efficacious in polecats (Mustela eversmanni), a species closely related to the European mink, and other carnivore species.4 However, the use of recombinant CDV vaccines is forbidden in the European Union, and monovalent inactivated vaccines are no longer commercially available. A safe and effective vaccination campaign is essential for protection of valuable and endangered susceptible species in zoos and breeding centers/reintroduction projects. The goal of this study was to evaluate and compare the humoral immunogenicity of a commercial recombinant CDV vaccine (Purevax™, Merial, Duluth, GA) and an experimental immuno-stimulating complex CDV vaccine (CDV-ISCOM, Erasmus MC, Rotterdam) in European mink.

Previously unvaccinated captive European mink housed in a breeding and reintroduction center in Tallinn, Estonia were used for this study. Six mink were vaccinated with Purevax™ and six mink were vaccinated with CDV-ISCOM. As a negative control group, five mink were injected with a phosphate buffered saline solution. The mink were vaccinated three times intramuscularly at 3-wk intervals. Blood was collected from the jugular vein prior to each vaccination. Post-vaccinal blood samples were taken 3 wk and 1 yr, after the last vaccination. Serum antibody titers were determined by virus neutralization (VN) and ELISA tests.

Both types of CDV vaccine produced an increase in serum titer (booster effect) after the second and third vaccinations. Antibody titers were produced in all animals after three vaccinations. The mean VN antibody titer induced after three vaccinations with CDV-ISCOM was 20-fold higher than that produced by Purevax™ (1:1280 vs 1:57). Mean antibody titers measured by ELISA followed the same trend, but were higher. One year after the last vaccination, VN titers had declined, but were still detectable, with those after CDV-ISCOM vaccination being higher (1:160...
In the Purevax™ group two animals did not have a detectable titer after 1 yr. Control animals did not produce titers throughout the study. None of the animals showed clinical signs of CDV infection, or any other negative effect that could be attributed to vaccination.

This study demonstrates that the Purevax™ and CDV-ISCOM vaccines appear safe for European mink and induce a humoral immune response in this species as determined by VN and ELISA tests. The presence of a humoral immune response has been shown to be positively correlated with increased survival following challenge with CDV infection in other species and may be expected to offer protection for mink. In conclusion, this study suggests that while both vaccines induce a humoral response, the CDV-ISCOM vaccine protects European mink better against CDV infection because it induces higher antibody titers in this species. Further work will be conducted to determine the cellular immune response produced by both vaccines.

LITERATURE CITED

VACCINATION OF SOUTHERN SEA OTTERS (*Enhydra lutris nereis*) FOR CANINE DISTEMPER AND INTERPRETING RESULTS OF SEROSURVEYS

David Jessup, DVM, MPVM, Dipl ACZM,¹* Chris Kreuder, VMD, MPVM, PhD,² and Michael J. Murray, DVM³

¹California Department of Fish & Game, 1451 Shaffer Rd. Santa Cruz, CA 95060 USA; ²Wildlife Health Center, Old Davis Road, University of California, Davis, CA 95616 USA; ³Monterey Bay Aquarium, 886 Cannery Row, Monterey, CA 93940 USA

Abstract

There are approximately 2800 southern sea otters (*Enhydra lutris nereis*) all living off the coast of Central California and they are listed as threatened under the Endangered Species Act (ESA). Disease organisms coming from terrestrial sources are very significant contributors to mortality and appear to be limiting potential for population recovery. Epidemics and cumulative effects of pathogens and toxins in recent years have resulted in record mortalities. We have attempted to use serosurveys to help determine prevalence and distribution of diseases in the live population.¹ Until recently, we had found no evidence of serum neutralizing (SN) antibodies to canine, phocine or cetacean morbilliviruses and assumed that these viruses were not common in the nearshore ecosystems of California which support sea otter populations. However, when additional samples, some of which were duplicates of previous samples, were submitted to another laboratory, detectable and potentially significant (SN) antibody levels were found.

A small number of southern sea otters are maintained in captivity for research or display purposes. One such facility is adjacent to an ecological reserve with an abundant raccoon population, some of which rarely manage to enter the compound containing captive sea otters. The second is a very large public aquarium with a sea otter stranding and response program as well as display animals. Thousands of hours may be spent rehabilitating or training these animals for behaviors that facilitate minimally invasive research and it is desirable to reduce the risk of debilitating or potentially fatal disease to as close to zero as possible. For these reasons a three-shot series of a canarypox vectored live recombinant canine distemper vaccine (Purvax, Merial, Athens, GA 30601, USA), which had been developed for black footed ferrets, was used at the standard dosage 30 days apart. Blood samples were taken at day 0 and at about days 30, 60, 90 and then every 90 days to develop a vaccine response curve. Since this initial work another five captive sea otters have been vaccinated and we have tracked their antibody response. All animals responded to vaccination by developing SN antibodies and none showed any signs of untoward side effects.

The vaccination of these healthy captive adult sea otters provided an opportunity to compare results of tests for SN antibodies to canine distemper from two laboratories before vaccination
and at 30-day and longer intervals thereafter. Results suggest that the two SN tests provide comparable results but have different sensitivities, one appears too insensitive to detect lower titers, the other appears to be too sensitive and thus subject to false positives, based on current interpretation guidelines.

These studies highlight some of the problems inherent in wildlife serosurveys, the value of comparing results from two or more laboratories, and the value of establishing an antibody response curve for rare species. Currently available commercial vaccines appear to provide potentially protective SN antibodies and could be used in the event of a canine distemper or similar morbillivirus outbreak in wild otters.

ACKNOWLEDGMENTS

The authors thank Ms. Debbie Brownstein of CDFG-MWVCRC, the staffs of the Marine Mammal Training program at University of California, Santa Cruz and the Monterey Bay Aquarium particularly Jennifer Coffey, and the Cornell and Oklahoma State Veterinary Diagnostic Laboratories. Funding was provided by the CDFG-OSPR SSEP program.

LITERATURE CITED

IDIOPATHIC POLYMYOSITIS IN THE DOMESTIC FERRET: AN EMERGING FATAL DISEASE

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Abstract

During an 11-yr span (1994 to early 2005), Northwest ZooPath has received 1943 ferret biopsy or necropsy submissions. Since late 2003, a previously unrecognized disease process tentatively termed idiopathic polymyositis has been diagnosed in 13 ferrets at Northwest ZooPath.

Signalment, clinical signs, blood work and vaccine history for ferrets with polymyositis are summarized in Table 1. The ferrets ranged in age from 5 – 24 mo of age and average age was 10 mo. Nine were males, four females and all but one male and two females were neutered. Clinical signs included high fever (ten), lethargy (eight), recumbency, ataxia, posterior paresis or pain when moving (six), inappetance or anorexia (three), and abnormal stools (three). Blood work revealed mild to marked leukocytosis with mature neutrophilia (twelve), and mild to moderate, usually nonregenerative, anemia (eleven). Common serum abnormalities included mild to moderate elevation of ALT (six), mild hyperglycemia (six), and hypoalbuminemia (six). Treatment including various antibiotics, antiinflammatories, glucocorticoids, antipyretics, pain killers, interferon, and cyclophosphamide, was ultimately unsuccessful in all cases and the patients either died (six) or were humanely euthanatized (seven). Bacterial cultures of various tissues and feces from three animals revealed no pathogens.

Distribution and severity of lesions are summarized in Table 2. Necropsy usually revealed no gross lesions, although red and white mottling and dilatation of the esophagus, and white streaks in the heart, diaphragm and intercostal muscles were seen in few ferrets. Histologic changes included moderate to severe supplicative to pyogranulomatous inflammation involving the skeletal muscle and blood vessels at multiple sites, particularly the esophagus (13), heart (12) and muscles of the hind limbs and lumbar region (11). Myleoid hyperplasia of spleen and/or bone marrow (12), hepatitis (six), pneumonia (six) and mediastinitis (four) were also prominent.
features. Cultures, electron microscopy and protozoan immunohistochemistry conducted on some of these animals have been negative for infectious agents.

The etiopathogenesis of polymyositis in ferrets is not known. It appears to be a disease of young ferrets characterized by rapid onset of clinical signs, high fever, neutrophilic leukocytosis, treatment failure and death (or euthanasia). The distribution of histologic lesions, particularly in the esophagus, suggests that this is likely a single distinct entity. Culture data are incomplete, and the febrile nature of the disease, leukocytosis, and suppurative inflammatory features of the lesions suggest an infectious etiology, especially bacterial infection; however, the uniform failure of patients to respond to a broad variety of antibiotics, and the inability to detect bacteria in histologic sections suggests that bacterial infection is not likely. Various forms of vaccine-related polymyositis are seen in humans.\textsuperscript{1,2,4,5} Ferrets reportedly can develop vaccine reactions, but myositis was not described as an adverse affect.\textsuperscript{3} The vaccine history of the study animals is not consistent, and conclusions that incriminate vaccines can not be drawn from these preliminary studies. Heritable immune mediated disease seems unlikely as affected ferrets are from different breeding facilities. Studies are underway to search for other infectious agents, and for other commonalities in affected animals that may provide clues as to the underlying cause.

ACKNOWLEDGMENTS

The authors are grateful to the following for submission of cases: Brantley and Jordan Animal Hospital, Macon, GA; Ocean State Veterinary Specialists, East Greenwich, Rhode Island; Somers Animal Hospital, Somers, New York; Essex Animal Hospital, Bloomfield, New Jersey; Midwest Bird and Exotic Animal Hospital, Westchester, IL; Rutherford Animal Hospital, Rutherford, NJ; Affordable Pet Clinic, Nampa, ID; All Pet Complex, Boise, ID; South Wilton Veterinary Clinic, Wilton, CT; Bird and Exotic Pet Hospital, Midvale, UT; Tennessee Valley Veterinary Clinic, Tuscumbia, AL.

LITERATURE CITED

### Table 1. Signalment, clinical signs, blood work and vaccine history for ferrets with polymyositis.

<table>
<thead>
<tr>
<th>Ferret</th>
<th>Origin</th>
<th>Age</th>
<th>Sex</th>
<th>Initial signs</th>
<th>Hemogram</th>
<th>Chemistry</th>
<th>Cultures</th>
<th>Vaccines</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 G03-6172</td>
<td>Marshall's</td>
<td>5 mo</td>
<td>n/m</td>
<td>Acute myorhabdomyolysis, recumbent, died</td>
<td>Neutrophilic leukocytosis (46000), HCT-22%</td>
<td>El. CPK, AST, ALT, T. Bili.</td>
<td>nd</td>
<td>Fervac-D #1 (kit)</td>
<td>Multi. antibiotics</td>
</tr>
<tr>
<td>2 G04-221</td>
<td>Marshall's</td>
<td>10 mo</td>
<td>n/m</td>
<td>3 mo lethargy, generalized paresis, fever, die</td>
<td>Neutrophilic leukocytosis (36000), HCT-30%</td>
<td>El. ALT, hyperglyceremia</td>
<td>nd</td>
<td>Fervac-D #1 (kit)</td>
<td>Multi. antibiotics, buprenorphine, dexamethasone, interferon</td>
</tr>
<tr>
<td>3 G04-619</td>
<td>Marshall's</td>
<td>12.5 mo</td>
<td>n/m</td>
<td>5 days lethargy, fever, tachyptnea, anorexia, euthanized</td>
<td>Neutrophilic leukocytosis (16800), HCT-15.9%, thrombocytopenia</td>
<td>El. ALT, alk phos, GOT, T. bili, hyperglyceremia</td>
<td>Liver, lung, kidney</td>
<td>Fervac-D #1 (kit)</td>
<td>Multi. antibiotics, buprenorphine, meloxicam, alpha interferon, cyclophosphamide</td>
</tr>
<tr>
<td>4 G04-594</td>
<td>Marshall's</td>
<td>12 mo</td>
<td>n/m</td>
<td>1 day fever, braxism, vomiting, lethargy, euthanized</td>
<td>Neutrophilic leukocytosis, (8000), HCT-30%</td>
<td>Pseudomonas sp.</td>
<td>neg. amnobic, viral Purpurav #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 G04-5861</td>
<td>Marshall's</td>
<td>10 mo</td>
<td>n/m</td>
<td>Abnormal urol, posterior paresis, euthanized</td>
<td>Neutrophilic leukocytosis, (29000), HCT-28.5%</td>
<td>El. ALT</td>
<td>nd</td>
<td>Fervac-D #1 (kit)</td>
<td>Multi. antibiotics, interferon</td>
</tr>
<tr>
<td>6 G04-5862</td>
<td>M&amp;P Farma</td>
<td>6 mo</td>
<td>m</td>
<td>Fever, pain, orange spots on skin, posterior paresis, inappetence, euthanized</td>
<td>Neutrophilic leukocytosis (34000), HCT-29%</td>
<td>Hyperglyceremia</td>
<td>nd</td>
<td>Fervac-D x 3</td>
<td>Multi. antibiotics, buprenorphine, meloxicam, interferon, transfusion</td>
</tr>
<tr>
<td>7 G04-6005</td>
<td>Marshall's</td>
<td>1.5 yr</td>
<td>n/m</td>
<td>Diaphoria, wt. loss, lethargy, fever, died</td>
<td>Neutrophilic leukocytosis (47000), HCT-22%</td>
<td>Hyperglyceremia</td>
<td>Fecal, no pathogens</td>
<td>Fervac-D #1 (kit)</td>
<td>Multi. antibiotics</td>
</tr>
<tr>
<td>8 G04-4207</td>
<td>Marshall's</td>
<td>7 mo</td>
<td>f</td>
<td>Fever, lethargy, recumbency, pain, euthanized</td>
<td>Neutrophilic leukocytosis (14500), HCT-26.4%</td>
<td>Hyperglyceremia</td>
<td>nd</td>
<td>Rabies 6 mo</td>
<td>Multi. antibiotics, interferon</td>
</tr>
<tr>
<td>9 G04-4411</td>
<td>Hybrid European Polecat x New Zealand</td>
<td>2 yr</td>
<td>n/m</td>
<td>Fever, lethargy, anorexia, pain, died</td>
<td>Neutrophilic leukocytosis (24500), HCT-31%</td>
<td>Hyperglyceremia</td>
<td>nd</td>
<td>Morbil x3, Imrab; booster both at 1.5 yr</td>
<td>Multi. antibiotics, buprenorphine, cyclophosphamide</td>
</tr>
<tr>
<td>10 G04-4415</td>
<td>Marshall's</td>
<td>11 mo</td>
<td>m</td>
<td>Lethargy, weakness, died</td>
<td>Neutrophilic leukocytosis (45000), HCT-24%</td>
<td>Hyperglyceremia</td>
<td>nd</td>
<td>Fervac #1 (kit) Imrab boosters</td>
<td>Multi. antibiotics, buprenorphine, cyclophosphamide</td>
</tr>
<tr>
<td>11 G05-086</td>
<td>Marshall's</td>
<td>5 mo</td>
<td>f</td>
<td>Fever, lethargy, posterior paresis, euthanized</td>
<td>Neutrophilic leukocytosis (6500) and HCT (35%)</td>
<td>Hyperglyceremia</td>
<td>nd</td>
<td>Vx (7)4 mo</td>
<td>Multi. antibiotics, buprenorphine, meloxicam</td>
</tr>
<tr>
<td>12 G05-282</td>
<td>Marshall's</td>
<td>6 mo</td>
<td>n/m</td>
<td>Anorexia, lethargy, fever, reluctant to drink, tachyptnea, die</td>
<td>Neutrophilic leukocytosis (16700), HCT-44%</td>
<td>Hyperglyceremia, hyperalbuminemia</td>
<td>El. ALT, lipase</td>
<td>Fervac #1 (kit) booster 2 mo, Imrab 3 mo</td>
<td>Multi. antibiotics, dexamethasone</td>
</tr>
<tr>
<td>13 G05-461</td>
<td>Marshall's</td>
<td>6 mo</td>
<td>n/f</td>
<td>Lethargy, loose stool, seizures, febrile, died</td>
<td>Neutrophilic leukocytosis (28700), HCT-25.1</td>
<td>Hyperalbuminemia</td>
<td>Light growth, Bacillus sp.</td>
<td>Fervac x3 Imrab-3 mo</td>
<td>Multi. antibiotics, buprenorphine, meloxicam</td>
</tr>
</tbody>
</table>

*Not available.
*Not done.
### Table 2. Distribution and severity of histologic lesions and concurrent disease processes in ferrets with polymycosis.

<table>
<thead>
<tr>
<th>Ferret</th>
<th>Esophagus</th>
<th>Heart</th>
<th>Skeletal</th>
<th>Diaphragm</th>
<th>Tongue</th>
<th>Stomach</th>
<th>Intestine</th>
<th>Hepatitis&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Myeloid hyperplasia</th>
<th>Pneumonia&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Other Lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+++</td>
<td>++</td>
<td>++</td>
<td>na</td>
<td>na</td>
<td>-</td>
<td>-</td>
<td>+++</td>
<td>na</td>
<td>+</td>
<td>Enteritis&lt;sup&gt;f&lt;/sup&gt;, vasculitis/DIC&lt;sup&gt;e&lt;/sup&gt;, renal mineralization</td>
</tr>
<tr>
<td>2</td>
<td>+++</td>
<td>+++</td>
<td>na&lt;sup&gt;a&lt;/sup&gt;</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>+++ (brn)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>+</td>
<td>DIC, peritonitis, synovitis, mediastinitis</td>
</tr>
<tr>
<td>3</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
<td>na</td>
<td>na</td>
<td>+++++</td>
<td>+++++</td>
<td>++++++</td>
<td>++++++&lt;sup&gt;e&lt;/sup&gt;</td>
<td>na</td>
<td>Splenitis, lymphadenitis, vasculitis, peritonitis, viliary cystadenoma, synovitis</td>
</tr>
<tr>
<td>4</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>na</td>
<td>na</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+++ (sp)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-</td>
<td>Mineralization renal and muscle</td>
</tr>
<tr>
<td>5</td>
<td>++++++</td>
<td>++</td>
<td>++++</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>-</td>
<td>-</td>
<td>+++ (spf)</td>
<td>na</td>
<td>Enteritis, mediastinitis</td>
</tr>
<tr>
<td>6</td>
<td>+++</td>
<td>++++</td>
<td>++++</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>-</td>
<td>+++ (spf)</td>
<td>+</td>
<td>Enteritis, isch hyperplasia, hepatocellular vacuolar change, ependymitis</td>
</tr>
<tr>
<td>7</td>
<td>+++</td>
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<td>na</td>
<td>na</td>
<td>na</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+++ (spf)</td>
<td>+++</td>
<td>Enteritis</td>
</tr>
<tr>
<td>8</td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>na</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+++ (spf)</td>
<td>-</td>
<td>Portal hepatitis, enteritis, pulmonary congestion</td>
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<tr>
<td>9</td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>+</td>
<td>+++ (spf)</td>
<td>+</td>
<td>Portal hepatitis, hepatic lipidosis, renal tubular necrosis</td>
</tr>
<tr>
<td>10</td>
<td>+++</td>
<td>++++</td>
<td>++</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>-</td>
<td>+++</td>
<td>+++ (spf)</td>
<td>-</td>
<td>Mediastinitis, aspiration pneumonia, enteritis</td>
</tr>
<tr>
<td>11</td>
<td>+++</td>
<td>++++</td>
<td>++++</td>
<td>na</td>
<td>na</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+++ (spf)</td>
<td>+</td>
<td>Ureteritis</td>
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<td>++++</td>
<td>++</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+++ (spf)</td>
<td>-</td>
<td>Hepatic lipidosis, pulmonary congestion, root ganglioneuritis, mediastinitis</td>
</tr>
<tr>
<td>13</td>
<td>++++++</td>
<td>na</td>
<td>++++</td>
<td>na</td>
<td>na</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>+++ (spf, hns)</td>
<td>na</td>
<td>Centrilobular necrosis, enteritis</td>
</tr>
</tbody>
</table>

Key to symbols used: + mild, ++ moderate, +++ severe. - tissue present but not affected.

<sup>a</sup>Tissue not available.
<sup>b</sup>Suppurative hepatitis.
<sup>c</sup>Bone marrow.
<sup>d</sup>Spleen.
<sup>e</sup>Acute neutrophilic interstitial pneumonia.
<sup>f</sup>Lymphoplasmacytic enteritis, considered unrelated to the polymycosis.
<sup>g</sup>Disseminated intravascular coagulation.
PREVALENCE OF *Helicobacter* sp. IN SELECTED SPECIES AT THE DENVER ZOOLOGICAL GARDENS, A PROSPECTIVE STUDY FROM 2004-2005

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Abstract

At the time of this writing, a total of 15 species, 35 individual animals, have had gastric biopsies performed opportunistically during medical procedures. None of the animals were exhibiting signs of gastritis clinically at the time of endoscopy. All animals were intubated and anesthetized with isoflurane (Attane, Minrad Inc., Buffalo, NY, 14203, USA) and positioned in left lateral recumbency. A survey exam of the esophagus and stomach was performed initially and then four gastric biopsies, primarily from the fundic region, were obtained using an oval cup forceps with a spike. All biopsy samples were placed in 10% neutral buffered formalin and submitted to the same diagnostic laboratory (IDEXX Laboratory, Westminster, CO, 80234, USA) and were examined by the same pathologist. Each biopsy sample was sectioned at 5-6 μm thick and stained with hematoxylin and eosin, and then evaluated for pathologic changes via light microscopy, as well as for the presence of spirilliform bacteria. If no bacteria were observed under light microscopy Warthin-Starry silver stain was used to determine if spirilliform bacteria were present.

Results were grouped in one of four ways: 1. normal tissue microscopically and stains negative for spirilliform bacteria, 2. normal tissue microscopically, stains positive for spirilliform bacteria, but no inflammatory infiltrates seen (incidental finding) 3. gastritis microscopically, stains positive for spirilliform bacteria and inflammatory infiltrates seen 4. gastritis microscopically and stains negative for spirilliform bacteria. Animals with gastritis were described as superficial type, lymphoplasmocytic and eosinophilic variant, widespread, chronic. Animals that had incidental findings for *Helicobacter* were described as spirilliform bacteria associated with superficial mucosal surface and glandular elements, but not associated with inflammation. Results from the study showed 46% (n=16) in group 1, 20% (n=7) in group 2, 32% (n=11) in group 3, and 2% (n=1) in group 4. Based on these results *Helicobacter* can be a common pathologic finding without being a primary cause for gastritis. Interpretation of results from gastric biopsies should be evaluated with clinical signs before instituting therapy and additional tests may be indicated to rule out other potential causes for gastritis.
CROSS-SPECIES TRANSMISSION OF LENTIVIRUS BETWEEN BOBCATS AND PUMAS IN FRAGMENTED HABITATS OF SOUTHERN CALIFORNIA

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Abstract

Species-specific lentiviruses are prevalent in many non-domestic species of the family Felidae. Seroprevalence can approach 100% in some populations. However, previous serosurveys in bobcats (Lynx rufus) have found that lentiviral prevalence is usually less than 10%. Blood from 17 wild bobcats captured in Orange County, CA was screened to assess lentiviral seroreactivity using a standard immunoblot assay to detect antibodies to feline (Felis catus) immunodeficiency virus (FIV), lion (Panthera leo) lentivirus (LLV), and puma (Felis concolor) lentivirus (PLV) antigens. DNA was isolated from blood cells of all animals with positive or inconclusive immunoblot results and subjected to PCR-amplification using degenerate feline lentivirus pol primers. Additionally, we screened a subset of positive individuals with a commercial FIV antibody diagnostic test (SNAP™ test, IDEXX Laboratories, Westbrook, ME) to compare assay sensitivity.

Ten of 17 individuals (59%) had antibodies that bound strongly to the PLV gag protein on the immunoblot with weaker affinity for LLV and FIV antigens. Two individuals had inconclusive immunoblot results with weak binding to PLV only. PCR product was amplified from all ten individuals positive by immunoblot. The SNAP™ test had a relative sensitivity of approximately 80% compared to PCR or immunoblot.

Phylogenetic analysis of the 10 amplified proviral sequences revealed that the lentivirus infecting these individuals is closely related to PLV isolated from a puma captured in Orange County in the late 1980s. Interestingly, genetic distances between the Orange County PLV and bobcat pol regions were less than distances between the Orange County puma sequence and PLVs from pumas in non-overlapping geographic locations. We conclude that lentiviral infection in bobcats may be more common than previously believed, and that immunoblot or PCR has higher sensitivity of detection than a commercially available FIV ELISA. Further, the homology between bobcat and puma lentivirus suggests that cross-species transmission of feline lentivirus has occurred in Southern California. We speculate that shrinking habitat and scarcity of resources in urban regions may lead to greater contact rates between large carnivore species, thus prompting interspecies transmission of this virus.
RISK FACTORS AND TREATMENTS FOR LYMPHOMA IN AFRICAN LIONS (Panthera leo)

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Abstract

Lymphomas are common in exotic felids especially in African lions (Panthera leo).1-3 This study evaluates age at diagnosis, sex, clinical signs, lymphoma immunophenotype, treatment(s), and length of survival time from diagnosis. A total of 11 lions were included in this study. The average age at time of diagnosis was 16.5 yr, 82% were male. Clinical signs included weight loss, lethargy, seizures, epistaxis, vomiting, collapse, or sudden death. The spleen was significantly enlarged in all but one case. Bone marrow involvement was only detected in one lion, but metastatic spread to peripheral lymph nodes and liver was common. All lymphomas were confirmed microscopically. Eight cases were confirmed to be T-cell lymphomas, and one case was confirmed to be a B-cell lymphoma. Therapies consisted of no treatment, supportive care, splenectomy, and various chemotherapies. Survival after diagnosis ranged from 0 days (euthanasia) to 240 days, with a majority of the animals being dead within 30 days after the diagnosis. One African lion with a small cell T-cell lymphocytic lymphoma was treated by a splenectomy, followed by chemotherapy with adriamycin (Doxorubicin Hydrochloride Injection, USP, Pharmacia Inc., Kalamazoo, MI 49001 USA), prednisone (Roxane Laboratories, Inc., Columbus, OH 43216 USA), and lomustine (CCNU®, Bristol-Myers Squibb Co., Princeton, NJ 08543 USA). Complete clinical remission was confirmed by bone marrow biopsy and CBC 2 mo after treatment was initiated. Treatment is ongoing and no clinical relapse has been noted for over 16 mo. Treatment for lymphoma in exotic felids is uncommon, usually attributed to the challenge of handling the animals, and to typically late diagnosis. Recently, however, chemotherapeutic regimens have been attempted. The actual response to the chemotherapeutic protocols is still largely unknown due to a limited sample size. The long-term survival in the one animal presented here may be due to the fact that it has a small T-cell lymphocytic lymphoma (T-zone lymphoma) which has an indolent biologic behavior.
ACKNOWLEDGMENTS

The authors would like to thank the following institutions or organizations for their participation in this study: Hogle Zoo, Knoxville Zoo, Potter Park Zoo, San Francisco Zoo, Toronto Zoo, Wildlife Way Station, and Woodland Park Zoo.

LITERATURE CITED

INCIDENCE OF NEOPLASIA IN A COLONY OF CAPTIVE FELIDS AT THE KNOXVILLE ZOOLOGICAL PARK, 1979 TO 2003

Michael A. Owston, MS, DVM, Edward C. Ramsay, DVM, Dipl ACZM, and David Rotstein, DVM, MPVM, Dipl ACVP

Abstract

A review of medical records and necropsy reports found neoplasms in 27 zoo felids including six Panthera leo (three males, three females), three Panthera pardus (two males, one female), one Panthera onca (one female), 11 Panthera tigris (three males, eight females), two Panthera uncia (one male, one female), two Felis concolor (one male, one female), one Felis rufus (one male), and one Acinonyx jubatus (one female). Neoplasia rate at necropsy was 43% (25/58), and overall rate of neoplasia in the collection was 21% (27/130). Neoplasia was identified as the cause of death or reason for euthanasia in 21% (12/58) of those necropsied. Neoplasms were observed in the endocrine (n = 11), integumentary (n = 11), reproductive (n = 7), hematopoietic/lymphoreticular (n = 5), digestive (n = 2), hepatobiliary (n = 2), and respiratory (n = 1) systems. Multiple neoplasms were observed in 10 animals. Both benign and malignant neoplasms were observed in all systems except for the respiratory and hematopoietic/lymphoreticular systems where the process was benign in the former and malignant in the latter. Of the endocrine neoplasms, those involving the thyroid and parathyroid glands predominated (n = 10) over other endocrine organs (n = 1) and ranged from hyperplasia to carcinoma. In the digestive system, only the pancreas had neoplasms present. Both hepatobiliary tumors involved the biliary tree. In the integumentary system, 63% (7/11) of neoplasms involved the mammary glands with mammary carcinoma representing 83% (6/7) of neoplasms. The only respiratory tumor was a benign laryngeal papilloma. Hematopoietic/lymphoreticular tumors included lymphosarcoma (60%, 3/5) and mast cell tumor (40%, 2/5). Leiomyomas (60%, 3/5) and uterine adenocarcinomas (40%, 2/5) were observed in the female reproductive system, and seminomas were observed in the male reproductive system.
DIABETES MELLITUS IN A CHEETAH: ATTEMPTING TO TREAT THE UNTREATABLE?

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Abstract

In April 2004, a 12-yr-old male cheetah (Acinonyx jubatus) presented with polydipsia and moderate weight loss. The cheetah had an unremarkable health history and had been normoglycemic for the past 10 yr. Following presentation, a blood sample taken under restraint in a squeeze cage showed hyperglycemia (357 mg/dl; ISIS 132 ± 35 mg/dl). Subsequent samples revealed persistent hyperglycemia although an initial fructosamine value of 362 µmol/L was within normal limits for domestic carnivores.1 Concomitant glucosuria on free-catch urine was also noted. A diagnosis of diabetes mellitus was made.

Treatment with the oral hypoglycemic glipizide (Glipizide tablets, Watson Laboratories, Inc. Corona, CA 92880 USA) was started at a conservative dose of 2.5 mg p.o. b.i.d. (Fig. 1). As side effects were not noted, the dose was increased to 5.0 mg on day 10. Response to treatment was monitored with weekly blood and free-catch urine samples. Treatment with glipizide reduced blood glucose levels for over 70 days (from 371 to 255 mg/dl). However, this therapy had to be discontinued due to severe elevation of liver enzymes believed to be caused by the drug (Fig. 1).

Insulin therapy was next considered. However, blood samples revealed elevated serum cortisol levels (11 µg/dl; ISIS 6.7 ± 0.2 µg/dl). In addition urine analysis showed an elevated cortisol-creatinine (C:Cr) ratio of 7.3 (healthy cheetah: 1.1; domestic cat: <1.0). Concern arose that insulin resistance caused by the hyperadrenal state would complicate insulin therapy. Ultrasound revealed moderate bilateral hyperplasia of the adrenal glands but no evidence of adrenal tumor (AT). Adrenal hyperplasia is a common finding in captive cheetahs.2 Ultrasound also showed multiple nodular areas throughout the pancreas.

Further diagnostics were performed to determine the cause of hypercortisolemia. A blood sample was taken to determine endogenous ACTH and baseline cortisol levels. Results showed that endogenous ACTH was similar to the value of a non-diabetic cheetah (26.8 pg/ml and 34.6 pg/ml, respectively) and considered non-diagnostic for either pituitary-dependent...
hyperadrenocorticism (PDH) or adrenocortical neoplasia. A high-dose dexamethasone suppression test (HDDST) was also performed. Dexamethasone sodium phosphate (0.1 mg/kg) was injected intravenously in the lateral tail vein using a 23 g butterfly while the cheetah was gently restrained in a squeeze cage. A subsequent blood sample was collected at 8 hr from dexamethasone injection using the same technique described above. The HDDST showed a suppression of the plasma cortisol concentration from 11.1 µg/dl to 3.19 µg/dl at 8 hr. In domestic animals, an 8 hr post-dexamethasone plasma cortisol concentration that is less than 50% of the baseline concentration is suggestive of PDH.\(^1\) Adrenal tumor was ruled out. A new urine analysis showed a persistently elevated C:Cr ratio (3.4) further supporting the diagnosis of hyperadrenocorticism. However, an MRI of the head using 7 ml of gadolinium (0.5 mmol/ml) i.v. to enhance the pituitary gland revealed no pituitary abnormalities. MRI of the abdomen confirmed moderate hyperplasia of the adrenal glands and the presence of multiple cluster-like nodules scattered through the pancreas.

Insulin therapy was initiated with 6 then 8 units of ultralente insulin, (Humulin U (Ultralente), Eli Lilly and Co., Indianapolis, IN 46285 USA) s.c. s.i.d. Unfortunately, within a week the cheetah developed severe azotemia (BUN 145 mg/dl; ISIS 38 ± 12 mg/dl), creatinine 9.1 mg/dl (ISIS 2.7 ± 0.8 mg/dl) and exacerbated hyperglycemia (glucose >500mg/dl). The cheetah was euthanatized at this time.

Gross necropsy revealed a moderately enlarged pancreas thickened by multiple cysts containing clear fluid or white, mucoid material. Histologically, cysts were solitary or multiloculated and lined by cuboidal epithelium. Dilated ducts often contained thick, proteinaceous material. There were multiple areas of interstitial fibrosis, and cells of the islets of Langerhans were frequently displaced by amyloid-like material.

LITERATURE CITED

Figure 1. Glucose values for a 12-yr-old male cheetah.
IMMOBILIZATION OF CAPTIVE SLOTH BEAR (Melursus ursinus), SPECTACLED BEAR (Tremarctos ornatus), BLACK BEAR (Ursus americanus) AND POLAR BEAR (Ursus maritimus) WITH A MEDETOMIDINE, KETAMINE, AND MIDAZOLAM COMBINATION

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Calgary Zoo Animal Health Centre, 1625 Centre Ave. E, Calgary, Alberta T2E 8K2 Canada

Abstract

In recent years, various combinations of drugs have been used for anesthesia of bear species in zoo and wildlife applications. Medetomidine and ketamine have both been associated with the risk of spontaneous arousal during anesthesia.1,7 Tiletamine and zolazepam (Telazol, Fort Dodge Animal Health, Fort Dodge, Iowa, 50501 USA) has no antagonist available for the tiletamine component, and has been associated with prolonged recovery times.1,6 A combination of medetomidine and tiletamine/zolazepam (MZT) has been used in several bear species successfully with minimal adverse physiologic effects. Although this combination has been successful for immobilizing bear species at the Calgary Zoo, particularly in grizzly bears (Ursus arctos), polar bears, and spectacled bears it has resulted in prolonged recovery times with up to 4 hr of heavy sedation after reversal of the medetomidine with atipamezole (Antisedan, Novartis Animal Health Canada, Mississauga, Ontario, Canada L5N 1V9)

Since 2001, four of the five species of bear housed at the Calgary Zoo have been immobilized with a combination of medetomidine (Zalopine, Orion Pharmaceuticals, Corporation, Espoo, Finland; 0.035 – 0.075 mg/kg i.m.), ketamine (Parke-Davis division, Pfizer Canada Inc., Kirkland, Quebec, Canada H9J 2M5; 2.5 – 4.0 mg/kg i.m.), and midazolam (Sabex, Boucherville, Quebec, Canada J4B 7K8; 0.05 – 0.09 mg/kg i.m.) (MMK). All bears were administered atipamezole (0.119 – 0.189 mg/kg,half i.m., half s.c.) at the conclusion of the immobilization procedure. There have been a total of 14 immobilizations in nine individuals. This combination is similar to MZT, using a dissociative anesthetic agent (ketamine) with a benzodiazepine tranquilizer (midazolam) and an alpha-2 agonist (medetomidine). The primary difference between the two combinations is the ability to alter the ratio between the dissociative and the benzodiazepine with MMK. Midazolam has a mean elimination half life of 77 ± 18 min in dogs, making it an ideal benzodiazepine to use in anesthetic protocols for short procedures in carnivores.4 Induction times using MMK in ursid species were 12.1 ± 2.12 min (range 9 – 15 min), with times to full recovery ranging from 20 min to 1 hr, with a single exception of a black bear exhibiting a 2-hr recovery to a normal appearance. Initial average heart rates were 59 ± 29 bpm (range 27 – 118 bpm). Initial oxygen saturation measurements were 86.14 ± 4.64% (range 76 – 93%) before supplemental oxygen was provided, and over 90% in all bears with supplemental oxygen. Similar to the satisfactory results produced using MMK in Siberian tigers
Panthera tigris altaica),\(^5\) MMK shows good promise to be an effective and safe immobilizing
drug combination for bear species, with short induction and recovery times and little risk of
spontaneous arousal.

**LITERATURE CITED**

ACUTE TETRAPARESIS ASSOCIATED TO CERVICAL VERTEBRAL INSTABILITY IN AN ADULT MALE KOMODO DRAGON (Varanus komodensis)

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Abstract

A 12-yr-old 61.5-kg male komodo dragon (Varanus komodensis) was reported to have eaten a large rock. It was speculated that the rock was probably stained with rat blood, or had a rodent odor after an outdoor feeding. A smaller rock had been ingested the week prior, and had been regurgitated successfully by the animal. The size and weight of the larger ingested rock made regurgitation unlikely. The animal was sedated for manual gastric foreign body removal. It was removed successfully with careful external massage, combined with esophageal access to the region of the cardias. The rock measured 17 cm in length, 11 cm in width and 5 cm in height, and weighed 1.23 kg. A prolonged (24 hr) recovery from sedation ensued. Thereafter, the animal began to show reluctance to lower its head while eating. Ataxia was present and most severe while the animal attempted to feed, or when it ambulated rapidly. The monitor appeared to be otherwise normal and in relative good health. The taxia was persistent, and lasted 12 mo, until the animal was found acutely tetraparetic. During this period, the incoordination seemed exacerbated by posture changes (neck ventroflexion) or activity.

The onset of tetraparesis was sudden, and apparent in the early morning. The monitor was unresponsive, and sedated for transport and examination. Radiographs were suggestive of cervical trauma and spinal cord compression. Following reversal, the animal was referred to a local hospital for advanced imaging. Computerized tomography (CT) and magnetic resonance imaging (MRI) revealed suspect lesions in the vertebral bodies. Images demonstrated degenerative changes between the first and second cervical vertebrae with osteophyte formation and mild bony vertebral canal narrowing. In addition, there was hyper-dense extra-dural soft tissue ventrally, resulting in severe vertebral stenosis and cord compression. CT images were consistent with spinal cord compression in the region of the first three cervical vertebrae. Intermittent positive pressure ventilation, which was initiated following sedation, was maintained for 36 hr, while the animal was transported to the LSU School of Veterinary Medicine’s Exotic
Animal department for surgical referral. Surgical decompression attempts were planned, but discontinued when the animal’s general condition and blood pH appeared to be incompatible with survival. The animal was humanely euthanatized. Necropsy and histopathology confirmed vertebral instability with secondary spinal cord compression between C1 and C4. Acute cervical trauma, even in a slight form, may have caused the unstable vertebrae to compress the spinal cord.

**Introduction**

Komodo dragons have been observed to eat and regurgitate very large objects in the wild. Entire goat and boar skulls have been swallowed and eventually regurgitated with minimal visible effect on the monitor. Wild Komodo dragons eat almost their entire prey, including all bones. They regularly eat and cut the prey’s flesh with their teeth, ingesting large portions of the prey whole. As predators, they leave behind almost none of the carcass, ingesting as much as possible. The indigestible material, mostly hair, teeth, and feathers, are voluntarily disgorged as a gastric pellet a variable amount of time later.1

**Case Report**

A pair (1:1) of komodo dragons (*Varanus komodensis*) was housed in adjoining and shared exhibits for over 10 yr. The 12-yr-old male reached close to 7 ft in total length, and weighed 61.5 kg. One morning it was reported to have eaten a large rock. It was speculated that the rock was probably stained with rat blood, or had rodent odor after an outdoor feeding. A smaller rock had been ingested the week prior, and had been regurgitated successfully by the animal. The size and weight of the larger ingested rock made regurgitation unlikely. The animal was sedated with 300 mg total (5 mg/kg) i.m. ketamine and 3 mg total (0.05 mg/kg) i.m. of medetomidine for manual gastric foreign body removal, as described by Rasmussen et al.3 It was successfully removed with careful external massage, combined with esophageal access to the region of the cardia. Following removal, the rock measured 17 cm in length, 11 cm in width, and 5 cm in height and weighed 1.23 kg. The anesthetic combination was successfully reversed with 15 mg total of atipamezole i.m.4,5 Following a prolonged (24-hr mild ataxia) recovery from sedation, the animal began to show reluctance to lower its head while eating. Incoordination was present and most severe while the animal attempted to feed, or when it ambulated rapidly. The monitor appeared to be otherwise normal and in relative good health. Ataxia was continuous, and lasted 12 mo, until the animal was found acutely tetraparetic. During this period, the incoordination seemed exacerbated by posture changes or activity (e.g., neck ventroflexion).

Exactly 1 yr following the procedure, the monitor was found unable or unwilling to move in its nocturnal enclosure. It appeared depressed, listless, and unresponsive. The monitor was breathing regularly, but otherwise was only mildly responsive to tactile and aural stimulation. Cursory evaluation on site revealed mild visible response to tactile or proprioceptive stimulation. All reflexes, including limb proprioception, appeared diminished or absent. Mild direct and
Consensual light responses were presumed to be extant, but appeared subjectively diminished. Peracute tetraplegia secondary to trauma was suspected.

In spite of severe apparent neurologic compromise, the monitor was sedated with 300 mg total ketamine (5 mg/kg) and 3 mg total medetomidine (0.05 mg/kg) i.m. by hand syringe. It was then transported to the Animal Healthcare Center for examination and radiographs. On arrival, the animal was intubated with a cuffed 8-mm endotracheal tube, and supplemental O\textsubscript{2} was administered at a rate of 5 L per min. Spontaneous respiration at a rate of 12 rpm was observed during exam, blood sampling, and radiography. Dorso-ventral radiographs of the head and neck revealed moderate scoliosis and narrowing of inter-vertebral space between C1–C2, C2–C3, and C3–C4. Attempts to position the cervical vertebrae by mechanical means were unsuccessful, so the deviation was not presumed to be positional. Severe apnea developed 85 min after induction. Sedation was reversed 90 min post-induction with 15 mg total atipamezole i.m. Intermittent positive pressure ventilation every 15 sec was initiated following reversal, and was maintained for 36 hr. An intravenous port was secured in the coccigeal vein, and a solution of 50% Lactated Ringer’s and 5% dextrose in water was given in a volume of 4 L over the following 36 hr. The animal was transported to a local hospital for advanced imaging.

**Materials and Methods**

Magnetic resonance imaging was performed on a GE signal 1.5T magnet (General Electric, Milwaukee, WI). The study was performed in the neurovascular array coil. Sequences performed included FSE TI (TR 617, TE 11.0 Ef), FSE T2 (TR 3000-4450, TE 96.0 Ef), 3D FSE T2 (TR 4000, TE 150 Ef, 1.7-mm slice thickness/0.0 GAP, 1 NEX, 6:26), 3D SPGR/30 (TR 22/TE 6.0 1.2 mm).

Computerized tomography (CT) images were performed on a GE pro speed spinal CT scanner (General Electric, Milwaukee, WI). The study was initially performed at 3-mm collimation, with 1-mm images obtained through the cranio-cervical junction with multi-planar reformations.

A website (http://digimorph.org/specimens/Varanus_gouldii/) with CT images of *Varanus gouldii* provided an approximation of expected “normal” images for the species.

**Results**

The MRI demonstrated severe vertebral stenosis at the C1/2 level, with narrowing of the effective diameter of the vertebral canal to a few mm, which caused severe cord compression. There was an abnormal increased T2 signal within the spinal cord at this level, consistent with edema/myelomalacia.

The CT images demonstrated degenerative changes at the C1/2 articulation with osteophyte formation resulting in mild bony vertebral canal narrowing. In addition, there was hyperdense
extradural soft tissue ventrally, resulting in severe vertebral stenosis and cord compression. This tissue was markedly hypo-intense on the long TR/TE, and was felt to represent epidural fibrosis.

CT and MRI revealed suspect degenerative articular lesions in the vertebral bodies with narrowing of the vertebral canal. CT images were consistent with spinal cord compression in the region of the first three cervical vertebrae.

The dragon presented to the LSU-SVM for additional diagnostics and possible surgery. At presentation, the animal was non-responsive. An 18-gauge catheter was placed into the ventral tail vein for intravenous access, and fluids (Normasol: 2.5 5 dextrose, 50:50) were initiated (25 ml/kg). Because the dragon was apneic, it was positive pressure ventilated six to eight times per minute. The heart rate was determined using a stethoscope and ultrasonic Doppler. The animal was bradycardic (HR<25 bpm). Atropine (0.04 mg/kg i.v.) was administered to counteract the bradycardia. The dragon had no righting reflex, withdrawal reflex, deep pain reflex, corneal reflex or any nocioception. A blood sample was collected from the ventral tail vein for blood gas analysis. The venous pH was 6.1. A second sample was collected and the venous pH was 5.8. Because of the absence of the reflexes and spontaneous breathing, in combination with the severe acidemia, euthanasia was elected. Following euthanasia, a full necropsy was performed.

Histologic examination of the spinal cord revealed moderate to severe axonal degeneration in all funiculi, but especially severe in the ventral-lateral and ventral-medial funiculi. The changes were attributed to compression related trauma; probably an impingement from within the ventral and/or lateral aspect of the vertebral canal. Additional histologic changes included a mild stress response in the adrenal and some thyroid follicular distention—considered a seasonal variation of normal thyroid morphology.

Necropsy and histopathology confirmed vertebral instability with secondary spinal cord compression between C1 and C4. The spinal cord was narrowed to 2 mm at the site of maximum compression between C2 and C3. Acute cervical trauma, even in a slight form, may have caused the unstable vertebrae to compress the spinal cord.

**Discussion**

Ataxia and paresis have been described in many domestic and wild animals. In kangaroos and some marsupials, unique cervical anatomy and late closure of epiphyseal plates make these animals prone to cervical injury and secondary compression of the spinal cord.² It is speculated that manipulation during the removal of the gastric foreign body may have lead to vertebral subluxation and instability. Varanid cervical anatomy, with the presence of a single occipital condyle in the skull base, as well a single intervertebral articular surface in each cervical vertebra, may make the cervical vertebrae prone to instability.
Preliminary clinical signs for the 12 mo prior to the presentation of tetraplegia were consistent with vertebral instability and ventral compression of the spinal cord. The fact that the signs were exacerbated with ventro-flexion was suggestive of cervical vertebral displacement and dorsal compression of the cord. A C1-6 compression could cause a spastic tetraparesis and ataxia due to the loss of function of the upper motor neuron and the general proprioceptive tracts, respectively. The gait observed would be expected to have a delay in the onset of protraction of all the limbs and a tendency to take a longer stride that was inaccurate in its placement. The animal seemed to have an exaggerated gait when ambulating rapidly for the year prior to the sudden onset of tetraplegia. Limb tone and reflexes appeared to be normal or increased, which was also consistent with the expected clinical signs.

ACKNOWLEDGMENTS

The authors are grateful to the Audubon Zoo’s Reptile Curator, Kevin Bowler, and to the Reptile keeper staff, for their dedication and effort in working with large monitors.

LITERATURE CITED

CONSIDERATIONS IN MANAGEMENT OF METABOLIC ABNORMALITIES IN A CETACEAN

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Abstract

Management of cetacean metabolic abnormalities poses challenges to the clinician due to this animal’s unique anatomy and water environment. Intravenous access can be accomplished in the fluke, peduncle, dorsal or pectoral fins in cetaceans. Their vascular rete structure, however, can make it difficult to accurately deliver medications to veins as well as avoid extravasation of drugs and subsequent perivascular sloughing. Oral and subcutaneous delivery of therapeutic agents have proven effective in managing some cetacean metabolic abnormalities, including hypoglycemia, metabolic acidosis, and hypernatremia. While our discussion will include initial treatment options for these conditions, diagnosis and correction of the underlying cause of the metabolic abnormality is the ultimate goal in managing the cetacean patient.

Clinical signs of hypoglycemia can occur when glucose levels drop below 70-80 mg/dl in cetaceans. Severe hypoglycemia is most quickly addressed with intravenous administration of 5-10% dextrose, however skin sloughing can occur with perivascular leakage of hypertonic solutions. Intraperitoneal administration of 5% dextrose has occasionally been administered when intravenous access is poor in cetaceans. Fluid therapy can also be delivered in a cetacean’s subcutaneous space between the blubber and epaxial muscles cranial to the dorsal fin. Though the space is relatively tight, administration of 2.5% dextrose/0.45% saline for hypoglycemic patients has been performed without obvious ill effect to surrounding tissue. Hypoglycemia can also be managed with oral administration of 10-12% dextrose, though feces should be monitored closely for glucose content and diarrhea development at higher concentrations of dextrose supplementation. Amount of dextrose given is to effect. Regardless of the route of dextrose administration, blood glucose evaluation needs to be performed to assess response to treatment and determine if further supplementation is necessary.

Metabolic acidosis in cetaceans is diagnosed, as in small animal medicine, by evaluating blood gases. In severe cases of metabolic acidosis, intravenous bicarbonate therapy is recommended, but acidosis can also be improved with fluid therapy and oral administration of bicarbonate. Sodium or potassium bicarbonate can be dosed at 1 mEq/kg or 84 mg/kg, divided b.i.d. or t.i.d., in a dolphin. Underlying electrolyte imbalances such as hypernatremia should be considered...
when selecting which form of bicarbonate to use. Arterial or venous blood gases are helpful in assessing response to therapy.

Cetaceans generally have a higher blood sodium level than terrestrial mammals, but levels over 160-165 mEq/L can indicate health abnormalities. Hypernatremia occasionally occurs in ill or anorexic cetaceans, and may be associated with ingestion of salt water. When possible, moving the animal to a brackish water environment will help control sodium intake. Subcutaneous administration of 2.5% dextrose/0.45% NaCl has also been attempted to dilute internal sodium levels. Oral administration of freshwater two to four times daily by orogastric tube, and injection of thawed food fish with freshwater will also help manage hypernatremia. As in other mammalian species, sudden correction of hypernatremia can result in adverse side effects. Maintenance fluid requirements for cetaceans are generally estimated at 40 ml/kg/day, and additional fluids may be indicated based on an animal’s metabolic or hydration status. Caution must be taken with any fluid administration to avoid over hydration and possible pulmonary or neurologic edema development.

Though intravenous access for fluid and drug therapy is possible in cetaceans, other routes of administration provide valuable alternatives when managing metabolic abnormalities such as hypoglycemia, metabolic acidosis, and hypernatremia. With any of these disorders, it is important to closely monitor the patient with blood analysis to determine the effectiveness of therapy and need for further supplementation.

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LITERATURE CITED

AN ERYSIPELOTHRIX PREVENTION PROGRAM IN CETACEANS

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Abstract

Erysipelothrix rhusiopathiae, a gram-positive bacterium, causes two forms of disease in cetaceans, a chronic skin condition and a peracute, often-fatal septicemia. A thorough review of this disease was compiled on compact disk in 2000 after the First International Workshop on Erysipelas in Cetaceans.1

In 2002, acute Erysipelothrix septicemia was diagnosed in three young male captive-born Tursiops truncatus at SeaWorld Orlando. Subsequently, all SeaWorld parks adopted a more rigorous Erysipelothrix prevention program, which focused on food fish preparation and cetacean vaccination. Frozen fish are thawed for approximately 24 hr in refrigerated temperatures before submersion in running tap water for 60 min. Chlorine levels greater than 12 ppm have not been found to kill the E. rhusiopathiae organism in vitro, thus the benefit of rinsing fish with tap water has been predominately dilutional, not bactericidal. Rinsing of mucus from fish skin helps reduce surface bacterial pathogen load prior to feeding the fish to cetaceans.

The current vaccination program targets all dolphins greater than 6 mo of age. Two milliliters of ER Bac® Plus (Pfizer Inc., Pfizer Animal Health, 235 East 42nd Street, New York, NY 10017 USA) is administered intramuscularly, boostered 3 – 4 wk later and every 6 mo thereafter. Originally developed for the porcine industry, the vaccine bacterin is a 64 kDa surface protein found in most variants of E. rhusiopathiae. Dolphins are monitored for signs of adverse reactions during the first 20 – 30 min following vaccination. To date, over 120 dolphins have been vaccinated multiple times without notable adverse side effects, such as local vaccine reactions or anaphylaxis.

Preliminary research of Erysipelothrix titers shows peak detectable titers within 2 – 4 wk of vaccination and waning of titers over a 5-mo period. The humoral immune response of dolphins to the vaccine antigen is very similar to the response reported in swine. While antibody titers of
swine declined by 10 wk after immunization, 75% of the pigs were protected from a challenge infection 20 wk after immunization. Until more information is available, we recommend an immunization schedule consisting of an initial immunization, a second immunization at 4 wk, followed by booster immunizations every 6 mo.

The dolphin cellular immune response to ER Bac® Plus vaccination is currently under investigation. Evidence of such cellular immune responses will be assessed by measuring *E. rhusiopathiae*-induced production of cytokine mRNA in cryopreserved mononuclear leukocytes. Development of real-time PCR assays for quantitation of *Tursiops* IL-2, IL-4, IL-5, IL-6, TNFα and IFN has been completed and antigen-specific assays have been initiated.

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The authors would like to thank the SeaWorld Animal Care, Training, and Laboratory staffs and veterinary technicians for their assistance with this program, as well as curatorial staff for their support of this program. We would also like to thank the staff in Dr. Patterson’s and Dr. Stott’s research laboratories for their help with this project.

LITERATURE CITED

EFFECTS OF ANESTHESIA AND ELECTIVE OVARIECTOMY ON SERIAL BLOOD GASES AND LACTATES IN YELLOW PERCH AND WALLEYE PIKE: CAN LACTATE PREDICT POST-OPERATIVE SURVIVAL?

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Abstract

Blood gases and lactate have been used as indicators of anesthetic depth and physiologic distress in many species, including fish.1-4 Blood lactate has been evaluated in fish under stress-induced or toxic experimental conditions.1,4 However, there has been no evaluation of blood lactate in fish undergoing clinical procedures nor correlation with post-operative survival. We hypothesized that serial blood lactate concentrations could predict post-surgical survival in fish.

Adult female yellow perch (Perca flavescens) (n = 8) and walleye pike (Sander vitreus) (n = 4) were anesthetized using MS-222 (induction at 200 mg/L and maintenance at 50-150 mg/L) on a recirculating anesthesia machine for elective ovariectomy. Blood samples were collected via repeated phlebotomy of the caudal vein of each fish at three time points; pre-anesthesia, following anesthetic induction (pre-surgical), and post-surgically. A hand-held clinical analyzer (i-STAT®; cartridges CG4+) was used to measure mixed venous/arterial P CO2, P O2, pH, and lactate. Fish were monitored for 2 wk post-operatively to determine short-term survival, during which time two perch but no walleye died.

For all fish combined, mean P O2 increased from pre-anesthesia to post-surgery, while P CO2 increased from pre-anesthesia to pre-surgery and then decreased post-surgically. Mean pH decreased with anesthesia, but returned to preanesthetic levels post-surgery. Mean lactate (± SD) increased from pre-anesthesia (1.3 ± 1.3 mmol/L) to pre-surgery (7.3 ± 1.8 mmol/L), but decreased after surgery (6.7 ± 2.3 mmol/L). Surviving perch and walleye had a mean post-surgical lactate of 5.7 ± 1.2 mmol/L and 6.0 ± 1.9 mmol/L, respectively, whereas the two perch that died had post-surgical lactates >10 mmol/L (10.6 and 10.7 mmol/L). The first perch that died shortly after surgery had a soft-tissue sarcoma, whereas the second perch died from an infarcted tail 10 days post-operatively.
Early results of this study suggest that persistently elevated blood lactate concentrations (>10 mmol/L) may be predictive of poor short-term post-surgical survival in yellow perch and walleye pike.

LITERATURE CITED

USE OF VASCULAR ACCESS PORTS IN CONSCIOUS GREEN IGUANAS (Iguana iguana) TO DETERMINE ARTERIAL BLOOD GAS PARAMETERS

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Abstract

Vascular access ports (VAP) have been used for arterial blood collection in non-lacertilians. We describe a technique for VAP placement in seven 1-kg adult green iguanas and report the arterial blood gas values from five iguanas. The blood samples were obtained using the ports while the animals were manually restrained.

VAP’s were purchased from Access Technologies in Skokie, IL, USA and consisted of a Sla port with a Hydrocoat catheter (size 3.5 French). Using sterile technique, a 1.5-cm incision was made on the right-lateral neck. Blunt dissection ventral to the external jugular vein exposed the internal and external carotid arteries. The catheter was inserted into the right internal carotid artery and then guided to the common carotid artery. The other end of the catheter was connected to a port located caudal-dorsal to the ipsilateral scapula. The skin was closed and the port was flushed twice a week with 0.2 ml heparinized 0.9% saline. Post-operative difficulties with the VAP included port disconnection (n = 1), inability to aspirate blood after a few weeks (n = 2), and infection (n = 1).

The iguanas were breathing room air prior to and during blood collection at an ambient temperature of 32°C. From the five healthy iguanas with a functional VAP, the blood pH, P_{CO2}, P_{O2}, HCO_3^-, BE, Na^+, K^+, Cl^-, Ca^{++}, Anion Gap, PCV, and TP (37°C) were 7.45 ± 0.07; 36.5 ± 6.5 mm Hg, 93.5 ± 5.5 mm Hg, 24.4 ± 2.2 mmol/L, 0.2 ± 2.2 mmol/L, 158.6 ± 3.6 mmol/L, 3.0 ± 0.5 mmol/L, 133 ± 5 mmol/L, 5.4 ± 0.4 mmol/L, 4.6 ± 1.3 mEq/L, 28.8 ± 5.7%, 4.8 ± 1.3 g/dl respectively (mean ± SD). Except for the low anion gap, these values are similar to the normal values for mammals. In conclusion, VAP’s can be used to collect arterial blood in conscious green iguanas.

THE USE OF LEUPROLIDE ACETATE FOR MALE CONTRACEPTION IN A NORTHERN FUR SEAL (Callorhinus ursinus) COLONY

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Abstract

Due to the relatively smaller populations of pinnipeds maintained in zoos and aquaria compared to other non-domestic species a greater emphasis has been placed upon the development of successful captive reproduction programs, rather than contraceptive techniques, for these species. However, effective population management often requires selective breeding and the development of reversible contraceptive techniques provides a management tool to achieve these objectives. To date, there have been limited contraceptive attempts in pinnipeds.1,3,6,7

Most pinnipeds, including the Northern fur seal (Callorhinus ursinus), have a highly seasonal reproductive pattern. Contraception can therefore be achieved through limited intervention during the breeding season. Strategic intermittent administration also minimizes the potential for adverse effects from contraceptive use.3,7

The New York Aquarium maintains a colony of Northern fur seals that included six animals (one 11-yr-old breeding male, two immature males, and three 13- or 14-yr-old females) at the initiation of the study. Two females had conceived eight times in the preceding 6 yr. Contraception was achieved by the i.m. administration of leuprolide acetate for depot suspension (Lupron Depot 3.75 mg, TAP Pharmaceuticals, Inc., Lake Forest, IL 60045 USA). Utilizing a trained presentation behavior, 18.75 mg (five vials reconstituted with 3 ml diluent) was administered monthly for 6 mo through the breeding season (28 April to 29 September 2003 and 7 May through 1 October 2004). Male Northern fur seals undergo marked weight changes during the breeding cycle and throughout the treatment interval his weight ranged from an early high of 260 kg to a terminal low of 130 kg. There were no births in 2004, and no evidence of pregnancy to date in 2005.

Leuprolide acetate has been used successfully for male contraception in Atlantic bottlenose dolphins (Tursiops truncatus),2,3,7 California sea lions (Zalophus californianus),3,7 and harbor seals (Phoca vitulina),3,7 and to control aggression or other male-associated behaviors among all male groups of California sea otters (Enhydra lutra)4 or California sea lions.5 Adverse injection site reactions observed in California sea lions in another study5 did not occur in this Northern fur seal. The seasonal use of leuprolide acetate for male contraception in this Northern fur seal
colony proved to be an effective and practical contraceptive technique and may have application to other colonial, seasonally reproductive, pinniped species.

ACKNOWLEDGMENTS

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LITERATURE CITED

LAPAROSCOPIC-ASSISTED OVARIECTOMY OF CHELONIANS: SIX CASES

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Abstract

Laparoscopic-assisted surgery is being used more frequently in veterinary medicine.\(^2,3,6,8-12\) For chelonians, laparoscopic procedures may reduce the need for more invasive surgical approaches such as plastron coeliotomy. A pre-femoral surgical approach to the coelom has been reported in turtles, but in some species this approach may not provide adequate visualization for some procedures.\(^1,4,5,7\)

Pre-femoral coeliotomy was performed in six turtles for management of retained eggs, ectopic eggs, oviduct prolapse, or elective ovariectomy. Specimens included one Gulf Coast box turtle (Terrapene carolina major), two red-eared sliders (Trachemys scripta elegans), one eastern painted turtle (Chrysemys picta picta), one four-eyed turtle (Sacalia bealei), and one Chinese red-necked pond turtle (Chinemys kwantungensis). Patients were positioned in dorsal recumbency. Laparoscopy provided excellent visualization, and laparoscopic instruments were used to identify and exteriorize ovaries, eggs, and oviducts. In four cases, bilateral ovariectomy was achieved through a unilateral approach. In two cases hemiovariosalpingectomy was performed due to unilateral oviduct damage, with the hope of maintaining future reproductive potential.\(^7\) Retained eggs were easily visualized and removed. In the box turtle, a large retrocoelomic granuloma was also visualized and resected. Unfortunately this patient died 2 days post-operatively secondary to sepsis. Five specimens recovered uneventfully and were returned to their enclosures in 24 hr. Skin healing was complete in 6 wk.

Selection of turtles for laparoscopic-assisted ovariectomy should be limited to females with mature, active ovaries. The ovarian pedicle of immature females generally does not have enough laxity to allow exteriorization. In these patients, a laparoscopic ovariectomy would be required.

LITERATURE CITED

EVALUATION OF AN IMPLANTED OSMOTIC PUMP FOR DELIVERY OF AMIKACIN IN CORN SNAKES (Elaphe guttata guttata)

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Abstract

Medical treatment of venomous or aggressive snakes is a challenge for the reptile veterinarian and a safe, effective and reliable method of drug delivery for these snakes is needed. Alzet® osmotic pumps (Durect Corp., Cupertino, CA 95014 USA, www.alzet.com) are miniature cylindric implants that operate on the basis of an osmotic pressure difference between the extracellular fluid and the osmotic agent in the pump (Fig. 1). As water diffuses across the outer semi-permeable membrane, the ‘salt sleeve’ compartment expands and presses on an internal flexible reservoir, thereby releasing the drug at a controlled, continuous rate. As the pump rate is defined by the semi-permeable membrane and osmotic gradient, the resulting delivery rate is independent of the drug being dispensed.

Nine adult corn snakes (Elaphe guttata guttata) were used in this study. Five snakes (Group A) had an osmotic pump (Alzet® Model 2002) surgically placed into the caudal coelomic cavity. The pumps were loaded with amikacin (Phoenix Scientific, Inc., St. Joseph, MO 64506) at a concentration designed to deliver 0.026 mg/kg/hr and each snake was administered a loading dose of 1.69 mg/kg of amikacin intramuscularly at the time of implantation. Blood samples were obtained via cardiocentesis at 0, 2, 24, 48, 72, 144, 216, and 288 hr after pump placement. Pumps were removed after 288 hr and blood samples obtained 48 and 96 hr after removal. Four snakes (Group B) received intramuscular injections of amikacin every 72 hr at a dose of 5 mg/kg for the first injection and 2.5 mg/kg for each additional injection for a total of 4 injections. Blood samples were obtained just prior to and 2 hr after each injection, and at 72 hr after the fourth injection. Samples were analyzed for amikacin via by fluorescence polarization immunoassay (TDx®, Abbot Laboratories, Diagnostics Division, Abbot Park, Illinois 60064, USA). Renal function was evaluated before and after the study via serum uric acid and phosphorus concentrations, and via renal scintigraphy with 99mTc-mercaptoacetyltraglycine (99mTc-MAG3).
The target serum concentration of amikacin was 8 µg/ml. The mean serum concentration for Group A was 6.31 µg/ml (SD = 0.86). The mean pump rate was determined to be the same as the expected rate of 0.13 µl/hr (SD = 0.017, Range: 0.12 – 0.16). Mean peak serum concentration for Group B was 16.1 µg/ml (SD = 2.7) and mean trough concentrations were 8.1 µg/ml (SD = 1.1). Mean serum concentration for Group A was less than the mean trough concentration in Group B. No evidence of decreased renal function was detected via serum chemistry analysis or renal scintigraphy in either group. One snake died due to migration of the pump into the trachea after inadvertent placement of the pump into the caudal air sac.

The Alzet® osmotic pumps were highly reliable and efficacious in delivering amikacin to corn snakes at a predictable and steady rate. They were easy to load, place and remove. Due to the potential for migration within the coelomic cavity, intracoelomic placement may not be appropriate for some snake-pump size combinations. Additional studies are planned to evaluate subcutaneous placement of these pumps in corn snakes.

**Figure 1.** Cutaway section of osmotic pump.
IN VITRO SUSCEPTIBILITY OF FUNGAL ISOLATES FROM REPTILES TO ANTIFUNGAL DRUGS

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Abstract

Clinicians are increasingly confronted with sick reptiles in need of safe and effective antifungal drugs. There few studies of pharmacokinetics of antifungal drugs have involved even fewer reptile species, and none addresses efficacy. There are currently no guidelines for selection of appropriate antifungal agents in reptiles because there are no data on efficacy of drugs against many of the fungi pathogenic to reptiles. The susceptibility of 26 fungal isolates originating from reptiles to various antifungal drugs was determined using NCCLS protocols standardized testing methods for filamentous fungi. Preliminary analysis of data indicates that MICs obtained for amphotericin B, fluconazole, terbinafine, and voriconazole were similar for the teleomorphic 

Naznizziopsis vriesii isolate and all 16 Chrysosporium anamorph of Nannizziopsis vriesii (CANV) isolates, but that MICs for itraconazole were slightly higher for CANV isolates from bearded dragons. Low MICs for amphotericin B, fluconazole, terbinafine, and voriconazole were similar for the teleomorphic 

Naznizziopsis vriesii isolate and all 16 Chrysosporium anamorph of Nannizziopsis vriesii (CANV) isolates, but that MICs for itraconazole were slightly higher for CANV isolates from bearded dragons. Low MICs for amphotericin B, fluconazole, terbinafine, itraconazole, and voriconazole (in isolates other than bearded dragon) suggest CANV isolates are sensitive to these compounds. Fluconazole MICs were high for all fungi except Trichosporon asahii. Paecilomyces lilacinus was resistant to fluconazole and to amphotericin B, but sensitive to terbinafine and voriconazole. Amphotericin B MICs were high for Fusarium solani and F. verticillioides isolates, and terbinafine and voriconazole MICs were also high for F. solani. In vitro sensitivity testing of reptile isolates suggests that itraconazole, voriconazole, and terbinafine are more potent than amphotericin B and fluconazole. Considering the pharmacokinetics of these drugs, itraconazole, voriconazole, and terbinafine would be expected to be the best options for treatment of CANV, Paecilomyces lilacinus, Trichosporon asahii, and Fusarium spp. mycoses in reptiles.

ACKNOWLEDGMENTS

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UPDATE ON IOHEXOL EXCRETION FOR THE EVALUATION OF RENAL FUNCTION IN THE GREEN IGUANA (Iguana iguana)

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Abstract

In a recent paper, plasma biochemistry, iohexol clearance (to determine glomerular filtration rate), and endoscopic renal evaluation with biopsy were performed in 23 clinically healthy 2-yr-old green iguanas (Iguana iguana).1 Following the i.v. injection of 75 mg/kg iohexol into the caudal (ventral coccygeal or tail) vein, serial blood collections were performed over 32 hr. Iohexol assays by high performance liquid chromatography produced plasma iohexol clearance graphs for each lizard. A three-compartment model was used to fit area-under-the-curve values and obtain the glomerular filtration rate using regression analysis. The mean glomerular filtration rate (± SD) was 16.56 ± 3.90 ml/kg/hr, with a 95% confidence interval of 14.78 – 18.34 ml/kg/hr. Bilateral endoscopic renal evaluation and biopsy provided tissue samples of excellent diagnostic quality, that correlated with tissue harvested at necropsy and evaluated histologically. None of the 23 animals demonstrated any adverse effects of iohexol clearance or endoscopy.

A prospective clinical study of five iguanas presented with suspected renal disease was undertaken. These animals were similarly evaluated using plasma biochemistry, iohexol clearance and endoscopic renal evaluation. In all cases, GFR was significantly reduced and ranged from 2 – 12 ml/kg/hr. Renal disease was also confirmed histologically by endoscopic renal biopsy and/or necropsy.
Iohexol assays are commercially available through the Diagnostic Center for Population and Animal Health, Michigan State University, East Lansing, Michigan 48824, USA, and have proven practical for the determination of renal function in the green iguana. Recommended diagnostics for the evaluation of renal function and disease in the green iguana include plasma biochemical profiles, iohexol clearance, endoscopic examination, and renal biopsy.

LITERATURE CITED

REPRODUCTIVE ENDOSCOPY AND ENDOSURGERY OF GULF OF MEXICO STURGEON (Acipenser oxyrinchus desotoi) AND SHORT-NOSED STURGEON (A. brevirostrum)

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Abstract

Two projects involving endoscopy of sturgeon have been undertaken as a collaborative research effort between the College of Veterinary Medicine, University of Georgia and the United States Fish & Wildlife Service, Warm Springs, Georgia.

The first project involved seventeen Gulf of Mexico sturgeons (Acipenser oxyrinchus desotoi) that underwent endoscopic sex determination, gonadal biopsy, and various reproductive surgeries as part of a conservation development plan.¹ The fish were anesthetized with tricaine methanesulfonate (MS-222) buffered with sodium bicarbonate, and maintained on a recirculating water anesthesia circuit. A 6-mm Ternamian EndoTip cannula, placed through the ventral midline, midway between pectoral and pelvic fins, permitted the introduction of a 5-mm telescope. Swim bladder aspiration and CO₂ insufflation of the coelomic cavity provided excellent visualization. Second and third cannulae were placed under direct visual control lateral and cranial or caudal to the telescope cannula. Sex determination was successfully performed in all fish; however five of 17 sturgeons (29 %) required endoscopic gonadal biopsy to confirm sex. Bilateral ovariectomy or orchidectomy was successfully performed in three males and four females. Unilateral ovariectomy and bilateral ligation of the müllerian ducts using an extracorporeal suturing technique was accomplished in an additional three females. No apparent morbidity was associated with the anesthesia or endoscopic surgery in any fish.

A second more invasive surgical procedure was undertaken in 12 female short-nosed sturgeon (Acipenser brevirostrum). These fish were first subjected to a visual appraisal of their reproductive tract, and any fish undergoing major reproductive activity were removed from the study. In 10 sturgeon, bilateral ovariectomy and müllerian duct ligations using intracorporeal and extracorporeal techniques were employed. At the time of writing these fish were still recovering.
from their endoscopic procedures; however, plans for radiotransmitter implantation and release are anticipated.

Minimally invasive endosurgery in fish offers exciting possibilities and might have significant applications in fish management, research, and conservation.

LITERATURE CITED

DEVELOPMENT OF A TOOL FOR ASSESSING AND MANAGING THE RISK OF AVIAN MYCOBACTERIOSIS DURING AVIAN TRANSLOCATION

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Abstract

Infectious diseases potentially impact the health of both individuals and populations. For diseases that are chronic, contagious, and elusive, as is the case with avian mycobacteriosis, risks may be magnified. This disease is problematic worldwide in both captive and wild populations. Once infected, an individual is capable of protracted shedding of viable organisms into the environment. Diagnosis is hampered by the lack of reliable ante-mortem tests, slow-growing cultures, and an inability to effectively treat the disease. Therefore, the best approach is to minimize introduction of the organism into an avian population, ensuring a source free of disease for both captive breeding and reintroductory programs. Due to ambiguity between institutions’ assessment of risk and the nature of this disease, many facilities are reluctant to accept birds from sources reporting a collection history with Mycobacterium avium. Review of the literature, case reports, and diagnostic reviews demonstrate the pervasive nature of the disease, but in no documentation are the complete risk factors of exhibit, species, and population, systematically analyzed by any standardized method. This paper outlines an easily understood risk assessment tool, created by a multidisciplinary group of experts, that allows managers and health experts to cooperatively evaluate risk factors associated with the spread of avian mycobacteriosis within and between institutions and into wild populations.

Introduction

Avian mycobacteriosis, or tuberculosis, is a pervasive disease issue in many avian species. Although the bacterial genus is ubiquitous as several species in soil, the disease in birds is most commonly caused by M. avium or M. genavense. Birds are infected by fecal-oral transmission within a contaminated environment. Feral bird species are considered contributors to outside exhibit contamination or exhibit substrates. Virtually, all avian orders have had representative infections, but it is more often diagnosed in Anseriformes, Gruiformes, Galliformes, and Psittaciformes.¹⁻³ In some particular species, mycobacteriosis has been found as a prevalent cause of death, such as in Micronesian kingfishers (Halcyon cinnamominia cinnamominia) (11% of deaths as reported in 1996) and white-winged wood ducks (Cairina scutulata) (80% of deaths as reported in 2003).⁴⁻⁵
While avian mycobacteriosis may cause mortality for some individual animals, exposure to this organism or an exhibit with historic contamination does not necessarily result in death or disease. Unfortunately many animal movement decisions are made based on the perception of risk since there is not much data available. As a result, many individuals that have extremely low risk of spreading disease may be unnecessarily euthanatized or quarantined. Risk assessment methodology helps integrate science into decision-making policy through a standardized approach to assessing the risk of disease. A multi-stakeholder workshop was held at Lincoln Park Zoo in order to provide a forum for open discussion between veterinarians and managers regarding animal movements and the risk of spreading avian mycobacteriosis. As a result of the workshop, a semi-quantitative risk assessment tool, useful for both veterinarians and managers, was developed. This effort has the potential to positively affect many individual species as it is a demonstrated problem industry wide. The disease significantly impacts captive breeding of many endangered species; common examples include increased mortality of breeding stock (e.g., Micronesian kingfishers), and decreased compliance with programmatic breeding recommendations (e.g., sunbittern [Eurypyga helias] Guam rails [Rallus owstoni]). When faced with this disease, managers and veterinarians are forced to make decisions for their collection as well as AZA® sponsored programs (SSP®, PMP, TAG, Avian SAG, and Reintroduction SAG) using information that is vague, contradictory, and not standardized within the industry. This tool, endorsed by both veterinarians and managers, offers one standardized approach to dealing with this issue.

Methods

Risk assessment follows a formal process, the phases of which include: 1) outlining the generic pathway of concern (in this case avian animal movement from point A to point B); 2) identification and weighting of risk factors specific to the pathway; 3) establishing evaluation or grading criteria by which risk factors (qualitative vs. semi-quantitative vs. quantitative) are ranked; 4) describing the relationship between factors in order to combine them all to calculate total measurement of risk; and 5) validation of the process. In this case, the source institution including enclosure, management and veterinary service contributions; quarantine and testing; shipment method; and post shipment environment are all considered in the model’s pathway.

Risk factors for each of the areas above were specifically defined (i.e., prevalence in the source population, likelihood of being infected by wildlife at all stages, sensitivity of the diagnostic test etc.). Each factor was then weighted according to its relative importance to overall risk of disease introduction or transmission; this step was a major part of the expert discussion during the first workshop. The total risk for each stage is calculated and the stages combined for overall risk characterization from source through destination—the lower the overall score, the lower the risk. A special data collection form was created using Microsoft Access© to take the users through this process in a step-by-step, transparent, organized manner.
The method described above is known as a semi-quantitative assessment. Internationally accepted methodology exists for conducting semi-quantitative risk assessments for issues surrounding animal health and animal movements.\textsuperscript{6-8} Two different, but equally appropriate examples, are available on-line: the USDA protocol for assessing Johne’s disease risk in cattle (http://www.state.vt.us/agric/VTCHIP/vchipchecklist.PDF), and the European Union financial investment risk assessment method (http://www.ltbcweb.com/cipratech/squat.html). Semi-quantitative calculations, using ranked categoric data (equivalent to those used to determine grade point average), are commonly used in cases where there is minimal quantitative data available – clearly, this is the case with avian mycobacteriosis.

Based upon final score, an individual animal will be placed into a risk category “red,” “yellow,” or “green” (Fig. 1). In general, the red category means movement of the animal is at high risk for transferring a mycobacteriosis positive individual, while those placed in the yellow category are acceptable with some reservations or issues needing to be addressed. Those in the green risk category have minimal risk of transferring the disease to the receiving institution or population. Standardized management recommendations and guidelines are being developed for each risk category (red, yellow and green) to assist managers with making decisions regarding animal movements once their risk has been assessed.

**Results and Discussion**

The expert elicitation workshop resulted in the inclusion of the following risk factors into the model (weights of each factor not included):

- Immune status of the bird to be shipped (individual medical history)
- Age class
- Parent history with respect to TB (risk of vertical transmission)
- Exposure history to positive birds at enclosure, building or run levels (horizontal transmission)
- Exposure history to wild birds
- Enclosure maintenance and hygiene
- Husbandry and enclosure environmental factors such as ventilation, water, substrate, equipment, food and lighting
- Exposure to people (personnel, contract workers and public) and biosecurity practices
- Quarantine management, personnel, biosecurity, including cleaning and disinfection practices, and degree of isolation and animal/people flow patterns
- Diagnostic testing – minimal screening recommendations and weighted values of other testing methods
- Shipping factors including both air and ground transport, environmental stress, and personnel/equipment hygiene and disinfection
- Post shipment quarantine/isolation and testing protocols
- Destination factors such as mycobacteriosis history and status in recipient population
• Impact of AZA program recommendations in captive settings
• Impact on potential reintroductions (e.g., IUCN guidelines, post-release monitoring etc.)

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LITERATURE CITED

Figure 1. Schematic flow diagram of avian mycobacteriosis risk assessment process.
Figure 2. Diagnostic test decision tree for avian mycobacteriosis. Reading from left to right, minimal recommended screening procedures include physical examination, radiographs, CBC and blood chemistry, and acid fast stained fecal smear. Further diagnostic testing recommendations, with interpretations, may be considered by following the flow diagram.
NEURAL LARVA MIGRANS DUE TO Baylisascaris procyonis IN CAPTIVE LOVEBIRDS AND LORIKEETS: A CASE SERIES

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Abstract

Neural larva migrans (NLM) has been identified as a cause of neurologic disease in parrots housed outdoors (seasonally) at the Toronto Zoo. Between August and October 1994, nine peach-faced lovebirds (Agapornis roseicollis) developed neurologic signs including head tilt, circling, nystagmus, loss of balance, incoordination, weakness, and extensor rigidity. Affected lovebirds had histologic lesions within the brain and/or spinal cord that included leukomalacia, axonal degeneration, and/or perivascular lymphoplasmacytic cuffing. Since June 2002, 14 of 41 green-naped (Trichoglossus haematodus haematodus) and Swainson’s (Trichoglossus haematodus moluccanus) lorikeets developed similar neurologic signs and histologic lesions to those seen in the lovebirds. Three lorikeets also had histologic evidence of Baylisascaris procyonis larvae within the brain. This case series demonstrates the difficulty in identifying the etiology of neurologic disease in parrots. The sole method of establishing a definitive diagnosis of NLM due to B. procyonis is through identification of larvae in tissue.1 Only three of the 23 cases reported in this case series had larvae present histologically. In the absence of histologic confirmation of larvae, the diagnosis of NLM is strongly suggested if several criteria are met. These include a history of exposure (directly or indirectly) to scat from raccoons infected with B. procyonis, characteristic neurologic signs, and the presence of leukomalacia in central nervous system tissue.2 Confirming exposure to infective B. procyonis eggs can be difficult since the eggs persist in the environment for years and may not be associated with scat. Treatment was ineffective in the cases described, which highlights the importance of prevention.

LITERATURE CITED

PATHOLOGIC EFFECTS OF CARPROFEN IN PIGEONS (Columba livia): AN AVIAN MODEL

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Abstract

Little information is published regarding the pathologic effects of non-steroidal anti-inflammatories in avian species. Injectable carprofen was administered intramuscularly to pigeons (Columba livia) at 2 mg/kg, 5 mg/kg, and 10 mg/kg for 7 days. Blood samples were obtained prior to administration of the drug, and again immediately prior to euthanasia for complete blood counts and plasma chemistry analysis. Randomly selected birds were euthanatized 24 hr after treatment days 1, 3, 5, and 7, and necropsies and histopathology were performed. Clinically significant pathologic effects were not found in these birds. Although an elevation of some plasma biochemical values occurred, specifically liver enzymes, the dose and length of treatment did not have a significant histopathologic effect on organ systems as a whole.

Introduction

Carprofen is a non-steroidal anti-inflammatory (NSAID) used therapeutically in veterinary medicine, to alleviate pain and decrease inflammation. Carprofen is a specific cyclo-oxygenase-2 (COX-2) inhibitor in the proprionic acid class of NSAIDs.6 This class is used for their analgesic, anti-inflammatory, and antipyretic properties, and presumably does not cause as many side effects as cyclo-oxygenase-1 (COX-1) inhibitors.6 The introduction of parenteral carprofen (Pfizer Animal Health, Exton, PA 19341, USA) in the United States presents another analgesic option to avian veterinarians. Although carprofen has been recommended in avian species for pain relief, few reports are available on the pathologic effects of NSAIDs, and specifically carprofen.1,3-5 The purpose of this study was to evaluate the pathologic and biochemical effects of parenteral carprofen in avian species, with pigeons (Columba livia) as a model.
Methods

Fifty-two apparently healthy pigeons were purchased from a private breeder. Eight birds were housed in six enclosures with four control birds in a separate enclosure. All birds were fed a commercial diet and water ad libitum. Baseline estimated white blood cell counts, plasma biochemical profiles, and cursory physical exams were performed prior to administration of the drug to determine overall health. All birds were weighed (mean 554 g, range 382-713 g) and were randomly assigned to one of three treatments groups, each containing 16 birds: carprofen at 2 mg/kg (Group 1), 5 mg/kg (Group 2), and 10 mg/kg (Group 3). The medication was administered once a day for 7 days to all birds in alternating pectoral muscles. The four control animals were treated with saline injections in corresponding volumes in alternating pectoral muscles. Four carprofen treated birds randomly selected from each group were humanely euthanatized at 24 hr after treatment days 1, 3, 5, and 7, along with one randomly selected control bird. Hematologic and plasma biochemical samples were obtained on all animals prior to euthanasia. All birds were necropsied with sections of infulia, proventriculus, ventriculus, small intestine, liver, kidney, and pectoral muscles submitted for histologic evaluation. Following fixation in 10% neutral buffered formalin, collected tissues were embedded in paraffin, sectioned to 10µm, and stained with hematoxylin and eosin for histopathologic examination by an observer blinded to the treatments. Histologic changes were ranked by the pathologist (CAS) as: N – tissue within normal limits, 0 – no lesion/not present, 1 – minimal, 2 – mild, 3 – mild to moderate, 4 – moderate, 5 – moderate to marked, and 6 – marked.

Results

Clinical Pathology

No statistically significant differences in hematologic parameters were measured between dosage groups, the control group, or within the groups over time. A statistically significant effect of treatment duration on total solids was detected. There was a trend of decreasing total solids on days 5 and 7 for each dose, while values were decreased on all days for the highest dose.

No significant difference in plasma creatine, potassium, albumin, total bilirubin, and blood urea nitrogen was measured between dosage groups or within the groups over time. Treatment duration had a statistically significant effect on sodium, chloride, calcium, total protein, globulin, alkaline phosphatase, and uric acid levels. The dosage of carprofen had a significant effect on the mean values of sodium, chloride, calcium, globulins, total protein, alkaline phosphatase, uric acid, glucose, aspartate aminotransferase (AST), and alanine aminotransferase (ALT).

Gross Pathology

The pectoral musculature had focally extensive pale areas that occasionally extended between the fascial planes in 33% of the birds in Group 1, 50% of the birds in Group 2, and 50% of the
birds in Group 3. No birds euthanatized 24 hr after treatment on day 1 had pale areas, but this lesion was present on half of the birds every euthanasia day thereafter. Mottled yellow livers were seen in 10 birds total with three in each carprofen treatment group and one control bird. Five of the birds with mottled livers were among those euthanatized 24 hr after the day one treatment. In the gastrointestinal tract, congested, erythematous small intestines were seen in seven birds, with representatives in all carprofen treatment groups. Of these birds, lesions were present 24 hr following treatment days 5 and 7. All other systems and organs were grossly normal.

Histopathology

Significant histopathologic changes were noted in the liver, kidney, and musculature. In the liver, acute lymphoid necrosis was significant, although by the ranking scale was considered only minimal (average 1). In the kidney, reactive diffuse lymphoid tissue and acute diffuse congestion were significant lesions. The pectoral muscle lesions consisted of myoregeneration. Histopathologic changes present in the ingluvia, proventriculus, ventriculus, and small intestine were not significant.

Discussion

Clinical pathology results revealed significant changes compared to documented acceptable avian liver, muscle and kidney plasma biochemical parameters. Clinical evaluation of the mean concentrations of glucose, sodium, calcium, and alkaline phosphatase were within normal limits compared to International Species Information System (ISIS) normal reference ranges for domestic pigeons. Uric acid values were within normal reference limits for all mean plasma values except for the 2 mg/kg dose on day 7. Chloride control values were higher than ISIS reference ranges, however all response values were within reference ranges. The most significant mean response value results were for AST and ALT, which were considerably higher than the clinical reference ranges. The mean values increased as the dose administered increased. Both values were statistically significant due to the effect of dose, and there was no effect of the length of treatment on the mean values of AST or ALT. This finding would suggest liver damage rather than muscle damage from multiple injections. Plasma creatine phosphokinase levels were not measured in this study, therefore elevations in serum AST or ALT due to muscle damage cannot be entirely ruled out.

Grossly pale areas were observed in the pectoral musculature indicating muscle damage, however significant necrosis of the muscles was not seen histopathologically. Acute, diffuse congestion of the kidney was observed in all animals, even controls, minimally or mildly. As clinically significant changes to the kidney values were not observed and this finding was present in the control animals, it would appear that the carprofen doses utilized in this study did not adversely affect renal tissue. The histopathologic changes to the liver were also mild, suggesting
that the AST and ALT elevations were transient and are not due to significant damage to the liver due to the medication.

The use of injectable carprofen at 2 mg/kg, 5 mg/kg, or 10 mg/kg did not cause clinically significant pathologic effects in these birds. Although an elevation of some plasma biochemical values, specifically liver or muscle enzymes, was likely due to the dose administered, the dose did not have a significant histopathologic effect on organ systems as a whole. Injectable carprofen can be used at each of the stated doses for a treatment length of up to 1 wk without significant clinicopathologic or histopathologic effects. Further research will be necessary however to determine efficacy and dosage for injectable carprofen in control of painful stimuli.

LITERATURE CITED

USING POSITRON EMISSION TOMOGRAPHY IMAGING OF THE PARROT BRAIN TO STUDY RESPONSE TO CLINICAL PAIN

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Abstract

To advance veterinary analgesia therapy, we developed methodology for positron emission tomography (PET) imaging of Hispaniolan parrots (Amazona ventralis).

Four adult Hispaniolan parrots (265-315 g, age 15+ yr) were scanned under isoflurane anesthesia with 2-deoxy-2-[18F]fluoro-D-glucose (FDG), 1 mCi was administered intravenously (i.v.) while birds were in the University of Wisconsin (UW) microPET P4 (Concorde Microsystems, Knoxville, TN, USA).1 To aid compartmental model analysis, studies were first performed with transmission scans followed by emission scans begun at FDG injection. In these kinetics studies, two parrots were positioned to obtain cardiac images for determination of blood pool time activity curves, and two parrots were positioned to observe the time course in the brain. All four parrots were imaged in control and arthritic conditions in the subsequent pain response study. Four hours prior to FDG injection, the right tarsal joint was injected with either 0.1 ml saline (control) or 3 mg sodium urate microcrystals in saline (experimental arthritis). Birds were kept alone in quiet darkened cages for 30 min following FDG injection, then anesthetized and positioned for scanning. PET scans were obtained during the period 45-95 min following FDG injection.

Analysis was performed using SPM and Spamalize.2 Magnetic resonance imaging (MRI) scans, acquired at the UW Veterinary School, were inspected for gross differences between subjects and one image was selected as a template. Lacking a parrot brain atlas, the template MRI was manually rotated to correspond to the orientation in a chick brain atlas.3 Control and stimulus PET images were manually registered by rigid body rotations and translation to the MRI template to within 1 mm. A brain mask drawn on the MRI template was applied to all 8 PET images, which were then further aligned automatically by rigid body rotations and translations and smoothed with a 4-mm kernel. A whole-brain voxel-wise t-test was performed comparing the images of the four birds in the stimulus vs. the control state. Based on the resulting statistical parametric map, regions of interest were drawn, normalized to whole brain image intensity, and compared between stimulus and control conditions.
Preliminary analysis suggests increased glucose metabolism under the arthritis condition occurs in the portion of the avian brain called the ectostriatum. Anatomic identification of regions needs to be refined with further studies. The method using FDG shows promise for PET imaging of parrot brain function, and further work is planned to study where in the parrot brain kappa opioid receptor occupancy is affected during the same pain model of arthritis.

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LITERATURE CITED

PRACTICAL CONSIDERATIONS FOR THE USE OF THE TUBULAR EXTERNAL FIXATOR (F.E.S.S.A.) IN THE TREATMENT OF FRACTURES IN BIRDS

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Abstract

This presentation describes a new model of a tubular external fixator in avian surgery. The Fixateur Externe du Service de Santé des Armées (F.E.S.S.A.) system was originally developed by the French army as a light tubular external fixator for human hand and foot fractures. Its excellent application for small bones has led to its successful use since 1990 in small animal medicine, especially in dogs, cats and rabbits with a body weight below 5 kg.²,³,⁵ The F.E.S.S.A. system (Fig. 1) is made of stainless steel and is extremely light weight (<10 g). Compared to other commercial external fixators the system was shown to be considerably easier to apply. Considering that the F.E.S.S.A. system can be reused in several patients, the costs favorably compare to free-form fixations such as polymethylmethacrylate, where the pins represent the major cost factor. Different models of the F.E.S.S.A system are available with a tube diameter of 6, 8, and 12 mm. Kirschner pins of up to 2 mm and 2.5 mm, respectively may be used. The length of the fixators varies from 30 mm to 118 mm. A linear or angular elongation by attachment of two fixators is possible. Minimum distance between pins is 2 mm. The pins may be placed vertically or in a 30° angle. The fixator may be used in different ways, such as a type I – III external fixator or as “tie-in” fixator (combination of intramedullary pin and external fixation). At our clinics the F.E.S.S.A. system has been used in birds with bodyweights ranging from 90 to 1000 g, with a success rate comparable to other avian orthopedic studies. The species where the system has been mainly used are psittacine, raptors, and pigeons to treat tibiotarsal fractures, humeral fractures, tarsometatarsal fractures, femoral fractures and antebrachial fractures. In all cases the 6-mm diameter F.E.S.S.A. system was applied with lengths varying between 30 and 70 mm and pins ranged from 0.8 mm to 1.35 mm in diameter. In mammalian surgery the use of threaded pins together with external skeletal fixation is generally recommended due to the increased pin bone interface. In addition, positive threaded pins are known to have a superior stability over negative threaded pins, hence reducing the risk of pin breakage.¹ In our experience the use of threaded pins can also be recommended in avian surgery, however negative threaded pins appear to be safe in the bird species included in the present study.
In five out of ten ulna fixation procedures in pigeons fissure formation or refracturing was observed. In most cases this complication occurred around the most distal pin and occurred regardless if the radius was additionally stabilized with an intramedullary pin or not. A possible explanation may be that the 4 cm connecting bar (including six pins) was not long enough. In birds leverage exerted on an ulnar fracture is significantly higher than in mammals due to a different relationship of muscle insertions to joints.\(^4\) Howard (1990) recommended the use of longer plates in birds compared to similar fractures in small animals.\(^4\) This suggestion might also apply for external fixation.

In large psittacine birds it is recommended to additionally stabilize screws with a cyanoacrylate tissue adhesive (Vetbond\textsuperscript{TM}, 3M Switzerland), since they tend to manipulate them, which may lead to instability. In our experience the F.E.S.S.A. system is well tolerated and offers a wide range of applications in relation to the size of birds treated and the fracture types. It therefore represents a valuable alternative to currently used external fixator systems.

**LITERATURE CITED**

Figure 1. Schematic view of the components of the F.E.S.S.A. external fixator. Tube with gliding (a) and threaded (b) holes, Kirschner pins (c), screws (d), and allen key (e). Insertion of pin perpendicular (c) or at 30° angle (f).
REVIEW OF AVIAN VIRAL DISEASES

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Abstract

Numerous viruses have been associated with disease in various avian species, however the extent to which birds maintained in captivity are infected is not well understood,1 and may be underestimated. Viral diseases diagnosed in birds by the Zoo/Exotic Pathology Service were reviewed. The material was from case submissions that included complete necropsies as well as limited fixed-tissue samples. Diagnosis was made by lesion type and in most cases the finding of inclusion bodies typical for the virus. In some cases specific probes were used to confirm the diagnosis. Diseases caused by adenovirus, calicivirus, circovirus, flavivirus (West Nile), herpesvirus, papillomavirus, paramyxovirus, polyomavirus, poxvirus and togavirus (WEE) were definitively diagnosed. Cases of probable parovirus were seen and a large number of cases of proventricular dilatation disease (a probable viral entity) were diagnosed. In addition, cases of probable viral disease-exact cause not determined were seen.

Viral disease was found in 15 avian families. The most common viral diseases diagnosed were circovirus (61.2% in Cacatuidae), polyomavirus (50.3% in Psittacidae), proventricular dilatation disease (63.23% in Psittacidae), herpesvirus (89.9% in Psittacidae), poxvirus (48.5% in Fringillidae) and adenovirus (87.1% in Psittacidae). The primary reason for the predominate occurrence of viral diagnoses in Psittaciformes is considered to be the large number of these birds in aviary and pet situations, and the willingness of their owners to spend money on diagnostics.

LITERATURE CITED

APPLICATION OF GEOGRAPHIC INFORMATION SYSTEMS TO IDENTIFY AFRICAN GREAT APE POPULATIONS AT GREATER RISK FROM HUMAN DISEASES

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Abstract

Recent outbreaks of zoonotic diseases in African great apes illustrate the potential role of infectious diseases in jeopardizing the persistence of great ape populations. The objective of this unique study was to illustrate the potential application of Geographic Information Systems (GIS) to generate hypotheses regarding which African great ape populations, including bonobos (Pan paniscus), chimpanzees (Pan troglodytes), and gorillas (Gorilla gorilla and Gorilla beringei), are at increased risk from human diseases. The most recently available (2000) human demographic data and core human health indicator data for the African great ape range countries were obtained from the Centers for Disease Control and Prevention and World Health Organization websites. Human population density and percent annual human population growth rate were used as combined indicators of environmental stress/vulnerability (as a proxy measure of human-great ape contact) and Infant Mortality Rate (IMR) and Healthy Life Expectancy (HALE) were used as separate indicators of disease burden among the human populations living in the great ape range countries. Cut-off values were determined, and using GIS (SIGEpi, Pan American Health Organization, Washington, D.C.), these indicators were analyzed to create maps of critical areas (countries) with both environmental stress and high burden of human diseases. When using IMR as the indicator of disease burden, the great ape range countries identified as critical areas included Benin, Guinea-Bissau, Ivory Coast, Liberia, Nigeria and Tanzania. Cameroon and Uganda were also identified as critical areas when using HALE as the indicator of disease burden; however, Benin was excluded. Including geospatially referenced maps of great ape populations in the analysis would then identify at-risk populations within these critical areas. Validation of the results would allow for targeted interventions such as increased disease surveillance of at-risk great apes, improved public health in the critical areas, as well as educational programs regarding zoonoses, thereby maximizing the use of limited resources. Further analyses should be performed at the first and second administrative boundary levels to identify within-country critical areas for human-great ape disease transmission. Improvements in public health infrastructure in these critical areas would benefit the human populations that have unmet health needs as well as these endangered species. This illustrates the connectivity...
between human and wildlife health, and provides a conservation-related argument for improvement of public health in these developing countries.
Abstract

Three species of lemur—ring-tailed lemurs (Lemur catta), black and white ruffed lemurs (Varecia variegata variegata), and blue-eyed black lemurs (Eulemur macaco flavifrons)—have been managed in a free-ranging setting on St. Catherine’s Island over the last 15 yr. Review of lemur health records and the preventive medical program resulted in identification of the morbidity and mortality causes reported in this study.

Introduction

St. Catherines Island (SCI) is a barrier island off the coast of Georgia. The island has many different habitats including freshwater and saltwater marsh, deciduous and evergreen forest, palmetto scrub, and open savannah. The island is separated from the mainland by 6 km of tidal marsh and river. There are approximately 14 miles of beach on the eastern side of the island.

In 1974, the Wildlife Survival Center was established on SCI with the mission to promote captive reproduction of endangered animals outside of the traditional zoological setting. This was a partnership between the SCI Foundation and the Wildlife Conservation Society. Species of prosimians that have been managed on SCI over the last 15 yr include ring-tailed lemurs (Lemur catta), black and white ruffed lemurs (Varecia variegata variegata), blue-eyed black lemurs (Eulemur macaco flavifrons), black lemurs (Eulemur macaco macaco), and crowned lemurs (Eulemur coronatus). The large habitats and isolation of the island have allowed for the development of various free-ranging prosimian projects. Ring-tailed lemurs, black and white ruffed lemurs, and blue-eyed black lemurs have been managed successfully in a free-ranging setting. Six ring-tailed lemurs were first introduced onto SCI in 1985. The population has
grown to up to 80 ring-tailed lemurs, which have established up to four distinct free-ranging troops. The free-ranging ring-tailed lemur program has provided researchers an excellent opportunity to conduct behavioral and conservation oriented research. Additionally, the lemurs have been instrumental in several of our local and international training and education programs. St. Catherines Island was one of the two sites used as a “boot camp” for training black and white ruffed lemurs to forage and climb trees prior to being sent over to Madagascar as part of the Betampona Restocking Project.

Preventive Medicine Program

The preventive medicine program for lemurs on SCI includes an annual physical examination and diagnostic work up under isoflurane anesthesia, including a complete blood count, serum chemistry profile, serum banking, periodic serology and disease screening, fecal examination for parasites and culture for enteric bacterial pathogens, whole body radiographs, tuberculin testing, external parasite collection and identification, and paternity testing. Dental prophylaxis, fipronil application, changing radio-collars, and vaccination for rabies and tetanus are also performed. Additionally, various methods of identification (transponder, ear tag, colored cat and radio-collars) are placed at this time.

Morbidity and Mortality

A. Trauma

Various forms of trauma were the most common problem observed in the free-ranging ring-tailed lemurs. Documented injuries have included lacerations, bite wounds, leg and tail fractures, and occasional head and vertebral fractures. Vertebral and skull fractures have required euthanasia. The following are a list of orthopedic injuries that have been documented predominantly in the ring-tailed lemurs and less commonly in the other two species: pelvic fractures (two) and coxofemoral luxations (two), cruciate and other stifle ligament injuries (three), bilateral elbow luxation with olecranon fracture (one), ulnar fractures (two), humeral fractures (three) (one of these involved the growth plate of the proximal humerus), clavicle fracture (one), tibial fracture (one), radial/ulnar fracture (one), femur fractures (two), and a metacarpal fracture (one). A fractured patella occurred in a blue-eyed black lemur and a fractured tuber calcaneus occurred in a black and white ruffed lemur. The majority of these fractures were successfully repaired utilizing a variety orthopedic techniques including using various types of pinning techniques, cerclage and Kirschner wires, bone plating, interlocking nails, and external skeletal fixation. Cage rest was used to treat less severe fractures.

B. External and Internal Parasites

Cuterebra (warble fly) infestation was a common problem in the free-ranging ring-tailed and black and white ruffed lemurs. The species of cuterebra, Cuterebra emasulator fitch, affecting
the lemurs are the same species that infest the native gray squirrel (*Sciurus carolinensis*). Cuterebra infestations are particularly problematic in juveniles and lower ranking troop members and may lead to localized abscessation and generalized debilitation. We have removed as many as 13 cuterebra from an individual lemur. Cuterebra infestations are seasonal, occurring from August to October, with variation in the incidence of cuterebra infestations from year to year. For example in 1999, we removed over 150 cuterebra from ring-tailed lemurs. The next year we decided to set up a controlled study to evaluate potential preventive treatment protocols and no cuterebra were observed, even in the control groups. Over the past several years, we have systematically performed annual examinations in June and July and placed fipronil (Frontline®, Merial Limited, Duluth, Georgia 30096 USA) on a shaved area between the scapulae. In 2003, we were performed annual examinations and applied fipronil in June and July for three troops and no warble flies were noted for the remainder of the season. One troop received their annual examination in mid August and 50% of the lemurs had early stages of warble fly infestation. The adult lemurs receive a cat dose (0.5 ml) of the drug and the juveniles (approximately 4 mo of age) receive 0.1 ml of the drug topically. One dose of fipronil has significantly decreased the incidence of cuterebra infestations.

Low-grade *Strongyloides* sp. infestations are common; however, clinical disease from this parasite is rare. A 3-day course of fenbendazole (Panacur, 100 mg/ml, Hoechst Roussel Vet, Warren, NJ 07059 USA) at 50 mg/kg of body weight effectively treats this organism.

**C. Infectious Diseases**

Previous studies on SCI have isolated a variety of infectious diseases from ticks recovered from various wildlife species. Preliminary serologic studies of lemurs from SCI documented evidence of exposure to *Ehrlichia* spp. and Rocky Mountain spotted-fever (*Rickettsia rickettsii*) in several lemurs. Attempts to isolate *Borrelia burgdorferi* (Lyme disease) from 45 skin biopsies taken from ring-tailed lemurs were unsuccessful. Recently, a study was conducted to evaluate evidence of exposure of lemurs residing on SCI to tick-borne ehrlichiae. Fifty-six lemurs of three species were serologically tested for exposure to *Ehrlichia chaffeensis* and *Anaplasma phagocytophilum*. Additionally, polymerase chain reaction (PCR) assays for *E. chaffeensis*, *A. phagocytophilum*, *Ehrlichia ewingii*, and *Ehrlichia canis* were conducted on blood samples from all lemurs. Twenty (38.5%) and 16 (30.8%) had antibodies reactive for *E. chaffeensis* and *A. phagocytophilum*, respectively. Two ring-tailed lemurs were PCR and culture positive for *E. chaffeensis*. The study showed that these lemurs have been exposed to or infected with tick-borne ehrlichiae, or both, but showed no clinical disease.

*Trypanosome cruzi* is endemic in the raccoon population on SCI and other locations in the southeastern United States. Free-ranging lion tailed macaques and lemurs released on SCI were tested for infection with *T. cruzi* by a previously described blood culture method. Seven of 11 lion-tailed macaques and one of 19 ring-tailed lemurs had positive cultures. The organism is most likely transmitted by the triatomine bug, *Triatoma sanguisuga*.  

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**References**

1. [Insert reference information]

2. [Insert reference information]
Gastrointestinal disease was a relatively common problem in all of the lemur species residing on SCI. Severe acute fibrinonecrotic enterocolitis was observed in four ring-tailed lemurs, two blue-eyed black, and one crowned lemur. The ileum and cecum were most commonly involved, however, all parts of the small and proximal large intestine were affected by this pathology. The onset of clinical signs was acute and included anorexia, lethargy, abdominal pain, and vomiting. Physical examination often revealed a mid-abdominal mass. Severely gas distended bowel loops were the most common radiographic signs. Consistent clinical pathology abnormalities included leukocytosis, monocytosis, elevated packed cell volume, hypoproteinemia, hypoalbuminemia, hyperkalemia, and hyponatremia. The problem required immediate medical intervention, which included crystalline and colloidal fluid therapy, broad-spectrum antibiotics, and analgesics. Exploratory surgery was performed in the four ring-tailed lemurs and revealed severe adhesion formation causing the involved gastrointestinal tract to be tightly adhered to itself (mass evident on palpation), peritonitis, abdominal effusion, and varying degrees of devitalized thickened bowel. There was often a foul odor to the abdomen, and obvious perforation was noted in two cases. Two cases required euthanasia during surgery due to the severity and extent of devitalized bowel. Two out of six cases were successfully managed with resection and anastomosis of the affected bowel. Although the etiology is unknown, enrofloxacin (Baytril®, Bayer Health Care LLC, Shawnee Mission, Kansas 68201 USA) use prior to the onset of clinical signs was noted in three of the six cases. Enrofloxacin had been used 8 mo, 5 mo, and just prior to onset of clinical signs in the three cases. Histopathology documented severe acute ulcerative, necrotizing gastroenteritis, typhlitis, and colitis. Gram-negative rods predominated with occasional Gram positive rods observed. A mixture of gram-negative bacteria was typically cultured. Feces and tissue submitted for Salmonella, Shigella, Campylobacter, and Yersinia culture were negative in all cases. Clostridium perfringens was cultured from affected gastrointestinal tract tissue in one case. Toxin assays for Clostridium difficile and Clostridium perfringens were negative.

In 1997, several ring-tailed lemurs and black and white ruffed lemurs succumbed to gastrointestinal disease and subsequent septicemia. Although, a common organism was not isolated in every case, Salmonella sp. was isolated on two occasions and histopathology substantiated this finding. Subsequently, Salmonella and Campylobacter sp. have occasionally isolated from healthy individuals; however, further mortality has not occurred.

D. Miscellaneous

Miscellaneous medical problems documented in the ring-tailed lemurs include canine tooth fractures with subsequent tooth loss or abscessation, frostbite to tail tips, scent gland abscesses and impactions, suspected snake bite (one), corneal ulcers, medial strabismus, tricuspid insufficiency (endocardiosis) (one), epilepsy (one), intestinal herniation with exposed mucosa and feces coming from hernia site in an infant (surgical repair was successful), femoral vein thrombosis (one), inguinal testicle (one), osteoarthritis (has been an occasional problem in geriatric lemurs, glycosaminoglycans have been administered long term in one animal), fleas
(one), ticks (occasionally observed but usually very low in numbers), eosinophilic dermatitis (one), *Capillaria hepatica* (incidental finding in one animal), cholecystitis (one), bacterial pneumonia (four), pleuritis (two), pulmonary septic thrombosis (one), cardiac septic thrombosis (one), mesothelioma of diaphragm (one), and a subcutaneous lipoma (one).

Causes of morbidity in black and white ruffed lemurs documented in this study were asymptomatic salmonella (one), ovarian/uterine bacterial abscess/infection (resolved with surgery), *Capillaria* (one), heavy tick infestation (one), fractured tuber calcani (one), low-grade strongyloides (common), dystocia (resolved with C-section), bite wounds, and cuterebra infestation. Causes of mortality in this lemur species included failure to nurse (five), congenital heart defect (one), cardiomyopathy (three), pneumonia and septicemia caused by *Klebsiella* (three), bacterial colitis leading to complete obstruction (one), necrotizing gastroenteritis with septicemia (one), renal failure (two), and colonic obstruction with subsequent rupture and peritonitis (one).

Causes of morbidity in blue-eyed black lemurs included abortion/stillbirths (possibly secondary to previous use of depoprovera and MGA implants for birth control), vulvar and scrotal ulcers (herpesvirus serology negative, biopsies reveal a pustular to eosinophilic dermatitis), chronic cholangiohepatitis (diagnosed on liver biopsy, elevated alkaline phosphatase, geriatric lemur), patellar fracture (one), and a rectal stricture requiring resection anastomosis with subsequent rectal/vaginal fistula formation. Causes of mortality in this species included acute focally extensive necrotizing enteritis with secondary septicemia (suspected *Salmonella*) (one), acute focally extensive ulcerative colitis (*Clostridium perfringens* cultured) (one), abortions/stillbirths (suspect secondary to changes induced by birth control), bite wound to abdomen with penetration into the ileum causing an intestinal abscess, adhesions, peritonitis (one), and hypertrophic osteopathy and chronic renal failure (one).

**ACKNOWLEDGMENTS**

We would like to acknowledge the lemur husbandry and medical staff at the Wildlife Survival Center and the technical staff at the South Carolina Veterinary Referral Center for their assistance over the past several years on various lemur medical and surgical cases.

**LITERATURE CITED**


THE RELATIONSHIP OF SERUM IRON ANALYTES TO IRON STATUS IN LEMURS

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Abstract

Iron overload (hemosiderosis) occurs in a number of non-domestic species in captivity including birds, rhinoceroses, and primates. Among primates, lemurs are considered to be particularly susceptible, although the true incidence and severity of iron overload in captive lemurs is not known. The diagnosis of iron overload in lemurs is most often obtained on post-mortem examination. While various iron parameters in blood are useful to screen humans and some domestic animals for iron overload, the reliability of these tests in lemurs has not been established. To assess the reliability of serum iron analytes as a measure of iron status in lemurs, serum iron, total iron binding capacity, ferritin, and transferrin saturation were measured in 33 lemurs of three species (ring-tailed lemurs [Lemur catta, n = 11], black lemurs [Eulemur macaco, n = 11], and red-ruffed lemurs [Varecia rubra, n = 11]), and compared to iron content in liver tissue obtained by biopsy.

Mean values for liver iron content and serum iron analytes varied by species. Liver iron levels correlated significantly ($P < 0.05$) with ferritin in red-ruffed lemurs and with serum iron, ferritin, and transferrin saturation in ring-tailed lemurs, but no correlations were demonstrated for black lemurs. This suggests that the validation of serum parameters as a measure of iron status in lemurs must be done for each species, and extrapolation from different lemur species or other primates is not appropriate.

LITERATURE CITED

PROPOSED TECHNIQUE FOR THE PREVENTION OF URETHRAL PLUG FORMATION AFTER ELECTROEJACULATION IN LEMURS

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Abstract

Substantial coagulum is produced in many primate species following electroejaculation, posing a significant obstacle to semen collection. Prolonged retention of a urethral plug consisting of coagulated vesicular secretions leads to abnormal urinary retention and eventual death. Thus, in species where urethral plugs form, any artificial semen collection can pose a serious health risk. Deposition of a vaginal or copulatory plug has been documented in some species of lemur1,3,4 and may indicate a greater likelihood of urethral plug formation in lemurs following electroejaculation. Urinary retention secondary to urethral plug formation following electroejaculation in lemurs has been reported.2 Therefore, development of a safe method for electroejaculation in lemurs is critical to the establishment of assisted reproductive techniques in these endangered species.

Semen was collected from apparently healthy ring-tailed lemurs (Lemur catta, n = 4) and ruffed lemurs (Varecia sp., n = 2) of breeding age (>4 yr) using electrostimulation following an IACUC approved protocol at the Gladys Porter Zoo. Each animal was collected twice 3 – 4 wk apart. After fasting for 8 – 12 hr, the animals were manually restrained for isoflurane administration via facemask. Once anesthetized, a 2.5 × 15 cm rectal probe was inserted. Following successful electroejaculation and digital rectal prostatic massage of 10 – 20 sec, a 3.5-Fr. urethral catheter was passed and 0.5 ml of 25% ascorbic acid was infused while the catheter was removed. Lactated Ringers solution was administered subcutaneously to each animal following semen collection. Two ring-tailed lemurs were used in a crossover design, in which each animal served as its own control, collected with and without the urethral catheter and ascorbic acid treatment. When not treated with ascorbic acid, the urethra was simply expressed and the animal was allowed to recover from anesthesia. Semen was successfully collected from all males and was very viscous and granular, solidifying within 1 min of exposure to room air. Both animals produced urethral plugs without treatment, but not after urethral infusion of ascorbic acid. All lemurs receiving the urethral infusion post-ejaculation urinated within 2 hr after collection.

In these two species of lemurs, thorough post-collection urethral and prostatic massage combined with the passage of a urethral catheter for administration of ascorbic acid appears to decrease the incidence of urethral plug formation in lemurs after electroejaculation. Further studies are
needed to fully assess the efficacy of this protocol, but urethral catheterization with ascorbic acid administration appears to ameliorate the risk previously associated with electroejaculation in these species.

LITERATURE CITED

CHRONIC LOW-DOSE DOXYCYCLINE AS A TREATMENT FOR PERIODONTAL DISEASE IN PRIMATES

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Abstract

Periodontal disease has been documented in many non-human primate species and is often a progressive condition leading to gingival retraction and tooth loss. Alveolar bone and periodontal tissues are composed of 60 – 90% collagen, and destruction of this collagen causes periodontal ligament and bone loss. Oral bacteria damage the gingival tissues, but it is the host immune response that triggers a cascade of inflammation involving collagenases, inflammatory products and osteoclasts resulting in collagen loss. Dentists use doxycycline at sub-antimicrobial doses in human patients to modify host immune response, resulting in less inflammation and less bone and periodontal ligament destruction.1 This low-dose doxycycline administration has also been used successfully in great apes, old world monkeys, and prosimians to treat periodontal disease. After dental cleaning and systemic antibiotics as indicated, doxycycline 0.3 mg/kg is given orally twice daily in a pulsatile regimen of 3 mo on, 3 mo off medication. Doxycycline suspension (10 mg/ml, various flavors and manufacturers) or capsules can be used. Some primates have stayed on the pulsatile regimen chronically without negative systemic effects. A male orangutan has now been treated for 4 yr in this manner. Periodontal disease in other primates has resolved, allowing for discontinuation of doxycycline. Ideally, low-dose doxycycline should be initiated prior to gingival retraction and root exposure. Sequential pictures of the gingiva and measurements of periodontal pocket depth will aid in monitoring disease progression. In numerous human studies, low-dose doxycycline has not induced bacterial resistance.2

LITERATURE CITED

CATARACT SURGERY AND INTRAOCULAR IMPLANT PLACEMENT WITH SUBSEQUENT RETINAL DETACHMENT AND SURGICAL REPAIR IN A CAPTIVE WESTERN LOWLAND GORILLA (*Gorilla gorilla gorilla*)

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Abstract

A captive-born 34-yr-old multiparous female western lowland gorilla (*Gorilla gorilla gorilla*) was diagnosed with retinal detachment and mature cataract development of the right eye in September 1997, presumably caused by previous trauma and secondary intraocular inflammation. The gorilla had exhibited behaviors indicating impaired vision for several years including holding food items close to her “good” eye for inspection before eating, and bending over to place her face close to the ground to forage for food. The left eye had no visible pathology until September 2003 when a central cataract was noted to be developing, and her vision appeared to be getting worse.

Following a complete physical and ophthalmic exam, surgical intervention to restore vision to her left eye was performed in October 2004. Biometric measurements of the fundus revealed a severely myopic left eye with an axial length measurement of 30 mm. The retina was intact and appeared normal (ultrasound evaluation) and the cataract was not completely mature. The cataract was removed using phacoemulsification and aspiration via a standard approach used in human medicine. A foldable intraocular lens implant (4.0 diopter, MA60MA, AcrySof, Alcon Laboratories, Inc.) was inserted, and the lens capsule and limbal incisions were closed with 9-0 absorbable suture. Post-operative treatment included subconjunctival antibiotics and steroids, as well as prophylactic oral antibiotics and nonsteroidal anti-inflammatory medication. Recovery was uneventful, and marked vision improvement was evident within 24 hr. No postoperative complications were observed, and the gorilla was integrated back into its family group within 10 days, with noticeable improvement in social interactions and foraging behaviors.

Three months after the surgical procedure, keepers noted an abrupt change in the gorilla’s behavior and vision. She moved very slowly and cautiously, feeling around blindly for food items on the ground, not responding to visual training cues, and again, putting her face to the floor to try to see or find food items. A presumptive diagnosis of detached retina was made, and an exam was performed within 3 days. Fundic exam revealed a significantly detached retina of the left eye, involving the macula region, which is important for fine detail vision. No other pathology was evident, and the intraocular lens implant was still in place. Repair of the retinal detachment was performed 4 days later (7 days after the acute blindness) was noted. The
procedure consisted of a vitrectomy, followed by an injection of 8 ml silicone oil into the posterior chamber after repositioning the retina. The retina was then tacked into place using pan retinal spot laser treatments. Postoperative treatment included cage rest for 3 wk, and oral antibiotics and nonsteroidal anti-inflammatory medication. The retina was rechecked under general anesthesia 17 days after the repair procedure was performed, and was found to be intact and healing well. Additional spot laser treatments were done as a precaution at that time. These procedures have successfully restored the vision of this animal, which continues to improve as evidenced by better social interactions and foraging abilities.

Several publications exist on the topic of cataract surgery.\textsuperscript{1-4} Further reading on this topic is encouraged.

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LITERATURE CITED

Implantation of a Cardiac Resynchronization Therapy Device (CRT) in a Western Lowland Gorilla (Gorilla gorilla gorilla) with Cardiac Disease

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Abstract

Cardiovascular disease causes significant morbidity and mortality in captive great apes. Fibrosing cardiomyopathy with left- or right-sided insufficiency is common, and is more prevalent in males over 30 yr old.1 A 24-yr-old, male western lowland gorilla (Gorilla gorilla gorilla) at the Birmingham Zoo was diagnosed with cardiac failure in March 2003. Evaluation of cardiac disease and progression was made using trans-esophageal and trans-thoracic echocardiography and electrocardiography (ECG). At initial diagnosis, the cardiac disease was categorized as a class 3 failure on a scale of 1-4 (4 most severe in humans). Treatment for cardiac disease was attempted with furosemide and enalapril, but the gorilla’s cardiac function worsened over the next 16 mo despite therapy. Repeat cardiac function evaluations performed every 7 mo documented the progression of disease to class 4 end stage cardiac failure. At this time, carvedilol, bumetidine, enalapril, acetylsalicylic acid and metolazone were added to the medication regimen, and the animal was evaluated to determine candidacy for implantation of a biventricular cardiac resynchronization therapy (CRT) device as treatment for this disease. ECG data from this animal was compared with values from multiple normal gorillas in other institutions, as human values appear to be significantly dissimilar.

This gorilla was successfully treated through surgical implantation of a biventricular CRT device. A portable fluoroscopy unit was used intra-operatively to evaluate the motion of the heart, location of the vascular structures, and placement of the pacing leads in the right atrium (RA), right ventricle (RV) and left ventricle (LV) as accessed by the coronary venous vessels. The implantation team consisted of an electrophysiologist, echocardiologist, veterinary cardiologists, a physician to perform anesthesia, and multiple specialty veterinarians. Additionally, team members were needed to implant, program and evaluate the CRT for the
procedure. Placement of the RA, RV and LV leads and device required 5.5 hr, an extended length due to technical difficulties and anatomic differences versus humans.

Electrical timing of the paced cardiac chambers was selected to maximize cardiac output as determined by the ECG. Interrogation and programming of the CRT device requires that it be within 2 inches of the reading/programming wand, which necessitated training of this animal for proper positioning. Training has allowed frequent evaluation of the CRT device, which constantly records the ECG and any abnormal cardiac rhythms for later retrieval. Appetite, cardiopulmonary function, activity level, attitude, and training all improved over a 6-mo period after CRT implantation until the pacing leads were dislodged during an altercation with a companion animal. The leads and device were replaced during a surgery identical to the initial procedure, with minor equipment modifications to accommodate the mechanical difficulties encountered in gorillas. This accidental loss of the CRT device confirmed its clinical value, as the animal’s health and cardiac function decreased significantly after loss then improved again after re-implantation, allowing for the release of this gorilla onto exhibit only 10 days later.

Although requiring special equipment and surgical skill, CRT implantation appears to be a viable option for treatment of non-ischemic dilated cardiomyopathy and hypokinetic cardiac disease in gorillas. Differences in human and gorilla anatomy and activity must be considered and managed during surgery and postoperative care. Although equipment designed for humans was utilized successfully in this animal, improvements could be made which might significantly decrease surgical time and decrease the risk of postoperative device complications in gorillas. In the future, special technical and surgical equipment designed specifically for gorillas with cardiac disease could streamline CRT implantation, allowing for an increased quality and length of line in these endangered apes.

ACKNOWLEDGMENTS

Thanks to the primate and maintenance staff at the Birmingham Zoo for their time and care of this animal. Also, thanks to Linda Garmon with Guidant Corporation for her continued time and devotion to training for CRT interrogation, and to the Wildlife Conservation Society and Zoo New England for providing comparative cardiac data from normal gorillas.

LITERATURE CITED


PRELIMINARY RESULTS OF THE NATIONAL GORILLA (Gorilla gorilla gorilla) CARDIAC DATABASE

Hayley Murphy, DVM\textsuperscript{1}* and Ilana Kutinsky, DO\textsuperscript{2}

\textsuperscript{1}Zoo New England, 1 Franklin Park Rd, Boston, MA 02121 USA; \textsuperscript{2}Michigan Heart Group, 4600 Investment Drive, Ste 200 Troy, MI 48098 USA

Abstract

Cardiovascular disease is the leading cause of morbidity and mortality in captive western lowland gorillas (Gorilla gorilla gorilla), accounting for 41\% of all deaths in adult gorillas.\textsuperscript{1,2} Since many of these deaths are from potentially treatable causes, the Gorilla Species Survival Plan (SSP) recommends that all captive adult gorillas undergo regular cardiovascular exams. Although many zoos currently perform cardiovascular examinations, the data remains scattered throughout the country stored in institutional archives, inaccessible to the animal care community as a whole. At this time, no normal ranges are readily available for gorilla cardiac parameters to help determine which animals have subclinical disease. The National Gorilla Cardiac Database is an on-going effort to gather and evaluate cardiac values for clinically healthy gorillas of different ages and sexes in order to create species-specific reference ranges. The database will serve as a reference tool for zoos when evaluating cardiac parameters in gorillas.

Echocardiograms from 33 gorillas submitted by ten zoos were analyzed by Dr. Ilana Kutinsky. Animals were excluded from the database due to findings consistent with severe cardiac disease (n = 3) or due to unspecified age and/or sex (n = 2). The remaining 28 echocardiograms were included in the database (see Tables 1-3). All echocardiograms were obtained from anesthetized gorillas. Anesthesia was usually induced using tiletamine hydrochloride and zolazepam hydrochloride (Fort Dodge Animal Health, Fort Dodge, Iowa 50501, USA) and/or ketamine hydrochloride (Fort Dodge Animal Health, Fort Dodge, Iowa 50501, USA) and maintained via isoflurane (Halocarbon Laboratories, P.O. Box 661, River Edge, NJ 07661, USA) or sevoflurane (Abbott Laboratories, Abbott Park, Illinois, USA).

Since many zoo veterinarians consult with medical cardiologists on gorilla cardiac evaluations, generalizations regarding gorilla cardiac health are often made using human reference ranges for echocardiographic parameters. Data collected in gorillas to date indicate that resting heart rates and blood pressure measurements are on average faster and higher than humans. Gorilla heart walls appear thicker and more dynamic than humans, supporting the contention that gorillas may have a higher resting sympathetic tone. Further investigation is needed to determine whether these increased parameters are a normal physiologic variation specific to gorillas, or represent a response to physiologic stressors possibly induced by captive husbandry conditions.
Using this project as a foundation, further investigations should identify the predisposing risk factors for cardiovascular disease in gorillas, identify gorillas most at risk, implement and assess possible preventive measures, and develop recommended treatment guidelines for affected animals. The objective is to decrease the high prevalence of cardiovascular morbidity and mortality in captive gorillas, thereby improving the quality of life in individual animals and increasing the reproductive viability and genetic contribution of individuals to the collective gene pool of this endangered species.

ACKNOWLEDGMENTS

The authors thank the following zoos for their participation in this project: Audubon Zoo, Cheyenne Mountain Zoo, Denver Zoological Gardens, Detroit Zoological Park, Gladys Porter Zoo, Knoxville Zoological Gardens, Little Rock Zoo, Milwaukee County Zoo Gardens, Omaha’s Henry Doorly Zoo, Smithsonian National Zoological Park, The Toledo Zoo, Zoo New England.

The authors urge additional zoos to submit data. To contribute to the gorilla cardiac database, please contact Dr. Hayley Murphy, Director of Veterinary Medicine, Zoo New England. 1 Franklin Park Road, Boston, Massachusetts, 02121 USA. Telephone: 617-989-2050, Fax 617-989-2080, email: hmurphy@zoonewengland.com.

LITERATURE CITED

### Table 1. Physiologic parameters in western lowland gorillas (*Gorilla gorilla gorilla*) by age and sex.

<table>
<thead>
<tr>
<th>Age Range (yr)</th>
<th>Sex</th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Blood pressure (mm Hg)</th>
<th>Heart rate (bpm)</th>
<th>Respiratory rate (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean (n)</td>
<td>Range Min. - Max.</td>
<td>Mean (n)</td>
<td>Range Min. - Max.</td>
<td>Mean (n)</td>
</tr>
<tr>
<td>0-10</td>
<td>F</td>
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<td>45.5 (3)</td>
<td>1.7-70</td>
<td>124/78 (2)</td>
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<tr>
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<td>M</td>
<td>4 (1)</td>
<td>NA</td>
<td>54 (1)</td>
<td>NA</td>
<td>120/80 (1)</td>
</tr>
<tr>
<td>11-20</td>
<td>M</td>
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<td>11-17</td>
<td>171.5 (4)</td>
<td>157-266.4</td>
<td>NA</td>
</tr>
<tr>
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<td>M</td>
<td>27.4 (9)</td>
<td>23-30</td>
<td>191.4 (7)</td>
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<td>175/102 (3)</td>
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<tr>
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<td>F</td>
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<td>86-146</td>
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<tr>
<td>31-40</td>
<td>F</td>
<td>35.3 (6)</td>
<td>31-38</td>
<td>98 (6)</td>
<td>71.4-113.6</td>
<td>119/61 (2)</td>
</tr>
</tbody>
</table>

*Female.*

*Male.*

*Number of animals.*

*Not applicable.*

### Table 2. Cardiac measurements in western lowland gorillas (*Gorilla gorilla gorilla*) by age and sex.

<table>
<thead>
<tr>
<th>Age Range (yr)</th>
<th>Sex</th>
<th>Age (yr)</th>
<th>Aortic root diameter (cm)</th>
<th>Left atrium (cm)</th>
<th>Right atrium (cm)</th>
<th>Right ventricle (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>Range Min. - Max.</td>
<td>Mean (n)</td>
<td>Range Min. - Max.</td>
<td>Mean (n)</td>
</tr>
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<td>NA</td>
<td>No data</td>
</tr>
<tr>
<td>11-20</td>
<td>M</td>
<td>14.2 (4)</td>
<td>11-17</td>
<td>2.9 (4)</td>
<td>1.9-3.4</td>
<td>4.1 (4)</td>
</tr>
<tr>
<td>21-30</td>
<td>M</td>
<td>27.4 (9)</td>
<td>23-30</td>
<td>4 (8)</td>
<td>1.8-5.6</td>
<td>3.9 (9)</td>
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<tr>
<td>21-30</td>
<td>F</td>
<td>24.8 (5)</td>
<td>23-26</td>
<td>2.9 (3)</td>
<td>2.6-3.4</td>
<td>3.6 (3)</td>
</tr>
<tr>
<td>31-40</td>
<td>F</td>
<td>35.3 (6)</td>
<td>31-38</td>
<td>3.1 (6)</td>
<td>2.6-3.7</td>
<td>3.8 (6)</td>
</tr>
</tbody>
</table>

*Female.*

*Male.*

*Number of animals.*

*Not applicable.*
### Table 3a. Dynamic cardiac measurements in western lowland gorilla (*Gorilla gorilla gorilla*) by age and sex.

<table>
<thead>
<tr>
<th>Age Range (yr)</th>
<th>Sex</th>
<th>Age (yr)</th>
<th>Mean (n)</th>
<th>Range Min./Max.</th>
<th>Mean (n)</th>
<th>Range Min./Max.</th>
<th>Mean (n)</th>
<th>Range Min./Max.</th>
<th>Mean (n)</th>
<th>Range Min./Max.</th>
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<td>2.4-2.9</td>
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<td>0.4-1.7</td>
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</tr>
<tr>
<td>0-10</td>
<td>M&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.2 (4)</td>
<td>11-17</td>
<td>4.9 (4)</td>
<td>4.0-6.3</td>
<td>2.7 (4)</td>
<td>1.4 (4)</td>
<td>0.9 (4)</td>
<td>0.9-1.3</td>
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</tr>
<tr>
<td>11-20</td>
<td>M&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.4 (9)</td>
<td>23-30</td>
<td>4.3 (3)</td>
<td>3.2-6.4</td>
<td>1.8 (3)</td>
<td>0.9-2.8</td>
<td>0.4 (4)</td>
<td>0.9-1.3</td>
<td></td>
</tr>
<tr>
<td>21-30</td>
<td>F&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24.8 (5)</td>
<td>23-26</td>
<td>4.0 (4)</td>
<td>3.5-4.4</td>
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<td>1.1 (4)</td>
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<td>31-40</td>
<td>F&lt;sup&gt;b&lt;/sup&gt;</td>
<td>35.3 (6)</td>
<td>31-38</td>
<td>4.5 (6)</td>
<td>4.2-5</td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Female.  
<sup>b</sup>Male.  
<sup>c</sup>Number of animals.  
<sup>d</sup>Not applicable.

### Table 3b. Dynamic cardiac measurements in western lowland gorilla (*Gorilla gorilla gorilla*) by age and sex (continued).

<table>
<thead>
<tr>
<th>Age Range (yr)</th>
<th>Sex</th>
<th>Age (yr)</th>
<th>Mean (n)</th>
<th>Range Min.-Max.</th>
<th>Mean (n)</th>
<th>Range Min.-Max.</th>
<th>Fractional shortening (%)</th>
<th>Ejection fraction (%)</th>
</tr>
</thead>
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<tr>
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<td>4.4 (3)</td>
<td>0.1-10</td>
<td>0.9 (3)</td>
<td>0.5-1.6</td>
<td>36.5 (2)</td>
<td>33-40</td>
<td>69 (3)</td>
</tr>
<tr>
<td>0-10</td>
<td>M&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.2 (4)</td>
<td>11-17</td>
<td>1.5 (4)</td>
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<td>62.3 (4)</td>
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<td>23-30</td>
<td>1.9 (7)</td>
<td>1.1-3.5</td>
<td>31.5 (2)</td>
<td>22-41</td>
<td>62.3 (4)</td>
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<tr>
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<td>24.8 (5)</td>
<td>23-26</td>
<td>1.2 (4)</td>
<td>1.1-1.4</td>
<td>33.8 (2)</td>
<td>32.5-35</td>
<td>69.8 (5)</td>
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<tr>
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<td>F&lt;sup&gt;b&lt;/sup&gt;</td>
<td>35.3 (6)</td>
<td>31-38</td>
<td>1.5 (6)</td>
<td>1-1.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Female.  
<sup>b</sup>Male.  
<sup>c</sup>Number of animals.  
<sup>d</sup>Not applicable.
USE OF BUSPIRONE TO MANAGE UNDESIRABLE BEHAVIOR IN THREE SPECIES OF CARNIVORES

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¹USDA APHIS Animal Care, 1131 Second Avenue, Napa, CA 94558 USA; ²Los Angeles Zoo, Health Center, 5333 Zoo Dr., Los Angeles, CA 90027 USA

Abstract

Occasionally captive nondomestic carnivores exhibit undesirable behaviors that may range from aggression to self-mutilation. These behaviors have been mitigated by a variety of methods including the addition of new enrichment items to their environment, or the use of anxiolytic agents.¹²³ The use of buspirone in three species of carnivores; a raccoon (Procyon lotor), a badger (Taxidea taxus), and an African lion (Panthera leo), lessened or solved the behavioral problems exhibited by these animals without noticeable side effects.

Case 1

A neutered 5-yr-old male raccoon weighing approximately 9.5 kg developed a habit of barbering the fur of the rear third of its body, its tail, as well as barbering the hair of its brother’s coat. While this behavior did not pose any health problems, it did result in an abnormal appearance to these exhibit animals. Initially the raccoon was given additional enrichment items with treats routinely hidden within the exhibit in an effort to break their barbering habit. Bitter apple chew deterrent was placed on the fur of both animals and had no effect on the barbering. When these methods proved unsuccessful the raccoon was treated with buspirone (Buspirone hydrochloride, Par Pharmaceutical Inc., Spring Valley, NY USA) 0.26 mg/kg p.o. b.i.d. to manage the behavior. During the first mo of treatment, the animal stopped barbering its sibling, however it continued to barber the lower third of his body and tail, but at a reduced amount. After 1 mo of treatment, the buspirone dose was increased to 0.53 mg/kg p.o. b.i.d. It stopped barbering its body while on the higher dose, but continued to barber the tail, never allowing the hair to grow back. In an attempt to stop the tail barbering, the buspirone was discontinued and amitriptyline (AstraZeneca Pharmaceuticals, Wilmington, DE USA) 10 mg p.o. s.i.d. was given for 23 days which appeared to cause the barbering of the tail to worsen with excoriations evident for the first time. The amitriptyline was discontinued, and no other drug regimens were started. The excoriations on the tail healed but the animal continues to barber the hair on its tail. The buspirone appeared to help to extinguish the barbering of the body hair and the hair of the other raccoon, however it did not completely extinguish the behavior of tail barbering in this animal.
Case 2

A spayed female badger weighing approximately 11 kg, had a lifelong history of apparent anxiety attacks which generally were manifested by loud screaming and obvious agitation. Over the years the worst episodes of this behavior resulted in the animal biting at sides of its body causing excoriations to the skin. Diazepam (Valium, Roche Pharmaceuticals, Nutley, NJ USA; 0.7 mg/kg p.o. s.i.d.) was given to manage the more severe episodes. The lesser episodes had been controlled fairly well with the addition of enrichment to the animal’s exhibit. Over a 10-yr period, the episodes grew worse in both intensity and duration. The typical side effects of the valium, inactivity and a tendency to sleep most of the day, were sub-optimal for this exhibit animal. After a particularly severe set of episodes the diazepam appeared to have little effect and was discontinued in favor of a new anxiolytic drug, buspirone, which was given at a dose of 0.45 mg/kg p.o. b.i.d. After 3 wk of treatment the episodes of self-mutilation ceased, and the animal appeared content and playful most of the day. The buspirone appeared to effectively control the aberrant behavior in the badger and the animal was maintained on the drug twice daily for over 18 mo with no obvious side effects.

Case 3

A 17-yr-old intact male lion weighing 183 kg housed with a female lion periodically exhibited very aggressive and possessive behavior towards its mate and its surroundings. This behavior occurred 2-3 times each year, with each episode lasting from 2 to 14 days. These events appeared to occur sporadically but were occasionally precipitated by large noisy crowds of people. The male often refused to eat or drink, and if on exhibit, would not allow his mate to eat, drink or leave the exhibit area. The male was treated with 0.11 – 0.33 mg/kg diazepam p.o. b.i.d. whenever these aggressive episodes occurred. The diazepam did not provide a reliable steady behavioral state and the lion would either appear too aggressive or too groggy. The episodes could be controlled with just a few days of diazepam treatment if the problem was recognized in the morning and the lion was kept in the night quarters for treatment. However if the lion was allowed into the exhibit during the time when one of the aggressive episodes occurred, it frequently refused to come in to the holding area, refused to allow the female in, and sometimes could not be administered medication for many days. These periods could last for up to 2 wk. The animal would be maintained on 0.11 – 0.33 mg/kg diazepam p.o. b.i.d. until it was no longer displaying possessive behavior as determined by the keepers when they arrived in the morning. Based on the animal’s behavior, the diazepam dose could be lessened or it could be discontinued. Because of the inconsistencies produced by the diazepam treatment, the treatment plan was changed to buspirone. The optimal dose of buspirone for this animal appears to be 0.16 mg/kg p.o. in the morning and 0.11 mg/kg p.o. in the evening. The lion has been maintained on this dose since May 2004. The lion exhibits all of its normal behaviors with no aggressive or possessive behavior seen. Because there have been no noticeable side effects to the buspirone there is no plan to discontinue the drug at this time. Treatment of the male with buspirone has improved the quality of life for both the male and the female lion.
LITERATURE CITED

MANAGEMENT OF SEVERE DENTAL DISEASE IN AN INDOCHINESE TIGER (Panthera tigris corbetti)

Nancy C. Boedeker, DVM,1* David A. Fagan, DDS,2 David Hager, DVM, MD, Dipl ACVR,3 Allan P. Pessier, DVM, Dipl ACVP,1 and Patrick J. Morris, DVM, Dipl ACZM1

1Zoological Society of San Diego, San Diego, CA 92112 USA; 2The Colyer Institute, San Diego, CA 92196 USA; 3Animal Imaging Center and Treatment Center, Cardiff 92007 CA USA

Abstract

A 3-yr-old wild-caught Indochinese tiger (Panthera tigris corbetti) was diagnosed with suspected fractures of all four canines and several molars when examined during crating for transport to the United States from Malaysia. This animal was imported to increase the genetic variability of this critically endangered, small population managed species in captivity. On examination during quarantine at the San Diego Zoo, the dental abnormalities were more extensive than expected and involved almost all teeth in all quadrants. Supernumerary, malpositioned, malformed, abscessed, and fractured teeth, retained and deformed tooth buds, retained and impacted primary and deciduous canines, and chronic mandibular and maxillary osteomyelitis were identified on spiral computed tomography (CT) images of the head. The goal of treatment was to resolve chronic localized dental infection and the risk of bacteremia. Four staged surgeries were successfully performed over a period of 2 mo, one quadrant at a time, to extract all teeth other than the incisors and three molars which were not associated with areas of suspected osteomyelitis. Risks associated with these procedures included the development of pathologic fractures of the mandibles or maxillae during the operative or postoperative period. The CT images were consulted preoperatively and intraoperatively to guide the surgical extractions.2 The extensive extraction sites were sutured closed after filling with absorbable gelatin sponges (Gelfoam, Pharmacia & Upjohn Co., Kalamazoo, MI USA) and a synthetic bone graft particulate (Consil Orthopedic Bioglass, Nutramax Laboratories, Inc., Edgewood, MD USA) designed to improve the rate of osseous growth while being resorbed and replaced with bone during the healing process.4 The animal was also placed on treatment with clindamycin at 12 mg/kg p.o. s.i.d. (Clindamycin hydrochloride capsules, Ohm Laboratories, Inc., North Brunswick, NJ USA) for a total of 7 mo. Meloxicam (0.09 mg/kg p.o. s.i.d.; Metacam, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO USA) was administered for clinically effective postoperative analgesia. Although two suture abscesses requiring minor debridement and resuturing were identified on recheck examination, no significant anesthetic, operative, or postoperative complications occurred and the animal tolerated the procedures well.

A recheck spiral CT scan of the head performed 4 wk after the final surgery revealed no evidence of fractures or active infection. Husbandry modifications, including the exclusion of
bone from the diet and the exclusion of chewable enrichment items (fire hose, tire), were made during the course of treatment. The majority of these items were reintroduced to the animal without complication beginning 4.5 mo postoperatively. The paucity of remaining teeth is not expected to be problematic for this captive animal and the long term prognosis for this individual is excellent. A follow up CT scan is scheduled for November 2005, 1 yr after the final surgery. This case highlights the value of both advanced diagnostics and collaboration with outside specialists in diagnosing and successfully managing certain complex cases.

Dental disease, often secondary to cage biting or other trauma, is common in captive carnivores. Each of the individual dental abnormalities diagnosed in this animal has been described in humans as well as domestic and exotic animals. However, it is unusual to find such a multitude of severe dental problems in one individual. Details on this animal’s early medical history are sparse and the etiology in this case remains uncertain. However, it is plausible that genetic, developmental, nutritional, and/or environmental factors may have contributed to the severity and extent of this animal’s dental disease. The gross abnormalities of the canine teeth resemble those described in three other large exotic cats which were attributed to trauma. Multiple dental abnormalities attributed to canine distemper infection have been described in a dog, but this is not well documented. In the case of this tiger, selected extracted teeth were examined histologically. Pulp necrosis and suppurative pulpitis were confirmed in a molar that had evidence of pulp gas on CT scan. Osteomyelitis could not be confirmed histologically, however, only small amounts of bone were available for examination. A fracture with repair by bone and cementum was identified in a canine tooth. Multiple teeth showed evidence of hypercementosis and multifocal ectopic aggregates of dentin, suggestive of cemento-osseous dysplasia as described in humans. Because this tiger is intended for breeding, the dental development of any offspring will need to be carefully monitored to determine if any of these dental abnormalities are heritable. With early diagnosis and intervention, impacted teeth can often be successfully managed with surgery to allow for full eruption and normal occlusion.5,6

LITERATURE CITED

Abstract

Tuberculosis, particularly *Mycobacterium bovis* and *M. tuberculosis*, is an important health issue in zoological collections. Zoos are a particular public health concern because of the close contact between tuberculosis-susceptible animals and humans, specifically animal handlers and visitors. Evidence of *M. tuberculosis* transmission between humans and elephants, confirmed by DNA fingerprinting, has been reported. Between 1994 and 2001, *M. tuberculosis* was isolated from trunk washes of captive elephants from 11 herds in the United States. To date, most reported cases of tuberculosis have occurred in captive Asian elephants (*Elephas maximus*). In 1997, the National Tuberculosis Working Group for Zoo and Wildlife Species partnered with the USDA to formulate the “Guidelines for the Control of Tuberculosis in Elephants.” This document outlines criteria for the testing, surveillance, and treatment of tuberculosis in elephants. The guidelines recommend annual monitoring of elephants by mycobacterial culture of three direct trunk washes collected over 1 wk. Isolation of *Mycobacterium avium* and non-tuberculous mycobacteria from elephant trunk wash samples is common, but these organisms have not been associated with clinical disease. This case report details clinical disease with fatal complications of an atypical mycobacterial infection in an African elephant (*Loxodonta africana*).

In September 2003, an African elephant presented with acute, severe lameness of the left rear limb with subsequent swelling of the stifle. Diagnostic procedures included aspiration cytology of the swelling, radiographs, and thermographic imaging. The exact location of the injury could not be detected, but a lesion to the stifle or coxofemoral articulation was suspected. After 13 mo of treatment, including pulse therapy with a variety of nonsteroidal anti-inflammatory drugs (NSAIDs), weekly to biweekly injections of polysulfated glycosaminoglycan, and intensive foot care efforts to treat secondary pedal lesions of both rearlimbs, the animal died acutely. Gross necropsy revealed granulomatous osteomyelitis with necrosis/loss of the femoral head and acetabulum and pulmonary granulomas. Both of these lesions contained acid-fast bacteria on cytology. While awaiting confirmatory culture results, quarantine procedures were established for the elephant facility and a program was established to screen all zoo personnel in close proximity of the elephant.
contact with the elephant or who participated in the necropsy. All personnel were tested by the Chicago Department of Public Health without documented conversion.

*Mycobacterium szulgai* was ultimately cultured from both coxofemoral and pulmonary lesions. *Mycobacterium szulgai* is an uncommon nontuberculous mycobacterium that is usually isolated from pathologic lesions in humans.\(^{21}\) This bacterial species was first identified in 1972.\(^{11}\) The lungs are the main locality for pathologic manifestation in humans and several cases have been in patients with acquired immunodeficiency syndrome.\(^{9,20,21}\) Infection due to *M. szulgai* most frequently produces thin-walled cavities in lungs resembling tuberculosis.\(^{4}\) Other documented sites of infection include the skin, bone, and tendon sheath (causing a carpal tunnel syndrome).\(^{2,9,10,12,19,20}\) Intra-operative contamination from ice water has led to *M. szulgai* keratitis after laser-assisted ophthalmic surgeries.\(^{6}\) A case of disseminated disease in a previously healthy young human has been reported.\(^{5}\) No evidence of human-to-human transmission of this organism has been documented and human cases are believed to originate from environmental sources.\(^{21}\) The natural habitat of the organism is unknown, but previous reports suggest an association of the bacteria with water of swimming pools and fish tanks.\(^{1,21}\) The organism has been cultured from a snail and tropical fish.\(^{1,3}\) No standard recommendation for the treatment of *M. szulgai* infection currently exists. In general, triple antibiotic therapies used in standard mycobacterial treatments are reported with a low rate of relapses and sterilization of sputum cultures within a mean of 3 mo.\(^{3}\)

Pulmonary lesions in this elephant were chronic; it was not possible to determine when initial infection occurred. Infection could have occurred in captivity or in the wild prior to captivity. Three trunk washes over the past year had been negative for mycobacterial culture. Osteomyelitis in the hip may have developed secondary to hematogenous spread from the lungs with the acute lameness resulting from a pathologic fracture associated with this infection. Alternatively, though considered less likely, a traumatic fracture of the hip could have occurred, with bacterial inoculation and secondary osteomyelitis as a result of increased blood flow to the site. The source of infection for this elephant remains unknown. Prevalence of this organism in the natural habitat or captive environment of the elephants has not been previously documented.

**LITERATURE CITED**


Coxiella burnetii INFECTION IN SOUTH AMERICAN FUR SEALS (Arctocephalus australis) AND SOUTH AMERICAN SEA LIONS (Otaria byronia)

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Abstract

Q fever is a zoonosis caused by the obligate intracellular bacterium Coxiella burnetii, classified in the Coxiellaceae family in the order Legionellales of the gamma subdivision of Proteobacteria. Unlike the family Rickettsiaceae, C. burnetii is highly resistant to physical and chemical agents and that leads to the suggestion that its developmental cycle consists of vegetative and spore-like forms. In animals the main clinical manifestation is abortion in domestic ruminants and other animals. A wide range of hosts can be infected without showing any clinical signs and, therefore, cats, dogs, rabbits, birds, etc., can also serve as a reservoir. Coxiella burnetii is excreted in milk, feces, urine, and in very high numbers in the amniotic fluid, placenta, and fetal membranes of parturient animals. Animals may shed infectious material long after abortion.

Acute Q fever in marine mammals has not been reported in the literature, but a pathologic examination of a Pacific harbor seal (Phoca vitulina richardsi) revealed a placentitis due to an infection with C. burnetii. In early 2004, Tierpark Hagenbeck maintained 1.2 South American sea lions (Otaria byronia) and 3.7 South American fur seals (Arctocephalus australis). In March, a female fur seal was killed when the breeding male tried to mate her. Postmortem examination revealed the presence of a fetus, foci of necrotizing placentitis, and congestion of multiple organs. Because there had been some stillbirths at our park previously, tissue samples were submitted to determine the possible presence of C. burnetii, and Coxiella-specific deoxyribonucleic acid (DNA) sequences using polymerase chain reaction (PCR) was confirmed.

In May, a second female fur seal was drowned by the male. This female had a fetus in her uterus, congestion of multiple organs, and a hemorrhagic, necrotic placenta. PCR evaluation also recovered Coxiella-DNA. Two weeks later, an abortion occurred in one of the sea lion pups. This pup had congestion in various organs as well as signs of hemorrhage and necrosis in the placenta. This animal was also confirmed to be Coxiella-positive by PCR. In early July, another fur seal was born dead. Apart from congestion in different organs, no pathologic lesions were found and no Coxiella-DNA was detected. A week later another sea lion had a stillbirth. The placenta in this animal showed signs of a placentitis with no pathologic lesions in the baby and no Coxiella-evidence. Unfortunately, the placenta was not examined for Coxiella.
LITERATURE CITED

SALMON POISONING DISEASE IN TWO MALAYAN SUN BEARS (*Helarctos malayanus*)

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Abstract

Approximately 1 wk after eating live trout from a northern California hatchery, two sun bears (*Helarctos malayanus*) at The Oakland Zoo developed vomiting, anorexia, diarrhea, and lethargy. A 25-yr-old, 83-kg, male sun bear exhibited a sudden onset of clinical signs, and a 20-yr-old, 47-kg, female bear that shared his enclosure was consistently 24 – 48 hr behind him in exhibiting clinical signs. A fecal flotation performed on loose stool from the male bear on the first day abnormal clinical signs were observed was negative for ova and parasites. Abdominal ultrasound of the male bear revealed mild ascites, mesenteric lymphadenopathy, and gastric dilation. Cytology of an aspirate of the abdominal fluid revealed a modified transudate with an increased number of eosinophils. Gastroduodenoscopy of the male bear revealed patchy erythema of the gastric mucosa and a large volume of green fluid in the stomach. The duodenum appeared thickened and pale. Gastrointestinal biopsies revealed severe lymphoplasmacytic and eosinophilic gastritis and enterocolitis, and erosive enteritis of the duodenal mucosa.

Subsequent flotation performed on a fecal specimen from the female on day 4 revealed multiple large, gold-colored, operculated trematode ova. The diagnosis of salmon poisoning was made after a U.C. Davis parasitologist identified the ova as those of *Nanophyetus salmincola*. Both bears were treated with oxytetracycline (Oxybiotic 200, The Butler Company, Columbus, OH 43228 USA) at 10 mg/kg i.m. s.i.d. for 12 days, followed by doxycycline (IVAX Pharmaceuticals, Miami, FL 33137 USA) at 10 mg/kg p.o. b.i.d. for 21 days. They also received praziquantel (Droncit, Bayer, Shawnee Mission, KS 66201 USA) at 4 mg/kg i.m. s.i.d. for 3 days, followed by praziquantel at 12 mg/kg p.o. once, 5 days later. Both bears also received famotidine (Pepcid, Merck, Fort Washington, PA 19034 USA) at 0.5 mg/kg p.o. b.i.d. for 7 days. Appetite began to gradually return within 2 days of the initiation of treatment, and stools slowly returned to normal consistency within 7 days. Fecal ova shedding began on day 4 after onset of clinical signs, and ceased approximately 9 days later.

Salmon poisoning disease is caused by a rickettsial organism (*Neorickettsia helminthoeca*) which infects a trematode, *N. salmincola*. This fluke requires two intermediate hosts: a snail (*Juga silicula*) and a fish (usually a salmonid). The definitive host, a fish-eating mammal or bird, becomes infected when it consumes trematode-infected fish. Wild black bears native to the endemic region of this parasite have been found to be infected with the fluke, but appear to be
resistant to development of clinical disease. Zoo bears fed raw or improperly frozen fish have contracted the disease, but the species most affected have been bears not native to the Northwest coastal areas (polar, sloth, Himalayan, and European brown). Fish hatcheries are providing potentially infected fish for sport fishing to a geographic range far wider than the parasite’s known range, which is defined by the habitat of the intermediate host snail. With ever-increasing emphasis being placed on environmental and behavioral enrichment for captive wildlife, many zoos have adopted the practice of feeding live prey. The potential for this disease should be considered whenever fish are fed to bears. This is the first published report of salmon poisoning disease in captive sun bears.
COMPLICATIONS ARISING FROM TETANUS IN A MANED WOLF (*Chrysocyon brachyuris*)

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Abstract

Tetanus is considered an uncommon disease in dogs.4 Following localization of *Clostridium tetani* in an anaerobic environment, the spores vegetate and produce a toxin (tetanospasmin) that is released into tissues and absorbed at the peripheral neuromuscular junction.1 Tetanospasmin inhibits neurotransmitter release centrally from CNS inhibitory interneurons, and release of extensor muscles from inhibition results in increased involuntary activity ranging from tremors to opisthotonos. In domestic dogs, tetanus can occur following surgery, deep or neglected wounds, replacement of deciduous teeth in puppies, dental disease, and complications from parturition.4 Diagnosis is based on the patient’s history and clinical signs. Clinical features of disease include increased muscle tone, cranial nerve signs, tonic spasms, and autonomic signs. Classic presentation is that of gait stiffness, a “sawhorse stance,” an elevated tail and excessive contraction of facial muscles. Facial changes include the characteristic sneering appearance (“risus sardonicus”), erect ears, wrinkled forehead, protrusion of the membrana nictitans, and contraction of masticatory muscles (trismus).1 Treatment of tetanus is via a combination of immunotherapy, antimicrobial therapy, sedatives, muscle relaxants, and nursing care.1,4

Hiatal hernia has been reported as a complication of tetanus in domestic dogs.2,5 Sliding hiatal hernia is the most commonly reported type of hiatal hernia reported in domestic pets, and is characterized by cranial displacement of the abdominal esophagus, esophagogastric junction and, often, a portion of the stomach through the esophageal hiatus.3 In domestic dogs, sliding hiatal hernia may be asymptomatic, or may result in signs of gastro-esophageal reflux and esophagitis. Reflux esophagitis is a disorder in which esophageal inflammation occurs as a result of mucosal contact with gastric or duodenal fluid or ingesta. Most hiatal hernia patients have some degree of reflux esophagitis, resulting from decreased lower esophageal sphincter pressure,3 however clinical signs may be subtle or inapparent. Clinical signs of esophagitis may include hypersalivation, frequent attempts to swallow, regurgitation, and behaviors that suggest esophageal pain. Medical management is directed towards increasing the tone of the lower esophageal sphincter, decreasing gastric secretions, and increasing the rate of gastric emptying.6 Complications of severe or persistent esophagitis include esophageal stricture and aspiration pneumonia.
An 18-wk-old, 11.3-kg, male maned wolf (*Chrysocyon brachyurus*) presented with mild coughing and hypersalivation. Signs of facial muscle contracture became evident 24 hr later. No wounds were detected during examination under anesthesia; however there were several sites where deciduous teeth had been recently shed. Treatment for suspected tetanus was initiated at this time, including administration of 16,000 IU i.v. of equine-derived tetanus antitoxin (Equivac TAT CSL Limited, Parkville, Victoria, Australia), 40,000 U/kg penicillin G i.v., and 15 mg/kg i.m. amoxicillin-clavulanate (Clavulox injection, Pfizer Animal Health, West Ryde, NSW, Australia). Forty-eight hours after initial presentation, the patient developed gait stiffness, and auditory and tactile stimulation resulted in periods of extensor muscle spasm in hindlimbs, progressing to opisthotonos. Severe muscle spasms were controlled using i.v. diazepam 0.25-0.5 mg/kg i.v. (Pamlin injection, Parnell Laboratories Pty Ltd, Alexandria, NSW, Australia) and 0.1-0.2 mg/kg i.m. acepromazine (A.C.P. 10, Delvet Pty Ltd, Seven Hills, NSW, Australia). The animal was housed in a dark, quiet cage and maintained on intravenous fluids. Metronidazole (10-15 mg/kg slow i.v. b.i.d.) (Metrin solution, Parnell Laboratories) was used as the primary antimicrobial therapy thereafter.

The maned wolf had improved after 4 days of therapy, and was resting quietly without the need for administration of tranquilizers or sedatives. Marked hypersalivation remained a prominent clinical sign. At that time, pharyngeal dysphagia was the presumed cause of hypersalivation; however the animal began to regurgitate, and endoscopic examination of the esophagus confirmed the presence of esophageal mucosal inflammation and ulceration. Thoracic radiographs revealed a hiatal hernia. Because the animal was unable to prehend solid foods (the result of trismus) and was losing body condition, a gastrostomy tube was placed to allow feeding. Medical therapies for esophagitis were initiated at this time, including the promotility agent, cisapride (0.5 mg/kg via gastrostomy tube t.i.d.; Prepulsid, Janssen-Cilag Pty Ltd, North Ryde, NSW, Australia), to increase lower esophageal sphincter pressure and stimulate more rapid gastric emptying, and the H2-receptor antagonist, ranitidine (0.5 mg/kg slow i.v. b.i.d.; Zantac injection, GlaxoSmithKline Australia Pty Ltd, Boronia, Victoria, Australia), to decrease gastric acid production. During the course of treatment, a decision was made to use omeprazole (1 mg/kg via gastrostomy tube s.i.d.; Losec tablets, Astra Pharmaceuticals Pty Ltd, North Ryde, NSW, Australia), in place of ranitidine, because omeprazole is considered a more potent and long-lasting gastric acid suppressor than the H2-receptor antagonists. A second promotility agent, metoclopramide (0.5 mg/kg s.c. prn; Maxolon injection, ICN Pharmaceuticals Pty Ltd, Auburn, NSW, Australia), was used as adjunctive therapy during episodes of apparently severe esophageal discomfort following tube-feeding. There was acute onset of a right hindlimb proprioceptive deficit 7 days after commencement of intravenous metronidazole. Metronidazole therapy was ceased and within 72 hr the proprioceptive deficit had significantly improved. After 18 days of antimicrobial and supportive therapy, all clinical signs of tetanus had resolved; however, clinical signs of reflux esophagitis persisted despite aggressive medical therapy. Movement of the sliding hiatal hernia resulted in persistent tension on the gastrostomy tube. This resulted in breakdown of the surgical wound in the abdominal wall, necessitating removal of the tube after it had been in place for 15 days.
After 24 days of intensive medical therapy, the maned wolf presented acutely with clinical signs of systemic inflammatory response syndrome, including tachypnea, hypoglycemia, hypothermia, and collapse, resulting in death. Necropsy examination findings were consistent with acute aspiration pneumonia with severe pulmonary edema. Sliding hiatal hernia (with displacement of approximately 60% of the stomach, the spleen and a liver lobe through the esophageal hiatus) and megaesophagus were grossly evident.

**LITERATURE CITED**

TREATMENT OF CRYPTOCOCCAL MENINGOENCEPHALITIS AND PRESUMED PULMONARY CRYPTOCOCCOMA IN A KING CHEETAH (Acinonyx jubatus) WITH FLUCONAZOLE AND AMPHOTERICIN B

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Abstract

A 6-yr-old, 44-kg, captive male king cheetah (Acinonyx jubatus) was evaluated for intermittent lethargy and depression of 1.5 wk duration. Initial workup, consisting of radiographs, bloodwork, and urinalysis, revealed a focal nodule in the left lung. Bloodwork results, including common feline disease serology, were within normal limits or negative. Results of the physical examination were unremarkable other than slightly decreased skin turgor. Over the next several days, central neurologic signs became more evident, with mental dullness progressing to stupor, ataxia, protrusion of the third eyelids, dilated but responsive pupils, protrusion of the tongue, occasional slow head tremors, and anorexia. Physical examination under anesthesia was again unremarkable. Further workup included CT scan, cerebrospinal fluid (CSF) tap, repeat bloodwork, and abdominal ultrasound. Cytology of the CSF showed elevated protein (300 – 400 mg/dl; feline normal reference range, <25 mg/dl), leukocytosis (7,000 cells/μl, mostly neutrophils; feline reference range, 0 – 3 cells/μl), and yeast organisms consistent with Cryptococcus sp. Serum and CSF Cryptococcus antigen titers by latex agglutination (Texas Veterinary Medical Diagnostic Laboratory [TVMDL], College Station, TX USA, and Cornell Diagnostic Laboratory, College of Veterinary Medicine, Ithaca, NY USA, respectively) were both positive at 1:32. Complete blood cell count and serum chemistries were again within normal limits. Fluconazole (compounded by Pet Health Pharmacy, Youngstown, AZ USA) (4.5 mg/kg p.o. b.i.d.) and lactated Ringer’s solution (1 L s.c. b.i.d.) was started. Fluconazole was chosen for its superior penetration into the central nervous system.²

Cultures of the CSF were negative for bacteria, and positive for Cryptococcus neoformans, the variant undetermined. Sensitivity results revealed intermediate sensitivity to fluconazole, and complete sensitivity to amphotericin B and the other azoles.

The cheetah became more alert and responsive over the next several days, but still had a poor appetite and necessitated hand-feeding. Clinical signs varied in severity from day to day, but greatly deteriorated 5 days later, at which point the dose of fluconazole was increased to 13.5 mg/kg divided b.i.d. (400 mg in a.m., 200 mg in p.m.). Six days later, amphotericin B therapy was initiated in hopes of achieving a synergistic effect, using an established veterinary protocol.¹ Initial treatment was amphotericin B (X-Gen Pharmaceuticals, Big Flats, NY USA) 0.5 mg/kg diluted in 1 L of warmed 0.45% NaCl + 2.5% dextrose fluids, administered s.c. three times per
wk. An additional 700 – 1000 ml of unmedicated fluids was also given s.c. for supportive care as needed. This protocol was chosen for its reported decreased nephrotoxicity\(^1\) and ease of administration in this patient. As clinical signs continued to fluctuate, and included one episode of vomiting, treatment for gastritis was again started with amoxicillin (22 mg/kg p.o. b.i.d.; STADA Pharmaceuticals, Inc., Cranbury, NJ USA) and esomeprazole (1 mg/kg p.o. s.i.d.; Nexium, AstraZeneca, Wilmington, DE USA). Amoxicillin was discontinued after 10 days, but esomeprazole continued for prophylaxis, especially due to the potential nephrotoxicity of the antifungal agents.

Venipuncture via the medial saphenous vein was performed every 7 days as long as the cheetah allowed. Urinalyses were run opportunistically. Samples did not necessarily reflect fasting, and water was always available. The first urine sample collected 3 wk after initiating amphotericin B was isosthenuric (specific gravity 1.010). Although the blood urea nitrogen fluctuated but remained in normal range, creatinine increased to 5.5 mg/dl (ISIS reference values, 2.4 ± 0.9 mg/dl) 4 wk after initiating amphotericin B therapy. This azotemia also correlated with a sudden aversion to food. Amphotericin B was thus temporarily discontinued, but normal subcutaneous fluids were administered b.i.d. for diuresis. Creatinine decreased to 4.2 mg/dl 3 days later, 3.6 mg/dl 1 wk later, and remained under 3.0 mg/dl for the next 5 wk. Thereafter, two urinalyses showed concentrated urine (specific gravity >1.040).

Amphotericin B therapy was re instituted just 4 days after the discontinuation, because of relapsing neurologic signs but a restored appetite. The protocol, however, was modified to 10 mg of amphotericin B diluted in 1 L of 0.45% NaCl + 2.5% dextrose s.c. three times per wk.

Neurologic signs continued to fluctuate, with the cheetah appearing to have relapses of several days' duration approximately every 2 wk. No further relapses were evident after 10 wk of combined therapy, and the cheetah's "personality" finally returned to normal. Esomeprazole was tapered to every other day, and amphotericin B therapy was further tapered to twice weekly dosing.

Four months into treatment, the cheetah was immobilized for re-evaluation. Cerebrospinal fluid was sterile on fungal culture, and cytology showed mild protein elevation (30 mg/dl), and few leukocytes (10 cells/μl, with 70% lymphocytes and 30% neutrophils). Cryptococcus antigen titers (TVMDL) were undetectable in the CSF, and positive at 1:2 in the serum. The pulmonary nodule was still present on radiographs but subjectively appeared less radiodense. Physical examination was unremarkable.

Amphotericin B therapy was continued until a cumulative dose of 20 mg/kg was achieved, almost 8 mo after initial treatment. The cheetah was then re-evaluated under anesthesia. Cerebrospinal fluid was again sterile and analysis showed protein of 30 mg/dl, and a leukocyte count of 1.6 cells/μl was within the reference range. Cryptococcus antigen titers (TVMDL) were undetectable in the CSF and serum. Radiographs showed the pulmonary nodule significantly

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reduced in size. The cheetah is considered in remission, but is being maintained on oral fluconazole.

This is the first reported case of a successful treatment of central nervous system cryptococcosis in a captive cheetah. The administration of amphotericin-B s.c. is reportedly less nephrotoxic, however this cheetah did become significantly azotemic. The goal of achieving a cumulative dose of this medication allowed flexibility in the dosing schedule, enabling adjustment and continuation of therapy. The overall combination of fluconazole and amphotericin-B has proven safe and effective for this cheetah.

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LITERATURE CITED

SUCCESSFUL TREATMENT OF A CAPUCHIN MONKEY (Cebus capucinus) WITH TOXOPLASMOSIS

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Abstract

Toxoplasmosis is a frequently diagnosed and often fatal disease of squirrel monkeys (Saimiri sciureus) and other New World primates, but only a single case report of a capuchin monkey (Cebus capucinus) exists in the literature. A 32-yr-old female spayed white-throated capuchin monkey presented to the University of Florida Veterinary Medical Teaching Hospital (VMTH) for paraparesis. The animal was immobilized for a physical examination, which revealed crepitus in the right stifle. The remainder of the diagnostic evaluation, including electromyography (EMG), radiography, complete blood count, and biochemistry panel, was unremarkable. A diagnosis of degenerative joint disease was made and treatment with anti-inflammatory medication was initiated. Despite treatment, the animal worsened and presented to the VMTH 4 days later with tetraparesis. Additional diagnostic testing was pursued, including analysis of cerebrospinal fluid collected from the lumbosacral space. A lymphocytic pleocytosis (20 WBC/μl; 4% neutrophils, 77% lymphocytes, 4% mononuclear phagocytes, and 15% eosinophils) and elevated protein (118 mg/dl) was found, indicative of meningitis due to a protozoal, fungal, or viral etiology. A presumptive diagnosis of protozoal meningitis was made pending titers to Toxoplasma gondii and Neospora caninum. Treatment with clindamycin and trimethoprimsulfamethoxazole resulted in rapid improvement and complete resolution of clinical signs within 2 wk. Serologic results revealed a negative titer to N. caninum, and a high positive titer to T. gondii (1:131,072). Toxoplasmosis should be considered in the differential diagnosis of capuchins with neurologic signs. Capuchins’ relative resistance to toxoplasmosis may be related to their less strictly arboreal habits, and occasional exposure to felid feces in their natural habitat.
**HYPOTHYROIDISM IN AN AFRICAN FOREST BUFFALO (Syncerus caffer nanus)**

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Abstract

A mature adult female African forest buffalo (Syncerus caffer nanus) of unknown age was presented with recurrent signs of hoof overgrowth, persistent anestrus, obesity, dull hair coat, and decreased activity. Complete blood counts (CBC) and serum biochemistry values were unremarkable. Decreased concentrations of triiodothyronine (T3) and total thyroxine (TT4) were noted when compared to domestic cattle and a healthy African forest buffalo. Treatment with oral levothyroxine (84 mg p.o. mixed with pellets every 24 hr; Thyro-L, Vet-A-Mix, Shenandoah, IA, USA) increased blood concentrations of T3 and TT4, and improvements in clinical signs were noted including weight loss, hair re-growth, and reproductive cycling. The animal responded to treatment for 6 mo until its death during an anesthetic procedure.

To our knowledge, this is the first reported case of spontaneous hypothyroidism in a bovid. The animal responded to dietary administration of levothyroxine with increased thyroid hormone concentrations, and improved clinical demeanor and body condition. Anecdotally, rumen enzymes are thought to inactivate this hormone, and the traditional methods of administration in domestic cattle, parenteral or rectal, are difficult in a nondomesticated bovid. The findings of this case report suggest that future cases of bovid hypothyroidism may respond to oral supplementation of levothyroxine above the normal dose ranges for monogastric animals. Hypothyroidism should be considered as a differential diagnosis for any individual with obesity, dull hair coat, persistent anestrus, and overgrown hooves. Diagnosis and treatment may be relatively straightforward.

**LITERATURE CITED**


PHEOCHROMOCYTOMA IN AN AFRICAN WARTHOG (*Phacochoerus aethiopicus*)

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Abstract

A 14-yr-old male African warthog (*Phacochoerus aethiopicus*) with a chronic history of unilateral epistaxis, degenerative osteoarthritis, and intermittent weakness in the distal lumbar trunk was evaluated under general anesthesia. The animal was housed singly and fed a commercial pelleted diet (Mazuri PMI Feeds, St. Louis, MO USA), alfalfa hay, and small amounts of fresh produce.

The warthog was anesthetized with detomidine (Domitor, Pfizer Animal Health, New York, NY USA), butorphanol (Torbugesic, Fort Dodge Laboratories, Fort Dodge, IA USA), and midazolam hydrochloride (Abbott Laboratories, North Chicago, IL USA) via blowdart. Indirect oscillometric blood pressure readings (Cardell, CAS Medical Systems, Inc., Branford, CT USA) averaged 162 mm Hg (systolic), 72 mm Hg (diastolic), and 107 mm Hg (mean arterial pressure), with a mean heart rate of 93 bpm. Rigid laparoscopic evaluation of the nasal meatus of both nares demonstrated no abnormalities. Radiographs of thoracic and pelvic limbs demonstrated severe osteoarthritis in all four carpi and tarsi. Cardiothoracic evaluation demonstrated a grade III/VI holosystolic murmur with the point of maximal intensity over the left intercostal space 4 to 5, above the sternal border.

The combination of progressive degenerative osteoarthritis, epistaxis, and cardiac murmur precluded resolution and the warthog was euthanatized. Gross necropsy demonstrated severe chronic osteoarthritis, hemorrhage in the ethmoid region, and firm mass on the left antebrachium that was later identified as a fibroma. The heart was grossly normal, but weights and measurements were not obtained. Mild endocardiosis of the mitral valve was observed. Although the left adrenal was normal in size, the right adrenal contained a circumscribed tan mass about 1 cm in diameter within the medulla. Representative tissues from all internal organs were placed in 10% neutral buffered formalin, embedded in paraffin, sectioned, and stained with hemotoxylin and eosin.
Histopathologically, the right adrenal medulla contained a unilateral medullary tumor that circumferentially displaced the cortex and compressed the remaining normal medulla. The mass was well defined but not encapsulated and consisted of sheets and nests of medium-sized round to somewhat elongate cells immersed in fibrovascular stroma. The cells had pink homogeneous cytoplasm. The nuclei were eccentric and anisomorphic, and relatively large, with stippled chromatin and small nucleoli. Mitoses were uncommon. Irregular areas of degeneration and necrosis were present in the mass. Immunohistochemical staining detected finely granular cytoplasmic expression of chromogranin, which was less intense than in cells of the normal adrenal medulla, and non-existent in the cells of the adrenal cortex. Neoplastic cells did not express neurofilament protein H chain. These findings are characteristic of pheochromocytoma (PC). The adrenal medulla was normal except for brown pigment of some of the cells. In the heart, myocardial fibers were separated slightly by pale interstitium. Elastin fibers of the heart were mineralized and collections of golden perinuclear granules consistent with lipofuscin were frequent in myocardial fibers. Severe atrophy of peripheral nerve fibers with fiber loss and increased pale ground substance between and around fibers within the nerve sheath was also noted. Testicular tubules were disorganized and collapsed, producing few sperm cells. The interstitium contained increased fibrous tissue and hemosiderin rich macrophages. No pathologic insult was observed in either nasal cavity.

Pheochromocytomas are known to cause constant or intermittent hypertension and have been associated with systolic heart murmurs in humans. Repeated nasal hemorrhage is certainly characteristic of hypertension, but was not observed in this warthog when compared to other warthogs anesthetized with similar drugs. Recent hemorrhage of the mass could have resulted in massive catecholamine release and instituted acute hypertension and epistaxis. This mass was rounded and benign in character. Pheochromocytomas have been reported in all domestic species, as well as a hippopotamus, sea otter, rat, wolfdog, and ring-tailed lemur.

Pheochromocytomas are uncommon in pigs. A review of over 10,000 necropsy specimens of domestic swine (USDA/FSIS eastern Laboratory, Athens, GA USA, pers. com., 2004) did not find PC in any swine. However, these market hogs were generally less than 2 yr old. Of 3.7 million swine surveyed in 1965 in Great Britain, one 2.5-yr-old female had a PC diagnosed postmortem in an abattoir survey. Only one other adrenal neoplasm in swine was observed; an adrenal cortical adenoma in a 6-mo-old gilt.

Pheochromocytomas produce noradrenaline and adrenaline leading to hypertensive states in domestic animals. Documentation of elevated indirect BP readings, compared to a conspecific (66/40) immobilized with similar anesthetic induction agents (Jackie Gai, pers. com., 2004) is compatible with a PC, though reference values for blood pressures in anesthetized warthogs are not reported and mean values obtained here are within generally acceptable limits for other domestic and exotic mammals. Plasma norepinephrine values in this warthog were elevated when compared to three other male African warthogs under anesthesia, but lower than one additional, clinically healthy male. Values were compatible with PC, however, no reference
values exist for norepinephrine values in African warthogs and should be interpreted with caution. Tissue norepinephrine values were not performed. Chronic intermittent epistaxis, without underlying site specific pathology, is also compatible with hypertension. Surgery is the treatment of choice for dogs with pheochromocytomas. Medical therapy permits metabolic and cardiovascular stabilization of patients before surgery and is used treat intraoperative arrhythmia and episodes of hypertension. Surgical intervention or medical treatment in this case would be impractical owing to difficulty in direct monitoring, acceptance of oral medications, and superceding degenerative conditions.

Clinicians should consider pheochromocytoma when evaluating aged swine with episodic weakness and epistaxis.

ACKNOWLEDGMENTS

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LITERATURE CITED

ELEPHANT RESTRAINT DEVICE ASSISTED ANESTHESIA IN AN AFRICAN ELEPHANT (*Loxodonta africana*)

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Abstract

Modern elephant management programs often include the use of protected contact. This allows improved safety for the elephant staff but may limit access to medical conditions occurring in elephants.

A 27-yr-old female African elephant (*Loxodonta africana*) weighing an estimated 3,700 kg was anesthetized for evaluation of a chronic, progressive, fistulous tract of the left ventral mandible. The mandible was routinely cultured, flushed with diluted peroxide, chlorhexidine, betadine solution, or alternating antibiotics, based on microbial sensitivities. To properly assess the left mandible, the elephant had to be placed in right lateral recumbency, which was accomplished with the use of a commercially available rotational elephant restraint device (ERD). Because of the protected contact management program, right lateral recumbency could not be guaranteed at the time of immobilization. Malpositioning, tusk fracture and/or related injury could occur upon recumbency without the additional control afforded by the ERD.

The ERD is a hydraulically operated unit that comfortably restrains an elephant, minimizing safety risks to the animal and staff. The ERD consists of one solid wall, three side panels, and hinged floor. The ends of the restraint are closed with moveable shift doors. The three side panels can be moved independently depending upon the size of the animal and are further subdivided with moveable “subpanels” to allow direct access to various areas of the animal. In addition, support straps help gently stabilize limbs when performing medical procedures. The unit is positioned within the elephant holding facility at the Kansas City Zoo. The unit was installed in 1994 during renovation of the elephant exhibit, whereupon the elephant management program was changed from free-contact to protected contact. The ERD is utilized for reproductive assessments, semen collection, transabdominal ultrasound, evaluation of integumentary wounds, ophthalmic and aural examination, and administration of injectable
medications. However, no elephant had been anesthetized and rotated in the restraint. The affected animal could not be guaranteed to re-enter the ERD once rotated, but would enter and station in the ERD on a daily basis. Because of this, a conspecific was conditioned to allow rotation without the use of sedatives or tranquilizers, to prepare for the actual immobilization. Adjustments in strap placement, cushioning, critical evaluation of mechanical stability, and placement of hydraulic panels allowed staff to prepare for the actual immobilization, minimizing complications.

The elephant was conditioned to enter and station in the ERD. After strapping the distal limbs, thorax and caudal abdomen for support, the elephant was immobilized with a combination of 3,000 IU of hyaluronidase (O’Brien Pharmacy, Kansas City, MO USA), 10 mg acepromazine maleate, and 7 mg etorphine hydrochloride (Wildlife Pharmaceuticals Inc., Fort Collins, CO USA) via pole syringe. Close monitoring of induction was performed and when stage III anesthetic plane was achieved, the elephant was rotated into right lateral recumbency, elevating the elephant 6 feet above the floor. No voluntary movement of the animal was noted while the restraint was in motion. Direct arterial blood pressure, indirect oscillometric blood pressure, blood gases, respiratory rate, excursion characteristics, cardiac rate and rhythm, and pulse oximetry was routinely monitored during the procedure. Anesthesia was maintained with intermittent boluses of etorphine hydrochloride. Intravenous physiologic fluids (lactated Ringers solution) were maintained via an i.v. aural catheter, and insufflation with oxygen was provided on a continual basis.

Oral examination and palpation demonstrated an incomplete transverse fissure of the left mandibular molar, intact gingival, and proper dental occlusion with the upper arcade. Digital radiographs of the left mandible were performed based on exposures obtained with a set of skeletonized jaws. Advantages of this diagnostic modality are the immediate imaging results, portability, and digital imaging and storage, and does not require a developer or fixative. Adjustments in radiographic angle and technique were made to obtain the best diagnostic image. Radiographic imaging demonstrated a sequestrum consisting of a fractured enamel plate of the mandibular molar with a fistulous tract that coursed ventrally to communicate through the skin.

The elephant was elevated 6 feet above the ground, which presented unique challenges. Because of the relatively small operating space, intubation was not possible, but insufflation was readily achieved and successful based on pulse oximetry trends. A commercial lift was utilized to elevate two large-animal circle anesthetic units to the level of the elephant’s head. During immobilization the legs were cushioned and restraint straps removed to lessen the potential for occlusive damage to the tissues. The ERD allows an elephant to be positioned in either right or left lateral recumbency.

Upon completion of diagnostic procedures, the narcotic agent was reversed with 1,400 mg naltrexone hydrochloride (Zoopharm, Laramie, WY USA) administered 25% intravenously and 75% subcutaneously. The elephant awoke within 90 sec and was rotated to a standing position.
within the restraint. Thereafter, the elephant was confined in the restraint for approximately 45 min, until no untoward effects were likely to occur. The elephant was released from the restraint and resumed normal eating and drinking within 8 hr, and voluntarily entered the restraint within 2 wk following the procedure.

The elephant was stable throughout the procedure; however, a predetermined objective for mean arterial blood pressures (<200 MAP) was not achieved. Hyaluronidase was utilized to promote rapid absorption of the narcotic and neuroleptic agents. Acetylpromazine was used to maintain peripheral perfusion by reducing the hypertensive effects of etorphine, which has been documented in previous immobilizations of African elephants. Etorphine hydrochloride, a powerful narcotic agent, has been successfully used as an immobilizing agent in both wild and captive African elephants.

Use of an ERD allowed full control of the immobilization, increasing safety for personnel, preventing injury to the elephant, and positioning the left mandible on the dorsal plane. Disadvantages are the elevated height of the elephant, relatively small operating space, and disrupted line of sight communication.

A second procedure will be performed in the near future to address the fracture and subsequent sequestrum diagnosed during the first immobilization. The elephant is currently being conditioned to allow restraint in a holding stall that will allow greater access to the oral cavity and surgical manipulation of the affected mandible.

ACKNOWLEDGMENTS

We thank the staff of the Kansas City Zoological Park for their care, concern, and expertise in helping make this procedure a success.

LITERATURE CITED

SUGGESTIONS FOR VETERINARIANS WORKING IN CENTRAL AFRICA

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Abstract

From a geopolitical standpoint, Central Africa is composed of the countries of Angola, Cameroon, Central African Republic, Chad, Democratic Republic of Congo, Equatorial Guinea, Gabon, Republic of Congo, Sudan and Zambia. The remarks in this paper will be limited to the Central African countries of the Congo Basin: Cameroon, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon and Republic of Congo. These countries are among the most biologically diverse countries in the world. All or parts of all of these countries are francophone and most have a legal system based on the French civil law system.

It is important to look at all of these countries from a historic perspective. All were colonized by European countries. The colonial period has had lasting effects, both overtly and subtly. Colonization was, for the most part, an exploitive activity. Some of the undesirable practices employed by the colonizers have been institutionalized in some countries. Pakenham provides an excellent overview of colonization across Africa.

Much of Africa, excluding Northern Africa, South Africa and parts of the Horn of Africa, function differently than the majority of the rest of the world. Most relationships are oriented vertically, creating in essence a number of “silos,” with wealth at the top and poverty at the bottom of each silo. Those lower in the vertical stratification expect those above them to benefit them in some way. From the perception of the local population, an expatriate working with them is inserted at some level into their “silo.” With that insertion comes the obligation to benefit those below. These vertical relationships at times seem to result in chaos. Understanding how one’s position in one or multiple “silos” is perceived is important in defining relationships with others.

In addition to being biologically diverse, the countries of the Congo Basin are also culturally diverse. Field teams may be composed of individuals from several different cultures. Cultural differences can lead to strife in a team. An example is the relationship between the Bantu and the Baka. The relationship is centuries old and can simplistically be described as a dependence of the Baka on the Bantu. A Bantu will not take an order from a Baka. It is extremely important to be aware of and respectful of cultural and tribal differences.
Witchcraft is common throughout Central Africa. Witchcraft can lead to conflict within a team and can be blamed for an unsuccessful mission. For those who believe in witchcraft, it is real and must be dealt with from the perspective of the believers. Geschiere provides an excellent overview of modern witchcraft.\footnote{3}

Several layers of bureaucracy must be dealt with. At the national level, permits to work with wildlife must be obtained from the ministry in charge of wildlife or protected areas. Travel plans may need to be filed with the national police (gendarmerie). Permits for importation of narcotics and other drugs must be obtained from the ministry of health. In sensitive areas or in areas near conflict, permission from the military may be required prior to entry into the area. Clearing customs with large amounts of equipment can be challenging. Having a detailed list of all equipment available for the customs agent can speed the process. Having an invitation letter from a local partner can also help.

The bureaucracy tends to filter down through provinces to districts to sub-districts to villages. Paying courtesy calls to officials at all levels is recommended if time permits. At the village level, depending on the size of the village, one may be required to deal with a sousprefet (highest-ranking federal official), police chief, commandant of the gendarmerie, the mayor and the tribal chief. In general, the sousprefet is the point of contact. The local situation can sometimes change the power dynamics, which can be a pitfall if one is not aware of the situation. Tribal chiefs can be very helpful because of their wealth of knowledge of the geography and biology of the local area.

Corruption is institutionalized in many African countries.\footnote{2} Dealing with corruption can be very time-consuming and expensive. The World Bank estimates that US $1,000 billion are paid in bribes worldwide. Paying bribes can be avoided with preplanning: have all permits in order prior to entering the country, and have an in-country partner to assist with customs. Be familiar with local laws and regulations, and do not break laws. In one study, the most common cause of expatriate arrest was associated with motor vehicles (79.5%), followed by drug/alcohol violations (7.7%), sexual assault (5.1%) satellite phone use (5.1%), and property damage (2.6%).

The infrastructure in all Central African countries is underdeveloped. Roads are often poorly maintained. Public transportation in the form of buses and bush taxis are readily available, but dangerous. Four-wheel drive vehicles are available for hire in most large cities. Boats for navigating waterways are generally readily available for hire. Fixed-wing aircraft can be very difficult to find and helicopters are extremely difficult to find. In general, medical equipment and narcotic anesthetic agents are unavailable. Basic camping equipment is available in some of the major cities. The electrical grid is unreliable and seldom extends far from moderately-sized towns. Communications are also unreliable. Telephone and internet connections are available in most large cities. Cellular telephones are becoming more common with increasing coverage, but vast areas remain outside coverage. In remote areas, satellite telephones may be the only means of communication.
There is a significant pool of well-educated biologists in the region. There are few veterinarians in the area and very few veterinarians with experience in wildlife medicine. A primary focus of any expatriate veterinarian working in the area should be to build the capacity of local veterinarians to ultimately take over the veterinary aspects of the project. There are a number of universities in the region that can form the basis of partnerships. A large number of NGOs operate in the region, including WWF, WCS and ECOFAC. Major governmental agencies that operate in the region include CARPE (USA), EU, GTZ (German), SNV (Dutch) and CF (French). Guides, porters and trackers are readily available.

Table 1 lists the major infectious diseases endemic to Central Africa. Many are preventable by vaccination or by modifying personal behaviors. Plasmodium falciparum infection is particularly dangerous because it often leads to cerebral malaria. Antimalarial drugs, insect repellants and appropriate clothing should be employed to limit exposure. HIV infection rates are high in many of the Central African countries.

Drinking bottled water and drinks or drinking treated water (boiling, iodination) is highly advisable. Eating well-cooked foods served hot and avoiding fresh fruits and vegetables unless prepared properly is also advised. Two good references for health considerations are Jong and Auerbach.\textsuperscript{1,4}

The greatest threat to health is trauma, and the greatest cause of trauma is vehicular accidents. Driving is dangerous; driving at night and on holidays is very dangerous. Hiring both a skilled driver and a well-maintained vehicle is wise.

There are a few medical facilities which would meet minimal standards in the West. Because medical evacuation can be very expensive, it is suggested that people working in the region have emergency medical evacuation insurance.

Many of the countries in Central Africa have legislation which, if enforced, would provide adequate protection for animals and their habitats. Unfortunately there is, in general, a lack of both human and financial capacity to effectively manage protected areas and enforce wildlife laws.

Legal and illegal extractive activities cause both habitat destruction and directly threaten animal populations. Logging and mining not only destroy habitat but also open remote areas with roads making illegal hunting much easier. Logging trucks often provide transportation for poachers into areas and for transporting bushmeat out of the area. The single most important threat to many species of animals in the Congo Basin is the commercial bushmeat trade. Each year, millions of tons of meat from illegally killed animals are sold both locally in Africa, Europe, the USA and Asia. Legal trophy hunting, if done sustainably, and if the local community benefits, can have positive effects by helping to reduce poaching.
Intrusion of people and livestock into protected areas can have significant degradative effects. This is a very complicated issue since local populations are often translocated out of their traditional homelands when protected areas are formed. The rights of indigenous peoples must be taken into account when protected areas are formed.

Armed conflict causes a breakdown in management of protected areas. Many animals in conflict areas are shot for sport or for food. This can locally decimate animal populations.

Emerging diseases in the region include Ebola virus and anthrax. Both have had significant impacts on great ape populations. It is yet to be seen if the recent outbreak of Marburg disease in Angola will have a major impact on animal populations.

**LITERATURE CITED**


**Table 1.** Major human infectious diseases endemic to Central Africa.

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<th>Parasites</th>
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ECOSYSTEM HEALTH IN GOMBE NATIONAL PARK, TANZANIA

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Abstract

Gombe National Park, Tanzania currently hosts the longest continuous study of wild chimpanzees. Studies at Gombe have spanned 43 yr and represent the only studies with nearly complete lifespan data on adult chimpanzees.2,3 The length and scope of the Gombe study make this population of the highest scientific importance to our understanding of ape behavior, ecology, and conservation. Loss and even precipitous decline of this population would be a major setback for primate conservation efforts.

Disease outbreaks, either in isolation or in concert with other risk factors such as environmental variations, demographic stochasticity, or loss of genetic diversity, can pose serious threats to the long-term persistence of mammal populations; these risks are elevated as population size decreases and/or population isolation increases.1 Many chimpanzee study sites are increasingly isolated by loss of habitat due to human encroachment and managers in parks containing chimpanzees perceive that disease outbreaks have been and continue to be significant causes of mortality for chimpanzees. The total population at Gombe has declined from perhaps as many as 150 in the 1960’s to near 100 in 2003, with death from disease as the leading cause of mortality (J.M. Williams, 2002. An analysis of mortality factors in the wild chimpanzees of Gombe National Park, Tanzania, unpublished report). Major epidemics at Gombe include suspected polio in 1966, respiratory diseases in 1968, 1987, 1996, 1999 and 2000 and sarcoptic mange in 1997.3,7,9,10 Mahale National Park has been struck by “flu-like” illnesses and an “AIDS-like” epidemic.8 Other chimpanzee study sites have also reportedly been affected by epidemic disease (e.g., Ebola in the Tai Forest, Ivory Coast and Lossi in Gabon). Many of these disease outbreaks are suspected to be the result of close contact with humans,5,11 and similar issues surrounding human-ape disease transmission are currently under investigation in mountain gorillas.4,6 These outbreaks have led park managers and researchers working in Gombe National Park to conclude that diseases originating from and/or spread by humans pose a substantial risk to the long-term survival of Gombe’s chimpanzee population.

A comprehensive ecosystem health program is currently being implemented in Gombe National Park. The purpose of this program is to standardize collection of long-term, longitudinal surveillance data on chimpanzees, baboons and humans that may be used for disease risk
Assessment and ecological modelling. Results of this project will be incorporated into the Tanzanian Park Authorities (TANAPA) strategic planning process for Gombe National Park.

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LITERATURE CITED

SUSPECTED *Leucaena leucocephala* TOXICOSIS IN FREE-RANGING RINGTAILED LEMURS (*Lemur catta*) AT BERENTY RESERVE, MADAGASCAR

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Abstract

In March 2003 we began to investigate a syndrome of alopecia in free-ranging ringtailed lemurs (*Lemur catta*) at Berenty Reserve, a 2-km² forest fragment in southern Madagascar. Alopecia was first observed in the ringtailed lemur population in the late 1990s in troops at the northern edge of Berenty, and by 2002 was observed in troops in the center of the reserve. While no animals exhibited alopecia in March 2003, we had the opportunity to immobilize (tiletamine-zolazepam; Telazol™, Fort Dodge) and evaluate 60 animals in an effort to determine a cause for the alopecia observed earlier in the year. We found no evidence of contagious disease upon examination of these 60 animals. However, subsequent investigation and observation revealed that alopecia was seasonal, first appearing in June and July and becoming more severe in August and September. Hair began to grow back in October and November, and by February/March alopecia was no longer apparent. The annual onset and resolution of alopecia appeared to be associated with the seasonal dependence of the lemurs on *Leucaena leucocephala* (leucaena) for forage. Further epidemiologic evaluation of 2003 and 2004 census data revealed strong associations between alopecia and the presence of leucaena within home ranges. Furthermore, leucaena exposure appeared to negatively impact infant recruitment. Leucaena, an introduced tree in Madagascar, is known to be toxic to mammals if ingested, particularly to non-ruminants, and has numerous effects including alopecia, growth retardation, and decreased fertility.  

Native to Mexico and Central America, leucaena has been promoted worldwide as an efficient source of timber as well as food for humans and livestock. Given its global distribution, leucaena may be negatively impacting other wildlife populations.

LITERATURE CITED

LAPAROSCOPIC REPRODUCTIVE STERILIZATION AS A METHOD OF POPULATION CONTROL IN FREE RANGING AFRICAN ELEPHANTS (*Loxodonta africana*)

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Abstract

In many areas of southern Africa, elephant populations have outgrown the carrying capacity of parks and reserves. Elephant populations in certain wildlife parks have caused dramatic changes to the natural flora and fauna and have forced wildlife officials in several locations to consider elephant culling. Ecosystem destruction by elephants and the animal welfare concerns around culling are two of the most significant conservation issues facing Africa. Wildlife officials are urgently seeking effective and humane methods of population control in elephants.

Laparoscopic surgery provides a direct view of internal organs and allows tissue manipulation via a minimally invasive procedure utilizing relatively small incisions. Recent advances in medical technology have made laparoscopic surgery a reality in very large animals, even in free-ranging situations.

In July 2004, an international team of veterinarians, technicians and wildlife officials performed the first-ever, hand-assisted laparoscopic sterilization of free-ranging female elephants. Animals were anesthetized via remote injection using a combination of etorphine and azaperone. The elephants were positioned in lateral recumbency and the skin was surgically prepared for laparoscopy. An approximately 35 cm incision was made in the paralumbar fossa just caudal to the last rib. The surgeon’s arm was introduced into the abdomen and manual palpation was used to identify the ovary and place a snare around the pedicle. A 12-cm internal diameter plastic tube was placed through the incision into the abdomen and positioned so that the snare and ovary were inside the tube. This tube served as a working port for easier access to the ovary and helped protect other visceral organs from trauma. An equine laparoscope (57 cm, 0 degree) was placed inside the tube and used to visualize the ovary. The ovarian pedicle was ligated utilizing 18-gauge stainless steel cerclage wire. Two wire ligatures were twisted around the base of each
ovarian pedicle using an electric drill. The peritoneum, muscle layers and subcutaneous layers were each closed with #2 PDS. The skin was closed using stainless steel suture in a modified far-far-near-near pattern, which incorporated stents. Once the procedure was complete on each side, the animals were rolled to the contralateral side for the same procedure.

During surgery, the elephants were fitted with telemetry collars for post-operative monitoring. VHS and GPS tracking technology were utilized for 10 mo after surgery to monitor and track the elephants after surgery. The incisions healed without complication, and ongoing direct observation of the animals and the herds have demonstrated no adverse social or behavioral issues since the surgical sterilization. A follow-up examination of the elephants is scheduled for June 2005, including a complete health assessment, evaluation of the surgical sites, ultrasonography of the reproductive tract and blood collection for complete blood count, serum chemistry and endocrinology profiles.

Male elephants have intra-abdominal testes, and thus surgical sterilization requires abdominal surgery. In an attempt to improve our elephant laparoscopy technique, a crane is now utilized to support the anesthetized elephant in a standing position, which allows for abdominal insufflation and improved laparoscopic visualization. Using this positioning technique, it is possible to perform reproductive sterilization procedures completely laparoscopically. This in turns allows for a much smaller incision, reduced surgical/anesthetic times, and a more rapid post-operative healing time. In males, a 10-cm incision is made just cranial to the tuber coxae. A cannula and 90 cm laparoscope with an operating channel are placed into the abdomen. Insufflation is employed and the testes are identified hanging from the dorsal body wall in the mesorchium. A modified epididectomy/vasectomy is performed by resecting a 4-cm portion of the deferent ducts. The peritoneum and subcutaneous tissues are closed using #2 PDS, and skin closed with simple horizontal mattress pattern and #2 nylon.

The initial investigation into sterilization of bull elephants began in February 2005, and the first in situ surgeries are scheduled for June 2005. The bull elephants will be fitted with telemetry collars and monitored for 10 mo post operatively.

Minimally invasive laparoscopic surgery allows patients to rapidly return to full function and can be utilized in free ranging elephants with minimal disturbance to the animals or the herd. In certain situations, surgical sterilization of free ranging elephants may be a useful tool to wildlife officials who are currently faced with ecosystem health concerns and animal welfare issues.

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VETERINARY CONTRIBUTIONS TO THE PAN AFRICAN SANCTUARIES ALLIANCE

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Abstract

Primate sanctuaries in Africa emerged in response to the increasing number of great apes injured and displaced by illegal hunting and habitat destruction. The Pan African Sanctuaries Alliance (PASA) was formed in 2000, and is an alliance of approximately 19 primate sanctuaries throughout Africa. PASA’s mission is to provide 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 (http://www.panafricanprimates.org). PASA includes committees on education, management, conservation, reintroduction, as well as veterinary healthcare. To improve the standards of healthcare and increase capacity of the sanctuaries to provide veterinary care, three annual workshops were held in various African countries (Uganda, Republic of Congo and Cameroon) from 2003-2005. Participants included veterinarians, veterinary assistants as well as sanctuary managers from the various sanctuaries. Didactic and practical sessions were conducted on topics relating to all aspects of healthcare of captive primates including preventive medicine, occupational health, nutrition, contraception, infectious and noninfectious diseases, neonatology, anesthesia and surgery, as well as laboratory and necropsy procedures. In addition, a PASA Veterinary Healthcare Manual has been produced that is a reference manual for the sanctuaries and provides standard operating procedures and other protocols. PASA has also been awarded a grant to improve the veterinary infrastructure at member sanctuaries and a questionnaire survey was conducted to determine the priority veterinary equipment needs. Immediate challenges to providing veterinary services to the sanctuaries include lack of infrastructure and remote location of some facilities, lack of access to veterinary supplies, lack of diagnostic support, and lack of expert consultation. Longer term challenges include the recruitment and training of African veterinarians and the establishment of standards of healthcare. Furthermore, reintroduction is a stated goal of PASA and disease risk analysis will need to be performed as well as development of protocols for disease screening and post-release health monitoring. The potential additional benefits of veterinary contributions to PASA include...
highlighting human health issues from the consumption of primate bush meat, and increased knowledge of primate tropical diseases and management of captive great apes in Africa. This will also be an opportunity to provide input on the health aspects of the World Conservation Union (IUCN) Special Survival Commission (SSC) Guidelines for Non-human Primate Reintroduction\(^1\) as well as collaborate with the Great Ape Health Monitoring Unit (GAHMU; http://www.eva.mpg.de/primat/GAHMU/index.htm).

**LITERATURE CITED**

SURGICAL STERILIZATION TO CONTROL AN URBAN POPULATION OF WHITE-TAILED DEER: PRELIMINARY RESULTS

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Abstract

Overabundance of white-tailed deer (Odocoileus virginianus) in urban and suburban landscapes poses a challenge to wildlife managers and local municipalities. Culling via lethal means can provide effective population control, but is not an option in many urban settings due to logistic and sociopolitical considerations.

A 4-yr project was developed to determine if surgical sterilization of females could regulate a population of white-tailed deer in Highland Park, Illinois, an urban environment. We used density-dependent population models to calculate that we would need to sterilize 80% of the females in the population to achieve population leveling, and then reduction over the next 4 – 6 yr. Helicopter surveys from 1994 – 2001 provided a mean uncorrected count of five deer/square mile; with an approximation of 50% detection rate, the estimated population was 10 deer/square mile. Between January 2002 and April 2004, we captured 181 individual deer at least once using baited clover traps or darting deer over a bait pile. Sixty-six deer were anesthetized, surgically sterilized by tubal ligation, sampled, marked and collared; 35 female deer received the same handling but were not surgically sterilized, and 79 males were anesthetized, sampled and marked. All captured females received a telemetry collar and were monitored throughout the study period.

Our current population model focuses on density-dependent sterilization to maintain deer at a fixed population level, in the absence of natural density dependence. Mortality and dispersal rates were determined from our empirical data, while recruitment was estimated from previous studies in similar urban settings in the Midwest. At levels of variance used in the literature, our model predicts that density-dependent sterilization can maintain populations near goal levels with minimal risk of local extinction. Model predictions are tested using empirical data collected during the study.
ACKNOWLEDGMENTS

This work is supported by a grant from the City of Highland Park (Illinois) and assistance provided by the Highland Park Police Department.

LITERATURE CITED

LONG ISLAND, NEW YORK, HOGNOSE SNAKE (Heterodon platirhinos) BIOTELEMETRY

Paul P. Calle, VMD, Dipl ACZM, 1* Jeremy A. Feinberg, BA, MS, 2 Timothy M. Green, PhD, 3 Robert P. Moore, DVM, 1 Kristine M. Smith, DVM, 1 Eric Baitchman, DVM, 1,† and Bonnie L. Raphael, DVM, Dipl ACZM 1

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Abstract

In May 2003, the United States Fish & Wildlife Service, Brookhaven National Laboratory (BNL), and the Wildlife Conservation Society (WCS) initiated a radiotelemetry study of eastern hognose snakes (Heterodon platirhinos) at BNL on Long Island (LI), New York. Although once common on LI, and still common elsewhere, 4 the LI population has plummeted and the snakes remaining at BNL may represent one of the last healthy populations in the region. 1,3,6 The purpose of the study was to improve management and conservation efforts by developing a better understanding of the species life history, ecology, and behavior with a focus on habitat use, home-range size, and movement patterns relative to feeding, nesting, and hibernation activity. Additionally, subsequent to its regional decline, biologists plan to estimate the current population size, develop a long-term management plan for habitat preservation and enhancement, and encourage further study of this unique species at BNL.

Five hognose snakes were collected at BNL for surgical radiotransmitter placement between May and June 2003, and nine between April and June 2004 (two of these nine had also been implanted in 2003). Snakes were housed at BNL prior to surgical radiotransmitter placement at either BNL or WCS.

Radiotransmitters (AVM Instrument Company, Ltd., Colfax, CA 95713 USA or Holohil Systems Ltd., Carp, Ontario KOA 1L0 Canada) were sterilized with either ethylene oxide (Anprolene, Anderson Sterilizer, Inc., Haw River, NC 27258 USA) or benzalkonium chloride (Benz-all, Xtrrium Laboratories, Chicago, IL 60609 USA). Snakes weighed 80 – 450 g, and the radiotransmitters weighed 4.5 – 5.5 g, with a ratio of transmitter to snake weight in the range of 1 – 5%.
Surgical anesthesia was achieved by local administration of 3 – 5 ml/kg of a diluted solution of lidocaine (Lidocaine HCL 2%, RXVeterinary Products, Grapevine, TX 76051 USA) without epinephrine (final lidocaine concentration 0.5%) that was injected s.c. at the incision site, i.m. within the muscle layers below the incision site, and extending s.c. proximally along the antennae tract. Local anesthesia has been successfully conducted in other snake species for surgical radiotransmitter placement as it was in these cases.2,5

Surgical procedures were conducted with the snake in left lateral recumbency after a routine presurgical scrub with chlorhexidine (Nolvasan Solution, Fort Dodge Animal Health, Fort Dodge, IA 50501 USA). A transparent surgical drape was placed over the snake and a 1.5 – 2 cm skin incision made on the right lateral body wall dorsal to the juncture of ventral scutes and lateral scales at approximately 60 – 70% of the snout vent length. The coelomic cavity was entered by blunt dissection between the ribs and the ventral coelomic muscles. Radiotransmitters were inserted into the coelomic cavity and passed distally beyond the surgical site. A 5 French polypropylene catheter (Polypropylene catheter, Sherwood Medical, St. Louis, MO 63103 USA), cut to length of the antennae, was then passed s.c. from the surgical site proximally along the lateral body. The antenna was inserted into the catheter and passed proximally. A stab incision (≤0.5 cm) was made over the proximal aspect of the catheter and it was removed leaving the antennae s.c. Minimal hemorrhage occurred and was controlled with pressure. The coelomic muscle layer incision was closed with one or two simple cruricate 3-0 PDS (PDS, Ethicon Inc., Somerville, NJ 08876 USA) sutures. The stab incision and skin incision were closed with one or two subcuticular 3-0 polydioxanone (PDS) mattress sutures in an appositional or everting pattern. Tissue adhesive (Nexabend liquid topical tissue adhesive, Closure Medical Corp., Raleigh, NC 27616 USA) was applied over both skin incisions and a single s.c. dose of 5 – 10 mg/kg enrofloxacin (Baytril 2.27%, Bayer HealthCare LLC., Shawnee Mission, KS, 66201 USA) was administered.

Snakes were housed at BNL for a several day postoperative (POp) recovery period and were then released at their respective capture sites. Observations demonstrated what was believed to be normal behavior in the snakes. All moved considerable distances after release and within several days began displaying behaviors that were typical throughout the field seasons. This consisted of a pattern of late spring stasis during which they all shed, resumption of movement in early summer, reduction of movement and aestivation from mid-summer to early-fall, and resumption of movement in late fall before hibernating. One snake that was tracked for 2 yr returned to hibernate in the exact same location both years, after moving several kilometers during the active season. During the course of study of these 12 snakes, three were confirmed dead (POp day 37 – 319 due to presumed predation in two cases and vehicular trauma in one). Transmitters were found unassociated with snake remains in three cases (POp day 36 – 130 either a result of transmitter loss from the snake or predation). Three snakes in 2003 were lost to follow up (POp day 23 – 124 due to presumed radiotransmitter failure). Initial information gained from the study will help biologists better manage this at risk species at BNL.
ACKNOWLEDGMENTS

This study was approved by the Wildlife Conservation Society’s Institutional Animal Care and Use Committee (#03-1). We thank the veterinary technicians at the Bronx Zoo’s Wildlife Health Center for their expert assistance and numerous volunteers for field assistance in locating and radiotracking the snakes.

LITERATURE CITED

SOUTHERN SEA OTTERS (*Enhydra lutris nereis*) AND OCEAN HEALTH: THE DIRTY OCEAN HYPOTHESIS

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Abstract

Disease organisms, contaminants and nutrients, all coming from terrestrial sources are very significant contributors to mortality in the southern sea otter population. Mortality due to diseases and parasites, particularly in prime age adult females, are driving population performance. Epidemics of some diseases, and the synergistic effects of pathogen exposure and ecological factors such as density-dependant diet change and nutritional stress, as well as increased exposure to toxins, have resulted in record mortalities in recent years. In the winter of 2004, we brought a group of disease ecology, epidemiology and species experts together to review current information on sea otter morbidity and mortality. From the assembled data it became clear that several anthropogenic sources of pathogen, chemical and nutrient pollution accounted for a very significant proportion of southern sea otter mortality. We believe this is the first demonstration that diseases and a complicated set of land sea connections, a “dirty ocean”, are limiting the potential for recovery of an ESA listed “threatened” and ecological keystone marine mammal species. Sea otters appear to not only be a very sensitive sentinel of this “dirty ocean”, but their health problems help identify specific threats to near shore ecosystems. Some of the problems identified are amenable to immediate improvement, such as enforcement of existing pollution laws, reduction of routes of entry for opossum and cat feces into marine environments, others will be more difficult to fix. We can “save” southern sea otters or move toward population recovery if we can improve the health of their near shore habitats, but this will take significant commitment and investment.

Introduction

Sea otters (*Enhydra lutris*) were hunted to near extinction during the Pacific maritime fur trade. Further hunting was prohibited by international treaty in 1911, at which time a dozen or so remnant colonies survived. The southern sea otter (*E. l. nereis*) is descended from one of these remnant colonies that survived along the Big Sur coastline of central California and contained perhaps fewer than 50 individuals at the beginning of the 20th century. Over the last century the
population has grown slowly, much more slowly than its theoretical maximum, and now numbers approximately 2800.

Coastal oceans are arguably among the most vulnerable habitats to human development. Humans live by the sea in disproportionately large numbers (20 million Californian’s live in its coastal counties), and the coastal oceans are the ultimate receptacles of urban, industrial and agricultural effluents. Furthermore, the coastal oceans are heavily utilized for recreation and food and as a transport medium for the goods and materials needed to fuel a growing global economy. As a high-trophic level obligate near-shore predator, sea otters may be more vulnerable to these activities than most other species, and as such may serve as sentinels of the health of California’s coastal oceans. For these reasons, and because our findings on sea otter mortality suggested terrestrial sources for many pathogens and chemicals, we reviewed the magnitude, patterns and causes of southern sea otter mortality and a growing body of evidence of land-sea connections.

Methods and Results

The participants reviewed numerous published papers\textsuperscript{2-6,9,10} and other unpublished studies. The demographics and population performance patterns of the southern sea otter population for the last century, recent trends in population performance, recent trends in mortality and both general and specific causes of mortality, clustering or mortality, as well as evidence for sources of pathogens and pollutants were reviewed.

Discussion

Overall patterns of mortality in California sea otters are remarkably different from those reported for sea otters elsewhere, typically late winter associated with food deprivation and harsh weather.\textsuperscript{11} In California mortality often peaks in summer and in recent years of record high carcass recovery, an additional spring peak in mortality has also been noted. Another oddity in California is the relatively high probability of death for prime age females. The typical pattern elsewhere is elevated mortality of dependent animals and pups, recently-weaned juveniles and very old individuals, but low mortality for prime-age animals.\textsuperscript{11}

A number of novel diseases, parasites and intoxications have been identified in southern sea otters over the last decade.\textsuperscript{1,6-8,10,12,13} Between 1992 and 2004 approximately 647 southern sea otters received complete postmortem examinations; this represents 29% of all animals whose bodies were recovered during that time period. There are few death assemblages for wild species that are comparable in detail, longevity, and percentage of the population examined. If we assume that sea otters found fresh dead are representative of the population as a whole, during the early to mid 1990s, diseases and parasites accounted for approximately 40% of mortality.\textsuperscript{13} This proportion appears to have increased to 50% for 241 otters examined at the MWVCRC from 1998-2003. When intoxication and all forms of diseases were considered, they accounted
for 64% of 105 sea otters examined between 1998 and 2001. As the leading general cause of death in California sea otters, diseases are an important limiting factor to population growth. Spatial and temporal patterns of protozoal infection and mortality suggest terrestrial sources. Miller et al 2002 showed a clear association between proximity to freshwater inputs into the ocean and proportion of otters infected with *Toxoplasma*. Kreuder et al (2005) reported clusters of mortality from May through November 2000 due to cardiomyopathy and myocarditis just north and south of Morro Bay respectively. Other causes of southern sea otter mortality exhibit similar clustering patterns in embayment areas with adjacent denser human populations.

Although we have significant data suggesting that the “dirty ocean” is central to the southern sea otter recovery problems, some uncertainty remains as to the potential influence of more difficult to detect sources of mortality such as predators that might consume sea otters (like killer whales) and some fisheries interactions. At this point we must conclude that disease and intoxications are significant demographic drivers of the California sea otter population and reflect a pathogen rich environment, but the influence of increased vulnerability due to food limitation, immune dysfunction or some interactive effect of these and other factors remains speculative.

ACKNOWLEDGMENTS

The authors thank Drs. Andy Dobson, Frances Gulland, Rick Ostfeld, Kevin Lafferty, and Mike Murray for their review of and input on this paper’s concept. We thank the staff of the CDFG-MWV/CRC, USGS/BRD and the Monterey Bay Aquarium. Additionally some of our other collaborators, Drs. K. Arkush and M. Griggs, W. Miller, N. Thomas have been the source of various useful insights and concepts.

LITERATURE CITED


GUIDELINES FOR VETERINARIANS WORKING IN LATIN AMERICA

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Abstract

In the last decade many zoos have become interested in establishing international conservation programs, with the objective to assist or direct field studies that may have a major impact in the conservation of wild populations of species of interest, and their environment. Latin America, a biologically rich region is the focus of many of these programs.

Latin America faces many wildlife, livestock and human health challenges as well as unique religious, social and economic realities. There are many government and non-governmental agencies in each country involved in wildlife management, with the challenge of organizing reintroduction programs, rehabilitation centers, and in-situ and ex-situ management of threatened species. As well, local diagnostic capabilities for identification of diseases varies widely across the region. At the same time, an increasing number of conservation biologists in Latin America are seeking input from veterinarians regarding many aspects of wildlife populations health assessment, disease monitoring and management, and hands-on assistance in the capture, restraint, sample collection, laboratory analysis, biotelemetry and handling techniques of wild animals.

It is here where wildlife veterinarians have a significant role to play within interdisciplinary teams working on conservation projects in Latin America. The challenge for veterinarians who wish to work in the region are: to identify colleagues and programs with needs and establish truly collaborative relationships; to understand and correctly address cultural differences; and to comply with international permit requirements and policies. Integration of local expertise in the planning and implementation process is key to the success of the project and will reinforce the long-term conservation efforts in this region.

There are different ways of identifying and contacting scientists or agencies involved with the species, diseases or region of interest, one can contact the national and state universities, and view their publications; another is through wildlife agencies, many of which have documented the priority species in the region and (as is the case in Mexico) put together teams of local specialists in order to work as consultants in the policymaking for the recovery of that species or taxon (e.g., Programa de Recuperación de Especies Prioritarias. http://www.semarnat.gob.mx). Another way of approaching this is through the Conservation Breeding Specialist Group (CBSG), which has conducted several Conservation Assessment and Management Plans (CAMP) and Population and Habitat Viability Assessment (PHVA) workshops in Latin-America,
assembling nearly 40 regional experts (wildlife managers, IUCN Specialist Group members, representatives of the academic community or private sector, researchers and captive managers) in each workshop to evaluate threat status of all taxa in a broad taxonomic group. The reports of the CAMPs and PHVAs which include contact information for the participants, are available via the web (http://www.cbsg.org/index.scd).

Projects must obtain permits for the capturing and sampling (Colecta Científica) of the species; a CITES permit for the movement of samples across international borders, and in some instances, an animal health permit, depending on disease issues in the region. You will need to contact the wildlife agency in the country, (which is usually the CITES authority) to obtain permits. Pending any concerns regarding the project, the agencies usually issue permits within 15 – 30 days, and in many countries permits are good for 6 mo. In some instances export permits can only be acquired in the host country when an exact count of the type and number of samples is known, so plan to spend some days in the capital city obtaining the official papers. Many countries have this information available via the web (e.g., http://www.semarnat.gob.mx)

Some authorities will only accept paper work in native language, will require a government biologist or ecologists to accompany you during the field trip, and will expect a complete report 15 days after the importation has occurred, with an official stamp from the last port of embarkation, so do no forget to pass the review point in the airports to get your permit stamped.

It is important to remember that many parts of Latin America are engaged in active campaigns to eradicate diseases of domestic animals, and therefore, within a country one can find many “borders” for limiting the spread of diseases. Having official letters from the institution you represent as well as the local institutions you will be working with, describing the nature of your work, the names of the participants and the equipment you are carrying will help you pass through the check points.

In developing countries, issues of poverty and rural development are intertwined with those of biodiversity conservation. Protected areas in Latin America are facing a whole host of problems such as emerging disease transmission, vulnerability of concentrated populations, natural and human disasters, etc. These facts are compelling reasons to increase the involvement of the veterinarian community in conservation efforts. Wildlife veterinarians can contribute in a significant manner to the planning and implementation of wildlife conservation projects. Remember that “what we know we have learned from others”. More and more institutions are investing in training foreign professionals: this has steadily increased the numbers of highly competent professionals dedicated to the discipline in Latin America.

Foreign veterinarians can play an important role in wildlife conservation projects in Latin America as long as they are culturally sensitive. From the drinking of mate in Argentina, to the official siesta in Central America, each country has its own cultural traditions and idiosyncrasies, differences that should not be undervalued. Your performance as a person and scientist will have
an impact on opportunities for other and future researchers, and, can open or close doors for
them. Striving to establish collaborative relationships, instead of having an imposing approach
can make the difference. Remember that such things as ownership of intellectual material or
authorship in publications are handled differently in other countries, and if these issues are not
addressed properly, the outcome for the project may not be good. Consider publishing your
collaborative research in a regional journal, you would be surprised by the quality of the peer
review.

Survive and enjoy your trip. Consult political and important disease matters maintaining a
serious and not alarming point of view. Remember that learning as much as you can about the
country you will be visiting can give you a broader understanding of the challenges you will
face. Always keep an open mind to learn different ways of doing things. Move your boundaries
and aim to participate effectively in in-situ wildlife conservation projects in Latin America while
you share and learn at the same time.

LITERATURE CITED

training visiting professionals, and performing workshops abroad can help rob Peter to pay Paul. Proc. Am.
HEALTH SURVEY OF MANED WOLVES (*Chrysocyon brachyurus*) AND DOMESTIC DOGS IN THE NÖEL KEMPFF MERCADO NATIONAL PARK, BOLIVIA

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Abstract

The threat of disease transmission from domestic animals to wildlife has become an increasing concern in recent years.3 Domestic dogs pose a significant risk as reservoirs of infectious diseases for wildlife4 and have been implicated in epidemics in African lions (*Panthera leo*),7 Ethiopian wolves (*Canis simensis*),6 and African wild dogs (*Lycaon pictus*).1,5 The objective of this study was to determine the prevalence of exposure to select infectious and parasitic agents of maned wolves (*Chrysocyon brachyurus*) within the Nöel Kempff Mercado National Park, Bolivia (NKMNP) and the domestic dogs surrounding the park and is part of a larger study examining the ecology, genetics, and health of the maned wolves within NKMNP.2 Five maned wolves were sampled during six anesthetic events within NKMNP from 2000-2004. Blood from 17 adult domestic dogs from a village bordering the park were also sampled. Results are presented in Tables 1 and 2. There was evidence of exposure in the maned wolves to many common canid pathogens, most notably canine distemper virus, canine parvovirus, canine adenovirus, and *Dirofilaria immitis*. A high percentage of the domestic dogs tested also had evidence of exposure to many of these same pathogens. The results of this survey provide evidence of exposure to multiple common infectious agents in the domestic dog populations around the NKMNP and in the maned wolf population within the park.

LITERATURE CITED


Table 1. Results of serologic testing for select infectious and parasitic disease agents in six samples from maned wolves in Nöel Kempff Mercado National Park, Bolivia.

<table>
<thead>
<tr>
<th>Animal ID</th>
<th>Disease agent</th>
<th>Methodology&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Occult</th>
<th>IHA</th>
<th>RFFIT</th>
<th>SN</th>
<th>SN</th>
<th>SN</th>
<th>F/A1</th>
<th>SN</th>
<th>Slide Aggl./AGID II</th>
<th>Microagglutination</th>
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<td><em>Dirofilaria immitis</em></td>
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<td>1:6</td>
<td>1:8</td>
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</table>

<sup>a</sup>IHA – indirect hemagglutination; RFFIT – rapid fluorescent focus inhibition test. SN – serum neutralization; HAI – hemagglutination inhibition; Slide Aggl./AGID II – slide agglutination/agar gel immunodiffusion test II.

<sup>b</sup>Non-applicable.
Table 2. Results of serologic testing for select infectious and parasitic disease agents in 17 domestic dogs near the border of the Noel Kempff Mercado National Park, Bolivia.

<table>
<thead>
<tr>
<th>Animal ID</th>
<th>Disease agent</th>
<th><em>Dirofilaria immitis</em></th>
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<th>Rabies</th>
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<th>Canine herpesvirus</th>
<th>Canine distemper virus</th>
<th>Canine parvovirus</th>
<th>Canine coronavirus</th>
<th>Canine brucellosis</th>
<th><em>Leptospira interrogans</em> serovars</th>
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<sup>a</sup>IHA = indirect hemagglutination; RFFIT = rapid fluorescent focus inhibition test; SN = serum neutralization; HAI = hemagglutination inhibition; Slide Aggl / AGID II = slide agglutination / agar gel immunodiffusion test II.

<sup>b</sup> Non-applicable.

<sup>c</sup> Animal vaccinated against rabies 4 yr before sampling.
INVESTIGATION OF AVIAN PATHOGENS IN BACKYARD CHICKENS OF NORTHWESTERN ECUADOR

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Abstract

Habitat loss is one of the leading causes of declines of wild animal populations. In the last 20 yr, it has become clear that disease poses a serious threat to natural populations, especially those that are endangered, occasionally leading to significant declines or extinctions. Disease in wild animal populations has also been recognized as playing an important role in natural systems, often altering ecological communities. Currently, the literature reflects numerous examples of disease causing significant declines in wild animal populations. Among birds alone, avian malaria and pox in Hawaii, and West Nile virus and Mycoplasma conjunctivitis in North America, have caused significant population effects in susceptible species. Extinction resulting from habitat loss/fragmentation is well documented, and such land-use changes have also been shown to result in the creation of new and different host-pathogen relationships.

A growing area of research within the field of disease ecology is aimed at understanding the direct relationship between disease and anthropogenic activity, which we now understand to play a significant role in wildlife health and its conservation. A variety of mechanisms have been proposed for this relationship, including: 1) the introduction of pathogens into new geographic areas, 2) the alteration of habitat which changes the ecology and/or range of a pathogen or its vector, 3) alterations in habitat that have increased the contact between wildlife and domestic animals, or 4) alterations to climate that affect either the pathogen virulence or the host’s immune response. However, to date, there are few examples where avian biodiversity declines due to disease were investigated in the context of habitat change.

The overall goal of our long-term project is to investigate how specific land use changes affect the health status of avian communities in a rural region of Ecuador. We are testing the hypothesis
that anthropogenically affected habitats can change the susceptibility of a host to infection (through an increase in physiologic stress to the individual host, or through diminishing genetic heterogeneity in a population), the exposure of a host to a pathogen (through an increase of the contact rate between humans/domestic animals and wild birds, introduction of novel anthropogenic pathogens or increasing the range of vectors that transmit disease through microclimatic changes) or change the transmission potential of a pathogen (through the addition of bacterial genetic material in an environment that facilitates a change in virulence for bacteria).

In Ecuador, a recent increase in the extent of human encroachment in the region surrounding the Maquipucuna Reserve has led to the degradation of forests, the introduction of domestic animals (including free-roaming chickens) and mismanagement of human/animal waste. For these reasons, we have chosen this area as our study site.

Backyard chickens may serve as potential pathogen reservoirs for wild birds in Maquipucuna. Our pilot study aimed to survey for avian pathogens present in the ecosystem by assessing the health of backyard chicken flocks. Ten flock owners living around the edge of Maquipucuna Reserve were interviewed to obtain information on flock management and husbandry. The mean flock size was 20 birds, and most birds were kept for eggs and meat, for either domestic consumption or local sale. Chickens were either sold at 24 mo or slaughtered at 36 mo. Vaccination rates were low, with most owners not vaccinating at all, and some vaccinating with one product either sporadically or annually. No owners deparasitized their animals. Mortality rates of offspring were reported as high as 50%, often associated with diseases causing neurologic signs, sudden death or respiratory problems. In addition, most owners reported observing epizootics of skin lesions consistent with avian pox. Most owners complained of their lack of knowledge about diseases affecting their chickens and lack of veterinary advice.

We conducted physical examinations and collected blood and ectoparasite samples from 100 randomly-selected birds from 10 flocks. Commercial enzyme-linked immunosorbent assays (ELISA) on all sera revealed that the backyard chicken population showed evidence of exposure to the following avian pathogens: infectious bursal disease virus (100%), avian encephalomyelitis virus (92%), chicken anemia virus (90%), infectious bronchitis virus (85%), Newcastle disease (97%), *Mycoplasma gallisepticum* (73%), and *M. synoviae* (68%). Twenty percent of animals were reported positive for avian influenza; however, testing artifact might account for these results. Necropsy and limited fecal examinations found low levels of internal parasitism, with cestodes, and ascarids identified as the most prevalent endoparasites. Ectoparasites were noted on all animals and identified as *Dermanyssus gallinae*, and *Ornithonyssus bursa*. Most of the animals (90%) had mild-moderate feather mite infestations.

The poultry diseases to which sampled chickens had been exposed are likely the cause for the high mortalities reported by local flock owners. Because wild birds are susceptible to some poultry diseases, free-roaming chickens might be potential vectors of pathogens that could affect wild birds. Subsequent to this pilot study, we will examine the disease prevalence and diversity of distinct avian communities inhabiting four land use types (“eco-friendly” agricultural land,
traditional agricultural land, secondary growth and primary growth forests). Specifically this project will examine a variety of indices to generate a “health score” for these avian communities, in order to correlate their health status with the degree of anthropogenic disturbance.

**ACKNOWLEDGMENTS**

The authors would like to thank the Maquipucuna Foundation for logistic support of this project and the following sponsors for providing financial support: Neurocare Consultants, Palm Beach, Florida; Bankers Equity, Athens, Georgia; Centurion Poultry, Athens, Georgia; HOPE Animal Medical Center, Athens, Georgia; Jittery Joe’s, Athens, Georgia; and Sigma XI Grants-In-Training. We would particularly like to acknowledge the chicken owners and the Santa Marianita community; without their trust and enthusiasm, this project could not have been realized. We would also like to thank Dr. Bolivar Valencia, who provided us with further logistic support in Ecuador.

**LITERATURE CITED**

HEALTH SURVEY OF FLIGHTLESS CORMORANTS (Phalacrocorax harrisi) AND GALAPAGOS PENGUINS (Spheniscus mendiculus) IN THE GALAPAGOS ISLANDS, ECUADOR

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Abstract

Since 2001, the Saint Louis Zoo, the University of Missouri – Saint Louis, the Charles Darwin Research Station, and the Galapagos National Park have collaborated on an avian health survey of multiple endemic species in the Galapagos Islands.1-3 As part of this survey, flightless cormorants (Phalacrocorax harrisi) and Galapagos penguins (Spheniscus mendiculus) have been evaluated every 6 mo since August 2003, with the goal of determining baseline hematology and biochemistry values, as well as disease prevalence. Morphologic data, blood, feces, conjunctival-choanal-coacal swabs, and ectoparasite samples have been systematically collected. This is the first time that comprehensive health evaluations have been conducted on the endangered flightless cormorant and Galapagos penguin.

Many of the 70 blood samples collected from the cormorants in 2003, and the 134 blood samples collected from the penguins in 2003 and 2004 have undergone complete blood counts (CBC), biochemistry analysis, and blood smear evaluations for hemoparasites, as well as extensive disease serology. Serologic tests were conducted for 14 different viruses, including West Nile virus, and for Chlamydia psittaci. Both bird populations appeared healthy on visual exam without clinically significant findings on CBC or biochemistries, except for some degree of eosinophilia. Flightless cormorants were seropositive for adenovirus type 1. Antibodies for C. psittaci were detected in both cormorants and penguins, while antigen was detected in the cormorants. Blood smears for many birds of both species revealed microfilarids.
LITERATURE CITED


GUIDELINES FOR VETERINARIANS WORKING IN CENTRAL ASIA

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Abstract

The new World Zoo and Aquarium Conservation Strategy (WZACS)4 clearly outlines the key role zoos and aquaria can and must play in order to participate to their full potential in the global conservation coalition. In order to become a major force in global field conservation, zoos and aquaria will have to create and support field conservation units of multi-disciplinary professionals. Zoo and wildlife veterinarians are especially acknowledged as a profession that can actively contribute to field conservation. The purpose of our presentation is to use our work in Mongolia as an example of minimum guidelines for zoo and wildlife veterinarians who wish to work in this area of the world.

Mongolia occupies an area of 1,565,000 km² and is bounded on the north by Russia and on the south by China. Located deep within the interior of eastern Asia far from any ocean, Mongolia has a marked continental climate, with long, cold winters and short, cool to hot summers. The average yearly temperature lies below freezing. Mongolia is highland country, with an average altitude of 1,585 m above sea level. Eighty percent of Mongolia's area consists of pasturelands, which support immense herds of grazing livestock; the remaining area is about equally divided between forests and barren deserts, with only a tiny fraction of the land in crops. With a total population of slightly more than 2 million, Mongolia has one of the lowest population densities of any country in the world.3 Whereas in past years, numerous conservation projects have trained local wildlife biologists, the country today still lacks trained wildlife veterinarians and increasingly relies on international experts in order to perform routine procedures.

It is essential that at the onset of any project local stakeholders are informed and sought as partners. These are possibly difficult to identify from abroad and therefore the integration of local knowledge in the planning phase becomes essential. Local scientists are easily contacted through the respective universities and local non-governmental organizations. Similar to many other countries in central Asia and in contrast to many African countries, Mongolia does not have a wildlife unit or service. The responsibilities are fragmented between the Ministry of Nature and Environment, the Academy of Sciences and the Mongolian National Commission for the Conservation of Endangered Species.
As in many former Soviet systems, knowledge is an important individual bartering tool and therefore is initially not made readily available; having to buy information not revealed in a previously published paper from a university researcher is not unheard of. This fact can lead to the duplication of efforts and inordinate frustration. Integrating alternative sources of information such as web-based forums offers direct uncensored information and facilitates the integration into the local scientific community (e.g., http://www.steppeforward.com/MongolBioweb.htm). Plan to actively participate in local scientific meetings. These can be official congresses and meetings but also regular networking events that bring biologists in Mongolia together to share ideas, initiate collaborations and transfer information in a relaxed atmosphere (e.g., BIOBEERS http://www.steppeforward.com/Biobeers.htm). As has been described previously by many authors, integrating a training program in your project will greatly enhance the value and will contribute towards a sustainable long-term approach.\textsuperscript{1,2}

A frank and honest discussion at the onset over issues relating to the ownership of the intellectual material and samples that issue from a collaborative project has proven very beneficial. The local rules governing authorship may possibly diverge from those in your own scientific community and should not be disregarded. Publishing in local journals (e.g., Mongolian Journal of Biological Sciences; http://www.steppeforward.com/journal.htm) and the local language will greatly enhance the value of the project and will directly benefit the local scientific community. The value of the web in making reports and documents available to a wider local community should not be overlooked.

Though obtaining the required permits (CITES, sanitation, capture etc.) for the various aspects of the work can be extremely time consuming and laced with frustrations, in the long run it is advisable to adhere to these regulations. Plan the costs and time for acquiring these in your project plan. Always consider a “Plan B” for in-country sample storage in case permits do not become available.

When working in the remote field, be aware that in many instances you will have to be self-sufficient in all aspects. This includes not only personal health issues but also in many cases the health of others; being prepared to help can be vitally important in many situations. A minimal understanding of mechanics, good navigation, outdoor and survival skills can in some situations become of utmost importance. Local knowledge in these areas is, in the authors’ view, often vastly overrated and it appears wise to plan to be self reliant and able to assist others in your party.

In order for a conservation project to be successful it will be essential to integrate many diverse issues. These can include diverse issues such as: poverty alleviation, rural development, empowerment of local stakeholders and communities, educational and medical requirements. In order to address these issues with the same rigor as the scientific aspects of the work, alliances and cooperations will have to be sought out. Realizing that no single discipline holds the solution to maintaining the health, welfare and conservation of wildlife species and habitats, the
establishment of truly multi-institutional transdisciplinary teams that perform effective and harmonious teamwork paired with seamless communication appears elemental. Long-term collaborations in which all partners understand and address the respective culturally and economically driven differences can be extremely fruitful and will contribute significantly to the conservation effort.

Veterinarians working in the field need substantial biological background, and veterinary knowledge and experience. But in order to be an asset to global conservation efforts, they also need to be versed in social, political and economic principles. The scale of the task in all cases greatly exceeds the purely scientific – veterinary aspects and must be appreciated as lasting conservation outcomes require wildlife rangers and park staff to be trained and developed, local communities encouraged to participate, and governments and donors persuaded to provide support.4

LITERATURE CITED

HEALTH AND MANAGEMENT OF WORKING ELEPHANTS IN MYANMAR (BURMA)

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Abstract

Myanmar has approximately 6,000 working elephants. Remaining wild elephants are declining, partly because of live-capture for captivity. Through health and reproductive assessments, genetic analyses and GPS tracking of captive and wild elephants, we are exploring linkages between the two populations and conducting studies to reduce morbidity and mortality of captive elephants. Captive elephants live and work in Myanmar’s forests in close proximity and contact to the remaining wild herds. We propose that reducing morbidity and mortality in the captive elephants will decrease the need for live-capture, and the risk of disease transmission, to wild elephants.

Introduction

There are an estimated 6,000 working elephants in Myanmar – half owned by the government operated Myanmar Timber Enterprise (MTE) and half owned privately.5 This may be one of the largest captive elephant populations in the world and its management will have a significant impact on remaining wild herds in Myanmar.4,6,8 With mortality rates higher than birth rates, the working population is probably maintained by supplementing it with elephants captured from the wild.5 There is evidence that continued harvest of wild elephants may have reduced the remaining wild populations of Myanmar. Recent surveys of wild populations in two of Myanmar’s protected elephant ranges revealed extremely low dung counts, indicative of small and declining herds. Constant contact with captive elephants in Myanmar’s forests may exacerbate the threat to Myanmar wild elephants by increasing the transmission of disease between these two groups. For both the above reasons, we believe that the conservation of wild elephants in Myanmar will require significant improvements in the care and management of currently existing captive populations.
Elephants owned by MTE receive veterinary care from the Burmese veterinarians that work for the timber company and travel extensively throughout the country to sites were the elephants are located.¹ There is a dire need for veterinary supplies and laboratory capabilities in the country. Currently, veterinary practices are based on the extensive field experience of lead MTE veterinarians. However, MTE veterinarians frequently rely on older published work³,⁷ and would benefit significantly from training that incorporates new insights into elephant health and new veterinary techniques. Similarly, because of their close-up experience of elephant health problems in the forests, MTE veterinarians may be able to make important new contributions to the care and management of elephants elsewhere.

The overall objective of our study is to work jointly with MTE veterinarians to develop long-term captive population management strategies to reduce mortality and increase births in the working timber elephants and stop the continued off-take of animals from the wild to supplement captive herds.

**Methods**

The health component of this study has five major objectives. These are to:

1. Conduct a training workshop, in conjunction with MTE veterinarians, on elephant management and veterinary care.
2. Develop protocols so that the MTE veterinarians can collect samples for reproductive, genetic, and health status assessments.
3. Analyze samples and provide data to MTE veterinarians to improve husbandry, preventive care and disease treatment of working elephants.
4. Develop a comprehensive bibliography of all published information on the health and management of Myanmar elephants.
5. Perform an epidemiologic evaluation of records available on the historic and current working elephant population.

Specific steps to achieve these objectives include:

1. Determine causes and rates of morbidity and mortality of captive MTE elephants.
2. Determine causes of low rates of reproduction in captivity.
3. Develop a genetic profile of the captive herds.
4. Develop a protocol to assess oozies—Burmese mahout—expertise in parallel with endocrine and health assessments to determine quality of care and potentially related stress.
5. Develop small population viability models to assess how current mortality effects long-term survival of the captive population and what supplementation from the wild is needed for short- and long-term sustainability.
6. Use population viability models to demonstrate how supplementation from the wild will negatively affect that population.
7. Get baseline health parameter data on free-ranging elephants.
8. Quantify habitat/space use using GPS and satellite tracking of captive and wild elephants.

Results and Discussion

During an initial exploratory visit in November 2004, we learned that the annual mortality rate for MTE working elephants was 2.4% (66) in 2003. Deaths occurred in all age groups (>18 yr, n = 40; 4 – 17 yr, n = 11; <4 yr, n = 15) and included preventable diseases (i.e., poor nutrition, heat stroke, diarrhea, dystocia, infectious and parasitic agents). Additionally, we collected samples for performing health, genetic and endocrine analyses of 22 elephants maintained in one of the working camps (results to be presented). A relationship also was established with the veterinary staff at the Yangon Zoo, including follow up donations of veterinary literature and journals to the zoo. We provided medical advice for the care of an orphaned elephant calf and other animals housed at the zoo during our brief visit. We are seeking funds for a training course to be conducted in late 2005 and hope to perform health evaluations on a larger number of zoo and working elephants during that visit.

The National Zoo already has an extensive conservation program for wild elephants in Myanmar. This program has focused on assessing wild elephant populations in protected areas and satellite-tracking of four wild elephants to learn more about their conservation status and ecology in Myanmar. Currently this work is being extended to a national elephant survey. Part of this work included collecting fecal samples for genetic and health assessments.

The Smithsonian team of researchers involved in this project includes a veterinarian, reproduction physiologist, geneticist, conservation biologist, and landscape ecologist. All members of this multidisciplinary team have extensive experience working with elephants and together provide the necessary expertise to study and understand the numerous factors affecting Myanmar’s captive elephants and the long-term survival of elephants in Myanmar. These challenges range from human land use and elephant population fragmentation, human-elephant conflict, poor reproduction and health care of captive elephants and lack of information on the health status of the wild elephants. A viable conservation initiative for the elephants of Myanmar requires that health issues be addressed as one component of a comprehensive program to address the anthropogenic pressures on both working and wild elephants.

The elephants of Myanmar are an excellent example of the fine line that exists between captive and wild animals, especially as it relates to health. Captive and wild elephants are regularly in direct and indirect contact. The working elephants live with their oozies who may expose them to diseases, such as tuberculosis. The working elephants in turn may encounter wild elephants at night in the forests where they forage and live during non-working hours. In fact, the majority of captive born calves are said to be sired by wild bulls. Potentially, the use of working elephants
in selectively extracting valuable timber provides new strategies for the conservation of elephants and forests. Most likely, “elephant-logging” is less damaging than machine-operated timbering projects that tend to clear-cut areas and also damage the soil and streams. However, decreasing the negative impact of such practices (i.e., minimizing off-take of elephants from the wild, decreasing disease risks to the wild elephants) is imperative.

LITERATURE CITED

SUCCESSFUL USE OF PUP FOSTERING TO INCREASE SURVIVAL OF ENDANGERED CHANNEL ISLAND FOXES (*Urocyon littoralis*)

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Abstract

Four subspecies of the Channel Island fox (*Urocyon littoralis*) were listed as endangered under the Federal Endangered Species Act on March 5, 2004 due to serious declines in populations over the last decade.¹ One of the four listed subspecies, *U. littoralis catalinae*, is present on Santa Catalina Island where the population declined by approximately 90% in 1999. This decline was believed to be the result of an outbreak of canine distemper.² One aspect of population recovery efforts on Santa Catalina Island was a captive breeding program which incorporated monitoring of dens with a closed-circuit video system. During 2001 and 2002 we observed certain mothers in the facility demonstrating negligent, rejection, or aggressive behavior that resulted in pup deaths. In 2002 these behaviors resulted in the deaths of 6 neonates (43% of total pups born that year). Because of the very small population size of foxes on Santa Catalina Island, and our desire to maximize productivity at the captive breeding facility, we instituted a program to intervene in circumstances where the female demonstrated inappropriate parental behavior. Though fostering of pups into new litters had never been utilized in this species, we believed that previous pup losses justified attempting this intervention technique.

Based on our behavioral observations in 2001 and 2002 we developed specific protocols for making the decision to intervene, nursing pups till fostering occurred, choosing an appropriate foster litter, and introducing pups to new litters. In the combined 2003 and 2004 breeding seasons intervention was undertaken to assist eleven fox pups in four litters. We successfully fostered eight pups from three females into the litters of five other females. All foster females accepted the new pups immediately and did not show any rejection or aggressive behaviors toward them. For the other three pups, intervention was undertaken due to the female spending inadequate time with the pups but otherwise exhibiting normal behavior toward them. Though we believe fostering would have been a successful option, we chose to first closely confine this female to the immediate vicinity of the den and to temporarily remove her mate. After these steps were taken this female spent adequate time with her pups. All eleven pups that received additional care were successfully raised to weaning. We believe these results suggest that fostering and other interventions can increase survival of young in captive breeding programs for this species if close observation and rapid response to abnormal parental behavior are employed.
LITERATURE CITED

ASSESSMENT OF VIRAL PRESENCE IN SEMEN AND REPRODUCTIVE FUNCTION OF FROZEN-THAWED SPERMATOZOA FROM PALLAS’ CATS ( Otocolobus manul) INFECTED WITH FELINE HERPESVIRUS

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Abstract

Feline herpesvirus type 1 (FHV-1) infection can produce acute clinical disease characterized by upper respiratory tract and ocular signs or a latent carrier state with periodic viral reactivation and shedding. It is unknown if this virus is shed in semen of infected cats, as has been reported for herpesviruses in other mammalian species. In the present study our objectives were to: 1) assess in vitro motility, acrosome status, and function of frozen-thawed Pallas’ cat spermatozoa, and 2) investigate the presence of FHV-1 DNA in seminal fluid and frozen-thawed spermatozoa of Pallas’ cats, inseminated domestic cat oocytes, and hybrid embryos formed by heterologous in vitro fertilization (IVF).

Over a 3-yr period (2000-2003) semen was collected periodically from four male Pallas’ cats infected with FHV-1. A total of 33 ejaculates were recovered from anesthetized males using a standardized electroejaculation protocol.1 Aspermic ejaculates (n = 16) were centrifuged (1700 X g) and cell-free supernatants frozen for FHV-1 DNA detection using PCR. Spermic ejaculates (n = 17) were diluted in cryoprotectant (Test egg yolk w/ 4% glycerol), slowly cooled to 4˚C, and frozen by pelleting on dry ice before storage in liquid nitrogen. For IVF, frozen sperm samples were thawed, centrifuged, and resuspended in equilibrated Ham’s F10 medium. Sperm motility and acrosome status were assessed in microdrops (2 × 10^6 motile sperm/ml) under oil (38˚C; 5% CO₂ in air) at 0 – 6 hr post-thaw and a sperm motility index [SMI = % progressive motility + (20 x rate of progressive motility)/2] calculated for each time point. Mature domestic cat oocytes, recovered laparoscopically from females treated with exogenous gonadotropins, were inseminated with frozen-thawed spermatozoa (5 × 10^5 motile sperm/ml; 10 – 17 oocytes/sample), cultured (38˚C; 5% CO₂ in air) for 48 hr, and then evaluated for embryo cleavage. All oocytes, embryos, and aliquots of frozen-thawed spermatozoa were frozen for detection of FHV-1 DNA using PCR. For FHV-1 PCR, DNA was extracted from cell-free seminal fluid samples (16 ejaculates), frozen-thawed spermatozoa (17 ejaculates), noncleaving domestic cat oocytes (n = 107), hybrid embryos (n = 89) formed by heterologous IVF, and
bilateral conjunctival biopsies (n = 28) and analyzed for presence of a 322 base-pair fragment of the FHV-1 thymidine kinase gene. This protocol reliably detects ≥ 240 copies of FHV-1 DNA.

Sperm pellets from each ejaculate were thawed to assess post-thaw sperm motility and function. For pre-freeze ejaculates, SMI averaged (± SEM) 71.6 ± 1.4 and 94.8 ± 1.0 % of acrosomes were intact. Immediately post-thaw, SMI was decreased (P < 0.05) to 52.8 ± 2.7 with fewer (P < 0.05) acrosomes (39.0 ± 3.4%) classified as intact. Values for both parameters continued to decline (P < 0.05) over 6 hr of culture (20.7 ± 1.4, SMI; 32.1 ± 3.5%, acrosome intact). All frozen-thawed samples (n = 16) used for IVF fertilized domestic cat oocytes, based on embryo cleavage within 48 h of insemination. Cleavage percentage ranged from 13 – 80%, with a mean value (± SEM) of 46.1 ± 6.0%. PCR analysis of seminal fluid, frozen-thawed spermatozoa and inseminated oocytes/embryos did not identify FHV-1 DNA in any sample. However, FHV-1 DNA was identified in all four males from a total of 13 conjunctival biopsies collected at the time of electroejaculation.

In conclusion, we were unable to detect cell-associated or non-cell-associated FHV-1 DNA in semen collected from male Pallas’ cats chronically infected with FHV-1. We also demonstrated that frozen-thawed Pallas’ cat spermatozoa exhibit adequate function after thawing to fertilize viable cat oocytes. Together, these results suggest that frozen-thawed spermatozoa from FHV-1-infected male Pallas’ cats may be used in females with minimal risk of transmitting FHV-1 to naïve individuals. These findings also may have positive implications for other cat species, such as domestic cats and cheetahs, which are infected with FHV-1.

LITERATURE CITED
A NEW REVERSIBLE MALE CONTRACEPTIVE: OPEN-ENDED VASECTOMY AND MICROSCOPIC REVERSAL

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Abstract

The open-ended vasectomy is a technique used in humans. Options for temporary contraception in males are limited, and the reversible vasectomy is the only method currently available method that does not impact behavior. The key to ease of vasectomy reversal is allowing sperm to leak from the distal end and form a pressure-relieving granuloma, yet at the same time sealing the proximal end securely enough (through needle cauterity) that spontaneous recanalization with failure of the vasectomy does not occur. This latter technique prevents the buildup of pressure in the testis, thereby preventing damage to the male’s reproductive capacity. This technique and the microscopic reversal of this surgery are associated with 90% reversal success (i.e., ability to impregnate partner post reversal surgery) in humans.1

Open-Ended Vasectomy Procedure

The typical midline incision used in neutering and vasectomy procedures is not used as this technique results in difficulty in freeing the proximal end of the vas deferens during the subsequent reversal procedure. With a scalpel and the aid of vasectomy clamps, the vas can be isolated from the cord via a small incision in the upper scrotum or at the external inguinal ring. In humans the incision is always less than 3 mm in their very thin scrotal sac skin. In many other animals, however, the thickness of the scrotum precludes this approach and it is best to make a 1 – 1.5 cm incision over the external inguinal ring. The vas is exposed and transected, and the abdominal (proximal) cut end of the vas deferens is cauterized by inserting a needle electrode about 1 cm internally. If only the mucosa is cauterized, and the muscle is unharmed, a very tight seal will form. Do not cauterize or ligate the scrotal (distal) cut end of the vas deferens; the distal end is left open to leak and release pressure.

Microscopic Vasectomy Reversal Procedure

Using a scalpel, make an approximately 5 cm (total length) incision over scrotum (2.5 cm) and extend over to groin (2.5 cm). Bluntly dissect the vas deferens (longitudinally) with blunt nose small scissors (e.g., iris scissors). Free the vas deferens and place a small Penrose drain underneath to facilitate dissecting it from the cord. Free the vas deferens ends and secure the ends with vasovasostomy clamps. Resect the scarred ends of both sides of the vas deferens.
Aspirate translucent fluid from the distal cut end and check for the presence of sperm. Absence of sperm indicates that there is epididymal blockage, and vasovasostomy therefore cannot work. Vasovasostomy is completed with 9-0 nylon interrupted sutures, three in the mucosa and six in the muscularis.

We now are recommending that surgery be performed not as in humans (through the scrotum), but rather at the external inguinal ring. This will allow easier exposure of the vas, and avoid possible damage to the delicate scrotal blood supply. Also, we do not believe that an operating microscope is necessary for the microsurgical vasovasostomy; it would be easier and far less expensive to use high power loupe magnification for this. However, without the open-ended vasectomy, with subsequent epididymal obstruction, an operating microscope would be absolutely mandatory.

LITERATURE CITED

CONSERVATION SCIENCE IN A TERRORIST AGE: THE IMPACT OF AIRPORT SECURITY SCREENING ON VIABILITY AND DNA INTEGRITY OF FROZEN FELID SPERMATOZOA

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Abstract

In response to growing terrorism concerns, the Transportation Security Administration (TSA) now requires that all checked baggage at U.S. airports be scanned through a cabinet x-ray system, which may increase the risk of radiation damage to transported biologic samples. Ionizing radiation, such as X-rays, potentially may cause both double-strand (DS) and single-strand (SS) DNA breaks. Gametes are particularly susceptible to radiation-induced damage due to reduced capacity of DNA repair mechanisms. Of particular concern, DNA damage in gametes or embryos may produce inheritable defects in resulting offspring. Other aspects of gamete function, such as sperm motility, also may be directly or indirectly affected by DNA damage. The objective of this study was to investigate the effect of these new airport security regulations on the viability and DNA integrity of frozen felid spermatozoa. Semen was collected from two domestic cats (Felis silvestris catus) and one fishing cat (Prionailurus viverrinus), cryopreserved in plastic freezing straws, and transferred into liquid nitrogen dry shippers for security screening. Treatment groups included frozen sperm samples from each male scanned once or three times using a TSA-operated cabinet x-ray system, in addition to non-scanned samples (i.e., negative control) and samples, previously scanned three times, exposed to five additional high intensity x-ray bursts (i.e., positive control). Dosimeters placed in empty dry shippers were used to quantify radiation exposure. Following treatment, semen straws were thawed and spermatozoa analyzed for post-thaw motility (percent motile, rate of progressive movement), acrosome status, and DNA integrity using single-cell gel electrophoresis (i.e., the comet assay). Dosimeter measurements determined that each airport screening procedure produced ~16 mRem of radiation exposure. Our results indicated that all levels of radiation exposure adversely affected (P < 0.05) post-thaw sperm motility. However, there were no differences (P > 0.05) in percentage of acrosome intact spermatozoa among treatment groups. Results also showed that the amount of double stranded DNA damage was greater (P < 0.05) in sperm samples from both cat species scanned three times compared to samples scanned once or negative controls. Our findings demonstrate that new airport security measures may cause radiation-induced damage to frozen felid spermatozoa and suggest that similar damage may occur in other valuable biologic samples when transported on passenger aircraft. We recommend that alternative modes of sample transportation should be used whenever possible.
ACKNOWLEDGMENTS

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LITERATURE CITED

BEST PRACTICES: IDEAS FOR IMPROVING BIG CAT CARE

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Abstract

Best Practices are standards set and methods employed by various zoological institutions, sanctuaries, and private individuals for the care, husbandry, and housing of big cats. Big cats, for the purpose of this paper, include all species of leopards, tigers, lions, jaguars, cougars, and cheetahs. These Best Practices typically exceed the minimum standards set by the USDA Animal Welfare Act for the care and housing of big cats.

Enclosure designs for big cats employ a variety of elevations, vegetation, and water elements, making the environment pleasing for both big cat and viewing public alike. While ample space is desirable, providing elements such as water for the species that like to swim, such as tigers, and tree branches for the arboreal species, such as jaguars, contribute to the appeal of the enclosure and provide enrichment for the animals that live there.

Housing non-domestic cats properly may be a challenge. Fencing should be designed to be strong enough to safely hold the species if hit with full force. There is no written standard for fence height other than it must be appropriate for the species and must securely contain the animal. Tigers have been seen jumping as high as twelve feet in the air. Many curators at larger facilities agree that tigers and lions require fencing height in excess of 14 feet high for safe containment. Many institutions house tigers and lions behind 18-foot-tall reinforced cyclone fencing with kick-ins at the top or behind a moat surrounded by smooth cantilevered walls. Climbers and jumpers (such as cougars or leopards) require a completely enclosed exhibit. Regardless of the choice of containment, cats should not be able to extend any body part through enclosure walls, barriers, and/or fencing.

Many clever methods of housing cats were found in use at both sanctuaries and zoological institutions. Efforts to provide housing that is insulated from the extremes of heat and cold result in a variety of methods that work well in the situations where they are located. Consideration of local environmental factors is important. For example, elevated housing in regions where fire ants are prevalent is desirable and adds to the comfort of the animals.

The Animal Welfare Act does not regulate enrichment, however it is encouraged for all captive big cats. A simple wooden denbox offers shelter, an elevated resting space, and a place to hide. The sides and floor of the wooden box may also provide enrichment when the animal uses them.
to sharpen its claws. Big cats often utilize elevated resting platforms when they are offered. These may vary from a simple sturdy wooden spool to a more complex arrangement of rocks or branches. Big cats will utilize toys, and while this play activity varies by individual, offering an assortment of big cat-proof toys is encouraged. The safety of toys for big cats should be considered carefully, as some may be damaged and could pose a threat if the cat were to ingest portions of the toy. Rubber tires generally are poor choices of toys for the larger species, however there are those individuals that never show any desire to bite or ingest the tires. Boomer balls are generally very hardy toys but may still be damaged by the bigger cats, and should be checked regularly for wear. Small amounts of spices, perfumes, or other scents may be strategically placed in the enclosure for the cat to find and explore. Large clumps of grasses, branches, or tree trunks may also provide interesting enrichment for cats.

Water must be available to big cats at all times. Watering devices should be indestructible and difficult to overturn. Stainless steel livestock containers have proven to be durable and easy to clean. Stainless steel buckets attached to an enclosure fence may work for some big cats, however some of the larger species have been known to destroy these. Due to their flimsy construction, galvanized buckets are poor choices for water containers.

Big cats may be trained to perform a variety of simple behaviors to aid in their care. Those that have been hand-reared and handled by experienced trainers may allow fairly advanced veterinary procedures such as obtaining blood samples, auscultation of the lungs, administering fluids subcutaneously, as well as ultrasound examinations. Big cats that are held in protected contact may be trained to station on a target for simple visual examination by the veterinarian and may even allow hand-injections of vaccines or other drugs. Occasionally protected contact animals have been trained to allow blood sampling or the administration of subcutaneous fluids, but these are more difficult behaviors to train.
INVESTIGATION INTO THE EFFECT OF LEUPROLIDE ACETATE ON REPRODUCTION IN DUCKS

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Abstract

Depot leuprolide acetate is widely used to control avian reproduction, despite variable results. Treatment schedules are still empirical and vary widely; furthermore no information is available on differences in sensitivity between avian species or timing of treatment during the breeding cycle. The objective of this study is to investigate the effect of leuprolide acetate on egg production and fertility, semen quality, and circulating reproductive hormones in two duck species (mallard and black duck). In a pilot study, two male (one mallard, one black duck) and two female (one mallard, one black duck) ducks were injected with 2 mg/kg Lupron® (TAP Pharmaceuticals, Inc., Deerfield, IL) intramuscularly. Ducks were housed in pairs and had produced two clutches of eggs that were removed before study onset. Three blood samples were collected daily before treatment, and blood sampling continued weekly for 5 wk following treatment. Egg production recommenced 8 days after treatment in the female black duck and 6 days after treatment in the female mallard. All six black duck eggs were infertile; however, this pair had demonstrated similar low fertility in previous clutches. All eight mallard eggs were fertile. Following treatment, no decrease in plasma LH concentrations was measured in the male ducks. Plasma testosterone concentrations measured 1 hr after treatment increased substantially (black duck, ~3-fold; mallard, ~45-fold) in both males, which persisted throughout following blood sampling 1 wk later (black duck, ~2.5-fold; mallard, ~11-fold). In the females, circulating LH, PdG, E1-glucuronide, and testosterone concentrations did not decrease after Lupron® injection. However, 2 wk after treatment, plasma LH concentrations declined in both females, and steroid hormones decreased in the female mallard, most likely coinciding with end of egg production and onset of incubation, rather than a suppressive effect of Lupron®. These results indicate that following Lupron® treatment, male and female mallard and black ducks continued to show reproductive behaviors including pair-bonding, copulation and egg-laying, resulting in fertilized eggs for the mallards. Additional experiments (including semen evaluation) are ongoing with 28 pairs of mallard and black ducks. In conclusion, preliminary data reveal that a single injection of 2 mg/kg leuprolide acetate administered during the breeding season does not suppress reproductive function in male and female mallard and black ducks.
DENTAL DISEASE IN MACROPOD SPECIES AT MELBOURNE ZOO

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Abstract

Oral necrobacillosis or “lumpy jaw” is a common cause of morbidity and mortality affecting captive macropods.1,3,6,8,9 Dental disease remains the most common disease presentation for macropods at Melbourne Zoo despite a long understanding of the risk factors for its development. Oral cavity disease seen in macropods at Melbourne Zoo can be categorized as follows:

1) endodontal disease: pulp cavity exposure with or without infection, usually following traumatic injury;
2) soft tissue abscessation: resulting from foreign body penetration (generally grass awns);
3) periodontal disease: characterized by calculus accumulation, gingivitis and periodontitis without development of osteitis; and
4) classic lumpy jaw: the most frequent presentation, characterized by osteitis (severe necrosis and lysis of bone) as well as acute inflammation of soft tissues.

Lumpy jaw may occur as a consequence of progression of periodontal lesions or endodontal disease. A number of etiologic agents have been implicated in the development of lumpy jaw. The most important pathogens are anaerobic bacteria, predominantly Fusobacterium necrophorum.2,9 Macropods are not considered to be inherently susceptible to infection with F. necrophorum; however they are frequently exposed to important predisposing factors for necrobacillosis.12 Predisposing factors identified as contributing to development of lumpy jaw in Melbourne Zoo macropods include the process of molar progression, features of the captive diet, and environmental stressors.

The Process of Molar Progression

Sanson classifies macropods as “grazer grade,” “intermediate browser/grazer grade,” or “browser grade” marsupials, based on tooth form and function.11 In each jaw quadrant, an adult grazing macropod has three upper incisors and one large lower incisor, a reduced permanent premolar that is relatively rapidly lost through molar progression, and four molars. The mandibular tooth row is curved, so that only the anterior molars are in occlusion. The grazing molar of macropods operates at maximum efficiency when relatively unworn. Molar progression facilitates the migration of unworn teeth anteriorly into wear to replace worn teeth, thus providing a
mechanism by which fewer teeth are maintained in the tooth row. The dental formula of browsing macropods is identical to that of grazing macropods; however, the premolar is larger and, to a certain extent, prevents forward progression of the molars. It has been hypothesized that abnormalities of tooth wear and shedding contribute to the occurrence of lumpy jaw. A number of authors have proposed that captive diets that are insufficiently abrasive will delay the process of molar progression, or result in retention of post-functional teeth in grazing macropods. This may predispose to development of lumpy jaw. Food impaction associated with molar progression has also been proposed as an initiating factor. Butler reported that lumpy jaw lesions often developed at the site of erupting molars, but these lesions did not appear to be associated with abnormalities in tooth shedding. In many cases of lumpy jaw affecting red kangaroos (Macropus rufus) and red-necked wallabies (Macropus rufogriseus banksiana) at Melbourne Zoo, lesions have developed in the anterior molars at the time of shedding of the premolar.

**Diet of Captive Animals**

Trauma to periodontal tissue, resulting in establishment of the etiologic agent in the jaw, is also believed to initiate development of lumpy jaw, and may occur as a result of feeding stalky hays or sharp-awned grasses. It has also been suggested that a plaque-initiated periodontitis may provide the necessary gingival defect that allows invasion by *F. necrophorum*, and that a low fibre, high residue diet in captivity may result in greater proliferation of dental plaque than the free-ranging grazing diet. We believe that plaque-initiated periodontitis contributes to the development of lumpy jaw lesions in Melbourne Zoo macropods.

**Environmental Stressors**

Lumpy jaw has been reported in wild macropods, but is generally considered a disease of captivity. Environmental stressors (e.g., cold stress/exposure, high stocking density, high levels of interaction with zoo visitors) are believed to be contributors to disease development. Bacterial contamination of feeding areas (e.g., as a consequence of overcrowding or poor feeding and/or enclosure hygiene practices) also predisposes to development of disease in macropod groups. Environmental stressors are considered key risk factors for the development of lumpy jaw lesions in Melbourne Zoo collection macropods. Factors that have recently been identified as contributing to disease occurrence in red kangaroos (1995-2005) include the incidence of fighting among males, the availability of suitable shelter areas for animals, enclosure stocking density, and enclosure screening from vehicle noise.

The most common presentation for Melbourne Zoo macropods with lumpy jaw is unilateral facial swelling. Hypersalivation and “mouthing” are frequently observed, and animals are usually obtunded. Initial assessment of affected animals is carried out under anesthesia. Diagnostic techniques include a dental examination, diagnostic radiographs (with the head in a lateral oblique position to optimise views of the affected dental arcade), and blood collection for
routine hematology and biochemistry. Treatment consists of extraction of any mobile teeth and curretage of necrotic bone. The extraction site is flushed with sterile saline, benzylpenicillin 150 mg/ml solution (BenPen, CSL Ltd, Parkville, Vic. Australia) and/or metronidazole 5 mg/ml solution (Metrin Solution, Parnell Laboratories Australia Pty Ltd, Alexandria, NSW Australia). The site may be left open or packed with either Orabase Protective Paste® (Convatec Ltd, Bristol-Myers Squibb, Noble Park, Vic. Australia) or, if the defect is large, cotton umbilical tape coated with a zinc oxide-eugenol paste. Other authors have suggested placement of antibiotic-impregnated polymethylmethacrylate beads into the bony defect. Parenteral antibiotics (long-acting penicillin 1 ml per 10 kg i.m. (Norocillin LA injection, Norbrook Laboratories Australia Ltd, Gisborne, Vic. Australia) are given, and analgesia (ketoprofen 1-2 mg/kg SC (Ilium Ketoprofen Injection, Troy Laboratories Pty Ltd, Smithfield, NSW Australia) and/or buprenorphine, 0.01 mg/kg SC (Temgesic Injection, Reckitt Benckiser, West Ryde, NSW, Australia) is provided.

Affected animals are housed in an off-exhibit enclosure during the treatment course, in order to facilitate treatment and minimise contamination of the display environment with causative organisms. Antimicrobial treatment with clindamycin hydrochloride 11 mg/kg p.o. b.i.d. (Antirobe capsules, Pharmacia and Upjohn Pty Ltd, Rydalmere, NSW Australia), ceftiofur 2 mg/kg i.m. s.i.d. or long-acting penicillin 1 ml per 10 kg i.m. every other day is continued. Animals are anesthetized once weekly, for reassessment and debridement, until healing of the extraction site has occurred. Neuroleptic drugs such as azaperone 0.2 – 0.5 mg/kg i.m. (Stresnil Neuroleptic Injection for Pigs, Boehringer Ingelheim Pty Ltd, North Ryde, NSW Australia) and fluphenazine decanoate 2.5 mg/kg i.m. (Modecate, Bristol-Myers Squibb Australia Pty Ltd, Noble Park, Vic. Australia) may be used to reduce anxiety during hospitalization and treatment. In cases of severe and extensive osteomyelitis, or when animals have had repeated episodes of disease, euthanasia is considered appropriate.

LITERATURE CITED


PRESHIPMENT MEDICINE: PHILOSOPHY, PRINCIPLES, AND PRACTICE

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Abstract

Health testing of animals prior to transfer between collections has been performed for many years. Yet despite this history as an important and accepted practice of zoological medicine, preshipment testing remains an area of misunderstanding and occasional dissension between the staffs of shipping and receiving institutions. With the continued necessity and increasing number of animal transfers between facilities, it behooves our profession to better develop and clarify a philosophy of preshipment medicine as one which encompasses far more than just the bare minimum of testing required to legally move animals from one geographic region to another.

The goals of preshipment medicine are fourfold: (1) to ensure that the animal proposed for transfer is a suitable and healthy candidate for shipment, (2) to protect the health of the individual animal during the shipment process, (3) to monitor the health of the shipping collection, and (4) to protect the health of the animal collection at the receiving institution. Identification of medical concerns prior to shipment allows for treatment of an animal before it undergoes the rigors and stress of transfer. No animal should be shipped unless the transfer is determined to be beneficial to the animal, to the shipping and receiving collections, and to the conservation of the species.

Preshipment testing is an essential component of an institutional preventive health program. Few institutions have the resources to perform annual health examinations on every animal in the collection. In some species, difficulties and risks associated with immobilizations deter routine health assessments. In other animals, physiologic states such as age, pregnancy, lactation, rut, or stage of antler development may hinder or delay immobilization for routine health assessment. Complete health evaluation of animals immobilized for preshipment testing affords the veterinarian of the shipping institution a valuable opportunity to proactively assess the health of their collection. Data collected during preshipment testing, in combination with information gathered during routine health checks and necropsy findings, should serve as the basis for effective assessment of collection health. With the constant transfer of animals between collections, disease identification needs to occur prior to shipment, to prevent the spread of disease between collections and to allow for treatment of other in-contact animals.

Overall, the preshipment health assessment should be aimed at answering two central questions: (1) Is this animal suitable and healthy enough to undergo shipment to a new facility? (2) Will inclusion of this animal into a new collection pose any unacceptable health risks, either to the
animal or to the receiving collection? Veterinary evaluation of an animal proposed for transfer should include an overall assessment of whether the animal is suitable for shipment. Basic information such as animal identification, gender, life stage, and reproductive status should be confirmed to avoid shipment of either the wrong animal or an animal unsuitable for the needs of the receiving institution. A total health evaluation should be performed, looking not only at the health of the individual animal but also at the health of in-contact animals and any significant disease risks associated with the exhibit or enclosure itself. Visual examination of an animal is inadequate as a sole measure to assess health. The veterinary preshipment evaluation should include review of an animal’s medical records, a complete physical examination, and appropriate ancillary testing. The selection of tests to be performed should be guided by a number of needs, including those legally required for shipment, verifying the current health status of an animal and its historic exposure to infectious diseases. If the results of any specific test would bar the animal from inclusion into the collection of the receiving institution, it should be performed prior to transport whenever possible.

A basic principle of preshipment medicine includes clear, open, and proactive communication between the shipping and receiving institutions, and an understanding of the role each institution plays in the shipment process. The shipping institution should fully disclose any significant health findings (current or historic) of the animal intended for shipment and of any in-contact animals as well as any pertinent collection health history. The shipping institution is also responsible for determining whether an animal is healthy enough to be shipped and what tests and permits are required to ship an animal. The role of the receiving institution is to analyze the potential benefits and risks of the proposed transfer and to determine whether to accept the animal for shipment and quarantine. To facilitate the decision-making process, an animal’s complete medical records should be made available to the receiving institution for review prior to preshipment testing. Direct communication between the veterinarians of the shipping and receiving institutions provides for timely discussion of significant health information, so that a consensus can be reached on preshipment test requirements, and on shipment-related medical, physical, psychologic or dietary needs of the animal.

In practice, several questions arise around the necessity, timing and cost of preshipment testing. One question frequently posed is why an animal should be tested prior to shipment if quarantine testing will be performed at the receiving institution. Shipment is a stressful event, and an animal should not be shipped unless it is determined to be healthy enough to cope with this stress. Importation of animals into an established collection is one of the most likely ways to introduce disease. No animal should be shipped unless both the shipping and receiving institutions are reasonably certain that the movement of an animal between collections will be beneficial to the animal and to the health of both collections. When testing is delayed until an animal arrives at quarantine, these concerns are not addressed proactively, resulting in unnecessary shipments, the return of the animal, or its reshipment to another facility.
Another concern, often raised by non-veterinary zoo staff, revolves around why an animal should be immobilized for testing more than once during a shipment process. If an animal received a preshipment health assessment, why does it need to be reimmobilized and retested during quarantine? The stress of shipment itself may induce or uncover disease; repeat testing of an animal in quarantine allows reassessment of its health post-shipment, and affords the receiving institution the opportunity to assess any health changes, collect serum and tissue for banking, and to perform additional testing which was not needed prior to shipment. For most species, current anesthetic techniques allow for safe immobilization of animals, which should be viewed as an opportunity to assess and promote animal and collection health, not as a health risk. Of course, there are animals, species and situations in which it is advantageous to reduce or eliminate the need for immobilizations. For these situations, effective communication is needed to develop a plan that protects both the needs of the animal and of the collections. Samples and information collected during a single immobilization event should be shared between the institutions.

Often, concerns and questions are raised regarding financial issues. Who pays for testing? The general answer is that both the shipping and receiving institutions should share the costs. All zoos benefit from improved health of captive animals, and all zoos risk the costs of disease when an ill animal is shipped. Shipping institutions should accommodate all reasonable requests for preshipment testing, and receiving institutions should limit test requests to those necessary to determine health and collection risk. AZA-accredited institutions should budget for preshipment testing of animals shipped out by their institutions, and for quarantine testing of animals arriving into their collection. In certain instances, such as purchase of animals from private collections or from small institutions without ready access to veterinary care, the receiving institution should consider reimbursing preshipment testing costs. The amount of money spent on preshipment testing is often only a small percent of the total amount of time, effort and money spent in organizing an animal shipment, and should be easily offset by reducing time, effort and money spent in dealing with illness at the receiving institution. When illness or unsuitability is discovered in quarantine, the receiving institution expends staff time and money to resolve the problem, often while quarantine space is tied up and other shipments are delayed.

Preshipment medicine should stimulate collaboration and collegiality between zoo veterinarians as we advocate together for the health of animals being shipped, and for continued preventive veterinary care of all captive collections. Balancing the health needs of the animal and the institutions should never result in an adversarial relationship. We must educate other zoo staff, including directors and financial officers, regarding the importance, value and necessity of preshipment medicine. As experienced health professionals, we must resist the outmoded concepts that preshipment testing is a waste of money and time, and that our zoos do not have sufficient funding to pay for appropriate and necessary testing. Incorporating the philosophy of preshipment medicine into preventive health programs will continue to improve the health and welfare of all captive animal collections.
LITERATURE CITED

SPATIAL DISTRIBUTION AND POTENTIAL IMPACT OF NODULAR STOMACH WORMS (Cylicospirura spp.) TO SURVIVAL OF FREE RANGING MOUNTAIN LIONS (Puma concolor) IN OREGON

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Abstract

Information on long-term natural mortality of free ranging mountain lions (Puma concolor) in the Pacific Northwest has not been available. From January 1994 to August 2004, we mapped locations of mountain lion mortalities using geographic information system technology and examined available carcasses from mortalities of a study of 103 radio collared mountain lions (51 males, 52 females) on a 518-km² study area in the southern Cascade Mountains of Oregon (USA). Full or partial necropsy examinations were done on 34 adult and 27 subadult/kittens (36 male, 25 female) that died during the study. Causes of mortality were divided in 10 categories including legal and illegal hunting, trauma, predation, parasites, and natural disease and infection. The two highest causes of mortality for the 34 adult carcasses examined were parasite (nodular stomach worms) and disease related lesions, each accounting for seven deaths. Nodular stomach worms (Cylicospirura spp.) were associated with large ulcerative granulomas of the pyloric region of the stomach, which resulted in hemorrhage and peritonitis. When both adults and subadults (n = 61) are considered, eight mortalities (13.1%) were attributable to these parasites and ten to other diseases (16.4%). On an annual basis, the percentage of deaths attributable to a single mortality category would vary. In 1994 a public referendum, which prevented the use of dogs for hunting cougars, was passed. Immediately after the referendum, illegal harvest was the most important mortality factor until later in the study when parasites and disease became the highest single causes of death. On-going research is being conducted to further define the role of the parasite Cylicospirura in cougar ecology and health.
ASSESSING BASIC PHYSIOLOGIC PARAMETERS IN FREE-RANGING ATLANTIC WALRUS (Odobenus rosmarus rosmarus): A LOW-TECH APPROACH

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Abstract

Little is known about physiologic parameters of free-ranging walruses, yet basic physiologic data such as resting heart and respiratory rate are essential for meaningful monitoring of anesthesia, and may contribute to estimation of energy consumption/metabolic rate. Observations were made on 10 free-ranging adult male walruses (Odobenus r. rosmarus) at Young Sound in Northeast Greenland (74°18′N; 20°15′W) in August 2004. Animals that had been out of the water for at least 1 hr were examined. A battery operated electrocardiograph (Cardiovit AT-4 vet, Schiller AG, CH-6341, Switzerland) was equipped with custom made 10 m cords for bipolar recording. These cords ended in an insulated metal Luer-lock connector for easy attachment of aluminium 18-gauge, 1.5″ hypodermic needles. Each subject animal was slowly approached and the two electrodes were simultaneously applied with the aid of two light-weight metal rods with a distal “cup” using a gentle, stabbing motion. The electrodes were placed in the dorsal midline approximately 100 cm apart. The electrocardiogram was recorded for 3 min, and the heart rate was subsequently calculated as the mean for this period. Respiratory rate was determined visually, by observing the nostrils and respiratory movements of the animal in question. Mean heart rate ±SD was 36 ± 3.7 (29 – 43) beats/min. The respiratory rate ranged from 2.7 – 3.7 with a mean of 3.3 ± 0.3 breaths/min. A pronounced sinus arrhythmia was observed. The present study provides novel data on resting free-ranging animals. The technique is simple and affordable, and may be applicable to other marine mammals.

ACKNOWLEDGMENTS

The Commission for Scientific Research in Greenland is acknowledged for funding this research. The authors wish to thank the Danish Polar Center, the Sirius Sledge Patrol, E-Vet Denmark, and Simonsen & Weel.
USE OF CAMERA TRAPS TO HELP ASSESS PREGNANCY RATES AND PERINATAL MORTALITY IN ISLAND FOXES (Urocyon littoralis) ON SANTA CATALINA ISLAND, CALIFORNIA

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Abstract

The island fox (Urocyon littoralis) has experienced severe population declines since 1994. High neonatal losses during the first year of captive breeding on Santa Catalina Island raised significant concerns, but little was known about relative pregnancy success and neonatal loss in the wild population. We compared pregnancy rates and perinatal mortality in wild and captive island foxes during 2002 and 2003 to determine if pup losses in captivity exceeded those in the wild and to assess reproduction in animals released from the captive breeding program and translocated as part of population recovery efforts. In March 2002 and 2003, abdominal ultrasound examinations were performed on both captive and wild female island foxes to determine pregnancy status and fetal number. Wild pregnant foxes (n = 8 in 2002, n = 13 in 2003) were fitted with radiotelemetry collars to determine core use areas during denning. Pregnant captive females (n = 5 in both 2002 and 2003) were monitored for comparison. Camera traps, visual observation and targeted trapping were used to determine the number of pups that survived to weaning in the wild. Video monitoring and visual observations were used to determine weaning success for captive animals. The adult pregnancy rate for wild foxes (95%) was significantly higher than for captive foxes (47.6%; P = 0.003). Furthermore, perinatal mortality for both years combined was 43.2% for wild foxes and 15% for captive foxes (P = 0.055). Average weaned litter size for both years was 1.8 pups for wild foxes and 1.9 pups for captive foxes, and average ultrasound fetal count for both years was 2.5 for wild foxes and 2.0 for captive foxes. Successful reproduction was documented in both translocated and captive-released individuals, and these individuals reproduced equivalently to wild foxes that had not been intensively managed. Since both pregnancy rates and perinatal mortality are lower in captivity than in the wild, captive breeding programs can increase their contribution to fox recovery by focusing efforts on increasing pregnancy rates while maintaining the successful postnatal husbandry methods currently employed. The use of camera traps to help assess pup survival was both a reliable and non-invasive method. Subsequent to this study, the Wildlife
Health Center has employed camera traps to study river otters, mountain lions, and other species interactions in our ecosystem health investigations.
THE 7-YR ITCH: EXOTIC CHEWING LICE OF PACIFIC NORTHWEST DEER

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Abstract

A hair-loss syndrome has affected both Columbian black-tailed (Odocoileus hemionus columbianus) and white-tailed deer (Odocoileus virginianus leucurus) in western Oregon since 1998. Its distribution is widespread, seasonal, and limited to native species of deer. The population effects of this syndrome have not been fully measured, but it remains a cause of significant mortality and morbidity on an annual basis. A consistent finding in necropsies done on affected deer is the presence of large numbers of chewing lice, identified as an indeterminate species of Damalinia (Cervicola), a genus of chewing lice historically associated with Asiatic deer and African antelope. Genetics studies have supported this morphologic distinction between exotic and native families of sampled deer chewing lice. Sampling results of lice on native and captive exotic deer demonstrate a spatial relationship between native and exotic chewing lice of deer within the state. Of the 93 mule deer (Odocoileus hemionus) sampled outside of the hair-loss syndrome endemic area, all lice examined were Damalinia (Tricholipeurus) sp., native lice of North American deer. Observational data of the hair-loss syndrome demonstrate a temporal pattern that supports a spatial movement of the syndrome.
OPIOID RECEPTORS AND LIGANDS: IGNORING DOGMA MAY IMPROVE OPIOID USE

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Abstract

“The greatest enemy of knowledge is not ignorance; it is the illusion of knowledge.”
Stephen Hawking

Opioids have undesirable side effects. Treating or preventing the side effects without “reversing” the desired effects is a holy grail. Undesirable side effects include: hypotension, hypertension, respiratory depression, apnea, bradycardia, tachycardia, skeletal muscle rigidity, hypothermia, and hyperthermia.

Opioid Receptors

The classic opioid receptor types are: mu (μ, MOR, OP3), kappa (κ, KOR, OP1), and delta (δ, DOR, OP2). Sigma (σ) receptors used to be considered opioid, but are not any longer. Epsilon (ε) is argued about. There is little agreement regarding the classification of opioid receptor subtypes. Opioid receptors belong to the G protein-coupled receptor family.

Opioids

Agonists (mu) are: morphine, fentanyl, etorphine, carfentanil, A3080. A partial mu agonist is buprenorphine.

Antagonists are: naloxone, naltrexone, nalmephene, nalorphine, diprenorphine, levallorphan. The latter three, nalorphine, diprenorphine, levallorphan are older drugs; if they were discovered now, they would most likely be put into the next category.

Agonist/antagonists are: pentazocine, nalbuphine, and butorphanol. The dogma is that these are mu antagonists and kappa agonists. The anti-dogma is that butorphanol may be a partial mu agonist.2,5 It can be a mu agonist or antagonist depending on the circumstances.2,5
Opioid Receptor Effects and Interactions

Lower efficacy opioids must bind to more receptors than higher efficacy opioids to produce a given effect. Different effects of a drug also depend on activation of different numbers of receptors, which can be altered by changing various parameters of the task, such as the intensity of the nociceptive stimulus in antinociceptive procedures. When the intensity is increased, the potency of any drug will decrease as more receptors must be occupied, and there will be a point at which drugs that must bind to a large proportion of receptors (i.e., lower efficacy drugs) cannot occupy enough receptors to produce a given effect. In these situations, lower efficacy opioids produce antinociception using low-intensity stimuli but fail to produce antinociception using high-intensity stimuli. Thus, there is an interaction between the intrinsic efficacy of an opioid and the stimulus intensity (or the efficacy requirement of the task) in producing antinociception. Studies have examined the interactions among opioids with varying degrees of intrinsic efficacy in cases in which the lower efficacy opioid fails to produce antinociception on its own. In these instances, the lower efficacy opioid competitively antagonizes the effects of higher efficacy opioids. This is the exciting anti-dogma, relating the observations that when low efficacy opioids for a given effect are given after a high efficacy drug for that effect, the low efficacy drug will “reverse” the effect, instead of producing it.

Combining Opioids to Improve Analgesia

Using Opioid Antagonists or Agonist/Antagonists to Reverse All the Effects of a Mu Agonist

Using antagonists is commonly done. Using agonist/antagonists is less common. We did this for many years, in dogs and cats, using nalbuphine (100 µg/kg i.v.).

Combining Opioids to Minimize Side Effects While Preserving Desired Effects

There is a great need to be able to do this consistently and safely with mu agonists and opioid antagonists or agonist/antagonists. We commonly do this in dogs and cats to treat opioid induced dysphoria or respiratory depression, with low doses of naloxone (2.5 – 10 µg/kg i.v.) or butorphanol (50 µg/kg i.v.).

This can be done in white rhinoceroses. In the white rhinoceroses partial reversal with diprenorphine or nalorphine is possible. This may be done to improve the oxygen saturation, or to get the animal up to allow it to walk to a desired location, or to reverse other negative effects. There is residual sedation for 6 – 8 hr. The use has also been reported in the wapiti. The next two presentations will be new reports of the use of butorphanol for reversal of mu mediated side effects.

These are very exciting, useful drug interactions, however, the technique is not perfect and may be drug and species specific. In white rhinoceroses, the reversal with naltrexone is complete (at
the doses used) and should only be used at these doses, when the desired effect is complete reversal (e.g., after immobilization for treatment). There is a report in humans of a study where nalbuphine was used to reverse respiratory depression from high dose fentanyl, while attempting to maintain analgesia, in which the study was cancelled after four patients because all four patients had serious side effects and also required additional pain therapy.

LITERATURE CITED

IMPROVING CARDIO-PULMONARY FUNCTION FOR A SAFER ANESTHESIA OF WHITE RHINOCEROS (*Ceratotherium simum*): USE OF OPIATE COCKTAILS TO INFLUENCE RECEPTOR EFFECTS

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Abstract

Current field anesthesia protocols for white rhinoceros (*Ceratotherium simum*), using a potent mu opioid agonist (etorphine) and a tranquilizer (azaperone), cause respiratory depression and drug-induced muscle rigidity and tremors that further impair respiration, leading to a cascade of marked cardio-pulmonary alterations including hypoxia, hypercapnia, hypertension, tachycardia and acidosis.1,2 This hypoxia was corrected in a field situation by nasal intratracheal intubation with oxygen supplementation (15 – 30 L/min), but the acidosis and elevated CO₂ were not corrected; probably due to impaired ventilation and ventilation/perfusion mismatching in the lungs of recumbent rhinoceros.

A study is underway to develop safer field anesthesia protocols with improved muscle relaxation and less cardio-pulmonary alterations using a dosage of 40 – 90 mg butorphanol (a mixed mu opioid antagonist and kappa agonist) and 25 – 50 mg midazolam in combination with 2.0 – 3.5 mg etorphine in adult animals. In preliminary studies, the mu antagonist effect of butorphanol greatly lessens the respiratory depression3 and muscle rigidity and tremors caused by etorphine.4 Animals were less hypoxic with an increased respiration rate and slower heart rate plus a lower end-tidal CO₂. The majority of the rhinoceros became standing immobile within 10 min, which facilitated minor manipulative procedures and allowed crating without partial opioid reversal. Once in the crate, either naltrexone and/or diprenorphine were given. Naltrexone reversed the effects of both the butorphanol and etorphine. Diprenorphine appeared to only reverse the etorphine, leaving the sedative effects of butorphanol intact. Respiration improved in these animals and excessive head-pressing in the crate was not seen, with its potential to impair respiration.

ACKNOWLEDGMENT

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LITERATURE CITED

IMMOBILIZATION OF CAPTIVE FREE-RANGING FALLOW DEER (*Dama dama*) WITH A CARFENTANIL, XYLAZINE, AND BUTORPHANOL COMBINATION

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Abstract

Combinations of Telazol®/medetomidine, Telazol®/xylazine, medetomidine/ketamine and ketamine/xylazine are commonly used for immobilizing cervids, but are not completely reversible and may result in prolonged recovery times.1,3,7,11 Telazol®/xylazine and ketamine/xylazine can also be associated with prolonged time to recumbency.3,11 Carfentanil/xylazine and etorphine/xylazine are reversible combinations successfully used in cervid species, but these protocols may cause hypoventilation and hypoxia.2,5,8 Fallow deer in particular are difficult to immobilize.4-6,9 The anesthetic protocol described here achieves quick and reversible induction via small drug volumes, while maintaining good cardiovascular function through combination of a pure opioid agonist with a partial antagonist. Such competitive mixtures deserve more careful study to better understand the pharmacology and physiology of their actions, but preliminary trials appear promising.

Sixty-three captive adult free-ranging fallow deer (*Dama dama*) were immobilized at the Fossil Rim Wildlife Center between January 1998 and April 2005. Forty-seven were captured for movement to another area, 12 for examination, and four for removal of debris from antlers. They were darted i.m. with a combination of carfentanil (average dose =2.9 µg/kg; Wildlife Pharmaceuticals Inc., Fort Collins, Colorado 80524, USA), xylazine (average dose = 0.25 mg/kg; Xyla-Ject®, Phoenix Scientific, Inc., St. Joseph, Missouri 64503, USA) and butorphanol (average dose = 36.8 µg/kg; Torbugesic®, Fort Dodge Animal Health, Fort Dodge, Iowa 50501, USA). Anesthetic effects were reversed using yohimbine (average dose = 0.23 mg/kg i.m.; Wildlife Pharmaceuticals Inc.) and naltrexone (50 mg per animal, 1/2 i.v., 1/2 i.m.; Wildlife Pharmaceuticals Inc.). The average time from injection to initial effect was 3.53 min. The average time from injection to recumbency was 5.56 min. Following naltrexone administration, the average time to first sign of arousal was 1.89 min, and 2.97 min to standing.

Seven individuals received ketamine to assist in handling when anesthesia was “light” or when painful procedures were performed. One deer was intubated and placed on isoflurane for eyelid mass removal. Butorphanol partially reverses the effects of carfentanil, specifically the respiratory depression. Respiratory depression (defined as respiratory rate <12 breaths per min.

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or episodes of apnea) was seen in 16 deer and may be attributable to the effects of xylazine\textsuperscript{10,12} or inadequate antagonism by butorphanol. When respiratory depression was severe enough to cause episodes of apnea, the yohimbine reversal dose was given before the end of the procedure, usually resulting in an increased respiratory rate.

LITERATURE CITED

PHARMACOKINETICS OF CARFENTANIL AND NALTREXONE IN THE COMMON ELAND (Taurotragus oryx)

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Abstract

The pharmacokinetic parameters of carfentanil and naltrexone were determined in the common eland (Taurotragus oryx). Six adult females were immobilized with xylazine (0.23 ± 0.03 mg/kg i.m.) and carfentanil (16.9 ± 0.5 µg/kg i.m.) for a 45-min time period. A single intramuscular injection of naltrexone (1.66 ± 0.08 mg/kg i.m.) was sufficient for reversal. Serial blood samples were collected via jugular venipuncture during and up to 48 hr post immobilization. The quantification of carfentanil and naltrexone in these samples was performed by detection of their metabolites in plasma through liquid chromatography and mass spectroscopy methods. Carfentanil was rapidly absorbed following administration with the peak plasma concentration (Cmax) at 13.8 min. Naltrexone was readily absorbed and reached Cmax at 23.4 ± 16.8 min after administration. All animals stood 2.7 ± 2.2 min (X ± SD) after naltrexone administration. Carfentanil has a half-life of 7.7 hr, while naltrexone has a much shorter half-life of 3.7 hr. This protocol demonstrated a sufficient depth of anesthesia to perform clinically non-invasive procedures for the duration of the anesthesia with little risk of renarcotization.

ACKNOWLEDGMENTS

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IMMOBILIZATION OF AXIS DEER (Axis axis): EVALUATION OF THIAFENTANIL, MEDETOMIDINE, AND KETAMINE VS. MEDETOMIDINE AND KETAMINE

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Abstract

Thiafentanil oxalate (A3080) is a synthetic opioid useful for immobilization of non-domestic hoofstock.1-4 This study compared the combination of thiafentanil oxalate (Wildlife Pharmaceuticals Inc., Fort Collins, Colorado 80524, USA), medetomidine (Zoo Pharm, Laramie, Wyoming 82070, USA), and ketamine (Congaree Veterinary Pharmacy, Cayce, South Carolina 29033, USA) to a combination of medetomidine and ketamine for immobilization of 17 captive axis deer (Axis axis) undergoing vasectomy. Nine deer were administered thiafentanil (0.01 ± 0.003 mg/kg), medetomidine (0.09 ± 0.02 mg/kg), and ketamine (1.36 ± 0.33 mg/kg) (TMK). Eight deer were administered medetomidine (0.09 ± 0.02 mg/kg) and ketamine (3.48 ± 0.55 mg/kg) (MK). Induction time, arterial blood gas, heart rate, respiratory rate, and blood pressure values were monitored and statistically compared. Animals receiving TMK were reversed with naltrexone (Trexonil, Wildlife Pharmaceuticals Inc.) (100 mg/mg thiafentanil) and atipamazole (Antisedan, Pfizer Animal Health, Exton, Pennsylvania 19341, USA) (5 mg/mg medetomidine). Animals receiving MK were reversed with atipamazole (5 mg/mg medetomidine). Mean induction time was 3.5 ± 2.0 min in the TMK group, and 9.8 ± 6.7 min in the MK group. Animals anesthetized with TMK experienced unpredictable inductions, apnea, muscle rigidity, limb movement, and marked respiratory and lactic acidosis. Six of nine animals immobilized with TMK required intubation. Mean blood pressure values were 98 ± 15.2 mm Hg in the TMK, and 124 ± 26.2 mm Hg in the MK groups. MK resulted in smoother inductions, better respiratory function, and less adverse metabolic disturbances, and thus was considered superior to TMK for anesthesia in axis deer.

ACKNOWLEDGMENTS

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LITERATURE CITED


MODERATION OF ALARM AND FLIGHT RESPONSES IN PRONGHORN (Antilocapra americana) ADMINISTERED ZUCLOPENTHIXOL ACETATE

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Abstract

Zuclopenthixol acetate (ZA) was administered to hand-raised and trained pronghorn (Antilocapra americana) to evaluate the effect of ZA on flight and alarm behavior. Baseline observations were made when the pronghorn were 7 – 9 mo (30 – 34 kg) to rank their level of sedation, food and water consumption, locomotion, fearfulness, tendency to approach people, tendency to approach novel items, and tendency to associate with other pronghorn (social reinstatement). Pronghorn were administered ZA 1 mg/kg i.m. using the “Z” technique. The “Z” technique entails applying tension to the skin prior to injection, and subsequently releasing this tension after injection. This results in intact skin covering the i.m. injection site, such that drug can not leak from the injection site. After administration of ZA, pronghorn were regularly re-evaluated over a 5-day period. In addition, the pronghorn’s responses were evaluated once daily during the 5-day period when they were exposed to novel objects that were intended to incite a mild flight and alarm response. Mild sedation, changes in locomotion, and decreases in food consumption were initially observed, but soon resolved. Treated animals had decreased flight distances and alarm responses. This trial suggests that ZA has some potential for moderating flight and fear responses for some purposes, but there was variability among individuals, and ZA was not a replacement for training or basic management procedures. Further work is needed to evaluate alternate dosages, age-specific variations in dosages, long-acting decanoate formulations of ZA, the efficacy of ZA combined with other neuroleptics, and the potential for moderating undesirable aggression, sexual, and self-mutilation behaviors.
EFFECTS OF THREE METHODS OF STORAGE ON PO2, PCO2, AND pH OF GREVY’S ZEBRA (Equus grevyi) BLOOD

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Abstract

Evaluation and safety of new anesthetic techniques depends on critical physiologic monitoring. Blood pH/gas analysis is critical for physiologic evaluation of anesthetized patients. Literature states regimented handling and rapid processing of blood pH/gas samples is required for valid results.1 This is problematic in field situations, especially if numerous samples are collected and analyzed a distance from the anesthetized animal.

This study evaluated three storage conditions on stability of PO2, PCO2, and pH in blood from eight Grevy’s zebras (Equus grevyi). Arterial and venous samples in heparinized 12-ml plastic syringes were stored in ice (ICE) or at 22°C (RT), or with 2 mg/ml sodium fluoride at 22°C(NaF). One analyzer was used for analysis at average times of 20 (baseline), 79, 144, 204, 365, 326, 385, and 452 min.

Data were analyzed using the generalized estimating equation for sequential measure and ANOVA. Mean baseline PaO2 was 81–86 and PaCO2 was 49–55 mm Hg. Mean PCO2 and pH in all baseline samples were 61–65 mm Hg and 7.34–7.36 pH units.

Changes in PaO2, PaCO2, and pH are shown: Fig. 1, 2, and 3.

Zebra blood samples with physiologic blood gases and pH levels are stable in heparin + NaF for up to 7 hr at 22°C.

At RT in heparin alone, PCO2 increases and pH decreases due to metabolism. The increase in PO2 in ICE is from leakage into the syringe. Driving pressure in iced samples is higher than at room temperature because of increased solubility of oxygen, and lower P50 of hemoglobin.2

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LITERATURE CITED

Figure 1. Change in $P_aO_2$ over time.

Figure 2. Change in $P_aCO_2$ over time.

Figure 3. Change in $pH_a$ over time.
REVERSIBLE ANESTHESIC COMBINATION USING MEDETOMIDINE-BUTORPHANOL-MIDAZOLAM (MBMZ) IN CHEETAHS (*Acinonyx jubatus*)

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Abstract

Thirteen captive cheetahs (*Acinonyx jubatus*) were immobilized for annual routine examination. The cheetahs were given 35 ± 3.7 μg/kg of medetomidine (MED) + 0.2 ± 0.02 mg/kg of butorphanol (BUT) and 0.15 ± 0.02 mg/kg of midazolam (MID) intramuscularly (MBMz).

Once recumbent, the cheetahs were transported to the hospital and physiologic data were measured every 5 min for 60 min (HR, RR, SpO2, blood pressure, end-tidal CO2, and temperature) while breathing room air. Weight, EKG, arterial blood gases and cardiac output were also measured. If arousal occurred before 60 min, a ketamine supplement was given intravenously. After this time, isoflurane was administered and annual examination procedures were performed. At the end of the procedures, atipamezole (175 μg/kg), flumazenil (6 μg/kg), and naltrexone (0.25 mg/kg) were given intramuscularly.

This combination produced a fast and smooth induction (5 ± 1 min), adequate sedation for transport and minor procedures (MBMz anesthesia time 70 ± 16 min), and quick recovery. Hypertension occurred in all animals. Ventilation and oxygenation were good on room air (SaO2 91.7 ± 2.5 %, PCO2 39.4 ± 4.5 mm Hg). Pulse oximetry and mucous membrane coloration were not useful for evaluating blood oxygenation with MBMz combination (pale mucous membranes and falsely low SpO2 values).

MBMz combination seems ideal for field procedures where oxygen may not be readily available and quick recovery and release are desired. It is recommended for short procedures (≤40 min), due to sudden arousal that may occur after that time. For longer procedures, supplemental drugs are recommended (injectable agents or isoflurane in oxygen). Finally, this ketamine-free combination may be beneficial for animals with liver/kidney dysfunction, in which the metabolism and excretion of ketamine may be impaired.
PRELIMINARY INVESTIGATION AND CONTROL OF AN OUTBREAK OF Microsporum canis AT AN EXOTIC CAT SANCTUARY

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Abstract

An outbreak of dermatophytosis caused by Microsporum canis occurred in tigers (Panthera tigris) and humans at an exotic cat sanctuary in the fall of 2003. A facility-wide survey determined at least 48 of 103 (46%) inhabited cages were contaminated with M. canis. Transport cages and office furniture also cultured positive. Contaminated cages were inhabited by all species of felids maintained on the property, including tigers, lions (P. leo), a liger, clouded leopards (Neofelis nebulosa), black leopards (Pathera pardus), cougars (Felis concolor), bobcats (Felis rufus), and domestic cats (Felis catus).

A preliminary clinical trial with a 2% solution of lyme sulfur (LymDyp, DVM Pharmaceuticals Inc., Miami, Florida 33137) was conducted. Each cat in six contaminated enclosures housing multiple animals was cultured and assigned to one of four treatment groups or two control groups. Lyme sulfur solution was applied topically, via sprayers, to each cat in treatment Groups 1 – 4, every 2 wk for a total of seven treatments. In addition, the enclosure for treatment Group 1 was treated topically with lyme sulfur, at the same concentration applied to the cats, and the enclosure for treatment Group 2 was treated topically with Oxyclean® (Orange Glo International, Inc, Littleton, Colorado 80161), a peroxide based disinfectant, at a concentration of 28 mg/L (4 oz per gallon) of water. Cats in treatment Group 3 were moved to an uncontaminated enclosure after the third treatment. The enclosure for treatment Group 4 was not treated. The control cats (six individuals in two enclosures) were not treated. Samples were obtained from each individual and each enclosure every 2 wk, prior to any treatment. Mycologic cure was defined as failure to isolate M. canis in two sequential hair cultures.

Only three individuals attained mycologic cure, one of which later cultured positive. All three individuals were in treatment Group 4. Despite no specific environmental treatment in this group, the environmental cultures became negative after the 4th treatment.

Preliminary conclusions of this study include: 1) tigers appear to be more sensitive than other species of cats on the property, and seem to develop a carrier state similar to that seen in domestic Persian cats;1 2) treating the outdoor environment may not be necessary in controlling an outbreak; and 3) topical treatment with 2% lyme sulfur every 2 wk is not successful in
treating tigers infected with *M. canis*. Future studies are planned to examine topical and systemic combination therapies.

**LITERATURE CITED**

HEALTH ASSESSMENT OF FREE RANGING HECTOR’S DOLPHINS (Cephalorhynchus hectori hectori) CAPTURED FOR SATELLITE TELEMETRY IN NEW ZEALAND

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Abstract

Three Hector’s dolphins (Cephalorhunchus hectori hectori) were captured and released in the waters surrounding Banks Peninsula, New Zealand, for attachment of satellite transmitters (SPOT3). The trial was intended to evaluate the efficiency and safety of satellite tagging for potential application to the critically endangered Maui’s dolphin (Cephalocynchus hectori maui) and to acquire the first health data of live Hector’s dolphins. A comprehensive health and physiologic assessment was conducted prior to tagging and release, providing the first baseline health data for this species. The examination included body and blubber measurements and weight, hematology, biochemistry, serology, steroid endocrinology, culture from blowhole expirations and rectal and genital swabs. One female was seropositive for Brucella abortus by c-ELISA, a published cause of reproductive failure in dolphins. This serologic result was the first indication that a marine mammal Brucella sp. may be endemic in New Zealand. Tissues from four dead Hector’s dolphins following the field trial were tested for Brucella spp. by culture and nested PCR (OMP 25). Basic Local Alignment Search Tool (BLAST) sequence analysis confirmed the genetic relationship of the isolated Brucella sp. to B. suis, B. pinnipediae and B. cetacean. Further characterization is underway. The described Brucella spp. have been isolated from humans who have come in contact with infected cetaceans. They are potentially pathologic for humans and have to be treated as a zoonotic disease. Our finding has implications in the handling and examination of live and stranded Hector’s dolphins.
INTRAVASCULAR CILIATED PROTOZOA: AN IMPORTANT CAUSE OF MORTALITY IN CAPTIVE REARED KIHANSI SPRAY TOADS (*Nectophrynoides asperginis*)

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Abstract

Ciliated protozoan infections of the alimentary tract are common in amphibians and considered nonpathogenic. 4 Ciliates can also be found on the skin and gills of aquatic amphibians, but rarely cause disease. 1,5 Intravascular or visceral forms of pathologic ciliated protozoan infection have not been documented in amphibians. The Kihansi spray toad (*Nectophrynoides asperginis*) (KST) is a recently discovered and highly endangered species with a range limited to a single spray zone created by a waterfall along the Kihansi river in the Udzungwa Mountains, Tanzania. 5 Habitat destruction by a recently installed hydroelectric plant, and possibly chytridiomycosis, has completely decimated the wild population. Shortly after discovery of this species, 500 individuals were collected by members of the Wildlife Conservation Society and dispersed to captive breeding programs in several U.S. zoos. More recently the extant captive populations have been consolidated to two facilities, The Toledo Zoo and the Wildlife Conservation Society, to optimize breeding potential. There has been some success in the breeding programs, although progress has been impeded by husbandry problems and infectious disease, particularly a novel form of intravascular ciliated protozoan infection, detected at two of the breeding facilities. 2 This report describes the pathologic findings associated with this condition.

Northwest ZooPath has 67 KSTs on file from three different institutions, (Detroit, Toledo and Buffalo Zoos), and 20 of these toads (30%) were diagnosed with fatal intravascular ciliated protozoan infections. Nineteen were from the Toledo Zoo, one was from the Buffalo Zoo and none were from the Detroit Zoo. Twelve affected toads were females, seven were males and sex was not determined for one. All toads had large numbers of intravascular ciliates in all viscera.
Lesions associated with this condition were hepatic sinusoidal obstruction and hepatitis, glomerular capillary obstruction, and lymphatic obstruction and lymphangiectasia with regional edema and cellulitis of the legs and face. The source of the infection was believed to be skin, although ulceration was not commonly seen. Ultrastructural, immunohistochemical and molecular studies are currently being conducted to determine the identity of the ciliate. Husbandry conditions are being modified in an effort to limit the occurrence and spread of this infectious disease.

LITERATURE CITED

SEROLOGIC SURVEY OF DOMESTIC AND WILD CANIDS FOR LEISHMANIASIS AND TRYPANOSOMIASIS IN BOLIVIA

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Abstract

Leishmaniasis and trypanosomiasis are important zoonotic diseases in many parts of South America. Domestic dogs and crab-eating foxes (Cerdocyon thous) are considered significant reservoirs for pathogenic Leishmania spp. We sampled 124 dogs and 8 wild canids (5 pampas foxes (Pseudalopex gymnocercus) and 3 crab-eating foxes) and tested them for antibodies to Leishmania donovani and Trypanosoma cruzi using indirect immunofluorescence assays. Forty dogs lived in towns on the eastern border of Madidi National Park, part of the Amazon basin in northwestern Bolivia. The remaining dogs and all of the wild canids were from the Chaco, a tropical dry forest in southeastern Bolivia. Seven dogs (17.5%) from the Madidi area had positive titers (≥1:16); four of these dogs were clearly positive for T. cruzi. The other three dogs were positive for both T. cruzi and L. donovani, but because of cross-reactivity it could not be determined which organism was predominant. In the Chaco, 44 of 84 (52%) of dogs had positive results. Sera from 34 of these dogs were clearly reacting to T. cruzi; the remaining 10 reacted similarly to both organisms. Two of the Madidi dogs, and 36 of the Chaco dogs, had high titers (≥256). One crab-eating fox was positive; this animal had equally low positive titers (1:32) to both organisms. In these two areas of Bolivia, trypanosomiasis may be more common than leishmaniasis in the domestic dog population, and dogs in the Chaco may have much greater exposure than dogs in more humid forests.
DISSEMINATED *Mycobacterium kansasii* IN A REINDEER (*Rangifer tarandus*)

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Abstract

A 2-yr-old female reindeer with a history of lethargy and dyspnea was diagnosed with multiple pulmonary abscesses radiographically. At necropsy the animal had severe diffuse granulomatous pneumonia and pleuritis with severe multifocal granulomatous myocarditis, lymphadenitis, nephritis, esophagitis, enteritis, and thyroiditis. *Mycobacterium kansasii* was cultured from pulmonary, renal, hepatic, and lymph node sections. *Mycobacterium kansasii* is a slow-growing non-tuberculous mycobacterial species that causes disease in severely immunocompromised individuals. The popularity of reindeer in children's zoos, petting zoos, and holiday exhibitions makes diagnosis of *M. kansasii* in a reindeer a significant public health concern.

Introduction

*Mycobacterium kansasii* was first characterized in 1953 at the University of Kansas. It is a slow-growing photochromogenic mycobacterium (Runyon group 1) and is the second most common non-tuberculous mycobacterial species isolated in AIDS patients, following mycobacterial species in the *M. avium* complex (MAC).3 The most common disease presentation in humans is chronic pulmonary infection with cavitation, resembling classic tuberculosis.9 There are infrequent reports of disseminated infections in severely immunocompromised individuals as well as focal dermal and arthritic lesions. Tap water is believed to be the major reservoir in human disease although it has been cultured from lakes, ponds, swimming pools, sewage, and sphagnum moss.3,4,9 Interestingly, there are few reports of *M. kansasii* in animals in the United States and Europe. This is the first report of disseminated *M. kansasii* infection in reindeer (*Rangifer tarandus*).

Case Description and Methods

A 2-yr-old female reindeer from the Binder Park Zoo was noted to be lethargic and dyspneic for approximately 2 mo. The reindeer did not respond to empiric antibiotic therapy. Thoracic radiographs revealed multiple pulmonary abscesses in both lungs. Corynebacterial pneumonia
was suspected. Purulent green-white material from the left prescapular lymph node was submitted for bacteriology. Culture was unrewarding. The animal was euthanatized and submitted to the Diagnostic Center for Population and Animal Health (DCPAH) at Michigan State University for a complete necropsy.

At necropsy the reindeer was extremely thin (approximately 175 pounds) and mildly dehydrated. There were multiple 0.5 – 3.0 cm³ firm subcutaneous nodules on the face and neck with central areas of caseous necrosis. One submandibular nodule was filled with clear mucinous material and contained multiple 0.2 – 0.5 cm³ granulomas. The left prescapular lymph node was enlarged and cross sections revealed purulent to caseous gritty material, suggestive of mineralization. There were dozens of tan to yellow 0.2 – 2.0 cm³ abscesses and mineralized caseogranulomas randomly distributed over the diaphragmatic and thoracic pleura, often arranged linearly, parallel to the ribs. Numerous 0.1 – 2.0 cm³ abscesses and caseogranulomas were scattered multifocally throughout all lobes of both lungs, in the thoracic, mesenteric and sublumbar lymph nodes, within the esophageal mucosa, the myocardium of both ventricles, the small intestinal submucosa, and both thyroid glands. Both kidneys had 0.2 – 4.0 cm³ caseogranulomas and multiple wedge shaped infarcts.

Sections of tissue were collected in 10% buffered formalin and processed routinely for histopathology, and immunohistochemistry. Tissues were submitted to the Michigan Department of Community Health and the bacteriology section at the DCPAH for bacterial culture. Sections of lymph node were submitted to the virology section at the DCPAH to screen for bovine viral diarrhea virus.

**Results and Discussion**

An impression smear of necrotic material from the left prescapular lymph node revealed large numbers of acid fast positive staining organisms. Histologic examination of tissues revealed variably sized multifocal to coalescing granulomas with central caseation and mineralization in sections of both lungs, heart, liver, both kidneys, both thyroid glands, thoracic, mesenteric, and sublumbar lymph nodes, and within the submucosa of multiple sections of small intestine. Caseogranulomas had acid-fast bacilli with prominent banding within the central necrotic debris and within the cytoplasm of both epithelioid macrophages and multinucleate giant cells.

Immunohistochemical staining of tissue sections was positive for *Mycobacteria* sp. and negative for chronic wasting disease. Virus isolation tests on sections of lymph node for BVD virus were negative.

Both laboratories isolated *M. kansasii* from sections of lymph node, lung, kidney, and liver. Identification testing indicated a *Mycobacteria* sp. other than *M. tuberculosis* complex, based on genetic probe testing. *Mycobacteria kansasii* was subsequently confirmed based upon growth
characteristics, colony morphology, photochromogenicity, biochemical profile, high pressure liquid chromatography and genetic probe testing.

*Mycobacterium kansasii* is a photochromogenic, slowly growing mycobacterium species that is most commonly isolated from water (tap water, ponds, lakes, swimming pools, aquariums, and sewage), but rarely from animals and soil. There are individual case reports of *M. kansasii* in a dog (*Canis familiaris*), a goat (*Capra hircus*), a llama (*Llama glama*), a rhesus monkey (*Macaca mulatta*), and four squirrel monkeys (*Saimiri sciureus sciureus*). A survey of lymph nodes from cattle in the United States identified multiple strains of *M. kansasii* in the lymph nodes of clinically healthy animals. The primates and the goat were identified through routine tuberculosis testing. The dog was clinically ill with dyspnea and had a persistent pleural effusion. All reports documented histologic lesions consistent with mycobacteriosis.

This case of *M. kansasii* in a reindeer is of significant public health concern because reindeer are popular animals for exhibition in children's zoos, petting zoos, and holiday exhibitions. This young animal had disseminated granulomatous disease that was grossly and microscopically indistinguishable from *M. bovis*, a member of the *M. tuberculosis* complex. Definitive identification of mycobacterial species requires bacterial culture and PCR. This reindeer had been screened for Johne’s disease (*M. avium ssp paratuberculosis*) via a radiometric fecal culture several months prior to the development of clinical illness. *Mycobacterium kansasii* had been identified in fecal material and was not considered a primary pathogen at the time of identification. The information was filed and forgotten until the post-mortem diagnosis of mycobacteriosis, thereby perpetuating the potential transmission of *M. kansasii* to animal care staff and other animals in adjacent exhibits. Fortunately, there was no direct contact with zoo visitors.

The source of this mycobacterial infection in the reindeer was not identified. The reindeer had been housed with one other female reindeer from the time she was acquired as a calf. There is no record of direct contact with any other animals. The hoofstock at the zoo are housed in a large barn with a common air handling system. The most likely source of infection in this case is drinking water. *Mycobacterium kansasii* has been cultured from municipal water sources (tap water), lakes, ponds, swimming pools, sewage, and rarely, soil. There have been no reports of human-to-human, animal-to-animal, or animal-to-human transmission of *M. kansasii*. Disseminated mycobacteriosis in animals and humans is typically associated with immunocompromised individuals. Human cases of *M. kansasii* have been reported in patients with AIDS, systemic lupus erythematosus, chronic pulmonary disease, and those undergoing immunosuppressive therapy. There are a few reported cases of focal dermal and arthritic infections in humans with a history of localized trauma. The majority of these people have a history of immunosuppressive disease or therapy. There are rare individual case reports of immunocompetent individuals with *M. kansasii*. The severity of this reindeer’s disseminated disease and the fact that she was shedding the organism in her feces prior to exhibiting clinical symptoms.
illness suggest immunosuppressive disease or compromised immune function. Virus isolation tests performed on sections of lymph node for BVD virus, which causes immunosuppression in ruminants, were negative. Other factors considered as possible stressors and thus causes of immune suppression included the stress of captivity and display, and the fact that this animal was behaviorally subordinate to the other reindeer it was housed with. There is little information about this reindeer prior to its arrival at the zoo. It is not known if the dam raised it and it received passive maternal immunity or if it was “hand raised” and fed milk replacer, which may have had a marked effect on its immune status as a calf.

No other animals housed at the zoo, including the other reindeer, have been diagnosed with mycobacteriosis prior to, or subsequent to this reindeer’s demise. Mycobacterium kansasii should be considered a primary pathogen in animals and should be added to the list of differential diagnoses for animals with nonspecific signs of illness. Animals infected with M. kansasii may pose significant zoonotic risk to zoo visitors and employees.

ACKNOWLEDGMENTS

We wish to thank Dr. David Rost and Dr. Robert Emery for submission of this case.

LITERATURE CITED

WEST NILE VIRUS ANTIBODY TITERS FOLLOWING VACCINATION IN A KNOWN WEST NILE VIRUS NAÏVE MIXED AVIAN POPULATION AT THE LOS ANGELES ZOO

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Abstract

West Nile virus (WNV) causes a potentially fatal disease in birds with mortalities reported in over 250 avian species.1 Experimental vaccine protocols using an equine approved vaccine have been attempted with mixed or unknown efficacy.3-5 Serum neutralization assays are one way to assess the immune response to WNV vaccine in birds;2 it is unknown at this time whether a given antibody titer correlates with protective immunity. The arrival of WNV at the Los Angeles Zoo was monitored by on-site mosquito and wild bird sampling which established 7 July 2004 as the exact date of arrival of the virus on zoo grounds. Prior to this date, 63 birds representing 28 species had been vaccinated using 1.0 ml of equine vaccine (Fort Dodge West Nile Innovator) on a schedule of days 0, 21 and 60, followed by an annual booster. Blood was collected at the time of each vaccination with plasma sent to Cornell University’s diagnostic lab for neutralizing antibody testing.

Out of 63 birds vaccinated for WNV, 31 maintained negative titers and 32 birds seroconverted. Three birds that initially seroconverted had negative titers on future rechecks. Two birds had antibodies to St. Louis encephalitis virus. Two birds of African origin had positive titers to WNV before vaccination. No consistent trend was seen between vaccination and antibody response either in general or within any taxonomic group. These data suggest that antibody titers, as detected by neutralizing antibody tests, are not a reliable means to assess vaccination status or protective immunity. No vaccinated birds have contracted WNV at the LA Zoo, while two unvaccinated psittacines developed clinical WNV and survived with medical management. Vaccination may impart protective immunity despite inconsistent antibody titers.

LITERATURE CITED

Fecal prevalence of shiga-toxigenic Escherichia coli O157 and Salmonella enterica of animals in contact areas of United States zoos accredited by the American Zoo and Aquarium Association

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Abstract

Outbreaks of shiga-toxigenic Escherichia coli (STEC) O157 have been associated with human-animal contact in public settings, including open farms, State and County Fair livestock exhibits and petting zoos. These outbreaks have sickened hundreds of people, sometimes severely, and caused at least two deaths in the past 5 yr. Human-animal contact settings vary in hygiene and sanitation practices, the degree of supervision, the extent of animal contact permitted, and in facility design. Recent surveys have shown that livestock on farms and at fairs often shed both STEC O157 and Salmonella spp. in their feces. Our goal was to estimate American Zoo and Aquarium Association (AZA)-institutional and individual animal fecal prevalence rates for both pathogens. We hypothesized that the standardized conditions and generally higher levels of hygiene in AZA contact settings would result in lower pathogen prevalence compared to animals in production or fair settings.

American Zoo and Aquarium Association zoos with human-animal contact areas (such as children’s zoos) were recruited to participate voluntarily and confidentially. Feces collected in the summer of 2003 and 2004 from animals in contact areas, were cultured for Salmonella spp. and STEC O157. Thirty-six zoos provided feces from 997 animals, including 526 goats, 192 sheep, 59 equids, 49 cattle, 45 pigs, 33 deer, 26 llamas, 17 birds, 16 rabbits, 10 rodents, 5 tortoises and 3 carnivores. STEC O157 was isolated from one quarantined bovid. Salmonella spp. was isolated at four zoos from three goats, one horse, one bovine and one giraffe. STEC O157 or Salmonella spp. was isolated from an animal in five of 36 contact areas (13.9%). Fecal prevalence of STEC O157 (1/997 = 0.1%) and Salmonella spp. (6/997 = 0.6%) was very low in animals connected with AZA contact areas, both in absolute terms and relative to the high prevalence (often >25%) for these pathogens in farm or fair setting. Contact areas at AZA zoos appear to present a low zoonotic risk to human visitors compared to other settings where human-animal contact may occur. Understanding the basis for this low prevalence may have future application towards lowering enteric zoonotic bacteria prevalence in animals in farm settings.
SEROLOGIC SURVEY FOR ENCEPHALOMYOCARDITIS VIRUS IN ZOOLOGICAL INSTITUTIONS THROUGHOUT THE UNITED STATES AND CANADA

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Abstract

Encephalomyocarditis virus, a cardiovirus in the Picornaviridae, has a worldwide distribution and can result in disease in a broad range of species.1,2,4 The virus was first isolated in the 1940's and has been responsible for multiple deaths throughout zoological collections. In the United States, most cases have been isolated to the gulf coast states. Historically, disease has been seen in hoofstock, particularly Proboscidae and Suidae, and non-human primates.2 While EMCV is considered zoonotic, the disease generally only causes mild symptoms in humans. Transmission is fecal oral and is associated with murine rodent species, which act as the primary reservoir hosts.4 The severity of the disease is variable among different species, ranging from asymptomatic to peracute death. Gross lesions generally are limited to the cardiopulmonary system and include pulmonary edema, pale streaks throughout the myocardium and pericardial effusion. In an effort to determine the extent of exposure of zoological collections to the virus throughout the United States and Canada, a serosurvey focusing primarily on hoofstock species was undertaken.

Serum samples were solicited from zoos across the country and submitted to the Texas Veterinary Medical Diagnostic Laboratory for routine serologic screening for EMCV using serum neutralization. Thirty-five institutions provided samples for screening representing 49 species. Twenty-seven institutions replied to a written survey of EMCV cases. Of these, six (2%) reported previous outbreaks or suspicious deaths associated with encephalomyocarditis.

LITERATURE CITED

PREVALENCE OF ORAL LESIONS IN SMALL NEOTROPICAL FELIDS AT THE SÃO PAULO ZOO, BRAZIL

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Abstract

The early detection of oral lesions is essential in zoo and wildlife medicine in order to prevent losses. In preventive medicine programs for captive animals, the oral examination is an obligatory clinical procedure. The entire collection of small neotropical felids at the São Paulo Zoo was submitted to a full clinical examination under general anesthesia, including a detailed examination of the oral cavity. The examined group was composed of 85 individuals: five ocelots (Leopardus pardalis), six margays (L. wiedii), nine Geoffroy’s cat (Oncifelis geoffroyi), nine Pampas cat (O. colocolo), 23 jaguarundis (Herpailurus yagouaroundi), and 33 oncillas (Leopardus tigrinus). The most frequent lesions found were: gingivitis 76/85 (89.4%), dental calculus 75/85 (88.2%), gingival retraction 65/85 (76.4%), dental erosion 14/85 (16.4%), dental fractures 24/85 (28.2%), dental pulp exposure 17/85 (20%), furca exposure 16/85 (18.8%), gingival pouch 10/85 (11.7%), dental excessive mobility 2/85 (2.3%), dental darkening 7/85 (8.2%). The lesions described were very important to evaluate not only for the potential risk of secondary diseases, but also to correct management errors and to perform specific treatments.
BALD EAGLE (*Haliaeetus leucocephalus*) FEATHERS AS AN ALTERNATIVE TO BLOOD FOR MICROSATELLITE DNA ANALYSIS: TOWARD A NON-INVASIVE TECHNIQUE FOR CONSERVATION GENETICS

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Abstract

The bald eagle (*Haliaeetus leucocephalus*) is currently classified as threatened in the lower 48 United States. In Massachusetts, only 12 active nesting sites presently exist, and the majority of breeding birds originated from a population of eaglets imported from Nova Scotia in the 1980s. Previous work using Random Amplified Polymorphic DNA (RAPD) demonstrated a genetic diversity among Massachusetts eagles of only 22%. The RAPD technique, while useful for genetic analysis of blood samples, proved inappropriate for analysis of feather samples from the same birds. To address this, our current work aimed at determining whether microsatellites would yield identical information for blood and feather samples. Utilizing GenBank sequences, 24 microsatellite primer sets representing 18 loci were designed and tested for polymorphism using DNA from eight blood samples and a single PCR annealing temperature. Thirteen microsatellites (54%) representing 11 loci were polymorphic, and three of these were selected to compare allele sizes in blood and feather DNA from the same eaglet. Preliminary results using microsatellite AJ620425 showed that 18 out of 44 blood/feather pairs amplified alleles of similar sizes. Feather DNA of the other 26 blood/feather pairs tested did not amplify any alleles. Data suggest that microsatellite alleles from blood and feather of the same bird may be consistent, however, multiple repetitions of the experiment are needed in order to determine optimum DNA concentration for feather samples. Additionally, we will need to refine the protocol so as to obtain greater amplification of feather DNA which tended to give somewhat weak signals.
PHARMACOKINETICS OF SINGLE DOSE SELAMECTIN ADMINISTERED TOPICALLY IN AMERICAN BULLFROGS (*Rana catesbeiana*)

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Abstract

Parasitism is frequently encountered in captive amphibians and may cause significant morbidity and mortality.2 Information regarding the use and efficacy of currently available anthelmintics in amphibians is limited.4 Unfortunately, the usual routes of oral or parenteral administration of anthelmintics to amphibians can be difficult especially in small individuals and those that reside in large groups. Selamectin has been shown to have a wide safety margin in mammals and is effective against several different types of parasites.1,3 Since frogs readily absorb substances through the skin, cutaneous administration of selamectin would be easy to administer and may prove useful in controlling amphibian parasites. In this study 32 American bullfrogs were randomly assigned to eight groups with four animals in each group. One group served as the pre-treatment control, and frogs in the seven other groups each received 6 mg/kg selamectin by topical administration to the skin on the back. Each group was randomly selected for sampling on days 1, 5, 10, 15, 20, 25, and 30. On these days, the frogs in the assigned group were euthanatized and plasma samples were obtained. Lung, liver, kidney, and skin sections were collected for histology. There were no adverse drug effects and no signs of toxicity on histologic analysis of tissues. The plasma samples were analyzed to obtain pharmacokinetic data and determine a potential therapeutic dosage for amphibians.

LITERATURE CITED

SEROprevalence of Pathogens in an Island Population of Wild Ocelots (Leopardus pardalis)

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Abstract

Spillover from domestic species has been frequently implicated as a source of disease in wildlife populations. Previous study of wild ocelots (Leopardus pardalis) has demonstrated that populations in close proximity to human settlements can be exposed to multiple pathogens of domestic dogs and cats. In contrast, prior serosurveys have determined that ocelots have an extremely low level of feline immunodeficiency virus (FIV)-like infection (0-5%). This low seroprevalence is remarkable because other wild felids have species-specific FIV infection rates approaching 100%. This study was designed to determine the seroprevalence of domestic animal pathogens and feline lentivirus (FIV) in an isolated island population of ocelots that has practically no contact with domesticated species. We collected serum samples from 12 ocelots native to Barro Colordao Island (BCI) and screened for antibodies to: (1) feline calicivirus, canine distemper virus, and feline herpesvirus using serum neutralization; (2) feline corona virus using immunofluorescence assay; (3) feline parvovirus using hemagglutination inhibition and (4) feline lentivirus using immunoblots with virus from three antigenically distinct FIV strains (puma lentivirus, lion lentivirus, and feline immunodeficiency virus). Sera from naïve or exposed animals were used as controls. All twelve individuals were seronegative for exposure to all pathogens with the exception of lentiviral infection. Five of seven females were positive for lentiviral infection, and one female’s serum was inconclusive. Interestingly, only one of five males was positive for lentiviral-reactive antibodies. These results are suggestive of female ocelot predilection for lentiviral infection but were only marginally significant when analyzed using non-parametric methods (P = 0.08). Gender bias for lentiviral infection has not been reported previously in FIV infection, and should such a relationship be validated by analysis of additional samples, this population would provide a rare opportunity to determine behavioral or ecological factors underlying this observation. Overall, these results suggest that isolation from domestic reservoirs will prevent the introduction of disease in small, high density populations of wild felids. We speculate that lentiviral seropositivity in this population represents infection with a species-specific virus that was enzootic prior to isolation of the BCI ocelot population. We hypothesize that the high density of ocelots on BCI leads to greater contact rates among
individuals and may explain the higher seroprevalence of lentivirus exposure in this population as compared to previously studied populations.
Abstract

A kea greater than 30 years old displayed clinical signs of chronic respiratory infection and had been on discontinuous treatment for aspergillosis for 10 yr. Several treatment regimes using antibiotic, anti-fungal and nebulising elements did not eliminate clinical symptoms. In October 2003 an endoscopic examination revealed thickened opaque air sacs and two small granulomas. Biopsies were examined and showed chronic inflammation but did not yield enough material for conclusive results. Computer tomography of this kea showed unusual cystic pulmonary changes. A clinically healthy kea underwent the same procedure and was used as a baseline to compare with the diseased kea. The lesions were diagnosed as chronic cystic pulmonary disease, which has not been described in this species before. These findings suggested that the clinical signs of recurrent dyspnea were unlikely to be due to ongoing infectious disease. The decision was made to withdraw all treatment apart from supportive care in the form of a heated enclosure and an individual diet with increased palatability. The kea showed rapid clinical improvement. Eight weeks after termination of medical treatment the bird was taken back to his original enclosure. He has been without any obvious clinical signs for over 12 mo.
LACK OF EVIDENCE FOR VERTICAL TRANSMISSION OF INCLUSION BODY DISEASE IN BLACK-NECKED CRANES (Grus nigricollis) AT THE INTERNATIONAL CRANE FOUNDATION

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Abstract

The causative agent of inclusion body disease of cranes (IBDC) is a herpesvirus that appears capable of persisting in a latent form with potential for intermittent shedding during periods of viral reactivation. Determination of previous exposure to this agent suggests a crane could shed the virus at any time, with or without showing signs of disease. Spread of the virus within or between flocks could also occur with vertical transmission of virus through eggs and offspring.

We reviewed the historic medical records from 22 black-necked cranes at the International Crane Foundation (ICF) for serum antibody titers to IBDC: two wild-caught, chronically seropositive adult cranes and their 20 offspring hatched between 1990 and 2004. All serologic testing was performed at the USGS National Wildlife Health Center in Madison, Wisconsin. A serum neutralization test was used to screen for the presence of IBDC specific antibodies; any sera that inhibited the cytopathic effect in the screening test was titered using a TCID₅₀ from diluted sera. Titers greater than or equal to 1:8 were considered positive evidence for exposure to the virus.

The adult male #14-3 was seropositive in 15 of 15 (100%) serum samples tested between 1988 and 2004. The crane exhibited a four-fold rise in titer within 6 mo of arrival from China, from 1:64 to 1:256. The crane’s titer subsequently declined, but has remained stable since 1990 (range 1:16 to 1:64). The serologic history of this crane suggests exposure to IBDC prior to arrival in the USA followed by recrudescence of a latent infection after shipment. Despite the serologic findings, no virus has been cultured from cloacal swabs taken from this crane to date.

The adult female #14-2 was seropositive in 11 of 20 (55%) samples tested between 1985 and 2004. All titers have been low since arrival from China (<1:16). This crane has also remained seronegative for extended periods, including a 5-yr period when housed with #14-3. Her initial seropositive status suggests original exposure occurred prior to arrival in the USA followed by recrudescence of a latent infection after shipment. Despite the serologic findings, no virus has been cultured from cloacal swabs taken from this crane to date.

The adult female #14-2 was seropositive in 11 of 20 (55%) samples tested between 1985 and 2004. All titers have been low since arrival from China (<1:16). This crane has also remained seronegative for extended periods, including a 5-yr period when housed with #14-3. Her initial seropositive status suggests original exposure occurred prior to arrival in the USA. The recurrence of low titers may be due to persistence of latent endogenous infection, re-exposure to the virus from #14-3, or variable detection of small amounts of antibody to IBDC in the absence of infection. All virus culture attempts from cloacal swabs have been negative, including after initial housing with #14-3 when his titer was declining.
Each egg from this pair was removed shortly after being laid and managed with a combination of artificial and natural incubation. Chicks from these eggs were either foster-reared by red-crowned cranes or hand-reared. All 20 offspring from this pair have been seronegative for IBDC (n = 58 samples). Most chicks were tested a minimum of 7 – 14 days after hatching and again at approximately 60 days of age. Two chicks had low detectable titers (1:4) at 8 days of age possibly due to the presence of maternal antibody, though this level is below the cut-off established for a seropositive test and the results were considered equivocal. Both chicks had no detectable antibody on subsequent testing. Six chicks were tested over multiple years (mean = 3.7 yr), all were seronegative.

Vertical transmission of IBDC through eggs has not been documented in cranes to date, though sampling has been limited. The serologic results reported here support the contention that IBDC is not transferred vertically via eggs from adult black-necked cranes that have serologic histories consistent with latent infection.

ACKNOWLEDGMENTS

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LITERATURE CITED

EPIDEMIOLOGY OF PARASITIC DISEASES IN VENEZUELAN ZOOS BETWEEN 1998 AND 2002

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Abstract

The occurrence and distribution of parasitic diseases in captive wild mammals in four Venezuelan zoos were studied from 1998 to 2002. Rates and percentages of morbidity and mortality were calculated using a retrospective analysis of zoo archive data. Bararida was the zoo with the highest index of mortality (4.60%). Primates (66.70%) suffered the highest proportion of deaths. The most frequent genera of parasites were Strongylodes sp. (nematodes), Hymenolepis sp. (cestodes), Platynosomum sp. (trematodes) and Trichomona sp. (protozoa). Primates, rodents, and hoofed animals were parasitized mostly by Trichomona sp.; carnivores and edentates by Strongyloides sp. Platynosomum sp. represented a new discovery as cause of death for primates in captivity.
USE OF A LAPAROSCOPE WITH ACCESSORY PORT FOR TRANSCERVICAL INTRAUTERINE INSEMINATION IN THE GIANT PANDA

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Abstract

Breeding giant pandas in ex situ programs has been difficult due to behavioral incompatibility, poor breeding position and inter-animal aggression. Because some individuals fail to mate naturally, the potential loss of valuable genes is a major concern to effective genetic management. Consistently successful artificial insemination (AI) would allow incorporating genetically valuable males with behavioral or physical anomalies into the gene pool. The major breeding facilities in China have made continuous progress in breeding giant pandas naturally and by AI. It is common practice at these centers to combine natural mating (with breeder males) with AI (using sperm from non-breeders). The use of AI only without natural breeding also has been successful in China, however, females usually are inseminated daily for 3 days. Our goal was to assess the efficacy of only one insemination using a recently developed laparoscope for transcervical intrauterine AI. Semen was collected from the male giant panda at the National Zoo in March 2005, assessed for ejaculate and sperm traits and diluted in TEST (Irvine Scientific, Santa Ana, CA) egg yolk diluent without glycerol. Female was monitored for natural estrus based on behavior, vaginal cytology and urinary hormones (increased estrogen). On the day following peak estrogen, the female was anesthetized, placed in supine position and a lubricated glass speculum (12 cm in length, 2 cm in diameter) was inserted in the vagina. The insemination consisted of inserting a 3.5-mm diameter laparoscope (36 cm long; 26 cm working length) through the speculum to visualize the cervix. Through an accessory port on the laparoscope, an 8 French catheter was inserted into the external cervical os and advanced into the uterine body. A total of $520 \times 10^6$ motile spermatozoa in 1.6 ml volume was deposited in utero. Female was monitored for pregnancy, and a male cub was born after a 121 day gestation. This birth confirmed that the laparoscopic technique was successful for producing a pregnancy after a single insemination. The use of this reproductive technique provides an approach for improving reproductive efficiency in animals that demonstrate poor breeding performance and helps ensure reproduction in genetically valuable animals.
ENDOCRINE CHARACTERISTICS OF FEMALE PALLAS’ CATS MAINTAINED UNDER ARTIFICIAL LIGHTING

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Abstract

The Pallas’ cat (Otocolobus manul) is a small felid endemic to Central Asia that is threatened with extinction. They have a pronounced reproductive seasonality, controlled primarily by circannual variation in photoperiod. Previous studies have demonstrated that artificial lighting conditions can cause abnormal reproductive cycles in captive female Pallas’ cats.1 The Pallas’ cat colony at NCSU is maintained under fluorescent light timed to simulate natural photoperiods. An analysis of fecal steroid metabolites was conducted in three female Pallas’ cats to evaluate whether their reproductive cycles mimic that of Pallas’ cats exposed to natural environmental lighting conditions. Fecal samples were collected two to three times per week throughout the breeding season (January-April) during the years 2002 and 2003. Ethanol extraction and enzyme immunoassays (EIA) were conducted to quantify the concentration of progesterone, estrogen, and cortisol metabolites in the fecal samples. Female 1 had fecal progestogen levels of 0.57 ± 0.28 µg/g in 2002 and 7.16 ± 5.39 µg/g in 2003. She was anovulatory in 2002 and was treated with exogenous gonadotropins in 2003. Corresponding baseline fecal estrogens were 262.9 ± 45.8 ng/g and 337.7 ± 78.1 ng/g. Anestrous estrogen levels in this species were previously reported as 50.2 ± 8.5 ng/g.1 Female 2, who became pregnant during both the 2002 and 2003 seasons, respectively had pre-pregnancy progestogen levels of 0.42 ± 0.10 and 0.45 ± 0.19 µg/g. Pregnancy fecal progestogen levels were 20.76 ± 10.86 µg/g in 2002 and 15.68 ± 10.28 µg/g in 2003. Baseline estrogen values were 201.0 ± 54.8 ng/g in 2002 and 162.4 ± 46.0 ng/g in 2003. Female 3 came to the colony in January 2003 from a 12-hr light cycle. Progestogen levels were 4.94 ± 8.24 µg/g and baseline estrogen levels were 145.0 ± 23.4 ng/g. Both Females 1 and 3 experienced pseudopregnancies during the 2003 season, but Female 3 did not exhibit luteal activity until late April, presumably as a result of a delay in acclimating to a simulated natural photoperiod. Cortisol metabolite levels varied among individuals, but the variation was not substantial and the females appeared well adapted to their artificial environment. When compared to previous data, the Pallas’ cat colony at NCSU displayed a seasonal estrus similar to other Pallas’ cats under normal environmental light stimulation.
PROPOFOL ANESTHESIA IN LOGGERHEAD SEA TURTLES (Caretta caretta)

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Abstract

Rapid, safe, and effective methods of anesthetic induction and recovery are needed for sea turtles (for review see Chittick et al, 2002), especially in cases eligible for immediate release. Free-ranging sea turtles undergoing laparoscopy for population biology studies have traditionally not received general anesthetics or sedative analgesics due to concerns over potential mortality following a return to water. We hypothesized that intravenous propofol would provide rapid induction of anesthesia in loggerhead sea turtles (Caretta caretta) with rapid recovery, allowing safe return to water shortly after the procedure. This study investigates the effects of propofol on anesthetic depth and physiology as part of a larger study involving the validation by laparoscopy of a hormonal sex determination assay in juvenile loggerheads.

Forty-nine loggerhead sea turtles were recovered as local fishery bycatch in pound nets and transported to a surgical suite. Treatment animals (n = 32) received 5 mg/kg propofol i.v., whereas control animals (n = 17) received no propofol. For analgesia all animals received a 4 ml infusion of 1% lidocaine into the site of incision as well as 2 mg/kg ketoprofen i.m. Turtles were placed in head down recumbency or right lateral recumbency to facilitate laparoscopic access to the reproductive organs. Physiologic data included heart and respiratory rate, temperature, and a single blood gas sample collected upon termination of the laparoscopy. Subjective data included jaw tone, ocular reflex, and pedal withdrawal scores: 3 (vigor) to 0 (none detected). Anesthetic depth was scored from 1, no anesthesia, to 3, surgical anesthesia. The turtle was observed until it appeared alert and was then returned to water for overnight observation before release the following day.

Turtles receiving propofol became apneic for a minimum of 5 min with a mean time of 13.7 ± 8.3 min to the first respiration. Limb movement returned at a mean time of 21.1 ± 16.8 min. The treatment animals were judged to be sedated (anesthetic depth score ≥1.5) when compared to controls for approximately 30 min. Mean respiratory rates for treatment animals were slower compared to controls for the first 14 min, then after 35 min, became significantly faster than the controls. Mean heart rates of treatment animals were significantly higher than controls between 40 and 44 min.
Physiologic differences between groups remained for at least 1 hr. Possible explanations for these differences include a compensatory recovery of treatment animals from anesthesia-induced hypoxia and hypercapnea or, alternatively, a stress response of the non-sedated control animals. The animals induced with propofol were easier to secure to the restraint device and moved less during laparoscopy. In conclusion, propofol is a safe and effective injectable anesthetic for use in wild loggerhead sea turtles that provides for a rapid induction and recovery.

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LITERATURE CITED

**Enterococcus Species: Prevalence and Antibiotic Resistance Characteristics in Wild Raptors Pre- and Post-Antibiotic Treatment**

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Abstract

Among potential pathogens, *Enterococcus* spp. have been implicated as indicator bacteria species for the detection of antimicrobial resistance. A normal inhabitant of gastrointestinal tracts, *Enterococcus* has worldwide distribution in human, mammalian, and avian hosts. Enterococcus is cited as the cause of 10% of all nosocomial infections in humans.\(^1\) Urbanization and habitat encroachment have lead to an increase in human and wildlife interaction, and antimicrobial resistance is a point of concern in both human and animal medicine. The source of antibiotic-resistant *Enterococcus* has been largely disputed. Several studies support the finding that related isolates arise from hospital settings resulting in a high incidence of nosocomial infections.\(^2\)\(^-\)\(^5\) Other studies support environmental sources including animals, as the reservoir for antibiotic resistant *Enterococcus* strains.\(^6\)\(^-\)\(^7\) This study evaluated the genotypic variability and the level of antimicrobial resistance of *Enterococcus* spp. recovered from wild and captive raptors presented to or housed at the University of Illinois Wildlife Medical Clinic.

Methods

Fecal cultures were obtained from 18 wild raptors [six *Buteo jamaicensis* (red-tailed hawk), five *Falco sparverius* (American kestrel), three *Bubo virginianus* (great horned owl), one *Otus asio* (Eastern screech owl), one *Pandion haliaetus* (osprey), one unknown (juvenile hawk)] and four captive raptor controls (one *Falco sparverius*, one *Bubo virginianus*, one *Buteo jamaicensis*, and one *Otus asio*). *Enterococcus* spp. were easily recovered on CNA and M agar with or without selective enrichment in *Enterococcus* broth. The genetic relatedness of *Enterococcus* isolates was evaluated by ribotyping (RiboPrinter® Qualicon, DuPont, Wilmington, DE.) The antimicrobial susceptibility was evaluated using a microdilution minimal inhibitory concentration assay (Sensititre®, Trek Diag. Westlake, OH). This study also investigated the effect of therapeutic antimicrobial treatment on the resistance patterns of three raptors (two *Buteo jamaicensis* and one *Bubo virginianus*).
Results

The *Enterococcus* population of the raptors was predominantly *E. fecalis*, and there was very little variability among the isolates. RiboPrint© results demonstrated two dominate strains of *E. fecalis* in wild and captive raptorial birds. The first strain (A) showed unique bands at 11 kbp and 13 kbp and the second (B) showed unique bands at 14 and 20 kbp. These two strains were found in both captive and wild raptor species.

Wild birds with no prior history of exposure to antimicrobials were included in this study, yet resistant strains of *Enterococcus* were isolated from every bird. Wild raptor isolates showed similar patterns of antimicrobial resistance when compared with isolates recovered from the captive raptor controls. While the *Enterococcus* isolates were uniformly susceptible to Beta lactams, they were innately resistant to cephalosporins. There was substantial variability with regard to the susceptibilities for fluoroquinolones, aminoglycosides, macrolides and tetracycline.

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LITERATURE CITED

1. Centers for Disease Control and Prevention (www.cdc.gov)
HEMATOLOGIC AND BIOCHEMICAL VALUES IN BLACK-FACED SPOONBILLS
(Platalea minor) IN HONG KONG

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Abstract

Introduction

Black-faced spoonbills (Platalea minor) belong to the family Threskiornithidae, which includes ibises and spoonbills. They are endemic to east Asia, and listed as endangered by the IUCN criteria. The total population is currently estimated at 1000 individuals. The three major wintering grounds are in Taiwan, Hong Kong and in Vietnam. Up to 25% of the world's population winters in Hong Kong. The black-faced spoonbill is a flagship species for wetland conservation in Hong Kong.

ISIS physiologic reference database does not contain reference ranges for black-faced spoonbills. The aim of this project was to obtain baseline data for blood values in this species, and to provide useful information which can be used to assess ill or injured black-faced spoonbills presented for treatment and rehabilitation.

Methods

In December 2002, 11 black-faced spoonbills were captured using a rocket net in Mai Po Marshes Nature Reserve, Hong Kong to be fitted with leg-mounted radio-transmitter to gather information about their utilization of wetland habitats and to investigate the species nocturnal behavior.

Six birds were physically examined. Two milliliters of blood were obtained from the jugular or ulnar vein of each bird, then stored in potassium EDTA and lithium heparin. Two air-dried smears were obtained from whole blood. The smears were examined for the presence of hemoparasites. The EDTA blood was processed for hematology using the Unopette method. The following biochemical parameters were obtained: calcium, phosphorus, total protein, albumin, globulin, uric acid, AST, LDH, glucose, CK, bile acids, zinc and lead. Two to three drops of blood were used for DNA sexing.
Results and Discussion

Based on physical examination, all birds were healthy at capture. Three birds were male and three were female. Ranges based on 90% confidence intervals are the following: RBC (10⁶/µl) 2.67 – 3.10, PCV (%) 42.57 – 48.76, WBC 9,305 – 17,315/µl, heterophils 75 – 86%, lymphocytes 7 – 19%, monocytes 2 – 6%, eosinophils 0 – 2%, basophils 1 – 2%. The following ranges were calculated for biochemistry values: calcium (mg/dl) 7.53 – 7.84, phosphorus (mg/dl) 2.20 – 3.15, total protein (g/L) 29.63 – 34.51, glucose (mg/dl) 238 – 278, AST (U/L) 278 – 405, LDH (U/L) 263 – 488, CK (U/L) 2597 – 7067, uric acid (mg/dl) 3.00 – 7.33, serum bile acids (µg/ml) 1.61 – 5.75, and zinc (ppm) 1.89 – 2.35.

Although these data are based on samples from only six birds, it provides a useful working reference for veterinarians treating this species of bird.

ACKNOWLEDGMENTS

The authors wish to thank Hong Kong Agriculture, Fisheries and Conservation Department for granting the permit allowing blood collection, and funding the tracking study, Alexandro Grioni and Vicky Elliot for their assistance with the blood collection, Gail Cochrane, Paul Leader and Ocean Park Corporation for allowing us to complete this project.

LITERATURE CITED

MUCOSAL COLONIC BIOPSIES FOR DIAGNOSIS OF SUB-CLINICAL COLITIS IN CALLITRICHIDS KEPT IN A ZOO COLLECTION

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Abstract

Spontaneous colitis is a major cause of poor welfare and premature death of captive New World primates of the family Callitrichidae (tamarins and marmosets), particularly cotton-top tamarins (Saguinus oedipus) and common marmosets (Callithrix jacchus) kept in research colonies. By contrast, the prevalence and significance of colitis in callitrichid species kept in zoo collections is not well documented.

Diagnosis of colitis is based on clinical signs in late stages, however, sub-clinical disease is often found only during routine post-mortem examination.3-5 Colonic mucosal biopsies have been extensively used as a research tool for studies aimed at determining the progression of colitis and response to therapeutic interventions in research colonies.1,2 The purpose of this study was to evaluate callitrichids kept at the Henry Doorly Zoo for sub-clinical colitis by using colonic mucosal biopsies.

Materials and Methods

Colonic mucosal biopsies were obtained from 12 callitrichids. Seven animals were tamarins: one cotton-top (Saguinus oedipus), one Geoffroy’s (S. geoffroyi), two golden lion (Leontopithecus rosalia), three moustached (S. labiatus thomasi). The other five animals were marmosets: four black tufted ear (Callithrix penicillata), and one common (C. jacchus) housed in various exhibits at the Henry Doorly Zoo between January and April 2004. The sex ratio (male:female) was 4:3 for tamarins and 4:1 for marmosets.

A physical examination, tuberculin test, and a blood sample for determination of physiologic parameters were done immediately before the procedure. Endoscopy was performed using a flexible ureteroscope (3.5 – 4.0 mm; Karl-Storz). Anesthesia was induced with 7% Sevoflurane via a mask and maintenance at 3% (Fig. 1). The endoscope was sterilized with gas between each animal. After inserting the ureteroscope rectally, the distance from the anus was recorded, such that mucosal biopsies were obtained from two locations, approx. 3.0 cm and 6.0 cm from the
anal ring. The presence of ulcers, erythema, or hemorrhage was recorded. The biopsies were fixed in 10% neutral buffered formalin, embedded in paraffin, cut at 5µm, and stained with hematoxylin and eosin (HE) and with Warthin-Starry silver for histopathologic examination.

Results and Discussion

With the exception of a Geoffrey’s tamarin (12412) with chronic soft stool, all monkeys were clinically healthy. The procedure lasted approximately 15 min and no complications, such as excessive bleeding or perforation occurred; all the monkeys remained healthy 6 mo after the procedure.

The results of histopathologic examination are: one moustached tamarin (MT #8690) had colitis, one Geoffroy’s tamarin (GT #12412) had suppurative exudate without mucosal tissue, whereas the remaining 10 had normal colons (83.3%).

Conclusions

While colitis has been extensively studied in research callitrichids, the disease has not been found in the wild.\textsuperscript{6,7} Little is known about the prevalence and significance of colitis in callitrichids kept in zoo exhibits. We found that collection of colonic mucosal biopsies was a rapid, safe, and useful technique for identification of callitrichids with sub-clinical colitis. Repeated colonic biopsies might aid in monitoring disease progression in certain individuals and assess the benefit of specific therapeutic interventions. Because of the ease of performing the procedure, the high risk of sub-clinical colitis in callitrichid species, and the known impact of the disease on the health and welfare of the animals, collection of mucosal colonic biopsies might be a useful adjunct to routine annual physical examination of zoo callitrichids. Monitoring of zoo callitrichids for colitis would help support responsible conservation of these unique, but either threatened or endangered species.

ACKNOWLEDGMENTS

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LITERATURE CITED

SQUAMOUS CELL CARCINOMA IN A 4-YR-OLD MALE NILE CROCODILE
(Crocodylus niloticus)

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Abstract

Malignant tumors have been described in different orders of reptiles, including Crocodilia.\textsuperscript{1,3,4} Many reports are based on post mortem findings. Ante mortem malignant neoplasia was found primarily in adult to geriatric crocodile patients.\textsuperscript{2} In our case, squamous cell carcinoma was diagnosed ante-mortem in a young 3.5 – 4-yr-old male Nile crocodile.

This crocodile presented with a 1-mo history of anorexia. According to the owner, the animal had ingested latex foreign objects before he stopped eating. Dehydration and anemia were identified on physical examination. Palpation revealed a foreign body approximately 1.5 – 2 cm in length in the crocodile’s stomach. The owner prohibited any additional diagnostics, including radiology. The foreign objects (parts of decorations form a terrarium) were removed by stomach lavage. Supportive therapy was initiated. During the next week there was no improvement. Additional diagnostic methods were applied. Survey radiographs and then contrast radiographs revealed a stenosing process in the duodenum, which led to gastrointestinal obstruction. Gastroscopy was performed using a medical fibrogastroduodenoscope. Due to the crocodile’s anatomic features, fibrogastroscopy permitted us to visualize only the esophagus and corpus (cardiac region) of the stomach. Pars pilorica, pyloric sphincter, and duodenum were not visualized. Pathologic tissue was observed neither in the esophagus nor in the cardiac region of the stomach. The reason for the gastrointestinal obstruction was not determined by radiology or endoscopy. Thus diagnostic celiotomy was performed. Diagnostic celiotomy permitted us to visualize tumors, which were causing the gastrointestinal obstruction. Multiple tumors (3-7 mm in diameter) were visualized along the entire length of the small and large intestine. Multiple metastases to the liver, pancreas, and kidneys were identified. Histologic examination revealed a squamous cell carcinoma. Invasive growth and polymorphous cells were observed. High mitotic index suggested a high-order malignancy. When histologic examination results were obtained, the patient was humanely euthanatized.

Malignant tumors have been diagnosed in reptiles at the Leningrad zoo on rare occasions (less than 1% of annual morbidity and mortality). According to some reviews, neoplasia is diagnosed less often in Crocodilia than in other orders of Reptiles.\textsuperscript{5} However, according to our experience neoplasia should always be included in differential diagnosis even in very young crocodile patients.
ACKNOWLEDGMENT

I’d like to thank Svetlana I.Litkina, Ph.D., professor of radiology department at Military Medical Academy, St.Petersburg, for her help in taking x-rays and for interpreting the results. I’d also like to thank Dmitrii E.Mazko, Professor, Ph.D., Chief of the Department of Pathomorphology at Oncological Institute named after N.N.Petrov, for histological evaluation of the tumor.

LITERATURE CITED

A DOSING REGIMEN FOR ORAL CARFENTANIL IMMOBILIZATION WITH INTRANASAL NALTREXONE REVERSAL FOR RESTRAINT OF LION-TAILED MACAQUES (Macaca silenus)

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Abstract

An oral carfentanil anesthetic protocol, with reversal by intranasal naltrexone, was evaluated as a new method for immobilizing lion-tailed macaques (Macaca silenus). Five adult macaques were given carfentanil-laced marshmallows. At doses of 60 mg/kg, anesthesia occurred within 12 min of consumption and was followed within 4 min by profound cardiopulmonary depression. Both apnea and bradycardia were restored within 1 min by administering intranasal (IN) naltrexone (30 mg/kg). A low carfentanil dose (0.05 mg/kg) did not induce adequate anesthesia. A carfentanil dose of 0.1 mg/kg produced immobilization without toxicity within 30 min and was readily reversed using less naltrexone (3 mg/kg IN). This data demonstrates that oral carfentanil (0.1 mg/kg) effectively immobilizes adult lion-tailed macaques, indicate that this species is more sensitive to carfentanil toxicity than are other non-human primates, and show that intranasal naltrexone rapidly reverses both immobilization and toxicity induced by carfentanil. The protocol was also successfully used in a field situation to capture and recover a spider monkey (Ateles geoffroyi).
MANAGEMENT OF A LATERAL HUMERAL CONDYLAR FRACTURE IN A POLAR BEAR

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Abstract

After a fall of 15 feet in his habitat, a 14-mo-old male polar bear was diagnosed with a fracture of the lateral humeral condyle with a subluxation of the medial condyle as well. From a lateral approach, the fracture was stabilized by two 5.5-mm interfragmentary cortical screws in lag fashion. The recovery was uneventful although he would not tolerate a cast. After 3 mo of confinement, he was reintroduced in his habitat successfully.

Introduction

A 14-mo-old polar bear had a history of severe acute trauma due to a 15-foot fall. It resulted in a non-weight-bearing lameness of the right front limb immediately after the fall. The bear was anesthetized (telazol 500 mg, xylazine 340 mg by pole syringe) and referred to the hospital facilities of the zoo. General anesthesia was maintained with isoflurane in oxygen administered through an endotracheal tube in a semiclosed circle system. Physical examination was normal except for a moderate swelling of the right elbow. Radiographic images of the elbow on the cranio-caudal view showed a closed articular intercondylar humeral fracture with a proximal displacement of the lateral condyle and a subluxation of the medial condyle. The bear recovered uneventfully from anesthesia and was confined to a small stall until surgery was performed 5 days after the injury.

General anesthesia was induced with a combination of zolazepam-tiletamine and xylazine injected intramuscularly (500 mg-300 mg). After endotracheal intubation, anesthesia was maintained by means of inhalation of isoflurane in oxygen with spontaneous breathing. Preoperative radiographic images were obtained to evaluate accurately the fragments displacement. Blood samples from the left femoral vein was drawn and submitted for complete blood count and chemistry profile.

The bear was positioned in dorsal recumbency with its right front limb maintained extended with a rope around its paw hooked up to an engine lift. The limb was prepared for aseptic surgery.
Methods

A 20-cm skin incision was performed over the lateral distal third of the right humerus extending distally to the elbow joint. Blunt and sharp dissection provided exposure of the lateral condyle, epicondyle and elbow joint. A large hematoma was present around the fracture. The fracture site was debrided and lavaged with sterile saline. Reduction of the fracture was achieved manually with some difficulty. Anatomic reduction was confirmed by palpating the congruity of the humeral articular surface. Then, the fracture was stabilized using two 18-gauge cerclage wires around the fragments. Interfragmentary compression was achieved with two 5.5-mm cortical screws in lag fashion. The first screw was inserted into the extensor fossa through the humeral condyles. The transcondylar lag screw was tightened until perfect joint congruity was achieved by palpating the articular surface through the joint incision. The second screw was placed proximally for rotational stability. After interfragmentary compression, the distal cerclage became loose and was removed. Anconeus muscle was approximated with polydioxanone USP 1 in a cruciate pattern. Subcutaneous tissue and skin were sutured with Polyglactin 910 USP1 in a simple continuous pattern and in a interrupted cruciate pattern respectively. The surgical incision was protected by a semiocclusive dressing before a full limb cast was applied including the foot with the carpus in flexion. Cefazolin sodium (10 mg/kg) was given i.v. during the surgery every 2 hr and ketoprofen (2 mg/kg i.m.) for a single dose. The following day, Cephalexin monohydrate (15 mg/kg) was incorporated in his feed every 12 hr for 19 days combined with ketoprofen (1 mg/kg) every 24 hr for 3 days.

Results and Discussion

Recovery from anesthesia was uneventful and the bear started to put weight on his cast immediately after 7 hr of anesthesia and 4 hr of surgery. The animal managed to remove his cast twice in 1 wk and was then left without it in an indoor enclosure. Surgical incision healed properly and he was fully bearing weight on his right front limb. Chemistry profile and complete blood count analysis were within normal limits.

Control radiographs were performed 3 wk postoperatively under anesthesia. Radiographic images showed callus formation gradually bridging the fracture line. Joint congruity was excellent and the two screws still in place. The bear was then moved outside in a small enclosure. A week after, he had access to a bigger enclosure with a pool. Two months later, control radiographic images showed proper healing with a large callus. At palpation, the right humerus was stable. The bear was finally moved into his habitat of origin with two other female polar bears. Since then, he is perfectly sound. He’s been very active with a normal growth.

Severe joint incongruity is frequently observed with humeral condylar fracture.\textsuperscript{1,2} Interfragmentary compression with internal fixation is essential to re-establish proper joint alignment.\textsuperscript{1,2} No particular intervention was performed on the medial condyle because the subluxation was corrected after the fracture reduction and interfragmentary compression.
Although this surgery is common in companion animals, to our knowledge, this particular fracture is fatal in large animal. Also, orthopedic procedures are rarely reported in bears. This case reported here shows that internal fixation applied to fracture in bears is possible. The large and strong musculature of the bear made fracture reduction challenging. Surgical intervention shortly after the injury and the use of neuromuscular blocking drugs may have helped decrease surgery time and anesthesia as well. Polar bears can sustain long surgical procedure under general anesthesia and lateral condylar fracture of the humerus can be treated successfully with two interfragmentary lag screws.

LITERATURE CITED

SERUM STEROID LEVELS ASSOCIATED WITH OVIPOSITION IN THE GREEN SEA TURTLE (Chelonia mydas), IN ATOL DAS ROCAS, STATE OF RIO GRANDE DO NORTE, BRAZIL

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Abstract

There is a lack of published information regarding reproductive endocrinology for most turtle species. In the case of marine turtles that are frequently exposed to many environmental challenges, more information on their reproductive physiology and behavior is essential for understanding how they function in their ecosystems. In Brazil, green turtles (Chelonia mydas) are one of the most common marine turtle species. The Biological Reserve Atol das Rocas (03°51’30"S e 33°49’29"W), 144 miles off northeast Brazil, is one of the nesting sites of Chelonia mydas in the West Atlantic. Every year during the nesting season (December–June), around 100 females nest on its sandy beaches. Reproductive activity peaks in March. In April 2004, we collected blood samples from 44 adult females immediately after oviposition. Samples were collected by venipuncture of the postoccipital venous plexus and the serum was frozen at -30°C until it could be transported to the Department of Animal Reproduction at the University of São Paulo for processing. The samples were assayed using commercial kits for estradiol (Double Antibody-DSL, Webster, TX, USA), progesterone and testosterone (Coat-a-Count, DPC, Los Angeles, CA, USA). The hormonal levels (mean ±SD) of the green turtle females were: estradiol 3.06 ± 1.66 pg/ml, progesterone 1.20 ± 1.65 ng/ml and testosterone 45.04 ± 26.47 ng/ml. This information not only increases our knowledge of the endocrine-reproductive system of this endangered species but also serves as a baseline against which to assess results from future studies.
MASTOCYTOSIS IN A CHIMPANZEE (*Pan troglodytes*)

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Abstract

Introduction

Mastocytosis in man is characterized by an increased number of mast cells in different organs and its cause is still unknown. In domestic animals, mastocytosis is characterized by cutaneous tumors in ferrets, dogs and cats, cattle and horses. Systemic mastocytosis is rare in dogs and cats, goats, and pigs. There is only one report of mastocytosis in zoo or wild animals (i.e., a gerbil with dermal and systemic mastocytosis). Apart from that, no evidence of reports in nonhuman primates was found. Herewith, the first report of mastocytosis in a chimpanzee, housed in the Royal Zoological Society of Antwerp, is presented.

Case Report

Chimpanzee “Maaike” (wild-born in early 1985) was brought to the zoo in July 1985. She was quarantined and underwent routine treatment. Afterwards, she developed as a normal animal in the group.

In 1995 Maaike gradually began scratching herself more than the other animals of her group. Parasitologic and microbiologic analyses of skin samples were all negative. To control the pruritus she was given 0.2 mg/kg astemizole, an H1-antihistamine (Hismanal, Janssen-Cilag, B-2600 Berchem, Belgium) orally. The symptoms diminished, but never disappeared completely and started again when discontinuing this treatment.

In 1996 Maaike showed skin lesions due to scratching and loss of hair. From then onwards, she received three capsules of 500 mg essential fatty acids daily (Canistar Omega 3 – Merial, 1070 Brussels, Belgium). For lack of improvement, she was anesthetized for blood sampling, skin biopsies and swabs. Laboratory analysis did not reveal any hematologic or biochemical anomaly. Microbiologic and parasitologic analyses were negative. Total IgE was not elevated (in comparison with human standards). IgE for different allergens was also negative (i.e., *Dermatophagoides pteronyssinus*, bananas, timotheegrass, *Aspergillus fumigatus*). Histopathology of the skin lesions at this time revealed signs of folliculitis and parakeratosis. Treatment with H1-antihistamine was continued with either cetirizine (Zyrtec – UCB Pharma, 1070 Brussels, Belgium) or loratidine (Claritine – Schering-Plough, 1180 Brussels, Belgium).
In 1997 pruritus intensified and Maaike was treated with 0.7 mg/kg methylprednisolone (Medrol – Pharmacia, 1130 Brussels, Belgium) and antibiotics to prevent secondary bacterial infections. The scratching diminished and lesions healed almost completely, however, when this treatment was discontinued, her condition worsened again. Maaike was again anesthetized and skin biopsies taken. This time histopathology showed signs of mastocytosis with 25-30 mast cells per field at high magnification between dermal papillae and in capillaries of the papillary layer of the dermis. Continuous treatment with a combination of the H1- antihistamine astemizole or hydroxyzine (Atarax – UCB Pharma, 1070 Brussels, Belgium) and the H2-antihistamine ranitidine (Zantac – Glaxo Wellcome, 1160 Brussels, Belgium) was restarted. Her diet was changed and ingredients containing histamine (or liberators) or other amines were banned. She had to be fed separately and was not allowed spinach, green beans, tomatoes, sauerkraut, pineapples, bananas, lemon, grapefruit, oranges, dates, figs, strawberries, raspberries, mandarins, honey. Simultaneously, continuous treatment with 0.3 mg/kg methylprednisolone every other day and four capsules of 311.5 mg essential fatty acids (Viacutan – Boehringer Ingelheim, 1200 Brussels, Belgium) daily decreased the symptoms gradually. Until today, Maaike’s pruritus is under control and her skin is normal again.

Discussion and Conclusion

The prevalence of human mastocytosis remains unknown and the disease is a diagnostic challenge which can take 10 yr between the onset of symptoms and the correct diagnosis. Blood and urine analyses for histamine and its metabolites are only useful in patients with systemic disease. Demonstration of mast cells in skin biopsies is most reliable. Because mast cells are the key effector cells in the pathogenesis of allergic diseases, differential diagnoses are atopy or exanthema, but immunologic tests were negative. Treatment of mastocytosis in man includes a combination of H1 and H2 histamine antagonists and possibly the intral esional injection or systemic use of glucocorticoids. Maaike was therefore treated orally with these combined histamine antagonists and methylprednisolone. Also histamine-rich foods and mast cell degranulation triggers were avoided. Although Maaike is not cured definitely, her condition is under control and she can lead a normal life in the chimpanzee group.

LITERATURE CITED

PHENOTYPIC CHARACTERIZATION OF Candida spp. ISOLATED FROM CROP OF Amazona spp. PARROTS

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Abstract

The purpose of this study was to morphologically and biochemically characterize Candida spp. isolated from the crop of parrots and to detect possible virulence factors, with the objective of associating the yeasts with the clinical signs presented by the birds. The samples (acquired by the introduction of a urethral catheter into the esophagus of the birds) were seeded onto Petri dishes containing Sabouraud agar dextrose augmented with chloramphenicol (100 mg/ml) and incubated at 37°C for 7 days. The isolates were studied regarding macro-and micromorphology, using gram-stained smears, germ tubes, pseudohyphae and/or hyphae production. Biochemical identification in genus and species was performed using kit API 20C AUX Bio-Mérieux. Twenty-five strains of the Candida sort were isolated, and five species of the genus were identified, being 28.0% C. humicola, 24.0% C. parapsilosis, 20.0% C. guilliermondii, 20.0% C. famata and 8.0% C. albicans. The demonstrated results were surprising since the literature available until then showed C. albicans as the most frequent species, and C. guilliermondii, C. famata and C. humicola, had not been isolated from the crop of parrots.
RISK ASSESSMENT AND RISK MANAGEMENT OF AN EPIDEMIC OF THALLOTOXICOSIS AT THE GEORGETOWN ZOO

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Abstract

Blood and fecal specimens from 84% of a random sample of animals (n = 26) at the Georgetown Zoo in Guyana were demonstrated by spectrophotometry to contain toxicologically significant levels of thallium. The topographic distribution of the mortalities and morbidities due to the thallotoxicosis were consistent with a pattern of criminal iatrogenic exposure of the affected animals. For all the animals examined by necropsy and toxicologic evaluation, the concentration of thallium in the heart was five to ten times the concentration in any other tissue. At the time of the epidemic, 1986, there were no physiologically based toxico-kinetic models (PBTXKM) for thallium in non-domestic animals. The estimation of the doses of Prussian Blue, the antidote of choice, was based on pharmaco-kinetic data from humans, laboratory rodents and domestic mammals.
SEMEN COLLECTION AND CHARACTERIZATION IN ROCKHOPPER PENGUINS
(Eudyptes chrysocome chrysocome)

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Abstract

A method for collecting and evaluating semen from Rockhopper penguins (Eudyptes chrysocome chrysocome) was developed to evaluate the low egg fertility rate found in our population. At the current rate of fertility and hatchability we do not have a self-sustaining population.

Six adult male Rockhopper penguins were used in this study. All six animals were conditioned to allow handling prior to the breeding season. Samples were collected once a week starting at the earliest projected date for the start of breeding season. After an individual animal had 2 wk of no ejaculate or ejaculate with no spermatozoa present they were no longer collected. A total of 59 samples were collected between 17 September and 31 December 2004. Forty-five of these samples were evaluated for volume and pH of ejaculate, spermatozoa concentration, and sperm quality (motility, viability and morphology). There was a large variation between individuals and between weeks for each individual. The average motility was 34.5%. Average volume of ejaculate was 0.23 ml. Average concentration of spermatozoa per ml was 16 × 10⁶. Average number of spermatozoa per collection was 1.7 × 10⁶. Average fraction of living spermatozoa was 82.9%. Average fraction of spermatozoa with normal morphology was 82.1%. Average pH was 6.47. During this season only one of these males paired up with a female. They produced one fertile egg, unfortunately the embryo died early in incubation.

Comparing these results with values found in Magellanic penguins (Spheniscus magellanicus), where sperm concentration was 243.4 × 10⁶/ml and total sperm per ejaculate was 6.4 × 10⁶, the males in our study population may be playing a large role in our decreased fertility. Additional studies will be done in the next breeding season to look at all of the males in the population and perform artificial insemination on unpaired females who are laying eggs.

LITERATURE CITED

EVALUATION OF THE EFFICACY OF WEST NILE VIRUS VACCINATION IN THE GREATER ONE-HORNED RHINOCEROS (Rhinoceros unicornis)

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Abstract

Given the broad range of species that have seroconverted or been affected by the disease caused by West Nile virus (WNV), rhinoceros are presumed to be susceptible to the virus.1,2 A 2004 North American zoo-wide census conducted for the annual greater one-horned rhinoceros (Rhinoceros unicornis) SSP Veterinary Advisor report revealed that 10 out of 21 institutions vaccinate their greater one-horned rhinoceros collection for WNV using the equine protocol for the killed vaccine (Innovator®, Fort Dodge Animal Health, Fort Dodge, Iowa, 50501 USA). Pre-and post-vaccine antibody titers were not measured in any of these animals. The objective of this study was to assess the serologic response of the greater one-horned rhinoceros to the killed equine WNV vaccine. Five immunologically naïve greater one-horned rhinoceros at three institutions in the United States were vaccinated using the commercial equine killed vaccine according to manufacturer’s recommendations. All animals were evaluated for an immune response based on comparisons of their pre- and post-vaccination antibody titers, serum protein electrophoresis, complete blood cell count, and serum biochemistry profile. Seroconversion did not occur in any of these animals following WNV vaccination, nor were there consistent changes in other hematologic parameters to support a detectable immune response. Possible factors in the lack of immune response may include ineffectiveness of the killed product, inadequate dosage and/or frequency of administration. Further investigation is warranted to evaluate whether changes in product type or administration might incite a humoral response in these animals.

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LITERATURE CITED

SPERMOGRAM AND SERUM TESTOSTERONE LEVELS IN WILD CAUGHT BRAZILIAN RATTLESNAKES (*Crotalus durissus terrificus*)

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Abstract

The Brazilian rattlesnake (*Crotalus durissus terrificus*) is distributed all over south and southwestern Brazil. This snake is responsible for 10% of the 20,000 annual snake bites in this country. The aim of this study was to collect and evaluate the semen of the Brazilian rattlesnake (*Crotalus durissus terrificus*) during a 12-mo period. The serum testosterone levels were also studied. Samples were obtained from wild caught adult males from the Sao Paulo state. It was possible to obtain 112 semen samples and 116 serum samples. The spermogram results are as follows: seminal volume 18.49 ± 2.04 μl, sperm concentration 1.39 ± 0.08 × 10⁹/ml. The highest value for pleomorphic sperm cells occurred in the winter (42.35 ± 4.18%). The lowest value occurred in the spring (17.67 ± 2.45%). In the summer (spermatogenesis peak) and autumn (mating season) we found intermediate values, 28.72 ± 2.73% and 28.53 ± 1.83%, respectively. The seasonal serum testosterone levels were: 8.89 ± 3.81 ng/ml (winter), 12.09 ± 3.58 ng/ml (spring), 52.6 ± 9.24 ng/ml (summer) and 43.12 ± 8.89 ng/ml (autumn). The results during the mating season and spermatogenesis peak (autumn and summer, respectively) matched with the highest testosterone levels.

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