“MAY I QUOTE YOU ON THAT?”

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Abstract

“May I quote you on that?” With increasing national interest in animal welfare issues, zoo and aquarium animal health professionals are finding themselves in increasing demand to talk publicly about veterinary care and well being of animals in their facilities. Institutions are calling on their veterinarians to be key spokespersons regarding animal care and treatment. This includes interviews with media that increasingly scrutinize the welfare of zoo and aquarium animals, in part due to targeted national campaigns by organizations that call for removing some species from public display in zoos and aquariums.

Today’s zoo veterinarians find themselves talking with the media about topics that were previously not discussed, including animal deaths, medical treatment procedures, and individual animal’s quality of life. This presentation will analyze this new trend and why it is critical to the future of the public display community that zoo and aquarium veterinarians are prepared to fill the important role as the expert voice in animal care.
VETERINARY CONFIDENTIALITY AND PRIVILEGE

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Abstract

Some states have statutes requiring veterinarians to maintain as privileged and confidential veterinarian-client-patient information and records. Many other states have veterinary board regulations imposing such a duty on veterinarians. Additionally, the A.V.M.A.’s Principles of Veterinary Medical Ethics (P.V.M.E.) recognizes that veterinarians are subject to a duty of confidentiality.

State veterinary practice acts and board regulations make it grounds for disciplinary action for a veterinarian to violate provisions of the practice act, regulations and, in some states, even the P.V.M.E. A summary of when it is legally and ethically permissible for veterinarians to discuss or disclose to a third party or the public, information and records on a patient or client and when it is not will be detailed in this presentation. Also, what liability, if any, might arise for a veterinarian who wrongfully discloses privileged or confidential information and records or fails to disclose such information when required by law to do so.
“CODE ONE, GORILLA ESCAPE!!” AN EXERCISE IN MEDIA CRISIS MANAGEMENT

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Abstract

In September of 2003 Zoo New England (ZNE), the parent organization managing the Franklin Park Zoo (Boston, Massachusetts) and the Stone Zoo (Stoneham, Massachusetts) was faced with a situation that all zoos fear, an escape of a potentially dangerous animal. Little Joe, a juvenile male Western lowland gorilla (*Gorilla gorilla gorilla*) escaped his enclosure. Though all institutions accredited by the American Zoo and Aquarium Association (AZA) develop contingency plans to deal with an escaped animal, few are prepared to deal with another potentially dangerous animal: the media. The circumstances surrounding Little Joe’s two escapes from his exhibit and the strategy for working with the media involved representatives from all areas of the zoo. Proper and immediate communication with staff, public and the media provided a forum that helped mitigate public relations damage to the zoo.

Wednesday, August 13, 2003. Boston (AP). “A gorilla who stands 5 feet tall and weighs 280 to 300 pounds got a brief taste of freedom Wednesday from the Franklin park Zoo. Little Joe climbed down in the moat that surrounds his exhibit and then up and out to freedom, but returned only 10 min later, said a zoo spokeswoman.” This story was carried on various news outlets across the United States. The entire incident lasted approximately 10 min, when the gorilla returned to the exhibit on his own accord without intervention. The next step for zoo management was to initiate our Code One: Public Relations (PR) response.

Our PR consulting firm, Rasky/Baerlein, was contacted and a press release providing the facts of the incident was prepared. Although the incident occurred at approximately 10:05 A.M. and was resolved by 10:20 A.M., an Associated Press reporter contacted ZNE at about 10:45 A.M. asking if there had been a gorilla escape. An internal meeting was held to inform the full staff of the incident and to provide an opportunity to ask questions. Also, the company policy regarding speaking to the press was reinforced. The release was completed and distributed by noon. Preparation began for a press availability to film the exhibit that afternoon at 3:00 P.M. All the local media attended. The strategy for this encounter focused on delivering several messages:

- The incident was quickly and safely resolved;
- Little Joe and the other gorillas were fine;
- The gorillas would remain off exhibit while the zoo investigated the escape and modifications made to prevent another incident.

Questions were answered as completely as possible, particularly regarding how Joe managed to climb out. At that time, this had not been determined. The local press reaction was to present the
escape as a somewhat humorous incident and although the coverage was national, it lasted only several days. This encounter with the media was considered to be successful as a result of:

- Being prepared with contact information and media response team members knowing their roles;
- Instant communication; immediate decision-making, particularly regarding informing the public;
- Being open and honest regarding the facts.

After examining the gorilla exhibit, modifications were made, and the gorillas (including Joe) were eventually put back on exhibit. Once back on exhibit, life for the gorillas and the zoo returned to normal.

On Sunday, September 28, 2003 (4 days after returning to exhibit) at 5:55 P.M., as the zoo closed to the public, Little Joe climbed out of the exhibit again (a different location) and followed a group of visitors out of the building. The visitors, a zoo employee who had brought several relatives to the park, encountered Little Joe as he left the building, and a security guard passing by called the Code One. Little Joe headed toward the rear entrance of the zoo, being tracked by the staff, and climbed over the fence separating the zoo from the 500 acre adjacent park. The zoo’s Dangerous Animal Recovery Team (DART), Boston Massachusetts State and Environmental Police, Boston Animal Rescue League and media outlets (print and electronic) all responded to the scene. The DART members and law enforcement officials were able to dart the animal within 8 min of him leaving the zoo, at which time he fled into the surrounding woods. A perimeter was established to contain Little Joe within the wooded area adjacent to the zoo and locate him for further immobilizing agents to be delivered. During this whole event and darting, the media was the next in line behind law enforcement officials doing crowd control. Once Little Joe was immobilized, he was transported to the off-exhibit gorilla holding area at the zoo, and recovered within about 20 min. The entire capture took approximately 2.5 hr.

While the capture of Little Joe was happening, the other emergency response team, our PR crew, was also preparing for the PR aftermath. The team met immediately to discuss the following:

- The course of events and gather as much factual information as possible from DART leaders John Linehan, Zoo President, and Hayley Murphy, D.V.M., Director of Veterinary Services.
- Media outreach, identify spokesperson.
- What staffing issues may need to be resolved in immediate aftermath?
- Prepare for press conference, identifying John Linehan and Dr. Hayley Murphy as key spokespeople for the incident.
- Held conference, key messages repeated:
  - Statement of facts as known
  - Sympathy to individuals injured
  - Make every effort to determine how this occurred.
  - Thank you to authorities for their assistance and good work.
• Preparation for the following mornings press attention

Monday, September 29, 2003
• Early A.M. press conference, again with key points related by John Linehan and Dr. Murphy
• Monitored news coverage
• Team coordinated press response including guided visits to the empty exhibit for b-roll, and convey honesty and cooperation
• Held internal full staff meeting to provide information and re-iterate policy regarding speaking with the press.
• Held afternoon press conference announcing measures being taken to make sure incident doesn’t happen again.
• Continued taking media calls and reiterating key messages
• Coordinated community and legislative outreach

Tuesday, September 30, 2003
• Continued to monitor news coverage
• Held press conference for community leaders to express support for Zoo
• Encouraged volunteers and community leaders to send “letters to the editor” to support the zoo
• What began as an extraordinary event, grabbing headlines from Boston, around the world, including The Late Show with David Letterman and the Tonight Show with Jay Leno, over the course of a few days turned away from the excitement of the event toward the pro-active measures taken by the zoo and its management. The PR team was able to counter images of the people injured speaking to the press with a group of activists supporting the zoo.

Summary of principles employed:
• Be prepared….in advance
  o An excellent starting point is an experienced consultant
  o Establish your relationship and priorities prior to a crisis
  o Establish key talking points
  o Have your PR people there to back up your key spokespeople if they are “animal” people
• Be empathetic
  o Be the first to say you’re wrong when you are
  o Say you’re sorry. Say it soon. Say it in person, if possible
• Be honest
  o The more information you can disseminate, the better.
  o Include your staff in all releases and discussions, without factual information, they will make it up.
• Speed
  o Prepare in terms of the “48-hr day”. Respond with your messages(s) immediately and continue at least two days, if not longer.
• Solution
  o “What will you do to make things better?” everyone will ask this, it is imperative to have a credible answer.
  o The competition for compelling stories is fierce. Your crisis planning should reflect this and recognize that the media is not the enemy, if you are prepared. By constantly communicating, Zoo New England was able to demonstrate a willingness and openness to the media, resulting in successfully communicating the facts and getting our message out to the public.
VETERINARY MEDIA EXPERIENCES AT THE LOS ANGELES ZOO: TIPS FOR SURVIVAL IN A HIGH PROFILE ZOO

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Abstract

Dealing effectively with the media is an art. Preparation before an interview, going into an interview with a core message, staying in control of an interview, bridging from tough questions, not falling into “traps”, and using appropriate body language are all effective techniques veterinarians can learn when speaking for their institution.1 A specific challenge to veterinarians is having to “translate” scientific and medical language into terms media and public can understand, and not appearing “too scientific” which can be perceived as uncaring.

During 10 yr of working together, the authors faced numerous challenging events that were faced pro-actively, instead of reactively, with carefully worded press releases and core messages, turning stories that could have been very negative for the zoo into stories that gained public sympathy and support. Additionally, using outside experts in the field where relationships had already been established before events occurred to support the zoo and corroborate the information given was also crucial. Careful selection of media personnel and establishing relationships there assisted in building a trusting relationship. Being honest, caring, and providing information to the public in a responsible way was a very successful way to deal with “hot stories” such as human tuberculosis in the zoo’s animals, deaths of aged and beloved animals, and animal medical problems related to an inadequate veterinary facility.

LITERATURE CITED

CORRELATING ANTE-MORTEM AND POST-MORTEM FINDINGS IN ZOOLOGICAL COLLECTIONS

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Abstract

Skeletal specimens from captive large non-domestic felids (n=55) were examined at the National Museums of Scotland, Edinburgh. Osteoarthritic lesions were assessed to give a score per specimen,1 with a higher score indicative of more numerous and severe lesions. As expected, specimens from older animals produced higher scores. Ante-mortem and necropsy records were then evaluated retrospectively to ascertain if clinical signs or reported pathology correlated with findings in prepared museum specimens.

For many specimens, ante-mortem records were brief and did not include data that could be associated with lesions found either at necropsy or skeletal examination. This likely reflects a combination of factors, including difficulties in noting clinical signs of disease in live animals.

Ante-mortem signs correlated better with certain diseases, for example vomiting and diarrhea with acute enteritis, or polydipsia/polyuria with chronic renal disease. Blood samples and necropsy/histology results were useful in identifying these diseases. Although lameness was noted in some animals, several specimens with high osteoarthritis scores did not have corresponding ante-mortem signs. This suggests either that these skeletal findings are not associated with significant morbidity or that ante-mortem disease detection requires refinement.

Necropsy is an invaluable technique, but it is important to correlate the findings with ante-mortem observations to assess disease significance. Other techniques should be used to assess normal behavior, anatomy and pathology to improve our care of captive non-domestic animals, to benefit group health within the collection and the species’ worldwide population.

LITERATURE CITED


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Abstract

Chronic wasting disease (CWD), a debilitating and fatal neurodegenerative disease, was first described in mule deer (Odocoileus hemionus hemionus) as a spongiform encephalopathy in 1980. Chronic wasting disease became a reportable disease in Canada in 2000. In 2003, a retrospective study of cervid deaths at the Toronto Zoo (TZ) was undertaken to follow up on the histopathologic diagnosis of spongiform encephalopathy that had been recorded in one mule deer which had died in 1978. The objectives of the study were to:

- Determine the most likely source of introduction of CWD into the TZ cervid collection in the 1970s;
- Assess the likelihood of spread within the TZ, and to other zoos and collections through the sale or donation of animals; and
- Assess the current CWD status of the TZ cervid collection.

Through archived zoo records, including inventory records, keepers’ daily reports, animal health records, and pathology records, it was possible to develop an understanding of the distribution of cervids in space and time in the TZ from 1973 to the present. A list of the mule deer (and of other cervid species that may have had direct or indirect contact with them, through environment, facilities, or equipment) was developed, and the CWD status of these animals was investigated. Archived, formalin-fixed, paraffin-embedded blocks including lymphoid tissue and/or brain were available from many of the cervids, at least 1 yr of age that had died at the TZ. These samples were retrieved from storage in the Pathobiology Department, University of Guelph, and sent to the Canadian Food Inspection Agency’s National Reference Laboratory in Nepean, Ontario, for evaluation by immunohistochemical staining (IHC).

Tissue sections from paraffin blocks were cut at 5 μm, mounted on positively charged glass slides, and immunostained with monoclonal antibody F99/97.6.1, which had been used in another study. The method used for the detection of prion protein (PrP) was that described by O’Rourke. For one mule deer, only H&E stained slides were available for evaluation, and PrP immunostaining was possible after the slides had been placed in preheated xylene (60°C) and...
then on a slide warming table (40°C) until the cover glasses could be slid off. In this case, the same methodology was also applied to known positive and negative slides that had previously been stained with H&E, for comparison.2

Cervids were considered to be “suspect” if they were >12 mo of age and had displayed one or more of the following signs: excess salivation, unusual behavior, neurologic signs, polydipsia/polyuria, weight loss, retention of winter hair coat, or pneumonia.1 Of 12 CWD-suspect mule deer, tissues appropriate for IHC were available from nine animals, seven of which were found to be positive for CWD. The earliest case of CWD was identified in a Colorado mule deer that died 21 mo after arrival at the TZ. Another suspect Colorado animal, an emaciated female, had been killed by a male 10 mo after arrival; unfortunately no tissues were available for IHC evaluation.

Based on clinical observation, a number of other cervids in the Canadian Domain area of the TZ were considered as suspects, and of these, appropriate tissues were available from 13 of 14 suspect black-tailed deer (Odocoileus hemionus columbianus), eight of 18 white-tailed deer (Odocoileus virginianus), one of one reindeer (Rangifer tarandus tarandus), five of six caribou (Rangifer tarandus caribou), and one of one moose (Alces alces americana). All of these suspect samples, from cervids other than mule deer, were negative for CWD.

Appropriate tissues available from all non-suspect cervids >12 mo old were also evaluated by IHC with negative results, except for one black-tailed deer. A group of black-tails had been moved into the mule deer exhibit 3 days after the last mule deer was moved out. Four months later, one of these animals died acutely and showed no clinical signs consistent with CWD. Its postmortem record indicated acute hemorrhagic nephritis, consistent with clostridial septicemia or toxemia, as the final diagnosis. In repeated tests, IHC was positive on brain tissue from this animal. This is an extremely unusual finding, since the black-tail had no previous history of exposure to mule deer at the TZ. It is now known that infectious prions can be found in the tonsils of mule deer as soon as 3 mo after exposure3 and perhaps it is possible to find prions in the brain within 4 mo after exposure in black-tails. Significantly, a total of 31 black-tails were tested, and all others were negative.

This study determined that mule deer from a Colorado zoo were the likely source of CWD, and that lateral transmission of CWD to offspring and to animals from another source had occurred within the mule deer herd. A black-tailed deer that was exposed to the contaminated mule deer exhibit, but never had direct contact with the mule deer, was also infected. The last CWD-positive death, the black-tailed deer, occurred in 1981. No mule deer had been moved from the zoo site. Three black-tailed deer were sold in 1988, 7 yr after the last CWD diagnosis: their whereabouts could not be traced, but it is unlikely that they were infected based on the history of the herd and the time lapse since the last CWD death. Since 2001, all cervids >12 mo of age that die at the TZ have routinely undergone testing for CWD.

ACKNOWLEDGMENTS

We thank the staff at the Toronto Zoo for their help and cooperation, particularly Drs. Bill Rapley and Graham Crawshaw. Special thanks to Mrs. Carol-Lee Ernst of the Department of Pathobiology, University of Guelph, who
retrieved postmortem records and tissue blocks for testing. The authors also thank Dr. Terry Spraker of Colorado State University for his helpful comments on IHC diagnosis, and Dr. Katherine O’Rourke of ARS, USDA, Pullman, Washington, for providing antibodies. Finally, thanks to Bruce Ullett who performed histological preparations and IHC assays.

This paper is presented with permission of the Canadian Veterinary Journal (Can. Vet. J. 2006;47:1185-1193).²

LITERATURE CITED

GASTRIC ENDOCRINE CARCINOMA IN THE BEARDED DRAGON: AN EMERGING MALIGNANCY

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Abstract

Bearded dragons are popular pets and exhibit animals. These lizards constituted approximately 3% of the reptile biopsy and necropsy submissions to Northwest ZooPath from 1994-2006.1,2 Some trends exist in bearded dragons regarding neoplasia and include peripheral nerve sheath tumors and myelocytic leukemia.3-4 This report describes an apparent emerging trend in the development of gastric endocrine carcinomas in this species, with a relative prevalence of this tumor of 1.5% at the primary author’s diagnostic service.

A review of the records at Northwest ZooPath, and the Veterinary Medical Teaching Hospital at the University of Wisconsin identified 6 bearded dragons with these neoplasms. Table 1 summarizes signalment, history, abnormal blood values, and lesions. Five were male, 1 was female. Ages ranged from 1.5 – 3 yr. All presented with anorexia. Two were anemic. Two had severe hyperglycemia. Gross lesions included nodular pale yellow to white masses up to 1 cm in diameter in the stomach or pylorus (4), and liver (4). Histologic examination revealed an endocrine carcinoma arising from the gastric or pyloric mucosa (6), with metastasis to liver (5), kidney (4), heart (2) and 1 each of pancreas, ovary, and oviduct. A Cherukian Schenk stain applied to tumor of case 6 identified cytoplasmic argyrophilic granules in the neoplastic cells. Immunohistochemical staining for glucagon was negative for case 6. Electron microscopy identified spherical, dense-core granules typical of neuroendocrine granules in the cytoplasm of neoplastic cells in the tumor from Case 6.

We conclude that young bearded dragons are predisposed to development of gastric neuroendocrine carcinoma, a high grade malignancy that readily metastasizes. The cause for the predisposition to this otherwise unusual tumor is unknown. Because two affected lizards had marked hyperglycemia, it is considered possible that these tumors may in some cases be functional glucagonomas.

LITERATURE CITED

<table>
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<td>3 yr, m</td>
<td>anorexia, 1 wk; died</td>
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<td>2</td>
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<td>2 yr, f</td>
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<td>fibrous osteodystrophy</td>
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<sup>a</sup>Not available.
<sup>b</sup>Endocrine carcinoma.
MORPHOLOGIC EVIDENCE OF HYPERTENSION IN WESTERN GRAY KANGAROOS (*Macropus fuliginosus*)

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Abstract

Marked renal vascular changes, suggestive of hypertension, were noted among several adult Western gray kangaroos (*Macropus fuliginosus*) some of which had clinical nervous system deficits, including blindness. To determine vascular lesion prevalence and other changes suggestive of hypertension, case histories and archival tissue sections from 20 adult (8.12) kangaroos that died or were euthanatized between 1994 and 2006 were reviewed. Average age at death was 9.7 yr. Antemortem blood work was unremarkable in all cases. Fourteen (70%) kangaroos had morphologic evidence of hypertension. Lesions included varying degrees of juxtaglomerular hyperplasia and tortuous renal arterioles with increased thickness of the tunica media and variable amounts of smooth muscle hypertrophy and/or hyperplasia. Occasional arteriolar reduplication also was evident. Similar vascular reduplication was noted in the CNS of one animal with neurologic signs. Four kangaroos had histologic evidence of ante-mortem retinal detachment, a common sequel of hypertension.

Hypertension, persistently high blood pressure, can be essential (idiopathic) or secondary to renal disease, endocrine disorders, diet and/or stress. In animals, hypertension can be difficult to assess as blood pressure evaluation and parameters can be altered by stress of capture and anesthesia. The cause of presumed hypertension in this mob is uncertain. Significant underlying renal disease was not noted in affected animals and only 3 animals had thyroid abnormalities. The majority of affected animals were females or low-ranking males, therefore social stressors may play a role in pathogenesis. Other potential predisposing factors, including genetics and diet, are being evaluated.

ACKNOWLEDGMENTS

We would like to acknowledge Jane Chladny and the University of Illinois Veterinary Diagnostic Laboratory’s histology laboratory for slide preparation and Zoological Pathology Program faculty, residents, and students who assisted with the necropsies included in this study. We would also like to thank Brookfield Zoo hospital staff for their essential support, and Mark Warneke for aid in compiling case materials.
ADENOMYOSIS (ENDOMETRIOSIS) IN BATS

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Abstract

Adenomyosis is defined as the occurrence of endometrial tissue in the wall of the uterus, while endometriosis indicates endometrial glands or stroma outside the uterus. In animals these conditions occur only in those species that menstruate, and have been well documented in nonhuman primates, dogs, cats and cattle. This paper presents the occurrence of adenomyosis (endometriosis) in a group of eight short-tailed bats (Carollia perspicillata).

In all cases the bats were presented dead with no premonitory signs. The uterus was variably enlarged, with thickened endometrium. Blood was seen in the lumen and in some cases coming from the vulva. Many of the animals had yellow-brown material in the lumen. Histologically the uterine lesion was infiltrative and comprised of variably sized tubular structures arranged in small clusters. These structures were lined by cuboidal to attenuated epithelial cells with scant to small amounts of granular eosinophilic cytoplasm and round nucleus. The nucleus had stippled chromatin and one or multiple nucleoli. Larger tubular structures contained intracytoplasmic granular eosinophilic material. These structures extended from the endometrial mucosa and penetrated through the submucosa in multiple places, but did not penetrate through the myometrium. Few mitoses were seen. There was a mild scirrhous tissue reaction.

Adenomyosis in humans may be asymptomatic or associated with clinical signs including abnormal bleeding and uterine enlargement. It indicates downgrowth of endometrial tissue into the myometrium. Hemorrhage can occur within the small endometrial downgrowths. In animals the cause has been considered to be prolonged estrogen stimulation, and focal or diffuse swelling of the uterus is the most commonly reported sign. The abnormal endometrial glands may become distended with purulent material. Endometriosis is the presence of functional endometrial tissue outside the uterus. The cause of endometriosis is not known for certain. Theories of its pathogenesis include retrograde menstruation through the fallopian tubes with subsequent implantation of endometrial cells in abnormal locations, metaplasia of coelomic epithelium, and vascular or lymphatic dissemination via pelvic veins or lymphatics associated with an immune system defect.

Although morphologically typical endometriosis was not seen in these bats, its occurrence is possible. Like primates, short-tailed fruit bats have a simplex uterus and true menstruation.\(^1,2\) This could also possibly explain why the adenomyosis in these animals appears to have been more severe than that described in domestic animals. The cause of the lesions is also not known. In humans a genetic predisposition for endometriosis has been documented, and the same may be true in animals.
LITERATURE CITED


LARGE CELL ANAPLASTIC B-CELL LYMPHOMA, PLASMA CELL MYELOMA AND OTHER CAUSES OF MORTALITY IN GOLDEN MONKEYS (Cercopithecus mitis kandti) FROM THE VIRUNGA VOLCANOES

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Abstract

The golden monkey, an endangered subspecies of the blue guenon (Cercopithecus mitis), is limited to montane bamboo forests of the Virunga volcano chain of Rwanda, Uganda and the Democratic Republic of Congo, sympatric with the endangered mountain gorilla (Gorilla beringei beringei). Golden monkeys are habituated for tourist viewing in the Parc National du Volcans in Rwanda. Population health monitoring by the Mountain Gorilla Veterinary Project, Inc, includes post mortem examinations.

Six golden monkeys have been examined post mortem. One older adult female found moribund in a farmer’s field had multiple enlarged cervical, mediastinal, splenic, pancreatic and sublumbar lymph nodes. There was marked pericardial effusion and pulmonary consolidated. The calvarium had several soft red foci with underlying thickening of the dura. All the above organs, plus liver and pancreas were infiltrated by a population of large, pleomorphic, neoplastic “round cells.” The diagnosis of multicentric, anaplastic, large B-cell lymphoma was made based on histologic appearance and immunohistochemical staining pattern. The monkey also had marked sparganosis. An adult male had an infected head wound with extension, via cellulitis and phlebitis, to embolic pneumonia and epicarditis and also had plasma cell myeloma characterized by marked, often atypical, plasma cell infiltration of lymph nodes, bone marrow, spleen, heart, salivary glands and adrenal. A third golden monkey was extremely emaciated and had a large subcutaneous and intramuscular abscess and evidence of sepsis. The other three monkeys died from trauma, two from human interactions and one from entanglement in vegetation.
RETROSPECTIVE PATHOLOGY SURVEY OF CAPTIVE MANGABEYS IN NORTH AMERICAN ZOOS, 1985-2006

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Abstract

The Species Survival Plan for mangabeys has recommended three of the seven living mangabey species to be target species in North America: the red-capped mangabey (*Cercocebus torquatus*); the golden-bellied mangabey (*C. chrysogaster*); and the black mangabey (*Lophocebus aterrimus*). These species have been kept in captivity in the U.S. since the 1870’s, but there is limited information on causes of morbidity or mortality in the captive setting.

In this investigation, a pathology survey was conducted in order to better define the causes of mortality in captive mangabeys. Surveys were distributed to 25 zoological institutions in North America. Gross and/or histopathology reports were received from 19 institutions (76% return rate). Of known mangabey mortalities between 1980-2006, reports were obtained for 34 of 48 red-capped mangabeys, 20 of 27 golden-bellied mangabeys, and 7 of 11 black mangabeys. The reports were reviewed and animals were categorized by species, age, and sex. Primary, secondary, and incidental lesions were recorded and these findings were used to calculate the percentage of deaths caused by specific diseases, and to evaluate the effect of signalment on these proportions. Trauma was a frequently reported cause of death in neonates (< 1 mo), and appeared clustered at individual institutions. Islet amyloidosis was commonly reported in mangabeys > 15 yr old and many of these cases were associated with an antemortem diagnosis of diabetes mellitus. Further in-depth studies of husbandry, management, and breeding histories are warranted to evaluate risk factors for these conditions and to suggest potential interventions.

ACKNOWLEDGMENTS

The authors thank all of the institutions and individuals who contributed pathology information for this retrospective study.

LITERATURE CITED

EVALUATION OF A FORMULA FOR HAND-REARING RED PANDAS (Ailurus fulgens)

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Abstract

Physiologic and behavioral benefits indicate the preference of maternal rearing red panda (Ailurus fulgens) neonates; however, there are circumstances that necessitate surrogate (human) or supplemental care and feeding.

The suggested formula, powdered canine milk replacer (Esbilac®) reconstituted with water to 19.6% solids, incubated with a lactase-enzyme preparation (Lactaid®), has resulted in constipation associated with inspissated feces in some animals.1 Additionally, the lactase-enzyme preparation is no longer commercially available in the United States, although marketed internationally, making practical use of the enzyme preparation problematic.

A modified formula, using equal proportions of two commercially available products: a powdered canine milk replacer (Esbilac®) and a higher whey protein, lower casein protein powdered human milk replacer (Enfamil®) developed to address similar clinical signs in sun bears (Helarctos ursinus) and giant pandas (Ailuropoda melanoleuca), was used for rearing two red panda neonates (Table 1).2 The reconstituted formula contained 19.6% solids, but was not predigested with a lactase-enzyme preparation.

Surrogate care was initiated on day 24 and 77. The suggested formula was initially offered. Both specimens became constipated producing inspissated feces with apparently undigested curd (casein). The modified formula was increasingly introduced from days 35-67, and days 81-105, respectively.

Constipation gradually resolved with an apparent increase in fecal moisture content. There was a concurrent reduction in the visual presence of undigested curd. The neonates were weaned at 164 and 174 d, respectively.

High casein milks produce a strong curd in the neonate’s stomach. Although an adaptation of certain species (e.g., bovids), in other species, the increasing size of the curd can exceed the digestive capacity of the species. In extreme cases, the undigested curd (lactobezoar) can physically obstruct the gastrointestinal tract.
The modified formula supported apparently normal neonatal development to weaning with desired changes in fecal characteristics to address constipation associated with the currently suggested formula.

LITERATURE CITED


Table 1. Ingredients and selected nutrient composition of a formula for feeding red panda.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount, g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esbilac ® powder</td>
<td>10</td>
</tr>
<tr>
<td>Enfamil ® low iron powder</td>
<td>10</td>
</tr>
<tr>
<td>Water</td>
<td>80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composition</th>
<th>As-fed basis</th>
<th>Dry matter basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total solids, %</td>
<td>19.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Energy, kcal ME g⁻¹</td>
<td>1.11</td>
<td>5.64</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>4.6</td>
<td>23.2</td>
</tr>
<tr>
<td>Whey, %</td>
<td>1.35</td>
<td>6.90</td>
</tr>
<tr>
<td>Casein, %</td>
<td>3.51</td>
<td>17.90</td>
</tr>
<tr>
<td>Whey:casein</td>
<td>28:72</td>
<td>-</td>
</tr>
<tr>
<td>Crude fat, %</td>
<td>7.1</td>
<td>36.1</td>
</tr>
<tr>
<td>Total carbohydrates, %</td>
<td>7.1</td>
<td>36.2</td>
</tr>
<tr>
<td>Ash, %</td>
<td>0.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>0.142</td>
<td>0.73</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.103</td>
<td>0.52</td>
</tr>
</tbody>
</table>
INFLUENCE OF DIET TRANSITION ON SERUM CALCIUM AND PHOSPHORUS IN CAPTIVE GIRAFFE

Elizabeth Koutsos, PhD,1* Doug Armstrong, DVM,2 Ray Ball, DVM,3 Cheryl Dikeman, PhD,2 Jack Hetherington,2 Lee G. Simmons,2 Eduardo Valdes, PhD,4 and Mark Griffin, PhD1

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Abstract

Pathology in captive giraffe is relatively common and has often been attributed to nutritional causes. It was hypothesized that reducing dietary starch and phosphorus (P) would change serum mineral concentrations to be more in line with typical mammalian values. Captive giraffe (n=6, Henry Doorly Zoo, Omaha NE), previously fed a commercially available diet, were transitioned to a reduced-starch diet for 1 yr (2005). Following the Giraffe Nutrition Workshop recommendations, another diet transition was made (2006). Blood samples were collected every 6 mo, and were analyzed for Ca and P. Data were analyzed by repeated measures ANOVA for effects of diet and season. When main effects were significant (p<0.05), students t-test was used to assess differences. There was no difference in serum parameters between 2005 and 2006 diets (p>0.20). Serum Ca was not affected by season or diet (p>0.20, mean = 9.04 ± 0.10 mg/dl), and serum P was not affected by season (p>0.20). Serum P was reduced by the 2005 and 2006 diets as compared to the 2004 diet (p<0.05; 7.35 vs. 9.58 ± 0.28 mg/dl respectively). Therefore, the Ca:P ratio was increased by the 2005 and 2006 diet compared to the 2004 diet (p=0.006; 1.26 vs. 0.98 ± 0.04, respectively). Given that 2004 Ca:P values were below a 1:1 ratio, the changes noted in this trial would be considered beneficial. Free-ranging giraffe serum Ca:P averages 1.04, thus the optimal ratio for captive giraffe warrants further discussion.1

LITERATURE CITED

BIOCHEMICAL AND PHYSIOLOGIC OBSERVATIONS IN MEERKATS (*Suricatus suricatta*) AT TWO ZOOS DURING A DIETARY TRANSITION TO A DIET DESIGNED FOR INSECTIVORES

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Abstract

These studies assess the short-term and long-term effects of a commercially available manufactured diet (Mazuri® Insectivore, PMI Nutrition International, P.O. Box 66812, St. Louis, MO 63166-6812 USA) intended for the feeding of insectivorous animals. The initial study evaluated palatability of the diet and the maintenance of health in captive meerkats over a 6-wk period. Five animals at two zoos were obese and healthy at the start and finish. Measurements of blood chemistries including cholesterol and cell blood count remained within physiologic expected ranges throughout the study. Plasma and serum amino acid levels also remained within normal expected ranges, except taurine, which was much higher than expected throughout (275 ± 52 and 338 ± 104 nmol/ml, respectively). No significant change in taurine occurred over time. After the initial 6 wk, it was decided to keep the animals on the test diet indefinitely, and there was opportunity to monitor their long-term status. Individuals at one zoo were restricted in their access to diet, and achieved a beneficial weight loss while maintaining good health. All animals remained healthy through the assessment at 5 mo on the test diet. Taurine was maintained at high values throughout the extended study (266 ± 33 nmol/ml plasma and 306 ± 49 nmol/ml serum, overall), and cholesterol levels did not exhibit a significant change. Approximate dietary energy requirement for captive meerkats in our study during southern California spring and summer was found to be 158 ± 3 kcal/meerkat/day, and weight loss was accomplished at approximately 114 kcal/meerkat/day.
INFLUENCE OF DIET AND TIME ON FAT AND RETINOL CONCENTRATIONS IN ADULT FEEDER CRICKETS

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Abstract

Many captive amphibians are fed supplemented crickets (Acheta domesticus) as a basal diet. There is concern that some amphibians have unique requirements for certain vitamins, particularly Vitamin A due to its association with squamous metaplasia of mucous producing epithelia, resulting in inability to capture prey. Because vitamin A is fat soluble, it was hypothesized that increasing fat concentration of crickets also may increase Vitamin A. Crickets were fed in a replicated randomized block design arranged as a 3 × 4 factorial consisting of three diets: MON (Hi Cal Monster Diet; Zeigler Bros., Inc. Gardners, PA); MAZ (Mazuri® Hi Calcium Cricket Diet; PMI Nutrition, St. Louis, MO); or EVO (Innova EVO Cat and Kitten; Natura Pet Products, Fremont, NE) and four feeding time periods: 24, 48, 72, or 168 h. The diets contained 2.9, 3.7 or 20.0% crude fat (CF), and 6,938, 1,151, or 1,880 IU/100 g retinol on a dry matter basis for MON, MAZ, and EVO, respectively. Data were analyzed using the GLM procedure of SAS® with p <0.05 accepted as statistically significant. Crickets fed EVO had higher (P<0.05) fat concentrations (20.7%) compared with crickets fed MON (16.2%) or MAZ (17.1%). Cricket retinol concentrations were not statistically different and averaged 24.6, 58.7, and 80.7 IU/100g DM for MON, MAZ, and EVO treatments, respectively. Time of feeding did not affect CF or retinol concentrations. Further replication of dietary manipulation may be warranted due to observed numerical increases in fat and vitamin A concentrations when crickets were fed a higher fat diet.
ENERGY AND PROTEIN SUPPLIES TO CAPTIVE ORANGUTANS

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Abstract

The diet of Sumatran orangutans at Perth Zoo was reviewed and altered to simulate more closely foods available in the wild. Diversity of offered plants was increased to over eighty species. Cereal based concentrates were replaced by foods of animal origin, including fish and cheese. Dietary supplements were eliminated. The proportion of different foods was adjusted to meet Dietary Reference Intakes for humans with respect to minerals and vitamins, as recommended by the U.S. Institute of Medicine.

Target body mass for non-pregnant non-lactating (NPNL) females was set at 45 kg, taking into account skeletal development in captivity is greater than in the wild. To achieve this target, dietary energy offered to each NPNL female was reduced from 9.2 MJ to 5.8 MJ per day. Males, with double the body mass, were allocated approximately twice the ration of NPNL females. Energy reductions took place in five stages, over 7 mo.

Acceptance of the diet has been high. Changes resulted in loss of body mass, in all six specimens considered to be overweight, out of a total of eleven adults. Fully mature NPNL females were able to maintain body mass on less than 0.4 MJ kg\textsuperscript{0.75}/day with regular menstrual cycles. A boost in dietary energy, equivalent to that of a mast fruiting season in the wild, is planned for the coming spring, to take advantage of a possible benefit of increasing day length on conception.
DIET-INDUCED DIABETES IN CAPTIVE PLAINS VISCACHAS (*Lagostomus maximus*)

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Abstract

Plains viscachas (*Lagostomus maximus*) are large, nocturnal rodents that inhabit the pampas of Paraguay, Bolivia and Argentina. They are considered to feed on poor quality food in the wild: grass, forbs and bushes.1 Plains viscachas have been kept and bred at Zurich Zoo since 1964 and have shown the tendency to develop a type II diabetes mellitus, which was supposedly caused by inadequate feeding.5

Diet-induced diabetes is a well known problem in many other rodent species like the tuco-tuco (*Ctenomys talarum*),6 degu (*Octodon degus*);4 and the fatty sand rat (*Psammomys obesus*).3 The aim of the present study was to examine the influence of two different feedings on body-weight and blood- and urine-values with respect to a clinical manifestation of diabetes mellitus in this species.

To this end, one feeding trial with a high-fiber, low-energy feed (grass hay only - Trial A) consisting of 4.7, 44.9, and 74.2% crude protein (CP), crude fiber (CF), and neutral detergent fiber (NDF) concentrations on a dry matter basis, respectively, and one feeding trial with low-fiber, high-energy feed (grass hay, carrots and pellets [Kliba NAFAG, Kaiseraugust, Switzerland]-Trial B), consisting of 15.0-20.4, 17.9-27.3, 29.8-45.2% CP, CF, and NDF concentrations on a DM basis, respectively, were carried out. Each feed was fed to the same twelve plains viscachas (six males, six females) over a period of 2 wk. Animals were weighed before and after each feeding period. At the end of each feeding period, animals were subjected to a short isoflurane anesthesia (Abbott, Cham, Switzerland, 2%; delivered by face mask), and blood was sampled by venipuncture of the *Vena femoralis* or the *Vena coccygea*. In addition, urine was sampled by applying manual pressure on the bladder. Blood samples were analyzed for glucose, insulin (analyzed by a Sensitive Rat Insulin RIA Kit [LINCO Research, St. Charles, Missouri, USA]), amylase and fructosamine as indicators of sugar metabolism. Triglycerides, cholesterol and lipase were analyzed by standard laboratory procedures as indicators of fat metabolism. Urinary glucose was evaluated by using a rapid strip test (Combur-Test *, Roche Diagnostics AG, Rotkreuz, Switzerland). Statistical analyses (t-test) were performed using the program SPSS 11.0 (SPSS, Chicago, IL USA).
Trial A led to a significant decrease in body weight (from 2.98 ± 1.22 kg to 2.80 ± 1.17 kg; p < 0.01) and Trial B to a significant increase in body weight (from 2.78 ± 1.07 kg to 2.96 ±1.17 kg; p < 0.01). There were no significant differences in blood glucose, amylase, triglycerides, cholesterol or lipase. Fructosamine- and insulin values differed significantly, with higher values at the end of Trial B (fructosamine from 226.83 ± 38.14 µmol/l to 268.00 ± 24.77 µmol/l, p < 0.01 and insulin from 0.32 ± 0.15 ng/ml to 0.46 ± 0.24 ng/ml; p< 0.05). An elevated urinary glucose value during Trial B could be seen in five animals.

In conclusion, it can be stated that a carbohydrate-based, high-energy diet bears a high risk for plains viscachas to develop a diabetes mellitus with the short-term consequence of glucosuria. The potential long-term consequences of diabetes mellitus (cataracts, hepatolipidosis) have been described. Remarkably, initial clinical indications of developing diabetes, due to concentrate feeding, were observed in a very short time of only 2 wk. Therefore, this species may prove valuable as an animal model for further diabetes research in the future. For the management of captive populations, a low-energy, high-fiber feeding regime appears warranted. However, the decrease in body weight on the hay-only diet during Trial A offers two different interpretations that should be investigated: either viscachas are not able to maintain body weight on a low-protein, high-fiber grass hay, as used during this study, or the animals may have stabilized their body weights on a lower level of this diet. In order to investigate these possibilities, further feeding studies, using a different hay source and longer feeding periods, with regular weighing intervals, are being conducted.

ACKNOWLEDGMENTS

We thank the keepers at Zurich Zoo, Switzerland, for their care and management of the animals.

LITERATURE CITED

THE EFFECT OF FISH ANALOG DIET ON BELUGA WHALE (Delphinapterus leucas) HEALTH AND BODY CONDITION

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Abstract

In zoos and aquariums the staple diet for marine mammals is freshly thawed, previously frozen fish and squid. Feeding a variety of fish to captive piscivores can be a major challenge to institutions, due to cost and availability thereby making a readily available, prepared fish analog-based diet very appealing. Past studies feeding the Mazuri fish analog product (PMI Intl, St. Louis, MO) to California sea lions and penguins have shown good acceptance of this product with no adverse effects, while increased rate of passage was observed when this product was exclusively fed to bottlenose dolphins. Our study examines the effect of feeding 10 - 50% Mazuri fish analog diet on beluga whale health.

Mystic Aquarium currently houses three adult beluga whales whose health status is monitored closely via physical examinations, dietary records, blood collection, gastric sampling, girth measurements and blubber thickness. In this 7-mo study, each animal was used as its own control and all variables were compared during the feeding trial to pre- and post- study baseline values using repeated measures ANOVA. Animal behavior was monitored daily while blood samples were collected twice monthly for hematologic analysis. Other parameters were measured on a monthly basis. All animals accepted the product immediately with no training required. Preliminary data indicate that the feeding of this product does not adversely affect animal health and that this product is an appropriate addition to beluga whale diets at the tested percentages.
ATROPINE: FRIEND OR FOE? PRUDENT USE OF ANTICHOLINERGICS WITH ALPHA-2-ADRENERGICAGONISTS

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Abstract

Atropine is commonly combined with alpha-2-adrenergic agonists to offset the bradycardia seen with these agents. Historically, in small animal medicine, atropine and other anticholinergics have also been used to decrease salivary gland secretions, decrease gastric fluid acidity, and inhibit the effects of vagal stimulation. However, developments within veterinary anesthesia in the last decade have led to concerns when combining anticholinergics with alpha-2-adrenoceptors unless clinically indicated. This paper reviews the pharmacology of these two groups of agents and the author provides his recommendations for prudent use of anticholinergics in wild mammal anesthesia.

Alpha-2-adrenergic Agonists

The alpha-2-adrenergic agonists have been used for their often reliable, dose-dependent sedation, analgesia, and muscle relaxation. This family of drugs includes xylazine, medetomidine, detomidine, and romifidine. They are highly lipophilic and as such will pass rapidly across cellular membranes.

None of the alpha-2-adrenergic agonists are “pure” agonists, they show a higher selectivity for alpha-2 receptors compared to alpha-1 receptors, however they still have effects at the alpha-1 receptors. Alpha-2 adrenoceptors are found in the cardiovascular, respiratory, renal, endocrine, gastrointestinal, hematologic, reproductive, and central nervous systems. The actual numbers of receptors, their sensitivity, and their distribution within the body may vary between species, and possibly with certain disease states. Alpha-2-adrenoceptors are both pre-synaptic and post-synaptic.

Despite the large number of different body systems containing alpha-2-adrenoceptors, we will concentrate here on the cardiovascular system as this is the most important with regard to anticholinergic interactions. Full descriptions of adrenoceptor pharmaceutical interactions can be found elsewhere. There is considerable variation between the different alpha-2-agonists but the classic cardiovascular progression is as follows:

- Initial hypertension: this is due to peripheral post-synaptic alpha-2 receptor activation (and some alpha-1) resulting in peripheral vasoconstriction.
- Bradycardia: this is primarily a normal physiologic response to the hypertension, but also occurs due to central pre-synaptic alpha-2 receptor stimulation favoring parasympathomimesis, combined with peripheral pre-synaptic alpha-2 activation
resulting in decreased noradrenalin release at peripheral sympathetic nerve terminals in the heart. This bradycardia can be in the region of half that seen pre-administration of alpha-2-adrenergic agonists. Cardiac output is calculated by heart rate multiplied by stroke volume, and therefore bradycardia will result in a reduced cardiac output. Therefore, it is recommended to give intravenous drugs administered later at a slower rate, or overdose may occur.

- Blood pressure returns to near normal: either normal or mild hypertension is seen, later developing to hypotension as baseline vascular tone decreases due to central effects and reduction in noradrenalin release peripherally.³

Anticholinergic Agents

Atropine has historically been used, in small animal medicine, to antagonize the bradycardia seen with the alpha-2-agonists, but they have also been used to decrease salivary gland secretions, decrease gastric fluid acidity, and inhibit the effects of vagal stimulation.⁴

Atropine is a parasympatholytic agent that inhibits the effects of acetylcholine on muscarinic receptors. The systemic effects are considerable, but the primary uses during anesthesia will only be discussed here.

Cardiovascularly, atropine has little effect on blood pressure but does dramatically increase heart rate. This effect is more pronounced in animals with higher vagal tone.⁵ Atropine decreases the watery component of saliva and respiratory secretions, but also decreases ciliary activity resulting in reduced clearance of more viscid mucus.¹ Atropine does increase relaxation of gastrointestinal smooth muscle, including esophageal sphincter pressure, and secretions of the gastrointestinal tract. However, gastric secretions are reduced only when using high doses that virtually block all other muscarinic sites.⁵ Atropine also has direct effects within the central nervous system, and at low doses can result in sedation, but in larger doses can cause delirium and excitement.⁵

Using Atropine with Alpha-2-adrenergic Agonists

A large number of anesthetic regimes advocate the use of combining atropine with alpha-2-adrenergic agonists as part of an induction polypharmaceutical cocktail. Often the biggest concern is the bradycardia seen following induction. However, as this is a normal physiologic response to transient hypertension, this should not be “treated” unless the bradycardia is compromising hemodynamic function, resulting in hypotension.

The increased heart rate following atropine administration on a vasoconstricted vascular system can potentially result in massive hypertension, increased myocardial oxygen demand, decreased diastolic filling time, minimal increases in cardiac output due to massive afterload, and potential hypertension-induced damage in cerebral, retinal and renal vasculatures.¹ Tranquilli⁶ states, “the co-administration of an alpha-2-agonist and an anticholinergic should be restricted to patients with good cardiac function that are exercise tolerant and may be receiving additional agents that enhance vagal activity (such as the opioids)”. However, in wild or zoo
situations we are often unable to fully assess that a patient is healthy and we incur a risk when utilizing these two pharmaceutical families together.

Use of atropine should be limited to cardiovascular resuscitation. If there are concerns regarding bradycardia following alpha-2-adrenoceptor administration, administration of a small dose of atipamezole has been advocated as a partial reversal to reduce cardiovascular effects.¹

In the United Kingdom, atropine and other anticholinergics are routinely used only in an emergency situation, and never as part of a standard induction protocol. In this authors hands, at the time of writing, the use of alpha-2-adrenoceptor agonists without the use of atropine has never compromised a patient.

LITERATURE CITED

REPTILE ANALGESIA: EFFICACY AND SIDE EFFECTS OF MORPHINE AND BUTORPHANOL IN BEARDED DRAGONS (Pogona vitticeps), CORN SNAKES (Elaphe guttata), AND RED-EARED SLIDER TURTLES (Trachemys scripta)

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Abstract

Pain and its amelioration are fundamental to the practice of veterinary medicine. In zoological medicine, however, our standard approaches to dealing with clinical analgesia may be providing a false sense of security for us as veterinarians, and little in the way of functional pain management for our patients. This stems from the fact that little is known about mechanisms underlying nociception, analgesic efficacy and side effects, pharmacodynamics, and opioid receptor binding characteristics in non-domestic species, and data are particularly lacking for reptiles.1,5 Butorphanol tartrate, a mixed opioid agonist/antagonist with κ-agonist activity, is an analgesic drug used widely to attenuate pain in zoological medicine, and is the most widely used analgesic drug in reptile medicine.5 However, there are no clinical data to substantiate its analgesic effect in reptiles. In contrast, morphine, an opioid with μ-agonist activity, attenuates behavioral responses to noxious thermal stimuli in red-eared slider turtles, anole lizards and crocodiles.2,3,6 Untoward side effects can be problematic, as opioid drugs frequently cause respiratory depression in many species.4,6 The objectives of this study were to: 1) determine the effects of morphine sulfate and butorphanol tartrate on nociceptive behaviors in adult, red-eared slider turtles (Trachemys scripta), bearded dragons (Pogona vitticeps) and corn snakes (Elaphe guttata) using a thermal hind limb or tail withdrawal latency test; and 2) evaluate effects of morphine and butorphanol on respiration in these three reptile species.

Infrared heat stimuli were applied to the plantar surface of turtle and bearded dragon hindlimbs, and to the ventral tail surface of corn snakes. Thermal withdrawal latencies were measured before and after subcutaneous administration of physiologic saline, butorphanol tartrate (2 or 20 mg/kg in bearded dragons and snakes; 2.8 or 28 mg/kg in turtles), or morphine sulfate (1, 10, 20, and 40 mg/kg in bearded dragons and snakes; 1.5 or 6.5 mg/kg in turtles). Thermal withdrawal latencies sampled at 2, 4, 8, and 24 hr post-injection were similar in reptiles receiving saline or butorphanol at any dosage. However, hind limb thermal withdrawal latencies increased in turtles and, less so, in bearded dragons after administration of morphine sulfate, indicating that morphine provided analgesia in these species. Corn snake tail thermal withdrawal latencies after...
morphine administration were highly variable at all four dosages, which precluded developing any conclusions regarding efficacy of morphine in this species. Because antinociceptive efficacy of morphine was clearly demonstrated in only turtles, ventilation was measured in freely swimming turtles before and after subcutaneous administration of physiologic saline, butorphanol tartrate, or morphine sulfate. Both butorphanol and morphine significantly depressed ventilation in turtles. Butorphanol tartrate, the most widely used analgesic in reptiles, may not provide adequate analgesia in red-eared slider turtles, bearded dragons and corn snakes, and yet cause significant respiratory depression.

ACKNOWLEDGMENTS

Supported by grants from the American College of Laboratory Animal Medicine Foundation and the Morris Animal Foundation, Englewood, CO, 80112.

LITERATURE CITED

SAFETY, UTILITY AND EFFICACY OF INTRAMUSCULAR ADMINISTRATION OF KETAMINE/ MEDITOMIDINE/ MORPHINE COMBINATIONS FOR IMMOBILIZATION OF AQUATIC CHELONIANS

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Abstract

Intravenous administration of propofol, followed by inhalant gas, remains the most popular method of anesthetizing aquatic chelonians; however, the consistent success of immobilization depends on adequate intravenous administration of propofol, which in turn depends on the species, the experience of the anesthetist, and the size and disposition of the animal. The objective of this study was to evaluate the safety, utility and efficacy of an intramuscular ketamine (K)/medetomidine (Me)/morphine(Mo) combination for the immobilization of aquatic chelonians. The addition of opioids, such as butorphanol, to intramuscular combinations of anesthetics, has become popular because of its synergistic and analgesic effects. However, little is known about butorphanol in the reptilian patient, and previous reports suggest that morphine is a better choice due to its μ-agonist activity. The goal of this study was to investigate a protocol that: 1) was reversible, for use under field conditions, 2) offered a wider margin of safety, 3) provided analgesia, and 4) provided an adequate plane of anesthesia to perform short surgical procedures, but 5) did not cause significant negative effects.

Nineteen map turtles (Graptemys spp.) were immobilized with ketamine at either 10 mg/kg (n=9), or 20 mg/kg (n=10), and medetomidine (0.15 mg/kg) and morphine (1.5 mg/kg) i.m. The average induction time was 42 min. The average time for harvest of shell biopsies was 60 min. The anesthesia was reversed using atipamezole (0.5 mg/kg; i.m.) and naloxone (0.02 mg/kg i.m.). The average time to spontaneous movement was 196 min. Ten animals needed re-dosing of naloxone (at various doses) the following day due to re-narcotization.

Twenty-two red-eared slider turtles (Trachemys scripta elegans) were anesthetized with either K(10 mg/kg)/Me(0.1 mg/kg)/Mo(0.1 mg/kg) i.m. (Group 1, n=7), or K(15 mg/kg)/Me(0.15)/Mo(0.1 mg/kg) i.m. (Group 2, n=15). The average induction time for the Trachemys spp. groups was 9 and 12 min respectively. The average surgical procedure was 46 min. The reversal protocol for Trachemys spp. was as above, except naloxone was increased ten-fold to 0.2 mg/kg. The recovery time after reversal administration was 10.4 and 5.9 min. All animals behaved normally within 30-60
min from reversal administration. All *Trachemys* spp. were euthanatized the following day. No evidence of pathology associated with anesthetics was found on full necropsies. Subjectively, the best results were obtained following the protocol for Group 2. Morphine appears to be a key supplement to previously described ketamine/medetomidine anesthetic protocols, allowing for rapid, consistent, reliable and reversible surgical anesthesia for short procedure.
USE OF THE BISPECTRAL INDEX (BIS) IN AVIAN AND REPTILIAN ANESTHESIA: PRELIMINARY RESULTS

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Abstract

This presentation describes the use of a wakefulness measuring device called the bispectral (BIS) monitor (Aspect Medical Systems International B.V., de Meeren, The Netherlands) in avian and reptilian patients. The index of wakefulness is calculated by an empirically derived algorithm on the complex waveforms of an electroencephalogram (EEG) in humans. BIS measurements have also been published from horses,³ pigs,⁷ goats,¹ dogs,² cats,⁵ rabbits,⁶ and dolphins,⁴ but to our knowledge not from birds and reptiles.

In nine feral pigeons (Columba livia) anesthetized with medetomidine, butorphanol and ketamine no correlation between reflex score and BIS score (BIS A-2000 XP®) was found. In a red kite (Milvus milvus) anesthetized with butorphanol and isoflurane BIS scores increased from an intraoperative average score of 51 ± 7 to 84 within 3 min following extubation indicating that the animal was fully conscious, although the bird remained in sternal recumbency, probably feigning death.

BIS values were recorded from a Hermann’s tortoise (Testudo graeca) which underwent lung lavage after midazolam and butorphanol premedication, propofol induction and isoflurane maintenance. BIS scores during the procedure were 25 ± 15, arising to 54 ± 4 for extubation and showing the first movements at 33 ± 8 BIS value. This was considered to be an effect of hypothermia (29 ºC mean rectal temperature).

Our observations show that BIS signals can be obtained from avian and reptile species. BIS monitoring in these species may prove to be useful to monitor the degree of wakefulness in view of depth of anesthesia.

LITERATURE CITED


EFFECTS OF ASSISTED VENTILATION ON COMMON EIDERS (Somateria mollissima) ANESTHETIZED WITH PROPOFOL FOR RADIO TRANSMITTER IMPLANTATION

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Abstract

Surgical implantation of radio transmitters is performed in waterfowl to track birds that do not tolerate externally applied equipment.1 It involves invasion of the coelomic cavity and ablation of the right abdominal air sac.1-3 When this procedure is performed in remote field sites, injectable anesthetics are popular because of difficulties with transportation of oxygen and inhalant anesthetics. Intravenous propofol is often used, along with a local anesthetic.2,3

Although propofol has been evaluated in waterfowl,2 to our knowledge, the physiologic effects during telemetry implantation have not been studied. Cardiopulmonary monitoring was performed in 14 common eiders (Somateria mollissima) anesthetized with propofol for transmitter implantation. Local bupivacaine was also administered. Venous samples were taken for blood gas analysis immediately prior to induction and at the end of surgery. Birds were intubated, maintained on room air, and ventilated at either 2 or 6 breaths/min (2 bpm or 6 bpm, respectively).

Post-induction, 6 bpm birds had minimal voluntary respiration, while 2 bpm birds continued to take voluntary breaths. The 6 bpm birds developed lower end-tidal CO2 values and higher SpO2 values than 2 bpm birds. At surgery’s end, 6 bpm birds had higher venous pH values and lower pCO2 values than 2 bpm birds. Venous pH increased over time in 6 bpm birds, but not in 2 bpm birds. Lactate decreased over time in both groups. All recovered well and were alive 6 mo post-operatively. Physiologic values can be maintained with propofol anesthesia with assisted ventilation at four to six bpm.

ACKNOWLEDGMENTS

Thanks to Dr. Dan Mulcahy for contributions of equipment, supplies, and intellectual discourse and to Dr. Chris Fransom for assistance in performing procedures and recording data. Thanks also to U.S. Fish & Wildlife Service personnel with the Alaska Maritime National Wildlife Refuge for their technical and logistical support.
LITERATURE CITED


DEVELOPMENT OF AN AVIAN BRACHIAL PLEXUS NERVE BLOCK TECHNIQUE FOR PERIOPERATIVE ANALGESIA USING MALLARD DUCKS

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Abstract

This investigation was conducted to develop a brachial plexus nerve block technique for perioperative analgesia in birds. Research on avian regional anesthesia is limited.2,4-6 A pilot study determined the feasibility of recording somatosensory evoked potentials (SSEP) for use in measuring the efficacy of the nerve blockade by testing the integrity of the brachial plexus.1,3 Eight adult female mallard ducks were anesthetized with isoflurane and used in several local anesthetic trials administering bupivacaine (2mg/kg, 8mg/kg) and lidocaine (15mg/kg)/epinephrine (3.8Μg/kg) perineurally with a saline control treatment. Both dorsal and ventral approaches to the brachial plexus were evaluated and a nerve stimulator was used to increase accuracy of administration. Sensory nerve conduction velocities (SNCV) for radial and ulnar nerves and cord dorsum potentials (CDP) were recorded prior to injection and at 5, 30, and 60 min post injection of local anesthetic or saline. For 24 hr post-injection, birds were intermittently monitored for the presence of a wing droop and decreased motor function. Surgical dissection and transection of the brachial plexus in one duck caused complete elimination of the CDP, which validated electrodiagnostic results.

Results were highly variable for all techniques. No technique consistently eliminated CDP or resulted in consistent wing droops. This may indicate that the treatment, dose, concentration, or volume of local anesthetic was ineffective in producing local analgesia. It is also possible that the methods used to assess loss of pain perception were not sensitive enough to assess the effects of the local anesthetic.

ACKNOWLEDGMENTS

Funding for this research was provided by a grant from the Center for Companion Animal Health, University of California, Davis, Veterinary Medical Teaching Hospital.
LITERATURE CITED


PULMONARY GAS EXCHANGE AND ACID-BASE STATUS DURING MEDETOMIDINE-ZOLAZEPAM-TILETAMINE ANESTHESIA OF FREE-RANGING BROWN BEARS (Ursus arctos)

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Abstract

In Sweden and Norway, around 75 free-ranging brown bears (Ursus arctos) are anesthetized each year for ecological studies in the Scandinavian Brown Bear Research Project. The aim of this study was to evaluate pulmonary gas exchange and acid-base status during anesthesia of free-ranging brown bears. The bears were darted from a helicopter with medetomidine, zolazepam and tiletamine (MZT) using standard drug doses according to body size (Table 1). During anesthesia of 34 brown bears, 75 arterial blood samples were collected and rectal temperature, heart rate, and respiratory rate were recorded. The blood samples were immediately processed for 15 different parameters with an i-STAT® Analyzer (CG4+, 6+, Abbott Laboratories, Abbott Park, Illinois, USA). For anesthetic reversal, atipamezole (Antisedan®, 5 mg/ml, Orion Pharma Animal Health, Espoo, Finland) was administered i.m. at 5 times the medetomidine dose.

Initial lactic acidemia (pH < 7.35, lactate ≤ 11.8 mmol/L) as a result of physical exertion during induction improved during anesthesia. P_{a}CO_{2} ranged between 29 - 54 mm Hg and P_{a}O_{2} ranged between 49 - 103 mm Hg. Four bears developed hypoxemia (P_{a}O_{2} < 60 mm Hg) but oxygen supplementation at 2 L/min markedly improved oxygenation (P_{a}O_{2} up to 290 mm Hg). Additional darts did not impair the physiologic parameters measured, indicating that the drug combination has a wide margin of safety in the species. In conclusion, mild to moderate alterations in arterial blood gases and acid-base balance were identified in anesthetized brown bears. Pulmonary function was adequate in most bears, but it is advisable to have supplemental oxygen available in case of hypoxemia.
ACKNOWLEDGMENTS

Many thanks to the Swedish Environmental Protection Agency, the Norwegian Directorate for Nature Management, and the Michael Forsgren Foundation for generous support of this study. Also, thanks to Ulf Grinde, our helicopter pilot during fieldwork.
Table 1. Age, sex, body mass and drug doses used in free-ranging brown bears in Sweden and Norway.

<table>
<thead>
<tr>
<th>Age</th>
<th>n, sex</th>
<th>Body mass (range)</th>
<th>Medetomidine$^{cd}$ total dose$^f$</th>
<th>Zolazepam + tiletamine$^e$ total dose$^f$</th>
<th>Medetomidine$^{cd}$ range$^g$</th>
<th>Zolazepam + tiletamine$^e$ range$^g$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearling</td>
<td>10F$^a$, 4M$^b$</td>
<td>15-41 kg</td>
<td>1.25 mg</td>
<td>31-122 μg/kg</td>
<td>62.5 mg</td>
<td>1.5-6.1 mg/kg</td>
</tr>
<tr>
<td>Subadult</td>
<td>3F, -M</td>
<td>48-65 kg</td>
<td>5 mg</td>
<td>62-104 μg/kg</td>
<td>250 mg</td>
<td>3.1-5.2 mg/kg</td>
</tr>
<tr>
<td>Adult</td>
<td>11F</td>
<td>62-103 kg</td>
<td>10 mg</td>
<td>46-146 μg/kg</td>
<td>500 mg</td>
<td>2.3-7.3 mg/kg</td>
</tr>
<tr>
<td>Adult</td>
<td>6M</td>
<td>80-241 kg</td>
<td>15 mg</td>
<td>67-125 μg/kg</td>
<td>750 mg</td>
<td>3.4-6.3 mg/kg</td>
</tr>
</tbody>
</table>

$^a$M = male  
$^b$F = female  
$^c$For yearlings: Domitor$^g$ vet., 1 mg/ml, Orion Pharma Animal Health, Espoo, Finland  
$^d$For subadults and adults: Zalopine, 10 mg/ml, Orion Pharma Animal Health  
$^e$Zoletil forte vet., Virbac S.A., Carros, France  
$^f$Initial total dose according to body size. Ten bears required additional darts subsequent to the initial dose.  
$^g$Actual dose according to body mass, including additional darts.
USE OF A POINT-OF-CARE ANALYZER IN THE FIELD UNDER WINTER CONDITIONS TO ASSESS CAPTURE STRESS OF CARIBOU (*Rangifer tarandus*)

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Abstract

Capture is potentially one of the most harmful activities to wildlife, yet effects of capture are rarely evaluated. We assessed the practicality of a point-of-care analyzer (i-STAT, Heska Corporation, Fort Collins, CO 80525 USA) to determine venous blood gases, lactate, glucose, and electrolyte levels (CG4+ and EC4+ cartridges) of caribou (*Rangifer tarandus*) captured during late winter, 2005 and 2006. Median daily temperatures during the 2 yr of study were -7 and -8°C. However, the analyzer has a lower operating temperature limit of 16°C. Samples were run with the analyzer and cartridges held in an insulated fabric bag with heated gel packs and chemical hand warmers, or with the analyzer placed under the clothing and against the skin of the operator. Blood samples were obtained from caribou after they were net-gunned, after transportation by helicopter and snow machine to a holding pen, and after processing. Major causes of cartridge failure were related to temperature, internal analytical failure, or exceeding the maximum detectable level of an analyte (especially lactate). CG4+ cartridges were more likely to have a failure in one or more analyte than did the EC4+ cartridges. The relatively limited storage capacity of the i-STAT was problematic when large numbers of cartridges were run in a short time.

Mention of trade names does not imply government endorsement.
BUTORPHANOL, AZAPERONE, MEDETO MIDINE ANESTHESIA IN FREE RANGING WHITE-TAILED DEER (Odocoileus virginianus) USING RADIOTRANSMITTER DARTS

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Abstract

Free-ranging white-tailed deer (Odocoileus virginianus) were successfully immobilized using a combination of butorphanol (0.58 ± 0.1 mg/kg), azaperone (0.37 ± 0.06 mg/kg), and medetomidine (0.19 ± 0.03 mg/kg) administered by remote injection of radiotelemetry Pneudarts (Pneu-Dart, Inc., Williamsport, Pennsylvania 17701, USA) from hunting blinds between November 2006 and May 2007. Mean times to locate deer, to induction, and to recovery were recorded. Physiologic monitoring (heart rate, respiratory rate, rectal temperature, end-tidal CO2, oxyhemoglobin saturation, and indirect arterial blood pressure) was initiated upon securing the animal, and continued every 5 min for a total of 20 min. Arterial blood gases were collected every 10 min. Mild to moderate hypoxemia, and mildly depressed ventilation based on arterial oxygen saturation and end-tidal CO2 values occurred in some animals. Muscle relaxation and anesthetic plane were adequate for completion of all procedures (weight, venipuncture, morphometrics, ± brief transport); two deer required intravenous butorphanol supplementation to achieve light anesthesia (0.19 mg/kg; 0.12 mg/kg). Recovery following intramuscular administration of naltrexone (1.34 ± 0.42 mg/kg; 2× butorphanol dose) and atipamezole (0.93 ± 0.14 mg/kg; 5× medetomidine dose) was rapid, smooth, and complete. Overall efficacy of Pneu-Darts (full drug delivery; tracking reliability; maintained intramuscularly until animal located) was 65%. Negative attributes included: time delay required between darting and locating animal to ensure full anesthetic effect; dart failure. No known mortalities occurred as a result of the study. This combination provided safe, reliable, short-term immobilization of free-ranging white-tailed deer. Evaluation for use in field immobilizations of other cervids is warranted.

ACKNOWLEDGMENTS

The authors thank Wildlife Pharmaceuticals, Inc. for supplying the immobilizing agents, Kristine Polk, Lara Metrione, Rhett Walker, Shannon McCarthy, Lynn Proenza, Hector Gutierrez, Tina Bruaset, Katryna (Katie) Fleer, Judilee Marrow, K. Marie Labak, and Linda Penfold at White Oak Conservation Center for assistance in deer feeding, tracking, restraint, and data collection.
IMMOBILIZATION OF TIBETAN YAK (*Bos grunniens*) USING A-3080® (THIAFENTANIL) AND XYLAZINE IN A WILDLIFE PARK

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Abstract

The use of opioids in combination with an α-2 agonist has been previously described in a number of non-domestic hoofstock immobilizations.1,2,4,6,9 Since the development of A-3080® (Thiafentanil, Wildlife Pharmaceuticals, Inc, Fort Collins, CO, 80522-2023 USA) in the early 90’s several protocols and dosages have been written for a wide spectrum of species with desirable effects during an immobilization.3,5,6,7,8,10 The effects of A-3080® have not been previously described on Tibetan yak (*Bos grunniens*).

Wildlife Safari houses a herd of 25 Tibetan yaks in an open setting, affording an opportunity to investigate this combination of drugs. A total of ten Tibetan yaks (*Bos grunniens*) were immobilized with thiafentanil and xylazine (TranquiVed® VEDCO, INC, St. Joseph, MO 64507 USA) for various medical procedures. This protocol was preferred over others used at the park previously for various reasons including faster induction, shorter duration of action, wide safety margin, fully reversible and lower cost.3,5,6,10 These characteristics are all desirable in an immobilizing agent, and are offered by A-3080®. Using these criteria, thiafentanil may be preferable when compared to carfentanil.

A Pneudart® rifle (Model 193, Pneu-Dart, INC. Williamsport, PA, USA) and C-type darts were used to deliver the drug. The first drug effect (time of initial injection to initial drug effect) ranged from 2-4 min (average =3 min.). The time from initial injection to lateral recumbency ranged from 4-8 min (average= 6 min.). Three of the ten yaks required additional A-3080® and xylazine due to dart malfunction or partial delivery of the drug. One of the ten yaks died under anesthesia due to compromised health status (poor body condition and chronic disease) and anesthetic complications.

A total of six male and two female yaks were immobilized with this protocol. One of the female yaks was darted on three separate occasions with the same combination of drugs, but different dosages. The doses were determined using estimated weights for all of the individuals. The six male subjects consisted of two juveniles and four sub-adults and ranged between 500 and 750 lbs (227-340 kg). Of the two females in the study, one was a sub-adult and one was an adult, ranging in weight between 450 and 800 lbs (204-363 kg). Actual weights were not recorded in any of the yaks. A range of 3.7-5.0 mg of A-3080® and 34-50 mg of xylazine were used for males. Female dosages were 4.0-7.5 mg of A-3080® and 30-50 mg of xylazine. An estimated median optimal dosage (mMOD) was 0.018 mg/kg of A-3080® and 0.15 mg/kg of xylazine, with satisfactory results. Propofol was administered intravenously (i.v.) at an estimated dose of 1 mg/kg to
maintain a light or surgical anesthetic plane. Short periods of apnea were observed on three of the ten yak after rapid administration of propofol. The apnea was treated by administration of doxapram i.v. at an estimated dose of 0.5 mg/kg. Vital parameters monitored included heart rate (HR), respiratory rate (RR), rectal body temperature, SPO2 (Pulse oxymeter NELLCOR® N-20, NELLCOR® Inc., Pleasanton, CA 94588 USA), blood gases (i-STAT®, Heska corp., Waukesha, WI 53188 USA), complete blood count (CBC) and chemistry panel. Reversals with naltrexone (at dose of 50mg of naltrexone for each 1 mg of A-3080®, 3/4 of total dose given i.m. and ¼ of total dose given i.v.) and atipamezole (at dose of 1 mg of atipamezole for each 10 mg of xylazine, total i.v.) were rapid (3-5 min; average = 4 min), complete, and without complications. No renarcotization effects were observed.

This study shows that the use of A-3080® and xylazine is an effective and safe option for the immobilization of Tibetan yak. Additional study is needed to determine whether the optimal A-3080® and xylazine dosages proposed in this study are the most effective dosages, and if this combination of drugs is suitable for use in wild Tibetan yak.

LITERATURE CITED

PRELIMINARY DATA FOR COMPARISON OF CARFENTANIL-XYLAZINE AND THIAFENTANIL-MEDETOMIDINE IN ELECTRO EJACULATION OF CAPTIVE GAUR (Bos frontalis gaurus)

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Abstract

Carfentanil citrate and thiafentanil oxalate have been used successfully to immobilize captive and free-ranging ungulates. The objective of this study was to compare the efficacy and certain physiologic parameters of protocols using the two opioids in gaur (Bos frontalis gaurus).

Seven adult gaur bulls were immobilized for electroejaculation at Omaha’s Henry Doorly Zoo. An estimated weight of 1000kg was used for all bulls. Each animal was immobilized twice using two protocols:

1) 10 mg carfentanil combined with 100 mg xylazine (CX), reversed with 1000 mg naltrexone and 24 mg yohimbine
2) 12 mg thiafentanil combined with 20 mg medetomidine; (TM), reversed with 120 mg naltrexone and 100 mg atipamezole.

Both combinations were delivered i.m. in the shoulder area via pole syringe. Electroejaculation was carried out by a standardized protocol to duplicate procedural stimulation on each animal. Induction and recovery times, initial rectal temperatures, heart rate, respiratory rate, anesthetic depth, oxygen saturation, indirect blood pressure and arterial blood gases were recorded at time of initial “hands on”, then at 10-min intervals pre-ejaculation and once post-ejaculation. Antagonists were administered ¼ i.v and ¾ s.c.

Both protocols require a very small amount of drug for a large ungulate, provide smooth inductions, and adequate anesthesia. Animals on CX showed better blood gas values (based on lower CO₂) and lower blood pressure values. Animals on TM had better muscle relaxation and smoother recoveries with no renarcotization noticed during this study. Additional immobilizations need to take place to further compare these two combinations in this species.

ACKNOWLEDGMENTS

The authors would like to thank veterinary technicians Nicole Linafelter and Amanda Mohn and the keeper staffs at the Lee G. Simmons Wildlife Safari Park and Omaha’s Henry Doorly Zoo for their participation and support in this research.
LITERATURE CITED


A SIMPLE, UNIQUE FIELD VENTILATOR FOR LARGE UNGULATES: ANOTHER USE FOR YOUR LEAF BLOWER

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Abstract

Field anesthesia of wild ungulates commonly involves the use of opioid-based drug combinations. Hypoxemia, hypercarbia, and acidemia are common problems resulting from respiratory depression seen with opioid-based anesthesia. Oxygen supplementation and/or respiratory support are generally recommended when using opioids. Oxygen supplementation alone reduces hypoxemia but does not improve ventilation and gas exchange.1 Intermittent, positive-pressure, field ventilation has generally been accomplished in large ungulates by the use of single or multiple, in-series, high flow demand valves using 100% oxygen as the driving gas.3 These systems require pressurized oxygen tanks to be carried into the field which is cumbersome and can be dangerous. Bellows-type ventilators are large, difficult to transport, and also require pressurized driving gases. Blower- or fan-driven ventilators have been used in veterinary medicine to ventilate large domestic species,4 including one using an electric vacuum cleaner as the drive source.5 A simple, effective ventilator, utilizing either an electric or gas-powered leaf blower as the drive source, was designed to be used as an emergency field ventilator during a giraffe anesthesia study.2 This ventilator is made of commonly available parts, has a pop-off valve and pressure gauge to prevent over-inflation, an expiratory valve to provide post-expiratory end pressure (PEEP), and is relatively compact and easy to carry into the field. This device was used to ventilate three captive, sub-adult giraffe ranging in estimated weight from 580 to 700 kg. Inspiratory pressures of 20 cm H2O were reached quickly (< 2 sec), p\textsubscript{a}O\textsubscript{2} values were significantly increased, and p\textsubscript{a}CO\textsubscript{2} values were significantly decreased over pre-ventilation values, indicating adequate ventilation efficiency.

ACKNOWLEDGMENTS

This study was funded through a grant from the Morris Animal Foundation (#D03ZO-63).

LITERATURE CITED


TREATMENT OPTIONS FOR ADVERSE REACTIONS TO HALOPERIDOL AND OTHER NEUROLEPTIC DRUGS IN NON-DOMESTIC HOOFSTOCK

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Abstract

Neuroleptic drugs have been commonly used in zoo and wildlife medicine for years. Despite potential side effects, there are few reports of adverse reactions to these tranquilizing agents in the veterinary literature and fewer that discuss treatment options in non-domestic species. In the authors’ practice, it is not unusual to observe clinically significant adverse reactions to haloperidol in non-domestic hoofstock. The objective of this article is to review the potential adverse reactions of these neuroleptic drugs and to discuss available treatment options.

Neuroleptic Drugs: Pharmacology and Use in Zoos and Wildlife

Neuroleptic drugs (ND) are used to treat psychosis in man when a tranquilizing effect is desired.10 Psychosis is defined as a derangement of personality with delusions, loss of contact with reality and deterioration of social functioning. In human psychiatry, the more accurate and preferred term for agents used to treat psychosis are the antipsychotic drugs (APD). The terms ND and APD seem to be used interchangeably. Furthermore, wildlife and zoo veterinarians use the term tranquilizer to describe the purpose and utility of these drugs.

Excellent reviews of the use and pharmacology of long acting ND in non-domestic species have been written10,11 and are appropriate for understanding shorter acting ND, such as haloperidol. Haloperidol and other typical ND act on the D2 subset of dopamine receptors.12 The D2 receptor is believed to be associated with extrapyramidal symptoms (EPS), the major side effect reported with ND. New generations of APD are becoming more popular in human psychiatry since they exert their effect on a different subset of dopamine receptors or on serotonin receptors, decreasing the potential for EPS. All ND/APD have the potential to cause side effects.12

The use of ND has been reported in wildlife medicine for almost 30 yr primarily to tranquilize wild hoofstock intended for relocation in southern Africa.5,6,11 Their use is now common in zoological settings, as well.1,3,4,7,9 The clinical use of ND in non-domestic hoofstock is comparable to the use of APD in human psychiatric emergencies of acute anxiety and panic attacks.10 Anxiety is a state of apprehension, uncertainty and fear resulting from the anticipation of a real or perceived threat and defines the temporary mental state of at least some of our non-domestic hoofstock during our husbandry manipulations. Furthermore, the perceived threat may trigger the innate and classic sympathetic “fight or flight” response. Regardless of the terms or inciting mechanism of anxiety in our animals, ND for tranquilization are available.3,11
Haloperidol is a butyrophenone derivative with tranquilizer/antipsychotic properties that are effective in the management of hyperactivity, agitation and anxiety in humans. The effective duration of action varies from 10-20 hr. It has been used successfully in African hoofstock species during translocation alone or in combination with longer acting ND. Haloperidol lactate is likely the most common short acting ND used in zoological institutions in the United States and has been successfully used in thousands of hoofstock in the author’s practice. This ND has a marked and predictable tendency to cause EPS in man. Haloperidol lactate injection (Bedford Laboratories, Bedford, OH 44146, USA) is routinely used at the San Diego Wild Animal Park (SDWAP) when relocating non-domestic hoofstock animals to new enclosures, the hospital or holding facilities. The use of other ND in wildlife species are discussed elsewhere. The oral form of haloperidol (Haloperidol hydrochloride USP, 20 mg tablets, Sandoz Inc., Irvine, CA 92604, USA) is used at the SDWAP in non-domestic equids with predictably positive results. The clinical success of oral haloperidol in our ruminant species has been variable but has proven effective by others. Anxiolytic drugs, such as benzodiazepines, are also used in the treatment of acute agitation and anxiety attacks in man and animals. In psychiatric emergencies in humans, the combination of antipsychotic and anxiolytics drugs, such as haloperidol and a benzodiazepine, are often used with synergistic benefits. Common side effects such as EPS and sedation are reduced since decreased amounts of each drug can be provided.

Adverse Reactions

Many psychotic conditions are caused by overactivity of dopamine in the brain, specifically the limbic system. The limbic system regulates thoughts and perceptions therefore abnormally elevated levels of dopamine can cause psychosis. Dopamine is blocked by APD in the limbic system but also causes similar action in the extrapyramidal system, which controls muscle activity. Muscle tone is a balance between the levels of dopamine and acetylcholine (ACH) in the extrapyramidal system. If dopamine is blocked or reduced, more ACH is released in the muscle resulting in increased muscle tension and EPS. The frequent side effects of ND are well described in the human literature but only a few reports are described in domestic animals or in wildlife species.

The three classic categories of EPS include acute dystonia, akathisia and pseudo-parkinsonism. Adverse reactions can also be categorized as “acute” (dystonia, akathisia and parkinsonism) and “tardive”, which means having symptoms that develop slowly or appear long after inception. Haloperidol is well known to cause tardive dyskinesia in humans following long term use but may also be triggered by acute high dose. Tardive dyskinesia causes repetitive muscular movements of the face, mouth, limbs or trunk. Acute dystonia consists of abnormal muscle spasms and postures of the head, neck and face. Akathisia is an extrapyramidal disorder consisting of restlessness, anxiety and inability to stand still. Drug induced pseudo-parkinsonism is characterized by muscle rigidity, tremors, diminished facial expressions and shuffling/stiff gait. At the SDWAP, adverse effects have only been noted following injectable haloperidol and can be characterized by one or more of the three classic categories of EPS and possibly tardive dyskinesia. Four case reports are described below.
Treatment Options for Adverse Reactions

Since adverse reactions to ND in non-domestic hoofstock are typically medical emergencies, treatment options must be understood. Treatment includes discontinuing or lowering the dose of the inciting ND, controlling excitatory signs with sedatives/hypnotics, and providing an anticholinergic drug.2,11,13 Other medications such as beta-adrenergic blockers (propranolol) are used to treat akathisia in humans.13

As stated above, ND block dopamine in the extrapyramidal system causing an increase in ACH and increased muscle tension. Anticholinergic drugs block the neurotransmitter ACH in the brain and are a common treatment for EPS to relax muscle tension. These include diphenhydramine, benztropine, biperidin, ethopropazine, orphenadrine, procyclidine and trihexyphenidyl.13 Intravenous or i.m. anticholinergic drugs provide rapid treatment of acute dystonia and drug induced parkinsonism in EPS. Since the ND we use may have long duration of action, the anticholinergics may be metabolized after several hours so additional doses may be necessary.13

New Antipsychotic Drugs

The use of the so-called atypical or second generation APD, is growing in human medicine due to their reported clinical efficacy and decreased tendency to cause EPS.10 However, this claim is challenged by some due to a separate list of side effects.12 Reference to the use of these drugs could not be found in the zoo and wildlife literature.

Clozapine is the prototype atypical APD and was the first to be released for use in human psychiatry. Clozapine is preferentially more active at limbic dopamine receptors and may explain reduced EPS.10 It is known to cause agranulocytosis so it is reserved for patients with unresponsive schizophrenia or severe EPS. Risperidone is a potent serotonin and moderate dopamine antagonist thereby reducing the potential for EPS.10 Side effects include sedation, insomnia, constipation and weight gain. An i.m. preparation is useful for emergency treatment of acute agitation and schizophrenia. Olanzapine is chemically similar to clozapine but does not cause agranulocytosis.10 Side effects include significant weight gain and sedation. Since an i.m. preparation is available its use in acute agitation is similar to risperidone. Quetiapine is another new APD with a high serotonin/dopamine receptor binding ratio responsible for its antipsychotic effect and low incidence of EPS.10 It can cause sedation, hypotension and dizziness. Ziprasidone is a new atypical APD similar to risperidone.10 This drug has great clinical potential and since an i.m. preparation is available it may replace haloperidol as the agent of choice in acute psychotic patients. Side effects are similar to risperidone.

In an effort to decrease side effects and improve control of our anxious and agitated patients, zoo and wildlife veterinarians are encouraged to expand the use of the new APD. In the author’s practice, all of the documented adverse reactions have been to haloperidol, a short acting ND that has been used for over 25 yr in zoo and wildlife species. It seems prudent to explore alternatives with less potential for dangerous side effects. Risperidone, olanzapine, ziprasidone, olanzapine are available in injectable form and human doses should be a reasonable starting point for our
non-domestic hoofstock. Further evaluation of these drugs with controlled studies and documentation of adverse reactions in zoo and wildlife settings are necessary as we search for ideal ND.

Case Descriptions

CASE ONE: A 5-yr-old, female, 1650 kg (est.), southern white rhinoceros (*Ceratotherium simum*) was received into quarantine at the SDWAP. Due to persistent anxiety, inappetance and injurious behavior, 160 mg of i.m. haloperidol (Haloperidol USP, 20 mg/ml, Kyron Laboratories, Benrose 2094, RSA) was provided. Four hr later, the animal was found thrashing on the ground unable to stand with opisthotonus and disorientation. Diphenhydramine hydrochloride (Baxter Health Care, Deerfield, IL 60015, USA) 500 mg was provided i.v. By 18 min, the muscle tone of the animal’s face, neck and back were normal and she was standing and resting calmly by 47 min. The next morning the rhinoceros was found in lateral recumbency with signs of another haloperidol reaction (deep excavation of dirt in immediate area). She stood up when approached, remained lethargic throughout the day but was normal at 48 hr PHA. Signs of EPS were noted. Stock sufficient emergency diphenhydramine if providing ND to large patients. The amount provided in this case was likely insufficient as relapse of EPS was highly suspected. Diphenhydramine is used to treat EPS in our practice due to its positive response, safety and varied clinical indications (antihistaminic activity).

CASE TWO: A 7-yr-old, female, 52 kg, blesbok (*Damaliscus pygargus phillipsi*) was anesthetized with 1.5 mg carfentanil citrate (Wildlife Pharmaceuticals, Inc., Fort Collins, CO 80522, USA) i.m., given 10 mg haloperidol lactate (Haldol, Ortho McNeil Pharmaceuticals, Inc., Titusville, NJ 08560, USA) i.m. and reversed with 150 mg i.v. naltrexone hydrochloride (Wildlife Pharmaceuticals, Inc.). The blesbok was found on the ground 60 min later with obvious opisthotonus, facial tics and redundant head movements. Renarcotization was ruled out by no response to supplemental naltrexone. Diphenhydramine (Baxter Health Care), 75 mg i.m. was provided and the animal was normal in 15 min. Typical EPS were noted and quickly reversed with diphenhydramine. Side effects of ND may be misdiagnosed due to similarity with other disease states.

CASE THREE: An 8-yr-old, male, 58 kg, Kenyan impala (*Aepyceros melampus*) became hyperthermic during anesthesia induction and was hospitalized for i.v. support. Haloperidol lactate (Bedford Laboratories) 7.5 mg and haloperidol decanoate (Sicor Pharmaceuticals, Irvine, CA 92618, USA) 75 mg were given i.m. prior to entering the hospital. For two days, the animal was calm but then became anxious so 15 mg of haloperidol lactate was provided i.v. and then repeated 5 hr later. Two hr later the animal was found disoriented, with facial tics and redundant head movements. Diphenhydramine (Baxter Health Care) 150 mg was given i.m. and by 30 min all EPS disappeared. Two i.v. doses of haloperidol caused acute dystonia, pseudo-parkinsonism and tardive dyskinesia since high doses of ND may trigger this adverse reaction. Diphenhydramine offered rapid and effective reversal of EPS.

CASE FOUR: A 1-yr-old, female, 23 kg, hog deer (*Axis procinus*) was anesthetized for shipment and given 5 mg of haloperidol lactate (Ortho McNeil Pharmaceuticals, Inc.) i.m. prior
to relocation to a holding facility. One hr later, it was found with thrashing on the ground with opisthotonus. The animal was given 6 mg of benztropine mesylate (Cogentin, 2 mg/ml, Merck & Co., Inc., Whitehouse Station, NJ 08889, USA) i.v. and was noted to be normal within 1.5 hr. In our practice, hog deer seem extremely sensitive to haloperidol induced EPS so this ND is avoided in this species. Benztropine mesylate is a valid option for treatment of EPS. 2

ACKNOWLEDGMENTS

The authors acknowledge the insight and input from the veterinarians, veterinary technicians and mammal department at the San Diego Wild Animal Park.

LITERATURE CITED

CERVICAL VERTEBRAL INSTABILITY IN KOMODO DRAGONS (Varanus komodoensis)

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Abstract

Cervical instability with secondary neurologic disease appears to be emerging as a significant cause of morbidity and mortality in captive Komodo dragons (Varanus komodoensis). Four confirmed cases of cervical subluxation resulting in nerve root and/or spinal cord compression are identified. In addition, four similar cases are acknowledged although the cause of neurologic signs is unconfirmed. All were adults (age range 10.5-17.5 yr) with no sex predilection apparent. Of the confirmed cases, three were trauma-induced and one had an unknown inciting cause. Cervical vertebrae affected included C1-C4. Clinical signs on presentation included ataxia, ambulatory paraparesis or tetraparesis to tetraplegia,1 depression to unresponsiveness, cervical scoliosis, and anorexia (primarily caused by inability to hyperextend neck as part of normal feeding strategy). Diagnosis of compression was confirmed with magnetic resonance imaging or computed tomography. Treatment ranged from supportive care to attempted surgical decompression. All cases resulted in mortality, ranging in time from 4 days to 14 mo post-presentation. Timely surgical intervention may be paramount for recovery. Necropsy findings primarily included axonal demyelinization, Wallerian degeneration, and cell necrosis of the spinal cord. Possible pathologies to investigate include cervical malformation resulting in ligament laxity and subsequent subluxation (similar to wobbler syndrome in dogs) and the presence of axonal demyelinization with Wallerian degeneration. Predilection for cervical subluxations may correlate with genetics of the species as well as captive dietary regimens. Care should be exercised with procedures involving manual restraint of Komodo dragons at the neck or manipulation of the neck.

LITERATURE CITED

DEVELOPMENT OF A POLYMERASE CHAIN REACTION TEST FOR *Entamoeba invadens*

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Abstract

*Entamoeba invadens* is a protozoal parasite of reptiles that causes colitis, abscessation of the liver and other organs, and sometimes, acute death. It is generally considered a commensal organism of chelonians, but has been implicated as a cause of disease in red-footed (*Geochelone carbonaria*) and leopard tortoises (*Geochelone pardalis*). Some of the apparent differences in species susceptibility may be due to the inability to distinguish nonpathogenic species of *Entamoeba* from *E. invadens*, rather than actual variation in severity of clinical signs among reptilian hosts. Diagnosis of *E. invadens* is currently by detection of trophozoites and/or cysts via direct fecal examination; however, definitive diagnosis of *E. invadens* has been difficult due to the almost identical morphology of nonpathogenic *Entamoeba sp*, such as *E. ranarum*, *E. insolita*, *E. barreti*, and *E. terrapinae*. Definitive speciation of *Entamoeba sp* is important to avoid misdiagnosis or overtreatment for nonpathogenic protozoa and exposure of potentially susceptible species in mixed collections. In this study, polymerase chain reaction (PCR) primers were developed for *E. invadens*, *E. ranarum*, *E. terrapinae*, and *E. insolita* and PCR testing was conducted on purified DNA from cell cultures as well as purified DNA from reptile stool samples with *E. invadens* trophozoites added. This study has developed successful PCR primers for four species of *Entamoeba* and demonstrates that PCR is a promising diagnostic tool for the definitive identification of *Entamoeba invadens*.

ACKNOWLEDGMENTS

The authors thank the individuals that have provided samples and technical assistance with this research including Daniel Eichinger, James Bradford, C. Graham Clark, Ellen Bronson, Christopher Bednarski, Jennifer Sohl, Steve Maltese, Nadia Bischoff, and many others.

LITERATURE CITED

PHARMACOKINETICS OF ITRACONAZOLE IN THE AMERICAN HORSESHOE CRAB (*Limulus polyphemus*)

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Abstract

American horseshoe crabs (*Limulus polyphemus*) developed white, proliferative soft tissue lesions affecting the gills, legs, and tail as well as ulcerative lesions affecting the ventral shell. On physical examination 39/46 crabs of all age groups were affected with one or both of the described lesions and their severity increased with age. Lesions were of un-specified fungal etiology based on culture, cytology, histopathology and PCR. In order to establish an anti-fungal protocol for treatment of infected crabs, a pharmacokinetic study using itraconazole was performed. Itraconazole was administered intravenously at 10 mg/kg to 10 adult, healthy American horseshoe crabs. Hemolymph samples were collected via cardiocentesis at 0, 0.5, 1, 2, 4, 6, 24, 48 and 72 hr following administration of itraconazole. The concentrations of itraconazole and its most active metabolite, hydroxyitraconazole were determined using high performance liquid chromatography. The t1/2, volume of distribution, and clearance were 25.78 hr, 10.95 L/kg, and 0.31 L/hr*kg, respectively. The AUC0-∞ and C0 were 49.93 ± 36.49 mg*hr/L and 9.73 mg/L, respectively. The active metabolite hydroxyitraconazole had a Cmax and AUC0-last of 0.08 mg/L and 2.23 mg*hr/L, respectively. Therapeutic levels (500 ng/ml) of itraconazole were attained in the hemolymph of all study animals. Results of this study conclude that itraconazole administered intravenously at 10 mg/kg every 24 hr should be effective in the treatment of susceptible fungal infections in the American horseshoe crab. Further studies are indicated to establish potential toxicities of itraconazole, as well as sensitivities of common fungal pathogens to itraconazole in the horseshoe crab.

ACKNOWLEDGMENTS

The authors thank the staff at Ripley’s Aquarium of the Smokies for their assistance and support during the study. This project was funded by a grant from the Companion Animal Fund, Department of Small Animal Clinical Sciences, College of Veterinary Medicine, The University of Tennessee, Knoxville, TN 37996 USA.
VALIDATION OF OSCILLOMETRIC NON-INVASIVE BLOOD PRESSURE MONITORING IN BOID SNAKES

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Abstract

Measurement of arterial blood pressure (ABP) is an essential part of anesthetic monitoring in human and domestic animal anesthesia,1 but this modality is rarely used with reptilian patients.2 Invasive blood pressure monitoring (IBP) using an intra-arterial catheter and arterial blood pressure transducer is considered the gold standard, but this methodology is labor intensive and somewhat risky as surgical placement of the catheter is typically required.1,3 Our goal was to validate a non-invasive oscillometric blood pressure (NIBP) monitor (Cardell Veterinary Model 9401) for use in medium to large boid snakes.

An intra-arterial catheter was placed in the right aortic arch and connected to a pressure transducer and oscilloscope to determine direct systolic, diastolic and mean arterial blood pressure.4 A blood pressure cuff measuring 40% of the circumference of the tail was placed distal to the vent. Simultaneous readings of IBP and NIBP were taken over a 45-min period for each animal.

At the time of abstract preparation, final data was available for three adult boa constrictors (Boa constrictor). Oscillometric blood pressure readings tended to underestimate diastolic and mean arterial blood pressure (MAP) and overestimate systolic arterial pressure. The difference between NIBP MAP and IBP MAP was smallest in the range of 50-60 mm Hg. These findings are similar to those found in domestic small animals when comparing invasive and non-invasive blood pressure monitoring.5,6 Further study is warranted to determine accuracy of NIBP in snakes of varying body sizes and the effects of short-term and prolonged hypotension in snakes.

LITERATURE CITED

MOLECULAR CHARACTERIZATION OF A COCCIDIAN PARASITE OF THE ADRENAL GLAND IN LEATHERBACK TURTLES (Dermochelys coriacea)

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Abstract

Leatherback turtle (Dermochelys coriacea) populations have undergone dramatic declines, decreasing over 70% globally in less than one generation.1 Very little is known about disease in this species, and the scant reports available deal primarily with opportunistic secondary bacterial infections. At necropsy of a wild leatherback turtle, a protozoan parasite that largely effaced normal adrenal tissue was identified histologically. The animal was assessed to be in good general health as indicated by nutritional status and evidence of recent feeding. Degenerate PCR primers targeting the apicomplexan small subunit ribosomal RNA gene were used to amplify products from adrenal tissue. Nucleotide sequencing of the PCR product revealed it to represent a novel coccidian parasite. Comparative sequence analysis shows that this organism is a member of the family Eimeriidae that diverges early in the Eimerian evolutionary history. The adrenal tropism of this coccidian is unique and this parasite likely represents a novel species. Similar findings were identified in two other leatherbacks and molecular confirmation that this is the same organism, as well as comparative histopathologic and ultrastructural studies, are currently ongoing. The consensus PCR protocol used here can be used to obtain sequence data for characterization of novel apicomplexan parasites. Further understanding and characterization of this parasite is needed to determine its role in leatherback health and significance to populations.

LITERATURE CITED

FENBENDAZOLE TOXICITY IN SHARKS

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Abstract

Fenbendazole is a benzimidazole anthelmintic that is used in an extralabel manner for the treatment of intestinal parasitism in many species. There are increasing reports, both published and anecdotal, of fenbendazole toxicity in several avian, reptile, and mammalian species.1,3-6 Current recommendations include fenbendazole administration as part of the quarantine protocol for some elasmobranches.3

Fenbendazole dosing recommendations for most elasmobranches, including zebra sharks (Stegostoma fasciatum), blacknose shark (Carcharinus acronotus), sand tiger shark (Carcharias taurus), nurse shark (Ginglymostoma cirratum), and lemon shark (Negaprion brevirostris) are 25 mg/kg p.o. 3 times/wk for 3 wk.3 While some specimens tolerate this dose without obvious detriment, others become acutely ill. Clinical signs can be apparent as early as 24 hr, and death within 1 wk. Signs of acute toxicity include anorexia, lethargy, necrotic margins to tail and pectoral fins, elevated respiratory rate, and erythematous lesions on ventrum. Clinicopathologic abnormalities are also noted with the most common findings being profound leukopenia, especially granulocytopenia, and anemia, as noted in other species.5

Histologically, lesions are consistent with a radiomimetic insult - destruction of rapidly propagating cells. The most common findings include necrosis of basal cells of the gastrointestinal mucosa and hematopoietic tissue of the epigonal gland. Bacterial overgrowth in the devitalized gut mucosa leads to fatal sepsis. Fenbendazole should be used with caution in elasmobranches.

LITERATURE CITED


INVESTIGATION OF THE USE OF BOVINE ALBUMIN FOR HEMATOLOGIC STABILIZATION IN PANCAKE TORTOISE (Malacochersus tornieri) BLOOD SMEARS

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Abstract

Bovine albumin is used in hematology for cell stabilization to protect against hemolysis especially in samples with low protein counts.1,3 Chelonian blood cells are fragile due to their lower total plasma protein concentration, and once exposed to anticoagulant, cells can be disrupted due to their low oncotic pressure. The use of bovine albumin as a cell stabilizer increases the likelihood of the red and white blood cells maintaining normal morphology.1,3 In this study, blood was collected and blood films prepared from fifty pancake tortoises (Malacochersus tornieri). Two blood smears were created from each sample collected. One smear was prepared from a blood sample containing one drop of 22% bovine albumin per five drops of blood and one from a blood sample containing no additive. The slides were examined at 400x and 1000x and evaluated for numbers of intact versus disrupted blood cells. Disrupted cells were classified as those cells which were smudged, lysed, disrupted or had any other technique artifacts. Results indicated a significant increase (p < 0.05) in intact cells (white and red) at both 400x and 1000x with the use of bovine albumin versus the blood films containing no additive. In conclusion, the bovine albumin minimized the cellular disruption for white and red blood cells that occurs during normal blood film preparation, therefore, increasing the accuracy of white and red cell counts and the differential cell count.

LITERATURE CITED

USE OF A MOBILE MOLECULAR LABORATORY FOR RAPID DIAGNOSIS OF CHYTRIDIOMYCOSIS AT THE SITE OF AN AMPHIBIAN MORTALITY EVENT IN PANAMA

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Abstract

Chytridiomycosis, a skin disease caused by the chyrid fungus Batrachochytrium dendrobatidis, has been implicated as the proximate cause of many amphibian population declines worldwide. In Central America, amphibian mortality events due to chytridiomycosis have occurred in a predictable pattern and have been associated with significant losses in amphibian biodiversity. 1 Because the effects of chytridiomycosis cannot be ameliorated in wild populations, there is an urgent movement towards development of ex-situ survival assurance colonies. 2 A prototype for amphibian survival assurance colonies is the El Valle Amphibian Conservation Center (EVACC) located at the El Nispero Zoo in El Valle de Anton, Panama. EVACC will ultimately house up to 40 native species and is located at an epicenter of amphibian mortality events due to chytridiomycosis in Panama.

Until very recently, diagnostic testing for chytridiomycosis in Panamanian amphibians required shipment of samples to remote laboratories in the United States or elsewhere and results were often significantly delayed by transportation time and government permitting requirements. In late June and early July of 2006, we evaluated the use of a mobile molecular laboratory capable of processing samples for conventional polymerase chain reaction (PCR) as a means of rapidly diagnosing chytridiomycosis in a rural location close to an active amphibian mortality event. The mobile laboratory consisted of a miniature thermocycler (capable of 16 PCR reactions per run), agarose gel electrophoresis equipment, UV transilluminator and microcentrifuge all assembled in a single foam-lined case by the MJ Research Company (now Bio-Rad, Hercules, CA USA). Equipment was transported as checked baggage on a commercial airline. A published conventional PCR reaction for amplifying a 300bp product specific for Batrachochytrium dendrobatidis was used. 3 Modifications for use in field conditions included a rapid protocol for preparation of template DNA from amphibian skin swabs (PrepMan Ultra, Applied Biosystems, Foster City, CA USA); pre-packaged reaction tubes with room temperature stable beads containing Taq polymerase, dNTPs and MgCl (PuRe Taq Ready-To-Go PCR beads, GE Healthcare, Piscataway, NJ USA); and use of pre-cast agarose gels containing ethidium bromide (Reliant FastLane Gel System, Cambrex Bioscience, East Rutherford, NJ USA). For use, the laboratory was assembled in a kitchen within a small house and utilized a single standard
electrical outlet. Positive and negative control samples were processed with each run of the PCR equipment.

Over a 2-wk period samples from over 25 species and 217 individual animals were analyzed and included 144 samples from 10 field sites in the El Valle, Panama region and 63 samples from field collected animals housed in EVACC that had been treated for presumptive chytridiomycosis using itraconazole baths. Of field collected samples 36/144 (25%) were presumptively positive for Batrachochytrium DNA. In samples from field collected animals previously treated for chytridiomycosis there was only a single frog with a weak positive result (1/63; 1.6%). Within these samples, 4 animals with both pre and post treatment swabs had positive samples at the time of capture and negative samples following itraconazole treatment.

Findings suggest that the mobile laboratory was successful at providing rapid preliminary diagnosis of chytridiomycosis at an in-country location close to a site of an amphibian mortality event. In addition, sampling of animals previously treated for presumptive chytridiomycosis allowed some evaluation of the effectiveness of the itraconazole treatment used in processing field-collected animals. Based on this experience, use of mobile molecular laboratory equipment may be useful in a variety of international wildlife disease investigations in which rapid in-country laboratory support may not be available.

Despite the advantages of rapid diagnosis, there are also significant caveats to use of mobile molecular laboratory equipment in a rural setting. A major concern is the possibility of contamination of reactions with non-sample source DNA with subsequent false-positive reactions. Negative controls used in this project were consistently negative until the last 2 PCR reactions (32 samples) performed suggesting that contamination may have become a factor late in the effort. An additional significant concern is that positive PCR results for any pathogen do not prove that the detected agent is responsible for an observed mortality event. In fact, preliminary positive PCR results may provide misleading information because subsequent comprehensive diagnostic investigation (to include complete necropsy and histopathology) may indicate an alternative cause of the mortality event.

LITERATURE CITED


EVALUATION OF COELIOSCOPY INCLUDING LIVER AND KIDNEY BIOPSIES IN FRESHWATER TURTLES (Trachemys scripta)

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Abstract

Twenty-two freshwater sliders (Trachemys scripta) were anesthetized and placed in right lateral recumbency. Following aseptic precautions, a 3 - 4 mm scalpel incision was made in the middle of the left prefemoral fossa, and the subcutaneous tissues and coelomic membrane were bluntly penetrated using straight hemostats. Coelioscopy was performed using a 2.7 mm telescope system (Karl Storz Veterinary Endoscopy America Inc, Goleta, CA). The endoscopist scored the ease of entry into the coelom using a scale from 1 to 5 (1 = impossible, taking more than 15 min; 2 = difficult, taking between 11 - 15 min; 3 = satisfactory, taking between 6 – 10 min; 4 = good, taking between 2 - 5 min; 5 = excellent, taking less than 2 min). Additionally the endoscopist scored the ease of location and visualization of the heart, lung, stomach, small intestine, large intestine, spleen, liver, pancreas, adrenal, gonad, kidney and bladder using a scale of 1 to 5 (1 = impossible; 2 = difficult; 3 = satisfactory; 4 = good; 5 = excellent). Following examination, endoscopic biopsies were collected from both the liver and kidney using 5 Fr (1.7 mm) endoscopic scissors and biopsy forceps. Following single suture skin closure, the procedure was repeated on the right side. All turtles recovered uneventfully, and five days later were euthanatized and subjected to necropsy examinations.

Left and right mean entry and endoscopy scores were > 3 for all measured parameters, except spleen visualization which was consistently impossible to locate from the left side. No iatrogenic trauma was evident at necropsy. Coelioscopy provides a safe and effective means for examination and biopsy of coelomic viscera of turtles.
COMPARISON OF TECHNIQUES FOR DETECTION OF *Brucella* sp. IN MARINE MAMMAL TISSUES

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Abstract

Unique strains of *Brucella* were first identified in marine mammals in 1994. Since then studies have been done to assess seroprevalence and potential health effects in many species, but have been hampered by the lack of sensitivity and/or specificity of traditional serologic tests for marine strains of *Brucella*. Additionally, postmortem diagnoses are classically based on culture of this fastidious pathogen, which poses a risk to laboratory personnel. As part of a comprehensive survey of marine mammal populations, several diagnostic tests have been developed specifically for the detection of exposure to, or presence of, marine *Brucella* sp. in serum or tissue samples. These include a competitive ELISA using a marine *Brucella* antigen, a genus-specific multiplex real-time PCR assay, and an immunohistochemical staining technique using polyclonal antibody to a marine *Brucella* sp. These tests, in addition to microbiologic culture, are being used to analyze cetacean, pinniped, and mustelid tissue and blood samples from wild and captive populations. Preliminary data have been collected on a subset of animals tested by at least two methods, and which are positive by at least one of these tests. No one technique has been able to identify *Brucella* in all cases. In these animals, real-time PCR identified *Brucella* in 82% (14/17), compared to 88% (7/8) by immunohistochemistry, 75% (12/16) by culture, and 70% (7/10) by cELISA serology. A combination of culture and PCR identified *Brucella* in 100% (n=18) of animals. These preliminary results indicate the benefits of a multifaceted approach to diagnosis of brucellosis in marine mammals.
COMPARISON OF FOUR SEROLOGIC ASSAYS AND CULTURE TO DETERMINE TUBERCULOSIS INFECTION IN CAPTIVE ELEPHANTS IN NEPAL

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Abstract

Our team conducted the first comprehensive range country elephant tuberculosis (TB) survey in January 2006. This collaboration encompassed the work of Dr. Kamal Giri in fulfillment of his M.V.Sc degree at the Institute of Agriculture and Animal Science; the support of the Department of National Parks and Wildlife Conservation and Tufts Center for Conservation Medicine; and the ongoing Elephant TB Initiative of Elephant Care International.

We examined 120 captive elephants and compared results of four serologic tests: the ElephantTB Stat-Pak®, MultiAntigen Print ImmunoAssay (MAPIA)™, an enzyme-linked immunosorbent assay (ELISA), and immunoblot with culture results from laboratories in Nepal and the United States. A total of 289 culture samples were collected from 119 elephants; blood was collected from 115 elephants. Cultures were processed at the National Tuberculosis Center (Nepal) and the National Veterinary Services Laboratories (United States).

Results of culture at the National Tuberculosis Center (4 positive), ElephantTB Stat-Pak® and MAPIA (6 positive; 9 suspect), ELISA (8 positive; 2 suspect) and immunoblot (0 positive) were evaluated to place elephants into the following categories:

1) high risk: tests suggest or confirm TB
2) low risk: elephants are test negative or equivocal
3) undetermined risk: no blood sample obtained

Results suggest an approximate prevalence of 13%, comparable to the prevalence among Asian elephants in the U.S.
As a preliminary management strategy, we recommended segregation of high risk elephants, repeat testing of elephants with equivocal results, screening all remaining captive elephants in Nepal, and TB screening of all mahouts.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the cooperation of the Department of National Parks and Wildlife Conservation, Nepal and support from the Abraham Foundation, the Mazuri Fund, the Walter J. Ernst Memorial Fund, the American Veterinary Medical Foundation, and the Dodge Foundation.
FACTORS ASSOCIATED WITH MYCOBACTERIOSIS IN CAPTIVE BIRDS

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Abstract

The objective of this study was to identify factors associated with avian mycobacteriosis in a population of captive birds. Inventory and necropsy records from all eligible birds in the collection of the Zoological Society of San Diego (ZSSD) from 1991-2005 (n = 13,976) were examined to identify birds with post-mortem evidence of avian mycobacteriosis (n = 172; 1.2%). A nested case-control study was conducted to identify and evaluate risk factors describing demographic, temporal, seasonal, and enclosure characteristics, along with move and exposure histories. One-hundred sixty-seven disease-positive birds (cases) were matched in a 1:7 ratio with 1169 disease negative birds of similar age and taxonomic grouping. Risk factors were evaluated using univariate and multivariate conditional logistic regression analyses. Four factors were significantly associated with the diagnosis of avian mycobacteriosis in the multivariate model. Case birds were more likely than controls to have been previously housed with a bird with mycobacterial infection involving the intestinal tract (Odds Ratio (OR) = 5.5, p < 0.01) or involving only nonintestinal sites (OR = 2.2, p < 0.01). Cases were more likely to have been imported into the collection than hatched at the ZSSD (OR = 4.5, p < 0.01). Birds that were frequently moved among ZSSD enclosures (> 3 times) were more likely to have disease than birds that moved less (OR = 2.6, p < 0.01). Identification of characteristics of birds with avian mycobacteriosis will help guide future management of this disease for captive bird populations.
PINNIPED TUBERCULOSIS CAUSED BY Mycobacterium pinnipedii: TRANSMISSION FROM AQUATIC TO TERRESTRIAL MAMMALS AND DIAGNOSTIC OPTIONS

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Abstract

In the last 7 yr three female South American sea lions (Otaria byronia) were diagnosed post mortem with Mycobacterium pinnipedii infections. All of these animals were wild-caught and in captivity for at least 8 yr. Adjacent to the exhibit of the South American sea lions, Bactrian camels (Camelus bactrianus), Malayan tapirs (Tapirus indicus) and crested porcupines (Hystrix cristata) are housed and cared for by the same keepers. Further investigations revealed M. pinnipedii-infections in all three neighbouring species. None of the staff working in this area tested positive.

All of the remaining animals were tested using various diagnostic methods. The diagnostic methods included comparative intradermal tuberculin testing, radiographs, PCR and culture of sputum sample, Rapid Test (RT) based on lateral flow technology (ElephantTB-STAT-PAK), multi-antigen print immunoassay (MAPIA) and ELISA (enzyme-linked immunosorbent assay). The ELISA as well as the RT, that provided a result within 20 min after blood sampling and that was supported by the MAPIA, delivered valuable information and will supplement the compilation of diagnostic tools for this zoonotic disease.
EDUCATION AS A TOOL FOR DISEASE MANAGEMENT: ELEPHANT ENDOTHELIOTROPHIC HERPES VIRUS CASE STUDY IN THE UNITED KINGDOM

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Abstract

Management of emerging infectious diseases often relies on front line staff having access to available information and being able to recognize clinical or pathologic symptoms of the disease before the disease can be reported. Elephant Endotheliotrophic Herpes Virus (EEHV) is an example of a devastating, emerging infectious disease that is thought to have a carrier or latent status within an animal and can be present within a herd for a long period before clinical signs are seen. This paper describes the importance of educational material combined with a lecture program directed towards veterinarians, elephant keepers, and collection managers as part of the United Kingdom’s (UK) National Elephant Endotheliotrophic Herpes Virus Programme.

Introduction

Elephant Endotheliotrophic Herpes Virus (EEHV) is one of the most important emerging diseases of elephants that has implications for the future of captive as well as wild population management programs. The first death due to EEHV reported in an Asian elephant (Elephas maximus) occurred in 1988,² but the disease was not officially described until 1996.³ Despite being recognized for over 10 yr still little is known about the epidemiology of this disease. In 2005 the first suspected case of EEHV was seen in the UK with a herpes virus being isolated in-utero from a calf at post mortem. One month later a confirmed case of EEHV occurred in a 3.5-yr-old calf that died within the same herd. One year later an unrelated, third case of EEHV was confirmed by gross lesions and PCR.

National EEHV Program

In response to the first case of EEHV, the concept of a National EEHV Programme was considered. By 2007 this had become a reality and was developed to provide an educational need and support structure both for clinicians and collections that housed elephants.¹

It was realized early on that the first line of management of EEHV would rely on the knowledge of keepers reporting suspected cases and introducing EEHV checks to daily routines. However despite keepers being aware of the disease, the knowledge of the lesions of the disease, and the actual ability to identify signs that could potentially be related to EEHV varied between keepers. This variation was not dependent on length of elephant experience but was related to individual interest and self-driven research. The level of knowledge varied from little or no knowledge of the disease, to keepers with a reasonable general knowledge of the disease, to other keepers that
had been misinformed about certain details of the disease. A key part of the management of the disease required education of the elephant keepers. The key for EEHV management is early therapy and this requires early recognition systems to be in place, principally through keeping staff.

**Education**

The education program was developed with three tiers of elephant related workers targeted. The first, most obvious, tier was the keeping staff themselves where material was provided to allow identification of lesions, understand the pathology of the disease, and to identify possible outcomes and basic concepts of disease spread within and between herds, with details on how to liaise with the collection’s veterinarians and other institutions.

The second tier concentrated on the veterinarians working with the collections that housed elephants, both African (*Loxodonta africana*) and Asian. Refresher courses were provided to the veterinarians through lecturing and the publication of technical manuals.

The third tier included the curatorial and collection managers from zoos that contained elephants. The educational aim here was to provide technical support but also to explain the potential outcomes of infection being confirmed within a herd, the potential costs of therapy, and the long-term management recommendations for moves and reproduction.

The primary aim in all of the tiers was to increase awareness of the disease, understand the implications and potential costs to a collection, increase EEHV surveillance through a central body, and to provide a regularly updated point of information that would vastly improve response time for suspected cases.

The UK National EEHV Programme education department considered that the priorities for education should include the following.

**Poster Campaign**

A poster campaign was targeted at all of the United Kingdom and Ireland’s elephant houses. This was primarily aimed at the elephant keepers to ensure that there was an easily accessible source of photographs of lesions and clinical signs. The poster, in addition, included a quick list of therapeutics and samples required for testing providing a concise review of EEHV in a flow chart format. The aim was to increase knowledge and have a local, in house reference chart if keepers (or veterinarians) were concerned that a potential case of EEHV was occurring.

**Lecture Tour**

A tour of all of the collections that housed elephants was undertaken. The target audience was primarily elephant keepers, but also included the veterinarians and collection managers. Slide presentations concentrating on EEHV but including tuberculosis, and other management related diseases were given depending on the requests of the individual collections.
In addition EEHV specific presentations were provided at national and international veterinary conferences to provide updates on recent research and to re-iterate the importance of early therapy and variation in the gross clinical signs seen within the UK e.g. oral ulceration had not yet been seen in any of the UK cases.

**Literature**

A technical manual reviewing all aspects of EEHV etiology, history within the literature, epidemiology, pathology, clinical signs, therapeutics, diagnostics, husbandry and management recommendations, and references were provided in an electronic format to all of the collections. This manual was peer reviewed for accuracy by clinicians in the EEHV international task force from the USA and Europe. Although aimed at clinicians, elements were relevant to managers and keepers, especially the comprehensive collection of images of the gross clinical signs.

In addition a leaflet was produced which focused on the lesions and clinical signs with details of further sources of information being provided. This was included with the poster campaign.

**Summary**

The educational campaign was part of a larger UK National EEHV Programme which included a famciclovir depot and delivery system, and an epidemiologic study of UK elephants. However for the successful management of individual cases of EEHV the most important aspect of the program was early recognition by keepers with an efficient reporting system put in place.

This program demonstrates that the management of any emerging infectious disease often relies on staff on the ground at the front line being the key for identification and subsequent management of any disease outbreak. For any disease management program these all important front line staff need to be educated and informed as changes occur within the literature and this educational need must not be forgotten about when designing a management program.

**ACKNOWLEDGMENTS**

Thanks are due to colleagues at ZSL and Port Lympne for their unfailing support during trying times when managing EEHV cases. In addition my thanks goes to Dr Thomas Hildebrandt, IZW, and Dr Willem Shaftenaar, Rotterdam Zoo for their help with the initial development of the UK National EEHV Programme. Not forgetting Erin Latimer, National Zoo and Dr Lauren Howard, Houston Zoo, for their advice on diagnostic testing and therapeutics respectively.

**LITERATURE CITED**

“WORMS, GERMS, AND YOU”: USE OF AN ON-LINE INTERACTIVE PROGRAM FOR ZOONOTIC DISEASE TRAINING IN THE ZOO ENVIRONMENT

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Abstract

In July 2006, Disney’s Animal Programs implemented an on-line training program to ensure cast members (employees) possessed basic knowledge of zoonotic disease biology and prevention techniques. The program was developed though a partnership with members of Disney’s veterinary services, safety and health, and operations learning and development teams in conjunction with the on-line training development company Get Thinking, Inc (www.getthinking.com). The program includes animated and narrated components as well as self examination of key points required for completion of the training.

The program is delivered in two parts. The first part is an introduction to zoonotic diseases targeted to all employees working within animal areas on the Walt Disney World property. This includes traditional zoo and aquarium environments as well as a ranch facility. Teams required to complete this training may include, but are not limited to, animal husbandry, veterinary, aquarium, life support, ranch, education and science, facilities and engineering, and custodial. The inclusion of facilities and engineering and custodial staff came at their request since members of these teams spend large amounts of time working in or near animal areas.

The introduction to zoonotic diseases includes an overview of basic disease biology, mechanisms of disease transmission, keys to disease prevention, and a summary of current processes and protocols. Much of the emphasis of the introduction is placed on the “keys to prevention”, a series of tools/rules that provide protection for employees working with or near the animals. These keys include: understanding at-risk people/groups, proper hand washing technique, proper use of protective equipment, ways to avoid insect/vector exposure, and rules about avoiding animal contact unless required by the job. Specific disease examples are used to emphasize key prevention techniques.

The second part of the training is an advanced course designed specifically for husbandry staff (keepers, managers, aquarists, etc.) working directly with animals. These staff members are required to satisfactorily complete the introduction before moving on to the advanced component. Each member of the husbandry team is assigned a training program based on the category of animals they interact with on a regular basis. These categories include: cetaceans, fish, primates, reptiles and amphibians, hoofed stock and pachyderms, rodents and other small mammals, carnivores, birds, and bats. Specific diseases are reviewed for each animal group using a standardized format and include: disease summary, disease reservoir, animal...
signs/symptoms, human symptoms, and route of transmission, at-risk group, and specific prevention techniques. Self learning exercises are available as a component for each animal category.

Since its inception, the zoonotic disease online training tool has been “launched” to more than 1000 employees. It is a convenient tool that can easily be customized for each individual employee. The on-line platform has many benefits including the decreased use of professional/trainer personnel, increased employee training compliance, increased access to commonly requested information, and increased enjoyment of training activities. We feel this program has not only met the requirements of AZA accreditation for employee zoonotic disease training, but has also greatly increased the knowledge, safety, and comfort of our employees working with or in close proximity to animals.
EVALUATION OF A VACCINATION PROGRAM AGAINST AVIAN INFLUENZA IN THREE DANISH ZOOS: SEROLOGIC RESPONSE TO VACCINATION WITH AN INACTIVATED H5N9 VACCINE

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Abstract

Avian influenza (AI, Influenzavirus A, Orthomyxoviridae) is a highly contagious disease of poultry, which may infect most if not all bird species. Between October 2005 and July 2006, highly pathogenic (HP) AIV of subtype H5N1 spread in wild birds and poultry in Europe. Within the EU, AI is a notifiable disease normally handled by culling.1 Vaccination of birds is generally not allowed, but based on a desire to protect genetically unique populations, an emergency vaccination permission was issued in the spring of 2006.2 In Denmark, an inactivated H5N9 AI vaccine (Gallimune Flu H5N9, Merial) designated for domestic poultry3 was used. Five hundred and forty birds in three zoos were vaccinated twice with a 6-wk interval. Vaccine doses were based on body weight (1-99 g: 0.1 ml; 100-2999 g: 0.3 ml; 3 kg-20 kg: 0.6 ml; >20 kg: 1 ml), and were administered subcutaneously. All individuals were blood sampled 4-6 wk following the second administration. To evaluate the humoral response to vaccination, H5-antibody titers were determined in a hemagglutination inhibition test (HI) following EU guidelines.1 Geometric mean titer (GMT), seroconversion rate (SR), and protection rate (PR) were calculated. Undetectable titers (<16) were regarded as 4 for the calculation of GMT.

The GMT following vaccination varied greatly among species, ranging from 5 in cockatiels (Nymphicus hollandicus, n=29) to 2195 in Amazon parrots (Amazona spp., n=10). Overall GMT was 137. 84% of the birds seroconverted, and the PR was 76%. No side effects related to vaccine administration or blood sampling were observed.

Significant differences in post vaccination titers were observed among and indeed within orders, and species-specific data appears to be the clinically relevant parameter rather than values based on higher taxonomic classification.

In the current investigation, penguins, pelicans, ducks, geese, herons, Guinea fowl, cranes, cockatiels, lovebirds, and barbets showed very poor response to vaccination, while very high...
titers and seroconversion rates were seen in flamingos, ibis, rheas, Congo peafowl, black-winged stilts, Amazon parrots, and kookaburras.

The overall PR and GMT reported here are similar to the response reported following the administration of inactivated H7N1$^4$ and H5N2$^{5,6}$ vaccines to various zoo birds. However the marked species differences in serologic response make such comparisons dubious, as mean results are likely to reflect the composition of collections more than the immunogenicity of the vaccines in question.

ACKNOWLEDGMENTS

The authors thank Helle Flaga, Eddie Bach, Henrik Futtrup, Brian Zacho, Janus Hansen, Jesper Nielsen, Julie Bertelsen, Mille Krambeck Hansen, Kirstin Anderson Hansen, Kamilla Zornhagen, Stine Nielsen, Lidija Vestergaard, Kirsten Brock, Hans Åge Hjeresen, Frands Carlsen, Louise Fisker, and Francesco Prandini.

LITERATURE CITED

EXPLORING THE TERRESTRIAL COMPONENT OF POTENTIAL LAND-SEA TRANSMISSION OF *Toxoplasma gondii* IN COASTAL CALIFORNIA

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Abstract

*Toxoplasma gondii*, a globally distributed protozoan parasite, infects a wide range of birds and mammals, including humans. Identified as a significant cause of mortality in the threatened California Southern sea otter population, *T. gondii* also presents an important public health concern. The terrestrial shedding of *T. gondii* by wild and domestic felids and studies linking otter infection to freshwater run-off suggest potential land to sea pathogen transmission along California’s central coast. High risk sites for marine exposure to *T. gondii* have been identified, but parasite burden in the terrestrial environment is not well characterized. Current limitations of molecular tests prevent direct measurement of parasite load in the environment. Our collaborative, interdisciplinary research approach, using current epidemiologic and molecular techniques, is addressing the hypothesis that terrestrial environmental contamination with oocysts and risk of exposure to *T. gondii* can be predicted based on the prevalence of infection in domestic felid, wild carnivore and wild rodent populations. Identifying areas of increased terrestrial *T. gondii* exposure and risk factors for environmental parasite accumulation will facilitate the identification and implementation of future management strategies to reduce the environmental exposure of humans and sensitive wildlife species to this pathogen.
THE U.S. DEPARTMENT OF AGRICULTURE ANIMAL AND PLANT HEALTH INSPECTION SERVICE-ASSOCIATION OF ZOOS AND AQUARIUMS AVIAN INFLUENZA SURVEILLANCE PLAN

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Abstract

Zoological institutions represent ideal sentinels for the detection of zoonotic disease in urban settings and other areas. Recognizing this, the U.S. Department of Agriculture (USDA) and the Association of Zoos and Aquariums (AZA) worked together to develop a joint USDA APHIS – AZA Avian Influenza Surveillance Plan. This program has been developed to complement the AZA Highly Pathogenic Avian Influenza Emergency Guidelines for Zoos and the AZA Avian Influenza Vaccination Study. This surveillance is funded by the USDA and includes the cost of collection kits, shipping, and sample processing. Program oversight and coordination is also funded by the USDA. It consists of passive surveillance of ill and dead birds found on zoo grounds along with active surveillance on healthy bird populations in zoo collections. Initial testing will be performed at three regional diagnostic laboratories that are in the National Animal Health Laboratory Network. Samples that are positive for highly pathogenic Avian Influenza subtypes (H5 and H7) will be forwarded to the National Veterinary Services Laboratory (NVSL) for final processing. Along each stage of processing, individual institutions will receive notification if any of their samples are tests-positive for Avian Influenza. Three regional coordinators (UC Davis, Lincoln Park Zoo, and Cleveland Metroparks Zoo) will collect and organize sample data from the three regional laboratories and from NVSL. Information will be stored in a database compatible with that of the U.S. Geological Survey’s National Wildlife Health Center’s database.
SURGICAL CORRECTION (APICOECTOMY) OF A MOLAR DENTAL PLATE SEQUESTRUM IN AN AFRICAN ELEPHANT (Loxodonta africana)

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Abstract

A 29-yr-old female African elephant weighing 3,384 kg was anesthetized with a combination of 7.5 mg etorphine, 15 mg acepromazine, and 3,000 IU hyaluronidase for surgical treatment of a chronic ventral mandibular fistula. The fistula originated from a previously diagnosed dental plate (tooth root) infection. Initial effects were noted within 3 min and the elephant became recumbent within 8 min. The elephant was guided into right lateral recumbency with preplaced ropes. The elephant was orotracheally intubated and maintained on isoflurane in oxygen through the use of paired large animal anesthetic machines equipped with four 30L reservoir bags. Digital radiography was utilized to guide the surgical procedure which involved the surgical creation of a second fistulous tract through the lateral wall of the mandible and directly into the apically infected dental plate portion of the molar tooth. The infected area was aggressively curetted, lavaged, and the resultant apical bony deficit and access tract was back filled and closed with an antibiotic impregnated calcium sulfate dental plaster. Pulse oximetry, ECG, blood gases, direct and indirect oscillometric blood pressure were consistently monitored. Goals for blood pressure parameters and respiratory excursions were achieved which minimized deleterious effects of lateral recumbency upon systemic circulation. The elephant was reversed with naltrexone and recovered uneventfully, although additional naltrexone was administered for one episode of renarcotization later in the day. The original ventral tract was allowed to drain and continued to do so for an additional 6 mo, whereupon the fistulous tract resolved. No further drainage or swelling has been noted for an additional 7 mo. The elephant continues to prehend, masticate, and behave normally. This case demonstrates the ability to diagnose and surgically correct dental abnormalities in an elephant based on similar reported cases in other animals.

ACKNOWLEDGMENTS

The authors would like to thank every department at the Kansas City Zoo for their contributions to the success of this procedure.
LITERATURE CITED


ELECTROCARDIOGRAPHY OF ASIAN ELEPHANTS (Elaphas maximus): DEVELOPMENT OF STANDARD TECHNIQUES AND CHARACTERIZATION OF NORMAL WAVEFORMS

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Abstract

Electrocardiograms (ECGs) are infrequently performed on captive elephants, and few large scale studies have been reported in the literature. Obtaining ECGs from elephants is challenging due to their size, thick skin, and tendency to be in constant motion. Commonly encountered problems include inadequate leads, insufficient cable length, and poor signal conduction. Novel clamps were designed and used in this study. Quick-Grip® Handi-Clamp™ 2” Curved Bar Clamps (Irwin Industrial Tool Company, DeWitt, NE 68341 USA) were modified by replacing one end of the clamps with a copper plate, which was connected to a conducting wire and 1/8 inch mono in-line jack. Long ECG cables (71 cm) were used.

ECGs were performed on a total of 19 Asian elephants (Elephas maximus); tracings from 10 elephants were obtained with a PageWriter Trim II (Philips Medical Systems, Bothell, WA 98041 USA), and 9 were obtained using a MAC 1200 (G.E. Healthcare, Waukesha, WI 53188 USA). A six lead system was used. Four clamps were placed on the elephant: one in each inguinal skin fold, and one over each triceps. Alcohol was applied to the electrodes to maximize conduction of the signal. Readings were obtained with the elephants standing as well as in right lateral (RL) and/or left lateral (LL) recumbency. Continuous tracings were obtained with the paper speed at 25 mm/sec, waves amplified to 20 mm/mV, and filters set at the maximum values. Generally, the best tracings were obtained from Lead I with the elephant standing or in RL recumbency. A partial summary of the data is provided in Tables I and II.
Table 1. Duration of elephant ECG waves and intervals in seconds. Ranges given with mean values ± SD in brackets. n = number of animals.

<table>
<thead>
<tr>
<th>Position</th>
<th>P range</th>
<th>P-R range</th>
<th>QRS range</th>
<th>T range</th>
<th>Q-T range</th>
<th>U range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing N = 9</td>
<td>0.08-0.28 (0.18 ± 0.06)</td>
<td>0.28-0.54 (0.38 ± 0.07)</td>
<td>0.09-0.20 (0.17 ± 0.03)</td>
<td>0.20-0.39 (0.27 ± 0.05)</td>
<td>0.56-0.86 (0.70 ± 0.09)</td>
<td>0.24-0.36 (0.30 ± 0.04)</td>
</tr>
<tr>
<td>RL recumbency n = 5</td>
<td>0.07-0.16 (0.11 ± 0.03)</td>
<td>0.29-0.42 (0.35 ± 0.05)</td>
<td>0.09-0.22 (0.17 ± 0.04)</td>
<td>0.15-0.32 (0.23 ± 0.06)</td>
<td>0.54-0.76 (0.62 ± 0.08)</td>
<td>0.10-0.33 (0.20 ± 0.06)</td>
</tr>
<tr>
<td>LL recumbency n = 7</td>
<td>0.10-0.26 (0.16 ± 0.05)</td>
<td>0.26-0.44 (0.33 ± 0.06)</td>
<td>0.11-0.24 (0.17 ± 0.04)</td>
<td>0.19-0.42 (0.25 ± 0.06)</td>
<td>0.56-0.84 (0.68 ± 0.10)</td>
<td>0.18-0.32 (0.26 ± 0.05)</td>
</tr>
</tbody>
</table>

Table 2. Amplitude of elephant ECG waves in millivolts. Ranges given with mean values ± SD in brackets. n = number of animals.

<table>
<thead>
<tr>
<th>Position</th>
<th>Heart Rate</th>
<th>P range</th>
<th>QRS range</th>
<th>T range</th>
<th>U range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing n = 9</td>
<td>26-44 (38 ± 6)</td>
<td>0.08-0.24 (0.13 ± 0.04)</td>
<td>0.67-1.27 (0.94 ± 0.18)</td>
<td>0.06-0.27 (0.16 ± 0.06)</td>
<td>0.10-0.19 (0.13 ± 0.04)</td>
</tr>
<tr>
<td>RL recumbency n = 5</td>
<td>34-41 (38 ± 3)</td>
<td>0.04-0.16 (0.10 ± 0.04)</td>
<td>0.69-1.25 (0.95 ± 0.19)</td>
<td>0.08-0.2 (0.12 ± 0.04)</td>
<td>0.05-0.2 (0.08 ± 0.05)</td>
</tr>
<tr>
<td>LL recumbency n = 7</td>
<td>33-59 (44 ± 8)</td>
<td>0.04-0.25 (0.11 ± 0.05)</td>
<td>0.32-1.16 (0.78 ± 0.26)</td>
<td>0.08-0.18 (0.13 ± 0.03)</td>
<td>0.1-0.16 (0.14 ± 0.02)</td>
</tr>
</tbody>
</table>
APPLICATION OF ELEPHANTTB STAT-PAK® ASSAY AND MAPIA™ (MULTIPLE ANTIGEN PRINT IMMUNOASSAY) FOR TUBERCULOSIS TESTING OF BLACK RHINOCEROS (Diceros bicornis) IN MANAGED CARE

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Abstract

Mycobacterium tuberculosis (Mtb) and Mycobacterium bovis (Mbtb) have both been documented in rhinoceros species in captivity.¹,⁵,⁷⁻⁹ Two culture confirmed cases of Mtb in black rhinoceros at two separate facilities had serum retrospectively analyzed with the ElephantTB STAT-PAK® Assay and MAPIA™ 4 (both from Chembio Diagnostic Systems, Inc., Medford, NY) after death. Both animals were positive on both assays at the time of culture. A third black rhinoceros was housed with one of the above culture positive rhinoceros, and tested positively on two separate occasions with STAT-PAK and MAPIA. In addition, this rhinoceros had positive skin reaction to PPD Bovis and had a high ELISA titer from the National Veterinary Diagnostic Laboratory in Ames, Iowa. This rhinoceros was euthanatized for debilitating arthritis. No evidence of mycobacterial disease was seen at the time of the post-mortem examination and no cultures were submitted. Frozen tissue samples are currently being cultured to help determine the status of this rhinoceros. The two culture positive rhinoceros had under gone anti-tuberculosis therapy prior to death.

Tuberculosis testing has proven to be problematic in a variety of species, and an assay to improve diagnostic confidence has been sought.²,⁸ Antemortem diagnosis that relies on culturing the organism is limited due to intermittent shedding of mycobacteria. Ancillary diagnostic tests such as the gamma interferon assay have limitations in application or in sensitivity and specificity for different species.

The use of the ElephantTB STAT-PAK® Assay and MAPIA™ has already proven useful in species other than elephants³ and the initial results in these cases show promise for rhinoceros. The availability of serum samples in these cases may not allow a detailed investigation as to when the infection was contracted but at least in one case the animal was negative 4 yr prior to positive culture results. Response to therapy may also be evaluated but again is limited by available samples. With the re-emergence of tuberculosis in managed wildlife, the need for early detection is crucial. This assay holds great potential for diagnosis of this infection in free-ranging rhinoceros and may facilitate movement from areas where tuberculosis is endemic in other species such as the Kruger National Park.⁶
ACKNOWLEDGMENTS

We would like to thank Curtis Eng and Ann Duncan for providing clinical information regarding these cases and supporting this endeavour.

LITERATURE CITED

COMPARATIVE PATHOLOGY OF IRON-STORAGE DISORDERS IN CAPTIVE RHINOCEROSES: POTENTIAL INSIGHTS INTO ETIOLOGY AND PATHOGENESIS

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Abstract

Browser rhinoceroses, (African black [Diceros bicornis] and Sumatran [Dicerorhinus sumatrensis]),\textsuperscript{7,10} along with tapirs (Tapirus spp.)\textsuperscript{8} and many other endangered wildlife,\textsuperscript{6} develop pathologic overloads of iron as a function of time in captivity; whereas grazer rhinoceroses, (African white [Ceratotherium simum] and Asian greater one-horned [Rhinoceros unicornis]), do not.\textsuperscript{7,10} Recent contributions by others\textsuperscript{1-5} in deciphering the complex control mechanisms involved in iron homeostasis now allow plausible hypotheses regarding the genetic basis for such differences. An antimicrobial peptide, hepcidin, has recently been identified as the principal hormonal regulator of mammalian iron balance by its interaction with ferroportin, the sole transmembrane channel for egress of cellular iron into plasma. Hepcidin deficiencies are responsible for most forms of hereditary iron overload syndromes in humans, and overproduction of hepcidin induces the anemia of inflammation or chronic disease, another condition commonly observed among captive rhinoceroses.

Histopathologic observations of necropsy tissues from approximately sixty captive rhinoceroses of these four species revealed patterns of iron-pigment deposition that differed from those seen in classical HLA-linked hereditary hemochromatosis or those associated with hemolytic or other anemic conditions. Instead, deposition of iron pigments heavily affected the reticuloendothelial system before involving hepatic and other parenchymal cells in distribution patterns that conformed most precisely to those observed in African (Bantu) iron overload syndrome,\textsuperscript{9} a condition characterized by both increased bioavailability of dietary iron and a genetic propensity for its increased assimilation.

These observations support an hypothesis that genetic mutations or polymorphisms resulting in defective hepcidin, ferroportin, or their interaction, could account for the uniform tendency of browser, but not grazer, rhinoceroses (among other wildlife species) to rapidly develop pathologic iron overburdens in captivity. Based on comparative pathology and blood and tissue assays, this difference between rhinoceros species could most likely be explained by an impaired response of ferroportin to modulation by hepcidin in the browsers. Collaborative studies have been initiated to test this hypothesis by sequencing the genes governing expression of hepcidin, ferroportin, and three other key proteins involved in orchestration of iron homeostasis in all four available species of rhinoceroses.
ACKNOWLEDGMENTS

These studies were supported generously by grants from the International Rhino Foundation/SOS Rhino, the Morris Animal Foundation, and the Fulbright Senior Research Fellowship Program. The author is particularly indebted to the many zoo veterinarians, keepers and institutional staffs who provided opportunities to participate personally in performance of necropsies and reviews of archival materials.

LITERATURE CITED

DERMATOPATHY IN CAPTIVE HIPPOPOTAMUS (Hippopotamus amphibius)

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Abstract

Ulcerative skin lesions were observed in three captive adult female hippopotamus (Hippopotamus amphibius) held in two North American institutions. Lesions appeared as cracking, peeling, or vesicles of the skin affecting the lateral and ventral aspects of the neck, limbs, thorax, and abdomen, dorsum, toes, and around the perineal region. Lesions progressed to tissue sloughing of variable severity, ranging from superficial, raw erythemic areas to deep, ulcerative lesions that drained blood, serum, or purulent material. While lesion appearance was similar to previously reported dermatitis in captive hippopotamus attributed to a group-G beta-hemolytic Streptococcus sp.,1 no predominant pathogens were identified in the hippopotamus from this report. Histologic evaluation of sloughed skin consisted of deep dermal collagen with bacterial cellulitis and vasculitis and superficial fungal colonization or ulcerative dermatitis with infarct and extensive colonization by bacterial and fungi. No viral pathogens were isolated and PCR testing for herpesvirus was negative. Lethargy, depression, lameness, and weight loss of variable severity were observed in all affected hippopotamus. Minimal response to previously described systemic antibiotics and topical treatment1 was observed in the hippopotamus from this report. Commercial cattle food-grade salt was added to the exhibit pool of both facilities at 2-3 parts per thousand with a positive response to salt bath therapy observed in all affected hippopotamus over a 4-6 mo treatment period. Seasonal recurrence of similar skin lesions were noted in all hippopotamus from this report. Seasonal recurrence of dermatitis has been previously observed in captive hippopotamus with similar lesions (V. Clyde, personal communication).

ACKNOWLEDGMENTS

The authors would like to thank Dr. Jim Wellehan at the University of Florida for performing the herpesvirus PCR, Dr Vickie Clyde and Dr. Roberta Wallace of the Milwaukee County Zoo for their consultation and expertise, and the hippopotamus care staff of the Woodland Park Zoo and Birmingham Zoo for their dedication and daily care of the patients in this report.

LITERATURE CITED

SURVEY OF LESIONS IN HOOFED-STOCK

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Zoo/Exotic Pathology Service, P.O. Box 267, Greenview, CA 96037 USA

Abstract

Records of hoofed-stock submissions to the Zoo/Exotic Pathology Service were studied, and the types of lesions, causes and organs involved were characterized.

Introduction

Any animal with hooves has been considered an ungulate, however, the use of the name "ungulate" has been inconsistent. It was originally used to refer to the orders Artiodactyla (even-toed) and Perissodactyla (odd-toed) - the so-called "true" ungulates, but over time the term expanded to seven different extant Mammalian orders some of which had no hooves. Recent advances in molecular biology/taxonomy, relying on genetic code similarities, indicate that the grouping was artificial. As a result, ungulate is now considered to have no taxonomic significance, and the definition is once again descriptive: a mammal with hooves.

Methods

The records of the Zoo/Exotic Pathology Service were examined to characterize the types of lesions seen in material submitted from animals considered hoofed-stock. These animals comprised 5.1% of mammalian submissions (10159 mammals of which 514 were considered hoofed-stock). Thirty-eight species were identified, and this paper presents the etiologies (if determined), morphologic diagnoses, and organs in the species submitted.

Results

The most common species represented made up approximately 70% of the submissions. These included gazelles (all types) (20.6%), impala (8.9%), nyala (7.5%), kudu (all types) (6.9%), antelope (other types) (6.1%), sitatunga (5.5%), waterbuck (4.1%), giraffe (3.8%), dik-dik (3.5%) and ibex (2.9%).

The most common etiologic diagnosis was ‘undetermined’ (56.6%). Others included bacterial infection (11.3%), mycobacterial infection (8.1%), congenital disease (5.2%), nutritional/metabolic disorder (4.3%), neoplasia (2.9%), protozoal infection and physical (1.7%), secondary (0.9%), virus (0.6%) and mycotic, toxic, allergy, and none/normal tissue (0.3%).

The ten most common morphologic diagnoses as a percent of animal submissions were enteritis (18.8%), pneumonia (11.9%), thymic hypoplasia (9.8%), nephritis (all types) (4.6%), septicemia...
and striated muscle degeneration including skeletal and cardiac muscle (3.5%), lymphoid hyperplasia of lymph nodes (2.6%), renal mineralization and cholangiohepatitis (1.7%) and vacuolar hepatopathy (1.4%). A large number of other diagnoses made up the remaining 40.5%.

Organ/organ system involvement was as follows: Gastrointestinal system (24.3%), respiratory system (16.5%), hematopoietic/lymphatic (13.3%), urinary tract (11.6%), whole body (11.0%), liver/pancreas (7.8%), skin/subcutis (5.2%), musculoskeletal (4.3%), cardiovascular (3.2%), reproductive (1.7%), central/peripheral nervous system (1.2%) and endocrine (0.9%).

**Discussion**

Without population data, it is difficult to determine if the numbers of each species represented is indicative of a greater propensity for problems, or simply a reflection of the overall population of these animals in zoos. For submissions with a possible etiology determined, bacterial diseases were the most common overall and the most common infectious condition. Generic identification of the organisms would depend on correlation with any cultures taken at necropsy. Congenital lesions and lesions considered most likely nutritional/metabolic, were the most common noninfectious conditions. Enteritis of all types was the most common morphologic diagnosis, and the gastrointestinal system was the most commonly affected organ system. The category of ‘secondary’ as an etiologic diagnosis refers to lesions such as amyloidosis, soft tissue mineralization following renal disease and peritonitis after traumatic perforation of the gastrointestinal tract.
MULTI-INSTITUTIONAL RETROSPECTIVE ANALYSIS OF FRACTURE TREATMENT METHODS IN NONDOMESTIC RUMINANTS

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¹Animal Health Department, Fort Worth Zoo, 1989 Colonial Parkway, Fort Worth TX 76110 USA; ²Department of Veterinary Clinical Sciences, School of Veterinary Medicine, Louisiana State University, Baton Rouge, LA 70803 USA

Abstract

As appendicular limb fractures in nondomestic ruminants are difficult to manage successfully, this study was commenced to investigate fracture repair methods and hopefully develop a set of recommendations for fracture fixation. The study methodology employed a retrospective examination of medical records involving appendicular limb fractures in any nondomestic ruminant species that is, or has been, housed at a participating facility. Five facilities (two academic institutions, three zoological parks) were chosen for inclusion in the study. Cases (n=49) consisted of at least 20 different species with a total of 62 fracture events. The majority of fracture events (n=36) had unrecorded/unknown etiologies, but transport, intra-specific trauma, and manual restraint were frequent causes in the remainder. Eighteen animals were immediately euthanatized due to poor prognosis. The remaining cases (n=31) were treated with amputations, stall rest, casts (normal and transfixation), external skeletal fixation [Type I and Type II – (normal and with IM pins)], IM pins only, and bone plates (normal and IM pin combinations). Hyperextension injuries, limb infections, and skin necrosis were seen in animals with either casts or bone plates applied. Subjectively, bone plates and casts had higher associations with fatalities, loss of a limb, and general postoperative complication rates than external skeletal fixation. In addition, bone plates and casts appeared to require multiple anesthesia events for managing complications compared to the external skeletal fixation repairs. Given the variation in species conformation, fracture classification, and case management, it is not possible to make definitive conclusions as to the optimal repair methodology without additional data.
LONG-TERM EVALUATION OF TELONICS® INTRAPERITONEAL RADIOTRANSMITTERS IN FREE-RANGING BROWN BEARS (Ursus arctos)

Jon M. Arnemo, DVM, PhD,1,2* Åsa Fahlman, DVM, VetMedLic,3,4 Knut Madslien, DVM,5 Sven Brunberg,6 Bjørnar Ytrehus, DVM, PhD,5 and Jon E. Swenson, PhD7

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Abstract

Intraperitoneal radiotransmitters (Telonics, Inc., Mesa, AZ, USA) were surgically implanted into 155 free-ranging, brown bears (Ursus arctos) from 1997 through 2006. The bears were anesthetized with medetomidine-tiletamine-zolazepam, and surgeries were carried out using a standardized protocol.1 Based on recommendations from the manufacturer, implants were disinfected by soaking in benzalkonium chloride prior to implantation.2-4

Implants were removed surgically from 28 bears after 3-9 yr. In 14 bears [mean 5.5 (range 3-9) yr after implantation] the implants were found free-floating. In 14 bears [5.7 (3-8) yr] the implants were encapsulated in the omentum and surrounded by 1-4 mm of connective tissue. In seven of these animals [6.0 (5-8) yr] the implants were encapsulated in and required amputation from an umbilicated and twisted loop of the omentum. Bacterial culture from the capsules and surface of the implants yielded no growth. Technical inspection (n = 26) showed signs of wear or discoloring of the wax on nine implants. Relative humidity inside the waterproof plexiglass cylinder was 5-20% and corrosion of the battery was seen in 18 implants.

Most biopsies from the capsules showed a moderate inflammatory reaction. However, a granulomatous inflammation in some capsules indicated a delayed-type hypersensitivity reaction. Aggregates of foamy macrophages filled with yellowish material may indicate that these cells phagocytose the wax covering the transmitters. Multiple hemorrhages in the capsules may have been caused by minor trauma from pendulous movements of the transmitter.

Contrary to advice from the manufacturer,1 we recommend that Telonics® intraperitoneal implants should be removed surgically prior to expiry of the batteries.
LITERATURE CITED

WILDLIFE BIOLOGISTS AND VETERINARIANS: NEED AND MECHANISMS FOR IMPROVED COLLABORATION

Michael Hutchins, PhD

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Abstract

Recently, there has been much attention given to the threat posed by diseases that can cross inter-species barriers and mutate into highly virulent forms. We have been deluged by stories on avian influenza, Ebola, chronic wasting disease, mad cow disease, monkey pox, drug-resistant tuberculosis and HIV-AIDS. However, we are just beginning to understand the complex interactions that occur between the disease organisms that affect wildlife, domestic animals and humans. Some threats are real, but they can also be sensationalized. Some can be managed and some not. This makes it essential that wildlife biologists and managers work together closely with the wildlife veterinary community to better understand, assess, monitor, and manage disease outbreaks when and if they occur. Both communities bring specialized knowledge to the table—the innovative combination of which is critical to finding workable solutions and to maintain the health of wildlife, domestic animals and humans. Biologist-managers bring their knowledge of wildlife social organization and behavior, demographics, genetics, nutrition, body condition, and population management, whereas veterinarians bring their knowledge of disease organisms, epidemiology, diagnosis, health and treatment. The purpose of this paper is to review why wildlife biologists and veterinarians need each other to effectively address the coming challenges. Various mechanisms for improved cooperation are also proposed.
PREDICTORS OF ANTIBIOTIC RESISTANCE IN APES AND EXOTIC FELIDS AT LINCOLN PARK ZOO

Michelle Madonia, MPH, 1* Susan Boyle-Vavra, PhD, 2 Robyn Barbiers, DVM, 1 and Dominic Travis, DVM, MS 1

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Abstract

Antibiotic resistance is an important issue in human and veterinary medicine because it can render many previously treatable diseases untreatable. In the United States and other developed countries, antibiotic resistance is increasing at an alarming rate, both in prevalence and also in the number of antibiotics affected. 2,6,9 Given this trend, it is crucial that practitioners be especially vigilant about how they administer many of the “last-resort” antibiotics, such as cephalosporins and fluoroquinolones, which are necessary to maintain control over disease. While antibiotic resistance has been well-documented in food and companion animals, thus far few studies of antibiotic resistance have been done in zoos. 5,7,8 In the few studies that have investigated antibiotic resistance in zoo animals, the prevalence of antibiotic resistance has been rather high. 1,3,4 The goal of this study was to investigate the association between the administration of cephalosporin and fluoroquinolone antibiotics to apes and exotic felids at Lincoln Park Zoo, and the risk of corresponding antibiotic resistance in their commensal enteric bacteria. It was hypothesized that animals administered antibiotics would be at higher risk for colonization by antibiotic resistant bacteria. In a cross-sectional design in 2004, fecal samples were collected from gorillas (Gorilla gorilla gorilla) (n=14) and exotic felids (Panthera leo krugeri, Uncia uncia, Leptailurus serval, Puma concolor californica, Panthera tigris altaica, Panthera pardus orientalis, Panthera pardus, Panthera pardus saxicolor, Acinonyx jubatus) (n=20) as soon after defecation as possible and shipped overnight on ice to Dr. Boyle-Vavra at the University of Chicago. There, samples were selectively plated to identify bacterial species, and commensal E. coli and Enterococci isolates were subjected to Vitek 2 (bioMerieux Inc.; 100 Rodolphe Street; Durham, NC 27712) susceptibility testing. Results were categorized as resistant, partially resistant, or susceptible. Odds ratios were calculated to compare antibiotic resistance between animals that were administered cephalosporins or fluoroquinolones over the past 10 yr and those that were not exposed to these antibiotics. Interestingly, 12.5% of gorillas and 22% of felids were found to have E. coli partially resistant to cephalosporins, while 10% of gorillas and 35% of felids were found to have Enterococci resistant to fluoroquinolones. Though not statistically significant, enrofloxacin use did predict increased fluoroquinolone resistance in ape Enterococci but not in felids. Cephalosporin use did not increase resistance in apes or felids. Behavioral and husbandry variables (dominance, gender, age, specific habitat, and being housed with other animals) were tested and did not predict bacterial resistance to cephalosporins or fluoroquinolones in either group.
ACKNOWLEDGMENTS

We would like to thank the Grant Health Care Foundation for funding this work, as well as the animal keeper staff at Lincoln Park Zoo for the collection of samples, and Drs. Jennifer Liang and Craig Miller and Mrs. Cecilia Simon for their considerable time and effort.

LITERATURE CITED

EFFECT OF COPPER OXIDE WIRE PARTICLES FOR CONTROLLING THE PARASITIC NEMATODE *Haemonchus* spp. IN GIRAFFE (*Giraffa camelopardalis*)

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Abstract

Gastrointestinal parasites, especially blood-feeding *Haemonchus* spp. nematodes, are extremely important in the care of grazing and browsing captive hoofstock species, as they have been linked to morbidity and mortality in facilities worldwide. Giraffe have been adversely affected by these parasites, especially in the Southeastern United States where environmental factors are optimal for parasite development and survival. Several issues confound parasite control in captive wild hoofstock species. Such issues include, but are not limited to, anthelmintic resistance by the parasites, animal compliance in administration of drugs, and the ability of facilities to monitor pre- and post-treatment fecal egg count (FEC) to verify effectiveness. The use of copper oxide wire particles (COWP, Copasure®, The Butler Company, Columbus, Ohio USA), a non-anthelmintic therapy, has demonstrated promising effect for controlling *Haemonchus contortus* in sheep.1,2 Toxicity can be an issue with sheep, but is rare in goats and cattle. Where wild hoofstock species fall in this toxicity scheme is unknown. Due to a high level of anthelmintic resistance, this study evaluated the effect of multiple doses of COWP in giraffe as an alternative. Doses ranging from 3.2-25 g per animal resulted in FEC reductions ranging from 27 to 95%. COWP were administered by mixing in loose feed or by capsules being incorporated into fruit. Results indicate that COWP can be used effectively to control *Haemonchus* spp. in giraffe, but potential toxicity should be monitored closely.

LITERATURE CITED

DOSAGE REQUIREMENTS FOR ORALLY ADMINISTERED PHENYL BUTAZONE IN AFRICAN AND ASIAN ELEPHANTS (Loxodonta africana and Elephas maximus)

Ursula Bechert, DVM, PhD¹* and J. Mark Christensen, PhD²

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Abstract

Phenylbutazone is a non-steroidal anti-inflammatory drug that works through inhibition of the arachidonic acid cascade to decrease production of prostaglandins and thromboxane. It has been used in elephants to treat inflammatory conditions like arthritis with empirical dosages ranging between 1-2 mg/kg every 24 hr. However, metabolic scaling calculations are unreliable due to the large difference in body size of elephants compared to other species, and potential negative side effects from use of phenylbutazone can include gastrointestinal ulceration and inhibition of T₄ to T₃ conversion. To determine safe and therapeutic dosing regimens for phenylbutazone in elephants, seventeen animals held in captivity in North America were used in this study.

Pharmacokinetic parameters of phenylbutazone were determined in ten African (Loxodonta africana) and seven Asian (Elephas maximus) elephants after single dose oral administrations of 2, 3 and 4 mg/kg doses as well as multiple dose administrations. There were significant differences in pharmacokinetic values between elephant species for clearance, terminal half-life, and mean residence time. For example, clearance for 2 mg/kg dosages was 27.9 versus 6.5 ml/hr/kg for African and Asian elephants, respectively, concurrent with mean residence times of 27.5 versus 66.4 hr. Asian elephants also showed a double peak in plasma concentrations versus time, suggesting entero-hepatic recycling of phenylbutazone in Asian but not African elephants. Different treatment regimens are recommended. Based on the results of this study, we recommend Asian elephants receive 3 mg/kg every 48 hr, and African elephants receive 2 mg/kg every 24 hr.

ACKNOWLEDGMENTS

We thank the elephant keepers and staff at the following organizations for collecting blood samples for this study: Kansas City Zoo, Riddle’s Elephant Sanctuary, the Bowmanville Zoo, Seneca Park Zoo, Wild Things, Inc., and Oregon Zoo. The Morris Animal Foundation provided funding for this research.
THE PHARMACOKINETICS OF ORALLY ADMINISTERED IVERMECTIN IN AFRICAN ELEPHANTS (Loxodonta africana): IMPLICATIONS FOR PARASITE ELIMINATION

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Abstract

Loxodonta africana are susceptible to a wide variety of parasites that are often treated with the broad spectrum antiparasitic ivermectin.1,6 The purpose of this study with African elephants was to (1) measure plasma ivermectin levels following administration of 0.1 mg/kg ivermectin p.o., (2) compare plasma ivermectin levels following administration with regular versus restricted feed rations, and (3) measure ivermectin excretion in feces. Using a cross-over design, six elephants were divided into two groups. Typical food rations were provided with ivermectin (Promectin E, Vedco, Inc., St. Joseph, MO 64507 USA) administration in the first group, and rations were withheld for 2 hr following administration in the second group. Blood and fecal samples were collected for 7 days following drug administration. After a 5-wk washout period, groups were switched and the procedure repeated. Plasma ivermectin was analyzed using HPLC (high-performance liquid chromatography). Combined results are presented in the table below, since there was no detectable difference in the pharmacokinetic data between the “fed” and “fasted” groups. Tmax demonstrated rapid absorption and was similar to parameters reported for horses.5 Cmax and MRT are substantially lower than values reported following 0.2 mg/kg p.o. dosing in horses5 and cattle.5 High ivermectin concentrations were excreted in feces, indicating substantial adsorption of ivermectin to particulate material in the digesta. This phenomenon is a significant factor modulating the oral ivermectin absorption process in ruminants.4 Although ivermectin may be effective for treating some infections in elephants at a dosage of 0.1 mg/kg, the resulting low plasma concentrations may affect the antiparasitic efficacy, particularly against ectoparasites. A dosage of 0.2-0.4 mg/kg p.o. would probably be more effective at eliminating dose-limiting parasites and may minimize development of parasite resistance. Further investigation into routes of administration such as topical would be beneficial.

ACKNOWLEDGMENTS

The authors would like to thank the Pittsburgh Zoo and PPG Aquarium Conservation Fund for support of this study.

LITERATURE CITED


**Table 1.** The pharmacokinetics of ivermectin following oral administration to African elephants.

<table>
<thead>
<tr>
<th></th>
<th>Plasma</th>
<th>Feces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cmax (ng/ml)a</td>
<td>7.2</td>
<td>1274.0</td>
</tr>
<tr>
<td>Tmax (days)b</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>AUC (ng*d/ml)c</td>
<td>18.75</td>
<td>1680.5</td>
</tr>
<tr>
<td>MRT (days)d</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>T ½ (days)e</td>
<td>3.65</td>
<td>1.0</td>
</tr>
</tbody>
</table>

aMaximum plasma concentration.
bTime to maximum plasma concentration.
cArea under the curve.
dMean residence time.
eElimination half-life.
PLASMA CONCENTRATIONS OF VORICONAZOLE IN HISPANOLIAN AMAZON PARROTS (Amazona ventralis)

David Sanchez-Migallon Guzman, Lic. en Vet,¹,* Keven Flammer, DVM, Dipl AVBP (Avian),²
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Abstract

Voriconazole (Vfend, Pfizer, Groton CT, USA) is a potent triazole antifungal agent that has a high in vitro activity against a wide variety of fungal pathogens including Aspergillus, Candida, and Cryptococcus spp.² The primary mode of action is the inhibition of fungal cytochrome P-450-mediated, 14 alpha-lanosterol demethylation, an essential step in fungal ergosterol biosynthesis.¹⁰ Voriconazole provides a therapeutic alternative to other antifungal drugs, especially in cases with Aspergillus spp. that are resistant to currently available therapy.⁵ The use of voriconazole in the treatment of aspergillosis has been reported in birds, but pharmacokinetic studies are limited.³,⁴,⁶-⁸ Comparison of plasma concentrations of different bird species indicates that there are prominent differences between some genera.⁷ The reported differences shows the necessity of specific studies for dosage recommendations in different species.⁷ To determine if a dose of voriconazole at 12 mg/kg in Hispanic Amazon parrots would achieve plasma concentrations exceeding the minimal inhibitory concentration for most strains of Aspergillus (0.4-0.5 µg/mL),¹⁹ we administered a single dose orally to a group of 15 birds. The birds were divided into 3 groups of 5 birds each. A single group was bled at each of the following points post drug administration: 0.5, 1, 2, 4, 6, 8, 12, 24, 32 and 48 h. Plasma samples were analyzed by high performance liquid chromatography (HPLC). The results indicated that at 12 mg/kg, voriconazole would need to be administered q 4-6 h. Voriconazole shows non-linear kinetics, and it is possible that a higher dose would prolong plasma concentrations. Studies investigating the safety of multiple dose administration are needed before accurate dosage recommendations can be made.

LITERATURE CITED


Abstract

This paper describes three cases of renal papillary necrosis (RPN) in Bengal tigers (Panthera tigris tigris) from different facilities that were previously treated with non steroidal anti-inflammatory drugs (NSAIDs) (Table 1).

Grossly, Case 1 had multiple gastric ulcers, yellow discoloration of the renal papillae and dehydration. In Case 2 the urinary bladder was filled with milky white urine and focal areas of necrosis were detected in the renal pelvis/medulla. In Case 3, the left kidney was firm and swollen and had black pigmentation of the pelvis.

Histologically, in all cases there was RPN. In Case 1 there was also renal tubulointerstitial and gastric mineralization. The kidney in Case 2 also had suppurative and necrotizing, tubulointerstitial nephritis in the medulla. Interestingly in Case 3, the renal lesion was unilateral and it was associated with infarction of the papillae.

In all cases the renal lesions are consistent with ischemia of the papillae associated with the use of NSAIDs in mammals and contributed significantly to the death of these tigers. However in Case 2 a bacterial etiology may be involved based on the presence of scattered gram-negative bacilli. Immunohistochemistry and Warthin-Starry stain were negative for leptospirosis. RPN can occur in humans and animals treated with NSAIDs as a result of inhibition of cyclooxygenase and synthesis of prostaglandins. It is common in horses with prolonged treatments with phenylbutazone or flunixin-meglumine.

Two of three tigers in this report were treated with flunixin meglumine. RPN has been previously documented in a tiger treated with this drug. The recommended dose for flunixin meglumine in cats is 0.25 mg/kg, although cats treated with 1 mg/kg during 7 days had no secondary/toxic renal or gastric effects in a study. In Case 1, five other tigers treated with the same protocol at the same time did not show any signs of disease. This suggests an individual, possibly genetic factor, may be implicated in this animal. Case 3 was treated with etodolac that has not been associated with renal disease previously; it has been used successfully in tigers with osteoarthritis but constant monitoring is recommended. Interestingly there was no clinical indication of renal insufficiency at any time in this animal. Based on these three cases and a
previous report of RPN in tigers, caution is recommended for the use of NSAIDs in felids, particularly tigers.

LITERATURE CITED

Table 1. Clinical history and treatment of three captive Bengal tigers (Panthera tigris tigris) with renal papillary necrosis.

<table>
<thead>
<tr>
<th>Case</th>
<th>Sex&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Motive of use of NSAIDs</th>
<th>Drug&lt;sup&gt;e&lt;/sup&gt;</th>
<th>Dose</th>
<th>Duration of treatment</th>
<th>Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (AS)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>F</td>
<td>2</td>
<td>82.5</td>
<td>Clinically healthy, treated with NSAIDs for minor surgical procedure</td>
<td>Flunixin meglumine (Finadyne®)</td>
<td>1 mg/kg</td>
<td>1 day (single dose)</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>2 (SFZ)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>M</td>
<td>16</td>
<td>173.7</td>
<td>Infected bite wounds, degenerative joint disease</td>
<td>Flunixin meglumine (Banamine®)</td>
<td>0.85 mg/kg</td>
<td>2 days (daily)</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>3 (BG)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>F</td>
<td>19</td>
<td>118</td>
<td>Vertebral osteoarthritis with medullar compression (two periods of treatment)</td>
<td>Etodolac (EtoGesic®)</td>
<td>5 mg/kg</td>
<td>7 days (with 3 days off)</td>
<td>Euthanasia</td>
</tr>
</tbody>
</table>

<sup>a</sup>AS = Africam Safari Zoo, México  
<sup>b</sup>SFZ = San Francisco Zoo, USA  
<sup>c</sup>BG = Busch Gardens, USA  
<sup>d</sup>F = female; M = male.  
<sup>e</sup>*Finadyne® (Schering Plough); Banamine® (Schering Plough); EtoGesic® (Fort Dodge).
ENVIRONMENTAL POLLUTION, BAMBOO, AND THE GIANT PANDA (*Ailuropoda melanoleuca*)

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Abstract

China’s burgeoning population and rapidly growing economy have produced an environment with potential to adversely affect health and welfare of humans and indigenous wildlife. The rise of industrialization, use of coal as a prime energy source, mining, smelting, sewage irrigation, and municipal sludge applications to soil are major contributors of pollutants. Two species of bamboo (*Chimnobambusa* sp. and *Pleiobastus* sp.) collected in the Wolong National Nature Reserve in Sichuan Province and shipped (with giant pandas) to the National Zoological Park (NZP) in Washington, DC had a black surface residue. Concerns that this residue might be harmful led to analyses (using the Association of Official Agricultural Chemist procedures) for cadmium (Cd), mercury (Hg), and lead (Pb). For comparison, four species of bamboo (yellow groove [*Phyllostachys aureosulcata*], bissetii [*Phyllostachys bissetii*], black [*Phyllostachys nigra*], and arrow [*Pseudosasa japonica*]), growing at the NZP, were cut about 50 cm above ground level (to minimize soil contamination) and analyzed for the same elements. Representative plants (at least three of each species) were separated into species composites of leaves, stems, and culms (only leaves and culms for arrow), and these plant parts were analyzed separately. Maximum tolerable mineral levels (MTLs) for animals, as defined by the National Research Council (NRC),³ vary with chemical form and solubility, animal species, composition of diet and water, and indices of toxicity. MTLs in dietary dry matter (DM) for chronic exposure range from 1 to 10 ppm for Cd, 1 to 2 ppm for Hg, and 0.5 to 45 ppm for Pb. Concentrations of Cd in DM of *Chimnobambusa* leaves, stems, and culms were 0.45, 0.40, and 0.25 ppm, respectively — higher than levels in all tissues of any other bamboo species except for *Pleiobastus* culms, which contained 0.27 ppm. Concentrations of Hg were higher in *Chimnobambusa* leaves (0.05 ppm) than in leaves of other species (0.03-0.04 ppm) but were <0.025 ppm in stems and culms of all species tested. Concentrations of Cd and Hg in all bamboo tissues were below their respective MTLs.

Concentrations of Pb in DM of leaves, stems, and culms of *Chimnobambusa* were 17,500, 6,630, and 2,950 ppm, respectively, and in *Pleiobastus* leaves, stems, and culms, 3,880, 5,060, and 439 ppm, respectively. Such high levels should be of concern if fed to giant pandas in China, but Pb concentrations in bamboo from NZP grounds also were higher than the NRC MTLs, ranging from 363-1,610 ppm in leaves, 132-574 ppm in stems, and 33-337 ppm in culms. The highest values were found in leaves of arrow and bissetii bamboo growing 6-23 m from a commissary and maintenance area with high vehicular traffic and where painting, welding, fueling, and
vehicle repair take place. To minimize dietary exposure of NZP pandas to heavy metals, bamboo for feeding is harvested largely from agricultural areas relatively remote from heavily traveled roadways. No reports of lead toxicosis in giant pandas have been found. However, ponies consuming grass hay grown in northern Idaho near a silver mine and a lead/zinc smelter, and contaminated with Pb and Cd (423 and 10.8 ppm as fed, respectively), exhibited declines in hematocrit, some Howell-Jolly bodies and nucleated erythrocytes in peripheral blood, weakness, and slight incoordination. These signs progressed to difficulty in prehension and swallowing and impaired muscle control of the lips and anal sphincter. Ultimately, periodic fine muscular tremors, severe incoordination, and esophageal paralysis were seen. These and additional toxicity signs, such as cardiovascular pathology, nephrotoxicity, altered immune function, decreased reproductive efficiency, and impaired bone growth and remodeling have been attributed to excess Pb exposure in other species.

Neurologically, lead blocks voltage-regulated calcium channels, thus inhibiting the influx of calcium that promotes release of neurotransmitters. It also competes with calcium for binding sites on receptor proteins that have secondary messenger functions, such as calmodulin and protein kinase C. Lead also competes with iron for ferritin-binding sites. A number of toxic mechanisms have been proposed, but lead’s ability to mimic the action of calcium has stimulated use of higher dietary calcium levels to decrease intestinal absorption of lead and to modulate its toxicity. Potentially important interactions of magnesium, zinc, selenium, vitamin E, vitamin C, and vitamin D with Pb absorption or metabolism have been reported.

ACKNOWLEDGMENTS

The authors wish to thank Lisa Stevens, B.S., Curator of Primates and Pandas at the National Zoological Park, Washington, DC for her assistance in obtaining the bamboo samples from China, and the volunteers from Friends of the National Zoo who helped with the extensive processing of samples in the laboratory.

LITERATURE CITED

SEA EAGLE (SYSTEMATIC ENVIRONMENTAL ASSESSMENT: EAGLES ASSESS GLOBAL & LOCAL ECOSYSTEMS): *Haliaeetus* AS BIOMONITORS OF AQUATIC ECOSYSTEM HEALTH WORLDWIDE

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Abstract

Eagles of the genus *Haliaeetus* are often referred to as fish or sea eagles because of what they eat and where they live. This close affiliation with aquatic ecosystems along with their large size and often vocal presence make them highly visible and vulnerable to competition for their preferred habitat and food source. They are also susceptible to the bioaccumulative effects of agricultural and industrial pollutants that end up in the water and increase in concentrations in consumers at all levels in the aquatic ecosystem, but have the greatest potential for deleterious effects at the level of this apex consumer. Their precarious position at the top of this complex food web has resulted in all eight of these species being threatened or endangered in at least part of their historic range while they are totally non-existent in many areas that once held numerous sea eagles. There are many programs and funded research projects trying to prevent the further decline and to facilitate the recovery of these impressive and charismatic species. *Haliaeetus* species seem nearly ideally suited as biomonitors of pollutants in the water and as indicators of the quality of the aquatic ecosystem in general. 3 The Swedish Society for Nature Conservation (SNF) undertook an investigation into the population status of white-tailed sea eagles (*H. albicilla*) in 1964 because of the alarming decline in populations of this once-numerous species all over Europe. In the early 1960’s, similar efforts were becoming organized in the Great Lakes ecosystem of North America because of similar declines in bald eagle (*H. leucocephalus*) populations. In 1971 the SNF launched “Project Sea Eagle” which helped organize various activities under two main headings: Monitoring and Research, and Conservation and Management. In 1985 the International Joint Commission designated the bald eagle as the indicator species for water quality in the Great Lakes basin of North America, 4 and the Department of Environmental Quality for the State of Michigan, USA started using bald eagles as a biomonitor for surface water quality and to assess safety of fish consumption by humans in Michigan watersheds. In 1989 the white-tailed sea eagle was chosen as an indicator of effects
from chemical pollutants and of environmental health in the Swedish Baltic Coast environment. Monitoring of breeding populations was integrated in the national Swedish Environmental Monitoring Programme (SEMP) under the Swedish Environmental Protection Agency (SEPA), which is currently working on a multifaceted national species action plan which also focuses on causes of mortality and productivity.

Much of these early efforts with *H. albicilli* and *H. leucocephalus* went into banding of young in successful nests and evaluating productivity, although eggshells, addled (unhatched) eggs and dead birds were examined. DDE and other metabolites of DDT along with PCBs (polychlorinated biphenyls) were determined to be the main contaminants responsible for population declines. In Michigan, specific toxic reference values were developed by combining concentration data from eggs and blood with reproductive outcome data. Studies showed that bald eagles nesting in coastal areas adjacent to the polluted Great Lakes averaged fewer fledged young per nest than birds nesting on rivers away from the coast, while birds nesting on large rivers eating anadromous fish from the Great Lakes had productivity levels somewhere in between. Blood samples were drawn from nestlings to check for contaminants, and these cause-effect relationships have been proven and critical effect levels have been determined. As populations of bald eagles recover, and they resume nesting in most of their historic range, they are even more useful as biomonitors. They can be used to monitor success of cleanup efforts of known contaminants as well as sentinels for emerging problems with contaminants and diseases.

Many countries have been monitoring and protecting *Haliaeetus* species for a long time. There are many success stories of recovered populations as well as continued and emerging problems in some species. A major conference, SEA EAGLE 2000, brought many researchers together while celebrating the 30th anniversary of the Swedish Sea Eagle Project. The extent of interest in *Haliaeetus* species worldwide, along with the excellent book of published proceedings helped stimulate the formal organization of SEA EAGLE (Systematic Environmental Assessment: Eagles Assess Global & Local Ecosystems) with Michigan researchers organizing initial efforts.

Techniques developed by many researchers handling and sampling bald eagles in Michigan and white-tailed sea eagles in Sweden have proven to be transferable to other *Haliaeetus* species such as the African fish eagle (*H. vocifer*) in Uganda and South Africa and Steller’s sea eagle (*H. pelagicus*) in the Russian Far East.

The goal of SEA EAGLE is to share technology and train people to develop local programs to assure the stability and recovery of all *Haliaeetus* species worldwide while using them as biomonitors of environmental health. Another goal is to use them and their plight to educate the public on the many and varied influences of human activity that can be understood by research and modified to allow successful recovery and management of these magnificent birds for present and future generations to enjoy. Zoos certainly have an important role in this process of education and appreciation of these species as well as the potential to help raise funds for these management and recovery activities by the judicious use of these charismatic birds in appropriate exhibits.
LITERATURE CITED


Abstract

Dr. Dalen Agnew is a work in progress. Raised on a horse farm in rural Michigan where snakes were killed on sight not conserved, history and animals were his main interests – one had to stay a hobby while the other became a career. At first, he studied Russian and Soviet politics, but after 2 yr, it became clear that a career with animals would be more fulfilling. (With the subsequent demise of the Soviet Union, this turned out to be a shrewd career move). After attending veterinary school with the intention of becoming a horse vet, he fell into a job at the Detroit Zoo (as a colleague so aptly put it – “nothing beats dumb luck”). Clinical medicine was ultimately unsatisfying, however, since there were never very many answers or hard data, just empirical doses and anecdotal evidence. Pathology provided more answers, yet still allowed ample interaction and impact with the conservation and zoo community. Another unexpected positive attribute of a pathology career is a more predictable schedule and more time for family. During a pathology residency and graduate program, Dr. Agnew and his wife of 14 yr had two children and are currently incubating a third. Now on the pathology faculty at Michigan State University, he and his family anticipate staying put for the foreseeable future, while maintaining a small backyard farm with horses, chickens, a dog, family dinners, snakes in the grass, and lots of good books about history.

Along the way, several aphorisms have guided his thinking towards not just survival (ultimately we can expect to lose this struggle), but thriving.

Working on the farm, he learned to “study the lazy man’s actions – they are models of efficiency.” You don’t need to be lazy, but by working efficiently, you can lead a more satisfying life.

Working in a zoo and watching valued colleagues quit or get fired, he learned “No one is indispensable”. Never take your job so seriously that you think you are the only one who can do it. You may be the only one who is doing it, but others will step up to the plate if you do not. The caveat to this rule is that you are indispensable to your family and children.

If you love your work, your home-life and work-life will mix. That’s OK, but don’t lose track of your priorities and save some time for just yourself and your family. Dr. Agnew’s first mentor (his father) always said: “Never go on vacation for less than 3 wk, otherwise they’ll just save stuff for you in your in-box.” Make sure you vacation for at least 3 wk!
And finally, another mentor, Dr. Linda Munson, provided the following chart (Fig. 1, borrowed and refined from Steven Covey’s *Seven Habits of Highly Effective People*) to help prioritize the many tasks that arise every day. Every time someone calls with a new project, put it in one of these boxes and prioritize it accordingly.

**Figure 1.** Prioritizing tasks.

```
<table>
<thead>
<tr>
<th>Important - Urgent</th>
<th>Important - Not Urgent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Important - Urgent</td>
<td>Not Important - Not Urgent</td>
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</tbody>
</table>
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AUTOBIOGRAPHY FOR PAUL CALLE

Paul P. Calle, VMD, Dipl ACZM

Wildlife Conservation Society, 2300 Southern Blvd, Bronx, NY 10460-1090 USA

Abstract

Dr. Paul P. Calle graduated from the University of Pennsylvania, School of Veterinary Medicine in 1983, completed a 1-yr internship in Small Animal Medicine and Surgery at the Animal Medical Center in New York City, followed by a 1-yr internship in Zoological Medicine and Surgery at the San Diego Zoo. He was staff veterinarian at the Cheyenne Mountain Zoo in Colorado Springs for 4 yr until accepting a position as veterinarian with the Wildlife Conservation Society (WCS) where he is currently a Senior Veterinarian. Dr. Calle is based at the Bronx Zoo, has primary responsibility for the health care of the animal collections at the New York Aquarium, Central Park Zoo, Queens Zoo, and Prospect Park Zoo, and shares clinical responsibility for the health care of the Bronx Zoo animal collections. In addition to clinical practice at these parks, he has traveled in support of WCS international field conservation projects. Dr. Calle is a Diplomate in the American College of Zoological Medicine. He is still married (to the same woman) after 23 yr and three children (two daughters in college and a son in high school) and lives in Danbury, Connecticut.
ARE OUR PROFESSIONAL EXPECTATIONS FOR CAPTIVE AND FREE-RANGING WILDLIFE VETERINARIANS ELIMINATING THE POSSIBILITY FOR HEALTHY WORK-LIFE BALANCE?

Jonna Mazet, DVM, MPVM, PhD

Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, Life Health Center, 1 Shields Avenue Davis, CA 95616 USA

Abstract

Today’s zoo veterinarian is a new type of transdisciplinary professional; they practice medicine in their communities and hold titles in every level of government and academia. The field of zoological medicine has seen an expansive broadening into the arenas of public education, conservation medicine, and ecosystem health. With this change, we have seen an ever higher bar being set for the skill sets expected of veterinarians. To succeed today, wildlife veterinarians need to be knowledgeable about more than the physiology of animals; he/she has to have a basic understanding of the natural history, niche, behavior, nutrition, and disease of all of the species potentially under his/her care. In addition, these veterinarians must have everyday common sense, non-technical skills, a general awareness of how the world works, and recognition that how we choose to live our lives impacts the environments in which we live. Are these expectations for an all-knowing and ever capable veterinarian compatible with work-life balance? Can we attain professional excellence without losing ourselves? Why do we want this zoological medicine career if it possibly eliminates our chances for personal happiness and financial security? As a community, we have the power to enable each other and adjust expectations without compromising excellence.

Autobiography

Jonna Mazet is a wife and mother of two teenaged daughters, as well as a Professor and Director of the Wildlife Health Center in the School of Veterinary Medicine, University of California, Davis. She is a wildlife epidemiologist active in investigating ecosystem health problems involving the interactions of wildlife, domestic animals, and humans. She teaches Conservation Biology, Epidemiology, and Policy and Communication in the veterinary and MPVM curricula at UC Davis and mentors wildlife conservation graduate students.
AUTOBIOGRAPHY FOR MARK A. MITCHELL

Mark A. Mitchell, DVM, MS, PhD

University of Illinois, College of Veterinary Medicine, Dept VCM, 1008 W. Hazelwood, Urbana, IL 61802 USA

Abstract

Dr. Mitchell received his D.V.M. in 1992 from the University of Illinois, and an M.S. in clinical epidemiology with an emphasis on wildlife medicine from the same institution in 1997. He completed his Ph.D. in clinical wildlife epidemiology with an emphasis on Salmonella in reptiles at Louisiana State University in 2001. From 1996-2007, Dr. Mitchell was a member of the Zoological Medicine faculty at Louisiana State University. In February 2007, Dr. Mitchell moved to be closer to family, and is currently an associate professor in Zoological Medicine and Surgery at the University of Illinois. Although he has had the opportunity to travel extensively and pursue many of the things he dreamed of as a child, his greatest pleasures come from spending time with his wife, Lorrie, and adopted daughter, Mary Yansung, and teaching Mary, a 14-mo-old, the International Codes of Zoological Nomenclature while his wife asks him to “not screw up this poor child.”
AUTOBIOGRAPHY FOR HAYLEY MURPHY

Hayley Murphy, DVM

Zoo New England 1 Franklin Park Road, Boston, MA 02121 USA

Abstract

Hayley graduated from Cornell University College of Veterinary Medicine in 1992. Before that she was a licensed veterinary technician at Cornell College of Veterinary Medicine. Upon graduation, Hayley worked for 3 yr in a crazy-busy, small animal and equine practice and volunteered at Roger Williams Park Zoo in Providence, RI. Hayley then became consulting veterinarian for Capron Park Zoo in Attleborough, MA while still working full time in private practice.

In 1995, she took an internship in zoo medicine at the Commonwealth Zoological Corporation (now Zoo New England) in Boston, MA where she has been for the last 12 yr.

Hayley is married to a small animal veterinarian, Dave, and has two children; Grace who is 7 yr, and Peter who is 5 yr. Pets: a geriatric bull mastiff (Bobo); a pug (Norman), a cat (Nicolas), fish and sea monkeys! Plants- 20 potted bonsai in training (her husband’s passion).

Hayley’s views on life balance are short and sweet:
1: You don’t realize you are out of balance until you achieve it- then it is hard to function without it.
2. Everyone’s idea of balance is very different- don’t judge.
3. It is easy to slip out of balance- but it’s not the end of the world- you just have to get it back.

When she feels like she is losing her perspective / balance, she tries to think of these things:
1. Try to spend time with and enjoy the people that you love.
2. Remember: Life is the “dash” and fill it with good times and people you want to be with. (The dash is the space between the date of your birth and the date of your death on your tombstone.)
3. Keep perspective- VERY IMPORTANT. The world doesn’t begin and end at the zoo!
4. Keep shaping your life like a pie- with different aspects filling in as slices. Try to have a lot of these slices (work, hobbies, friends, family etc), so if one slice disappears, it is still pretty full.
5. Stay away from negative energy (your own or others).
AUTOBIOGRAPHY FOR ELIZABETH STRAND

Elizabeth B. Strand, PhD, LCSW

University of Tennessee College of Veterinary Medicine, College of Social Work. 2407 River Drive, Rm A205 Knoxville, TN 37996-4543 USA

Abstract

Dr. Elizabeth B. Strand is the founding director of Veterinary Social Work at the University of Tennessee, College of Veterinary Medicine. She holds a Bachelor of Arts in Religion with an emphasis in Latin, a Masters of Science in Social Work, and a Doctor of Philosophy in Social Work. Dr. Strand is a licensed clinical social worker, a Certified Supreme Court Rule 31 Mediator, a grief recovery and compassion fatigue specialist, as well as a Mindfulness-Based Stress Reduction Teacher. Dr. Strand teaches communication skills and conflict management skills to families as a family therapist, in academic settings as a professor, and in organizations, as an internal social work consultant for veterinary medical teams.

To instill and nurture work life balance Dr. Strand encourages two principles. The first is to learn the skill of listening to other people and in turn avoid wasting time on unnecessary, preventable conflict. The second is to "fill your cup" everyday with something healthful for your body and mind and generally give to people from your saucer instead of your cup. Every now and then you must dip into the cup when it is really busy or someone really needs you, but this should be the exception rather than the rule.
Autobiography for Cynthia E. Stringfield

Cynthia E. Stringfield, DVM

Moorpark College, Department of Exotic Animal Training and Management, America's Teaching Zoo, 7075 Campus Road, Moorpark, CA 93021 USA

Abstract

Dr. Cynthia Stringfield graduated from UC Davis School of Veterinary Medicine in 1990 and completed an internship in Small Animal Surgery and Emergency Medicine at California Animal Hospital in 1991. She was an associate in small/to exotic animal practice for 3 yr before her career at the Los Angeles Zoo which spanned 10 yr. At Los Angeles, she was the primary veterinarian involved in the design and construction of the zoo’s $15-million Animal Health Center, and was involved in significant expansion of the zoo’s veterinary program, ending her time there as Chief Veterinarian. Additionally, she has been the California Condor Veterinary Coordinator for 13 yr, a member of the USFWS California Condor Recovery Team for 6 yr, and also serves as SSP veterinarian for this species. Currently, she is in her third year of tenure as a professor in the Exotic Animal Training and Management program, and serves as staff veterinarian for the 150 animals at the college’s teaching zoo.

Cynthia Stringfield has a son, Jakob, and daughter, Isabella, now 11 and 7, for whom she is the primary caregiver. She is divorced and currently shares her home and life in Simi Valley with her children, her partner of 3 yr and often his two children, two dachshunds (one of which has Addison’s disease and recurring generalized demodecosis), two rabbits, a kingsnake, a bearded dragon, and three Betta fish.
RUB A DUB DUB: IMPROVEMENTS IN WASHING METHODS FOR SEA OTTERS

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Abstract

The primary means of removing oil from sea otters (Enhydra lutris) is washing them in dilute detergent with prolonged rinsing in warm water, forced air drying, and recovery with variable access to sea water. Sea otter body temperatures normally vary over a range of at least 2 °C; however, both hypo- and hyperthermia have been problems previously observed when otters are captured, anesthetized and washed. Male southern sea otters deemed non releasable by US Fish and Wildlife Service were obtained and trained for medical and sampling behaviors, equipped with temperature monitoring devices, and washed in the same manner as they would be if oiled. A reductionist approach was used to try and isolate the effects of each stage in the washing procedures. Anesthesia alone resulted in a modest core temperature elevation. Temperature of rinse water (27 °C and 32 °C tested) made little difference in the rate of core body temperature loss, but did influence the depth of temperature depression. Otters exhibited significant behavioral changes after washing, primarily greatly increased grooming and time out of water. By providing washed sea otters with access to warmed or ambient temperature soft fresh water, very significant improvements were seen in otters’ grooming behaviors, core body temperature stability, subcutaneous temperature stability, return of coat insulating patterns as measured by visual and infrared imaging, as well as reduced caloric requirements to maintain base body weight. These improvements resulted in an approximately 50% reduction in the time required for recovery to a defined normal baseline. Based on electron micrographic imaging of river otter pelts it appears that scales and shafts of the hair form interlocking water tight plates that trap air against the skin and keep water out. Physical interlocking and electrostatic forces are believed to help hold these plates together and it appears that salt crystals and soap scum left on sea otter underfur hairs using previously accepted washing methods interfere with this. It appears that several simple and relatively inexpensive improvements in methods used to wash sea otters could greatly reduce the time required for recovery, thus the stress, labor and expense associated with washing oiled sea otters. This could also improve recovery and survival of oiled free-ranging sea otters and reduce costs, a source of some controversy, in the event another catastrophic oil spill occurs in coastal waters of Eastern Siberia, Alaska, the Pacific Northwest or California that support sea otter populations. Major oil extraction, shipping, transit and refinery operations occur and are planned for these areas, and the western Alaskan and California sea otter populations are listed as threatened under the Endangered Species Act of 1973.
LITERATURE CITED

UPDATE ON RED TIDE IN THE FLORIDA MANATEE (*Trichechus manatus latirostris*)

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Abstract

The indigenous neurotoxic red tide dinoflagellate, *Karenia brevis*, is a constant threat to manatee (*Trichechus manatus latirostris*) survival, particularly in southwest Florida. Since 1996, more than 500 manatee deaths and 33 manatee rescues have been attributed to red tide. Sporadic cases of brevetoxicosis can be diagnosed any time of the year; however, when a bloom coincides with manatee migration from warm-water sites, mass mortality may occur. Also, long after or remote from a bloom, ingestion of seagrass with accumulated brevetoxins can lead to mass mortality. Today, no feasible management actions exist to mitigate manatee exposure to red tide. Manatees with acute brevetoxicosis demonstrate neurologic symptoms, including tremors, seizures, paresis, and paralysis. Emergency response is critical to prevent affected manatees from drowning, and once rescued, most animals are successfully rehabilitated. However, the majority of manatees with brevetoxicosis are found dead. Pathologic findings are non-specific, and include congestion of airways and meninges, as well as copious amounts of blood on sections of liver, kidneys, and lungs. Since 2002, the quantification of brevetoxins using a competitive enzyme-linked immunosorbent assay has greatly enhanced diagnosis. Diagnosis is based on gross findings, brevetoxin concentrations in tissues and ingesta, and in environmental samples such as water, sediment, and seagrass. However, despite advances in the diagnosis of acute brevetoxicosis, little is really known about mechanisms of brevetoxin pathophysiology in manatees and chronic effects on health. Continuing research on samples from manatees exposed to brevetoxins, including carcasses and rescued manatees, is important to better understand the epidemiology and pathogenesis of this significant cause of manatee mortality.
IMPACTS OF LOGGING ACTIVITIES IN THE BOREAL FOREST ON THE HEALTH OF THE AMERICAN MARTEN (Martes americana)

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Abstract

A total of 154 live-trapped American martens (Martes americana) were examined under general anesthesia using isoflurane as part of a program to evaluate the impact of different logging strategies in the boreal forest of Quebec. Body condition indexes (weight/length), hematologic profiles and levels of parasitism were assessed and correlated with the percentages of residual forest and logged surface in a 1-km radius around each capture site, using Chi-square test as well as linear and logistic regressions. A weak, but statistically significant, association ($P = 0.04$) existed between body condition and the percentage of area logged, which suggests a possible impact of logging on the energy intake and expenditure of this species. No association between hematologic profiles and habitat indexes was noted. Indications of chronic poor condition such as anemia and dehydration were not related to the environmental indices evaluated. A significant positive relationship was shown between the neutrophil:lymphocyte ratio and the time of day at which the blood sample was taken. This change in the inflammatory cell populations, which is probably consecutive to the stress associated with the length of confinement in the trap, has therefore little value in the evaluation of chronic environmental stress. No association between the prevalence of the different fecal parasites and the habitat indices was observed. Martens in which ear parasites were detected were captured in areas with statistically lower percentage of logged surface than unaffected martens. This difference in levels of parasitism may be associated with a reduced density of this species of mustelid as logging pressure increases.
POST-RELEASE MORTALITY OF REINTRODUCED MIGRATORY WHOOPING CRANES (Grus americana) IN THE EASTERN UNITED STATES

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Abstract

In 2001, a public-private partnership began to reintroduce migratory whooping cranes (Grus americana) in the eastern United States. Cranes were costume-reared and released using one of two techniques; ultra-light aircraft-guided fall migration or direct release prior to fall migration. For the first 5 yr (2001-2006), mortalities in this population (both aircraft guided and direct release birds) were documented by intensive post-release monitoring using radio and satellite telemetry. Postmortem evaluation performed on all carcasses included gross examination (forensic examination was performed when heavy metal density was detected radiographically), histopathology, and other diagnostic procedures (bacteriology, virology, parasitology, and toxicology). Choice of ancillary diagnostic tests performed was partly based on the state of decomposition and volume of remains. There were 17 mortalities of 80 released cranes (21% mortality). Known or presumed causes of death included predation (n = 7), trauma (n = 6), non-infectious disease (n = 1), and unknown (n = 3). Contributory factors, such as poor roosting habitat, intraspecific aggression, waterfowl hunting, human constructions (power lines, fences), or gunshot injury, were considered. Each of these factors was found to be significant in at least one, if not several of the mortalities of this population. Despite the intensive monitoring of all birds, pathologic examination was often limited by some degree of postmortem decomposition or scavenging. The causes of death in this migratory population were of similar proportions when compared to a non-migratory flock of whooping cranes (Florida, USA).
POTENTIAL IMPACT OF COMMON FELINE DISEASES ON ENDANGERED OCELOTS IN SOUTHERN TEXAS

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Abstract

Currently, there are less than 100 wild ocelots (Leopardus pardalis) in the United States, all located in southern Texas. We investigated the impact that several feline common diseases could have on an isolated subpopulation of ocelots over a 100-yr period using population viability analysis (PVA) via the VORTEX computer program. Serology was performed on seven serum samples from free-ranging ocelots on the privately-owned Yturria Ranch. Samples were gravity-separated, immediately frozen, and later thawed. Serology was performed at Cornell’s Animal Health Diagnostic Center (College of Veterinary Medicine, Cornell University, Ithaca, New York) to determine the presence of antibodies to: feline leukemia virus (FeLV), feline immunodeficiency virus (FIV), feline infectious peritonitis (FIP), and feline parvovirus (FPV). Five ocelots were FPV-positive; two were FIV-positive; one was FIV- and FPV-positive. None were positive for FIP or FeLV, and one was negative for all four viruses. Results aided in developing parameters for PVAs that estimated disease impacts on this subpopulation over the next 100 yr. Viewed as an isolated subpopulation, the control PVA resulted in this subpopulation becoming extinct within 50-60 yr. With disease included in the PVAs, the prediction was extirpation 10-20 yr sooner (FeLV, FIP, and FeLV combined with FIV scenarios) or 20-30 yr sooner (FIV, FPV scenarios). The percent chance of infection varied from 0.5%-70.0%, and even at 0.5%, the life expectancy of this subpopulation was reduced by up to 20 yr. Follow-up studies should include health monitoring of these ocelots to determine if these infections have any effects on this subpopulation. Results of this study also indicate that infectious diseases need to be included in any future conservation strategies developed.
RISK EVALUATION FOR THE ACQUISITION OF EQUINE PIROPLASMOSIS IN PRZEWALSKI’S HORSES DURING REINTRODUCTION USING MATHEMATICAL TRANSMISSION MODELS

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Abstract

Equine piroplasmoses, caused by Theileria equi and Babesia caballi, have been identified as presumptive causes of mortality in newly reintroduced Przewalski’s horses (Equus ferus przewalskii) in the Dzungarian Gobi (Mongolia). To quantify the risk of infection for these horses, the parasites’ epidemiology was investigated in the local domestic horse population. The prevalences of the two pathogens were determined in 510 domestic horses in the reintroduction area by indirect immunofluorescence antibody test (IFAT) and multiplex polymerase chain reaction (PCR). The data were analysed by fitting four non-linear mathematic transmission models to the field data with the Maximum Likelihood method to determine the transmission parameters and selecting the best fitting model by conducting a Monte Carlo simulation study. Each of the models used different assumptions: (1) passive, maternal immunity or acquired immunity to the protozoa did not influence transmission dynamics; (2) maternal immunity had a different effect on transmission than acquired immunity which was again different to transmission in naïve animals; (3) maternal and acquired immunity had the same effect which was different in naïve animals; and (4) maternally protected animals were infected equally to naïve animals, but acquired immunity affected transmission differently. For the data for T. equi, model (1) fitted best which indicated that antibodies had no significant influence on the infection dynamics of T. equi. The maximum likelihood estimates of the parameters indicated that infection was expected 2¼ yrs after first exposure and then persisted lifelong. For B. caballi, model (2) performed best, and the infection rates suggested that foals from immune dams were expected to be infected at 4 mo of age, naïve animals were expected to be infected 12 yr after exposure, whereas immune animals were unlikely to be re-infected. The parasites were eliminated after approximately 2 yr. Because geographic causes could be excluded, the association of maternal and filial infections suggested that the risk for infection had a strong behavioral component. Thus, under certain circumstances, Przewalski’s horses are expected to become infected within 4 mo after arrival, whereas others will not acquire the infection for as long as 12 yr. Because the outbreak of clinical babesiosis can be related to the general immune status of a horse, which is suppressed by stress, a preventive treatment with imidocarb-dipropionate (1.5-3 mg/kg i.m. delivered by remote injection; Carbesia®, Pitman-Moore, Meaux, France) is being administered upon their arrival at the reintroduction site. Assuming similar transmission dynamics in Przewalski’s horses as in domestic horses, this will protect the animals with high risk behavior during the stressful reintroduction period for approximately 3 wk. However, when the drug level wears off, the animals with low risk behavior will not have been
infected with *B. caballi*, and only a few animals will have been infected with *T. equi*. Thus, further infections and clinical cases of piroplasmosis are to be expected after the animals have been released into the field.
DEVELOPING AN INTEGRATED IN SITU/EX SITU CLOUDED LEOPARD CONSERVATION PROGRAM IN THAILAND

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Abstract

The clouded leopard (Neofelis nebulosa) is one of the most charismatic and least understood of Asia’s many beautiful cat species. Little is known about the behavior or status of this shy and elusive cat in the wild. Rampant habitat loss and fragmentation throughout the clouded leopard’s forest habitat in Southeast Asia and active poaching of clouded leopards are causing a decline in their already uncertain population. Breeding clouded leopards in zoos has been a challenge world-wide, primarily due to male aggression, decreased breeding activity between paired animals, and high cub mortality. The Thailand zoos maintain a large population of genetically valuable, wild-born clouded leopards; however, health and reproduction were compromised due to poor husbandry, imbalanced diets and inadequate enclosures. To address these challenges, the Smithsonian’s National Zoological Park began working in partnership with the Zoological Park Organization of Thailand, the Nashville Zoo and the Clouded Leopard Species Survival Plan (SSP) to develop a multi-faceted clouded leopard breeding program in Thai zoos focused on improving husbandry, nutrition, veterinary medicine and reproduction. Since 2002, 22 clouded leopard cubs have been born, and two cubs have been imported to the USA for genetic augmentation of the North American clouded leopard SSP population. The Smithsonian’s National Zoo also has been working with the Thailand Department of National Parks, Wildlife and Plant Conservation and the non-profit organization WildAid Foundation to assess the numbers of clouded leopards and other carnivores living in nature. In 2003, the Dong Phayayen-Khao Yai Carnivore Conservation Project was established to provide continuous monitoring of carnivores in Khao Yai National Park. A major component of this project was the training of Thai forest rangers to monitor wild carnivores and prevent poaching in the parks. From 2003 through 2006, camera traps were deployed for a total of 6,172 camera trap nights at 215 camera trap locations. Camera traps recorded a total of 906 animal captures with 14 unique carnivore species, including the clouded leopard. A high concentration of poaching activity also was observed, and data were provided to the park management staff. Overall, these international and collaborative breeding programs and field monitoring projects for clouded leopards will serve as a model for conservation programs in Thailand, Southeast Asia and throughout the world.
DETERMINING THE SIGNIFICANCE OF A TREPONEMA-LIKE ORGANISM ISOLATED FROM AUSTRALIA’S MOST CRITICALLY ENDANGERED MAMMAL, THE GILBERT’S POTOROO (Potorous gilbertii)

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Abstract

The Gilbert’s potoroo (Potorous gilbertii) is Australia’s most critically endangered mammal with an estimated population of less than 30 individuals. There has been a long history of balanoposthitis (inflammation of the penis and prepuce) in individuals from both wild and captive populations of this species. Clinically, this is evident as crusty green tenacious preputial exudates with associated ulceration. Bacteriologic examination has revealed a number of potential pathogens amongst the mixed bacteria isolated. The most significant is a Treponema-like organism. Sequencing results from these spirochetes identified a 164 nucleotide segment of 16S ribosomal RNA, which had 92% similarity to Treponema species. Prevalence of infection with the Treponema-like organism was 17/26 (65.38%).

Tissue biopsy for culture, silver staining, and histopathology revealed a chronic inflammatory response with secondary epithelial hyperplasia in conjunction with moderate numbers of spirochetes strongly suggesting a causative relationship. Numerous coccobacilli were also found. These were from the Actinobacillus/Pasteurella group identified by partial 16S rRNA sequencing. Epidemiologic studies involved relating the nature and severity of the discharge and the subsequent identification of spirochetes (via dark field microscopy and via urogenital swabbing for PCR) to sex affected, time of year, age of animal and geographic location. These studies revealed a higher prevalence in males; however, there was no difference in prevalence between seasons or by geographic location.

This infection appears to play a highly significant role in the recovery program of the critically endangered Gilbert’s potoroo given the severity of balanoposthitis and reproductive dysfunction that is especially evident in the reproductively quiescent captive population.

LITERATURE CITED

AN INTERACTIVE PRIMATE NECROPSY TRAINING MANUAL FOR FIELD PERSONNEL

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Abstract

Health surveillance of wildlife populations is invariably difficult because of problems in obtaining useful biologic samples. Information gained from serosurveys and parasite screens are important tools to determine the prevalence of specific pathogens and assess population health. However, the actual risks posed by specific pathogens may not be ascertained by these methods. Necropsies can be used not only to determine the cause of an individual mortality, but to determine whether exposure to a specific pathogen or toxin impacts the health of a population. Given logistic difficulties, trained veterinarians are not always available when a mortality event occurs at many field sites. Therefore, it is important to have trained personnel available on-site that can perform necropsies safely yet completely. Towards this goal, we developed a step-by-step primate necropsy guide with drawings, photographs, and an accompanying interactive CD-ROM. All materials will be translated into Swahili and French but also have been designed for use by personnel with limited reading capabilities. The CD-ROM includes an animated necropsy and topics pertinent to the primate necropsy such as appropriate personal protection. Training materials were tested at a January 2007 Primate Necropsy Training Workshop held in Tanzania and attended by veterinarians, park wardens, ecologists and field assistants with varying experience in necropsy technique. Usefulness of training materials was assessed by a post-workshop survey. Irrespective of training and background, all participants found the materials to be useful and participants provided critical feedback to improve the training materials. These suggestions have been incorporated and materials will be made available, at no cost, to organizations working in primate conservation.

ACKNOWLEDGMENTS

The necropsy workshop was sponsored by the Lester E. Fisher Center for the Study of Conservation of Apes at Lincoln Park Zoo in collaboration with Tanzania National Parks (TANAPA), Tanzania Wildlife Research Institute, Jane Goodall Institute and the University of Illinois Zoological Pathology Program. Production of the final training materials was sponsored by an AAZV Mazuri Fund grant.
QUESTIONNAIRE SURVEY OF WILDLIFE BIOLOGISTS TO DETERMINE PERCEPTIONS OF VETERINARY CONTRIBUTIONS TO WILDLIFE MANAGEMENT AND CONSERVATION

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Abstract

There are increasing opportunities for the emergence and resurgence of diseases at the human, domestic animal and wildlife interface as a result of many human activities. These diseases are an increasing threat to public health, domestic livestock, the conservation of natural resources, and the economy. As a consequence, there is an urgent need for veterinarians to work as part of multi-disciplinary wildlife health teams to increase capacity to address wildlife health issues and mitigate or minimize the negative effects of these emerging diseases. The goal of this study was to determine how the zoo and wildlife veterinary community can improve assistance to wildlife biologists and more effectively contribute to wildlife health management and conservation. This was achieved by surveying wildlife biologists’ perceptions of veterinarians working in wildlife conservation and opinions on how veterinarians can contribute, as well as enquiring about wildlife biologists’ past experiences working with veterinarians.

A six-question, two-page questionnaire was sent to the members of the Virginia Chapter of The Wildlife Society (n = 146) and the Western Section of The Wildlife Society (n = 1031) via email in August, 2006. Fifty-three questionnaires were returned which resulted in a 4.5% return rate. Data were entered into an Excel spreadsheet (Microsoft Excel 2003, Redmond, WA 98052) and analyzed using SPSS statistical package (SPSS Inc., Chicago, IL 60606). The majority of biologists worked for a public institution (56.9%), whereas 35.3% worked for a private organization, and 7.8% worked for both. When asked about veterinarians’ knowledge of wildlife management, experience with working with wildlife, and training in population health, there was a general perception that veterinarians lacked these attributes (Table 1). In addition, there was a perception that veterinarians focused mostly on treating individual animals and were not available to assist with in situ conservation projects. However, there was a recognition that veterinarians could contribute to wildlife anesthesia, research, pathology/diagnostic services, disease surveillance and animal welfare (Table 2). In contrast, biologists felt that veterinarians did not have a useful role in conservation policy and regulations.

In general, veterinarians appeared to be under utilized by wildlife biologists (Table 3). Wildlife biologists reported working with wildlife veterinarians on a frequent or occasional basis, general practitioners on an occasional basis, and zoo veterinarians were hardly ever utilized (83% of respondents had never worked with a zoo veterinarian). The biologists who had worked with
veterinarians reported a positive experience. The most common reasons for requesting veterinary assistance are listed in Table 4.

In conclusion, it appears that the zoo and wildlife veterinary community needs to increase outreach to the wildlife management and conservation community. Specifically, formal exchanges and linkages between the American Association of Wildlife Veterinarians/ American Association of Zoo Veterinarians and the Society for Conservation Biology/The Wildlife Society may be particularly beneficial. In addition, a database of zoo and wildlife veterinarians who have specialized skills germane to wildlife management and conservation as well as availability of veterinarians by geographic region may increase wildlife biologist utilization of veterinarians. A priority should also be promoting the ability of zoo and wildlife veterinarians to contribute to wildlife health and conservation policy.

Table 1. Responses of wildlife biologists (n = 53) to the question “How would you rate veterinarians with regard to the following?” “Agree” and “Disagree” categories have been combined.

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<thead>
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<th>Question</th>
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<th>Neither Agree Nor Disagree</th>
<th>Agree</th>
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<td>Veterinarians are knowledgeable regarding</td>
<td>69.3</td>
<td>13.5</td>
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<td>Veterinarians mostly treat individual animals</td>
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<td>7.7</td>
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<td>26.9</td>
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<td>34.6</td>
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<tr>
<td>ranging wildlife</td>
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<td>Veterinarians are experienced with work with</td>
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</table>

Table 2. Responses of wildlife biologists (n = 53) to the question “Please indicate the level of importance you place on each of the following contributions of veterinary medicine to wildlife management and conservation.” “Useful” and “Not Useful” categories have been combined.

<table>
<thead>
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<th>Question</th>
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<td>0</td>
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<td>5.7</td>
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<td>Pathology/diagnostic services</td>
<td>3.8</td>
<td>3.8</td>
<td>92.4</td>
</tr>
<tr>
<td>Disease surveillance</td>
<td>5.8</td>
<td>9.6</td>
<td>84.6</td>
</tr>
<tr>
<td>Policy and regulations</td>
<td>36.6</td>
<td>32.7</td>
<td>30.7</td>
</tr>
<tr>
<td>Animal welfare and euthanasia</td>
<td>17.6</td>
<td>15.7</td>
<td>66.7</td>
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</table>
Table 3. Responses of wildlife biologists (n = 53) to the question “Have you ever utilized assistance or advice from a wildlife veterinarian, zoo veterinarian, or general practitioner?”

<table>
<thead>
<tr>
<th>Category</th>
<th>Never</th>
<th>Occasionally</th>
<th>Frequently</th>
<th>Always</th>
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<td>13.2</td>
<td>56.6</td>
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<tr>
<td>Zoo veterinarian</td>
<td>83</td>
<td>13.2</td>
<td>3.8</td>
<td>0</td>
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<tr>
<td>General veterinary practitioner</td>
<td>41.5</td>
<td>45.3</td>
<td>11.3</td>
<td>1.9</td>
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Table 4. The most common reasons wildlife biologists (n = 53) requested veterinary assistance.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of Requests</th>
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<td>Injured wildlife</td>
<td>22</td>
</tr>
<tr>
<td>Animal capture/anesthesia</td>
<td>14</td>
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<tr>
<td>Research assistance/IACUC</td>
<td>9</td>
</tr>
<tr>
<td>Necropsy/diagnostic services</td>
<td>9</td>
</tr>
<tr>
<td>Disease surveillance</td>
<td>8</td>
</tr>
<tr>
<td>Euthanasia</td>
<td>3</td>
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<tr>
<td>Animal translocation</td>
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</tr>
<tr>
<td>Regulatory work</td>
<td>1</td>
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</table>
CONSERVATION BIOLOGY POLICY: A DIFFERENT PERSPECTIVE

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Abstract

As veterinary medicine becomes more sophisticated, core values and reasons for conservation implementation can be overlooked. Most veterinarians approach conservation as a scientific issue. Other philosophic viewpoints of conservation policy can provide a different perspective towards these issues. These philosophic viewpoints comprise 1) defining conservation medicine and biology as applied interdisciplinary sciences which produce information that is used by parks, forest services, agencies, resource managers, as well as Congress, and is structured by functional and normative postulates; 13) outlining the taxonomy and the dichotomies of values associated with conservation (intrinsic versus extrinsic values, use value, existence value, direct and indirect value);6,7,10-12) 3) measuring these values on an economic and taxonomic level,12 and 4) defining cost versus benefit perspectives.2,3,5,8,9 Conservation issues which demonstrate these philosophies include illegal exploitation of wildlife, and Africa’s elephant (Loxodonta africana) conservation and nuisance animal problems. Practical considerations and possible solutions to the problematic issue of conservation biology policy include community-based actions, outside community activism, the Endangered Species Act (1973), benefit–cost analysis, and political solutions such as safe harbor and habitat conservation plans. Using African wildlife as an example, possible solutions include a market solution for preserving the black rhinoceros (Diceros bicornis), travel cost-benefit survey of an African national park in relationship to tourism, the CAMPFIRE program in Zimbabwe, and the viewing value (economic) of elephants.3 Approaching conservation biology policy from values-based and realistic cost-benefit perspectives can expand the field and contribute to further innovative solutions.

LITERATURE CITED

**CLINICAL MANAGEMENT OF PARTIAL AVULSION OF THE SUPERIOR HORN IN TWO EASTERN BLACK RHINOCEROS (Diceros bicornis michaeli)**

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**Abstract**

The horns of rhinoceros are unique in that they lack a bony core. Contrary to popular belief, it is not made of compacted hair rather keratinized tubules of squamous cells within an amorphous, keratinized, epithelial, fusiform, interstitial cell matrix. Each tubule arises from a dermal papillae at the base of the horn. Upon keratinization, the epithelial cells die, forming the rigid horn. All growth of the horn takes place from the base. The horn is analogous to the hooves of horses (*Equus* sp.), beaks of birds and turtles, and the baleen of whales.2,3

Two individuals (an adult male and a sub-adult female) partially avulsed the superior horn on separate occasions from horizontally placed caging materials. In both cases, >80% of the horn was avulsed and attached only at the rostral margin. The horns did not progress to falling off after several weeks to months and were mechanically removed under stationary operant conditioning. An initial myiasis and resultant infection of the germinal tissues in the male was treated by physical removal and application of fly repellent, and systemic antimicrobials and topical disinfection. The infection resolved over the course of 6 mo. The female did not incur infection or myiasis and minimal treatment was necessary upon removal of the horn.

These cases demonstrate that partial avulsions may not progress to falling off in a timely manner and intervention may be indicated. Captive environments for rhinoceros should be constructed with vertical posts/beams to minimize the possibility of horn trauma associated with horizontal structures.1,4,5

**ACKNOWLEDGMENTS**

We thank the staff of the Kansas City Zoo for their care and assistance in resolving these two cases.

**LITERATURE CITED**


THERAPY FOR NASAL SQUAMOUS CELL CARCINOMA IN A SLENDER-TAILED MEERKAT (Suricata suricatta)

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Abstract

A 5-yr-old male slender-tailed meerkat (Suricata suricatta) was diagnosed with squamous cell carcinoma of the left nasal cavity. Computed tomography (CT) scan of the skull to characterize the extent of the neoplasm revealed left nasal cavity involvement with adjacent lysis of the hard palate and left maxillary bone. Localized external radiation beam therapy was scheduled based on guidelines for domestic cats. The meerkat underwent a total of 19 radiation treatments over a 7 wk period. During the treatment period, left facial swelling decreased dramatically and quality of life improved. A post-treatment CT scan was performed 8 wk after the final radiation treatment, which demonstrated reduction in size of the soft tissue mass within the left nasal cavity, however rostral involvement of the right nasal sinus, increased destruction of left maxillary bone, and extension into the left retrobulbar space with ocular displacement and zygomatic arch destruction were observed. The meerkat began to clinically decline 1 mo after the second CT scan and humane euthanasia was elected 6.5 mo after initial presentation. Although radiation therapy did not extend survival time as long as was expected, it did result in significant reduction in severity of clinical signs. Treatment had no adverse effects on the meerkat and did not disrupt its dominant social status within the colony.

Case Report

A 5-yr-old male slender-tailed meerkat (Suricata suricatta) was diagnosed with squamous cell carcinoma of nasal origin, after a 5 wk history of a firm swelling on the left maxilla ventral and rostral to the left eye. Initial clinical signs were attributed to a canine tooth root infection, but swelling failed to resolve after removal of the suspected tooth. Initial gingival biopsies did not demonstrate neoplasia but a second biopsy of the area obtained 5 wk after initial swelling confirmed a diagnosis of squamous cell carcinoma. The meerkat was determined to be in good health otherwise based on complete blood count and serum chemistry results, and whole body survey radiographs. The swelling increased in size during the diagnostic period, and began to occlude air flow through the left nostril and compromise vision in the left eye.

Computed tomography (CT) was utilized to better evaluate the extent of the neoplasm. An axial pre and post intravenous contrast enhanced CT scan of the skull was performed 2 mo after the
swelling was first noted (GE HighSpeed Advantage helical CT). A contrast enhancing soft tissue mass filled the entire left nasal sinus. Lysis of the rostral hard palate, left maxillary bone, and squamous portion of the temporal bone were also detected. The nasal mass extended through the region of maxillary bone lysis and was visible as a soft tissue mass on the dorsum of the bridge of the nose. The tumor had not extended through the cribiform plate nor into the retrobulbar space. Localized external beam radiation therapy was scheduled based on guidelines for domestic cats. The meerkat underwent a total of 19 radiation treatments over a 7 wk period.

To facilitate each treatment, the meerkat was anesthetized using isoflurane chamber induction and maintained on a small face mask. Subcutaneous fluids were administered prior to recovery. Oral medications included doxycycline (Vibramycin calcium syrup, 10 mg/ml, Pfizer, New York, NY 10017 USA; 4.8 mg/kg b.i.d.) and meloxicam (Metacam oral suspension, 1.5 mg/ml, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO 64506 USA; 0.045 mg/kg every other day). Additionally, topical cyclosporine (Optimmune cyclosporine ophthalmic ointment 0.2%, Schering-Plough Animal Health, Union, NJ 07083 USA) and erythromycin (erythromycin ophthalmic ointment 5 mg/gm, E. Fougera & Co, Melville, NY 11747 USA) were applied to the left eye after each radiation treatment.

During this 2 mo period, left facial swelling decreased dramatically, improving air flow through the left nostril and quality of life. The meerkat remained the dominant animal within the colony and was re-introduced to the group after each treatment without incident. Mild left facial swelling and left nasal congestion returned 5 wk after the final radiation treatment. Weekly nasal flushes with sterile saline reduced the severity of clinical signs. A post-treatment CT scan was performed 8 wk after the final radiation treatment, which demonstrated some reduction in size of the soft tissue mass within the left nasal cavity. However rostral involvement of the right nasal sinus, increased destruction of left maxillary bone, and extension into the left retrobulbar space with ocular displacement and zygomatic arch destruction were observed. The meerkat maintained a good appetite and activity level until 1 mo after the CT scan, when intermittent open mouthed breathing was observed and the left eye was kept closed most of the time. A dramatic clinical decline was observed 3 wk later and the meerkat was humanely euthanatized, 6.5 mo after initial presentation. Gross findings on necropsy demonstrated that the neoplasia had completely occluded the left nasal cavity and had spread to the right nasal cavity. Neoplastic cells had infiltrated the surrounding mucosa and bony structures, and erosion and fracture of the hard palate was present. There was no neoplasia observed in surrounding lymph nodes or other organs, and other significant findings were restricted to mild chronic interstitial nephritis.

**Discussion**

Meerkats are in the family Viverridae (subfamily Herpestinae), and are native to the arid regions of southern Africa.\(^8\) They are highly social animals that form colonies of up to 30 individuals in the wild.\(^3\) The Houston Zoo collection is relatively large by U.S. zoo standards and consisted of 10 male and 10 female meerkats at the time of this case report, with the animal in this report being the dominant male. When evaluating treatment options for this meerkat, there was concern that repeated removal from the colony for radiation treatments would disrupt the animal’s social position or the colony’s social structure in general. Husbandry recommendations for this species stress that even temporary removal of an individual from an established group will be stressful to
the individual and may result in permanent rejection from the group. Repeated radiation therapy was elected in spite of these concerns and did not result in any social complications. Treatments did not appear to be stressful. The meerkat would enter a kennel voluntarily 3 days per wk for transport off grounds to the specialty hospital. When returned to the colony after recovering from anesthesia, the meerkat would quickly assimilate back into the group and maintain its dominant position even through the terminal stages of its disease. The meerkat was also able to help care for its two offspring that were born during the months the animal was receiving radiation therapy. Approximately 1 to 2 wk after euthanasia, the social structure of the meerkat colony underwent a significant shift with several weeks of fighting between conspecifics.

Intranasal cancer comprises approximately 1% of all veterinary neoplasms, with carcinomas being the most common form. Nasal carcinomas are characterized by progressive local invasion and a low metastatic rate. Prognosis is often poor because bone invasion occurs early in the disease process and surgical excision is often impossible. Radiation therapy with or without surgical debulking is currently the only therapy that has improved survival times in cases of nasal cancer, but squamous cell carcinomas tend to respond less favorably to radiation than sarcomas, adenocarcinomas, or lymphoma. Squamous cell carcinoma associated with the upper canine tooth and maxilla of a domestic ferret (Mustela putorius furo) was treated with a rostral maxillectomy followed by a course of radiation therapy. The tumor in this meerkat was located more caudally and, by the time of histologic diagnosis, was not considered surgically resectable.

Diagnosis of squamous cell carcinoma in this case was delayed due to suspicion that the nasal swelling was caused by an infected maxillary canine tooth. Gingival and alveolar biopsy obtained at the time of tooth extraction demonstrated gingival fibrous hyperplasia but did not reveal neoplasia, likely because the tumor was restricted to the nasal cavity at that time. More aggressive biopsies obtained 1 mo later confirmed a suspicion of neoplasia, but by that time the swelling had increased in size, no longer making surgical excision with maxillectomy feasible. A similar case occurred in a domestic dog that presented for dental referral when the site of a maxillary canine tooth extraction slowly enlarged over a 6 mo period. Initial excisional biopsy of the swelling revealed a papilloma with no evidence of neoplasia, but further resection 2 mo later diagnosed squamous cell carcinoma. The dog underwent a rostral hemi-maxillectomy with clean surgical margins and, though owners declined radiation therapy, was still in remission 5 yr later.

Potential side effects of radiation therapy for nasal cancer include rhinitis and mucositis, which commonly resolve within 1-2 mo after therapy is completed. Keratoconjunctivitis sicca, corneal ulcers, and cataract formation are possible at higher radiation doses. This meerkat was treated bilaterally with cyclosporine and erythromycin ophthalmic ointment after each radiation treatment in an effort to reduce the risk of secondary ocular abnormalities. On postmortem histologic examination, mild chronic interstitial nephritis was observed, though the meerkat did not demonstrate clinical signs of kidney disease, nor elevation in serum blood urea nitrogen and creatinine. The subclinical nephritis may have been attributed to long term oral meloxicam therapy.
Although neoplasia has been reported previously in viverrids\(^2\) and in a meerkat,\(^6\) diagnosis is often made at necropsy or shortly before euthanasia. This is the first report of antemortem diagnosis of neoplasia and attempted treatment in a colony-housed viverrid. It is possible that earlier implementation of radiation therapy may have resulted in a more successful outcome. Although radiation therapy did not extend survival time as long as was expected, it did result in significant reduction in severity of clinical signs and improvement in quality of life. Additionally, multiple anesthetic events and separation from the colony had no adverse effects on the meerkat’s overall condition, appetite, or social status within the colony.

LITERATURE CITED

MANAGEMENT OF DIABETES MELLITUS IN A L’HOEST’S GUENON (Cercopithecus lhoesti) WITH INSULIN GLARGINE

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Abstract

Diabetes mellitus is a challenging disease to manage in primates. Treatment regimes need to be developed in accordance with the management situation. Insulin injections and monitoring blood glucose values are not always feasible, and in some instances, the only options are oral therapy and monitoring urine ketone and glucose levels. Diabetes mellitus was diagnosed in a 12-yr-old male L’Hoest's guenon (Cercopithecus lhoesti) based on elevated blood glucose levels and glucosuria. Fructosamine and glycosylated hemoglobin levels were higher than that of a normal male L’Hoest’s guenon collected for comparison. Due to management limitations, insulin injections and regular blood glucose measurements were not possible, therefore, monitoring was limited to tracking body weight, and urine glucose and ketones using dipsticks (Keto-Diastix, Bayer Corporation, Elkhart, Indiana 46515 USA).

This male was treated for 13 mo with the oral anti-hyperglycemic agent metformin (Glucophage, Bristol-Myers Squibb, Princeton, New Jersey 08543 USA). Treatment was initiated at a dosage of 10 mg/kg orally twice daily. The dosage was gradually increased to 20 mg/kg over an 8 mo period with little response in urine glucose values. At dosages of 28-32 mg/kg, a reduction in urine glucose values as well as small decrease in fructosamine was noted (Table 1), however medication compliance decreased with the larger volume of medication. Metformin was discontinued 13 mo after treatment started due to medication refusal. A trial with glipizide (compounded formulation; Sail Drug, Hemet, California 82543 USA) at 0.5 mg/kg orally once daily was initiated. The dosage was gradually increased to 1.0 mg/kg over a 4 mo period. No change in urine glucose was noted on glipizide and medication compliance became problematic so therapy was discontinued. Insulin levels were not routinely monitored and the lack of a better response to metformin may have been related to insufficient endogenous insulin levels.

Additional therapy was not pursued until a change in exhibit housing 2.5 yr later made training for insulin injections and monitoring blood glucose with a glucometer feasible. A plan to treat this guenon with insulin glargine (Lantus, Aventis Pharmaceuticals, Bridgewater, New Jersey 08807 USA) was formulated. Challenges with training and changes in personnel delayed the start of treatment for 6 mo. Insulin glargine at a dose of 3 units subcutaneously once daily was started in August 2006. Treatment was interrupted twice due to posterior paresis associated with lumbar vertebral instability requiring a dorsal hemilaminectomy. Following surgery, insulin glargine was re-initiated at the same dose. This dose was gradually increased based on blood glucose values and increasing food consumption to 5-6 units of insulin glargine once daily. Insulin glargine is a recombinant human insulin analog with glycine and arginine amino acid substitutions. It is long-acting insulin intended for once daily usage in humans. Insulin glargine...
does not produce a pronounced peak effect reducing the potential for hypoglycemia.\textsuperscript{1,2} Twice daily insulin injections have been used historically in diabetic primates at the San Diego Zoo. Longer acting insulin was used in the afternoon in an attempt to compensate for the longer time between the afternoon and next morning injection however large fluctuations in blood glucose values were frequently seen. It was not feasible in this case to space the injections greater than 7 hr apart. Figure 1 illustrates the guenon’s morning and afternoon blood glucose values on insulin glargine during March 2007. Treatment with insulin glargine decreased the fluctuations in blood glucose and once daily injections simplified treatment. While glycosylated hemoglobin values changed little over time, the fructosamine levels dropped below values from the previous 5 yr (Table 1). One disadvantage of insulin glargine is the high cost. Otherwise insulin glargine has been an effective alternative to other insulin regimes.

LITERATURE CITED


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<th>Date</th>
<th>Blood glucose\textsuperscript{a} mmol/L (mg/dL)</th>
<th>Fructosamine\textsuperscript{b} μmol/L</th>
<th>Glycosolated hemoglobin\textsuperscript{b} %</th>
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<td>Mar 2003</td>
<td>14.4 (260)</td>
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<td>20.6 (371)</td>
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<td>no therapy</td>
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<td>25.3 (456)</td>
<td>403</td>
<td>18</td>
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<td>292</td>
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<td>Nov 2006</td>
<td>14.2 (256)</td>
<td>305</td>
<td>14.5</td>
<td>on glargine for 9 wk</td>
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</tbody>
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\textsuperscript{a} Obtained under anesthesia with the guenon fasted the morning of examination; no treatments administered; performed on ExpressPlus chemistry analyzer (Bayer Corporation, Elkhart, Indiana, 46515 USA)

\textsuperscript{b} Non-diabetic male L’Hoest’s guenon fructosamine = 196 μmol/L, glycosylated hemoglobin = 7.8 %

\textsuperscript{c} questionable result
Figure 1. Morning (AM) and afternoon (PM) blood glucose (BG) values during March 2007 in a diabetic L’Hoeist’s guenon (Cercopithecus lhoesti) under treatment with insulin glargine.
THE VALUE OF OSIRIX® FOR INTERPRETING CT AND MRI IMAGING IN ZOOLOGICAL MEDICINE

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Abstract

OsiriX is a Macintosh image processing software dedicated to DICOM (Digital Imaging and Communications in Medicine) images produced by medical equipment including computed tomography (CT) and magnetic resonance imaging (MRI). OsiriX is able to receive images transferred by DICOM communication protocol from any PACS (Picture Archiving and Communication System). OsiriX has been specifically designed for navigation and visualization of multimodality and multidimensional images: 2D Viewer, 3D Viewer, 4D Viewer (3D series with temporal dimension, for example: Cardiac-CT) and 5D Viewer (3D series with temporal and functional dimensions, for example: Cardiac-PET-CT). The 3D Viewer offers all modern rendering modes: multiplanar reconstruction, surface rendering, volume rendering and maximum intensity projection, 2D MPR (multiplanar reconstruction) both curved and orthogonal, 3D Maximum Intensity Projection, 3D Volume Rendering, 3D Surface Rendering, Virtual Endoscopy and anonymization. This software is freely available from the Macintosh web site (http://homepage.mac.com/rossetantoine/osirix/), and at the University of Georgia has been installed on a mobile Macintosh Apple laptop. DICOM images are loaded from the archive CD created by imaging equipment, enabling the user to quickly turn a series of 2D grayscale CT and MRI images into colored 3D reconstructions. These 3D reconstructions can then be used to create fly-throughs, surface and deep reconstructions, and rotations in any plane. This software has proven invaluable for the more detailed and accurate assessment of clinical cases, including pin-point lesion location and surgical planning.
SURGICAL TREATMENT OF PULMONARY MELANOMA IN A BEADED LIZARD (Heloderma horridum exasperatum)

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Abstract

An adult male beaded lizard (Heloderma horridum exasperatum) was examined because of anorexia and lethargy of 1 wk duration. Diagnostic testing included a physical examination, complete blood count, plasma biochemistry panel, whole body radiographs, and coelomic ultrasonography. A large palpable mass in the mid-coelom was confirmed by radiographs, and a smaller mass in the right lung was identified. Blood values were within reference ranges. The sonogram revealed a homogeneous mass with soft tissue echogenicity. Cytologic results from an ultrasound-guided fine needle aspirate were suggestive of a melanoma.

An exploratory coeliotomy was performed. The lizard was induced with propofol (PropoFlo, Abbott Laboratories, North Chicago, IL 60064 USA; 5 mg/kg i.v.), an endotracheal tube was placed, and anesthesia was maintained with isoflurane (Iso-thesia, Abbott Laboratories, North Chicago, IL 60064 USA; 2-3%). Artificial ventilation was provided at a rate of 2-3 breaths per min. The large mass (10x5 cm diameter) originated in the right lung, with extensive adhesions to the right liver lobe. The smaller mass (2x3 cm diameter) was contained within the right lung. A right pulmonectomy and partial heptectomy were performed to excise the tumors. Anesthetic recovery was uneventful. The lizard was prescribed butorphanol (Torbugesic, Fort Dodge, Fort Dodge, IA 50501 USA; 0.5 mg/kg i.m. s.i.d. for 7 days) and ceftazidime (Fortaz, Glaxo SmithKline, Research Triangle Park, NC 60045 USA; 20 mg/kg i.m. every 72 hr for 5 treatments).

Histopathologic evaluation of the mass confirmed the diagnosis of melanoma, and there was no evidence of neoplastic cells at the heptectomy margin.
CYSTOTOMY AND PERCUTANEOUS ENDOSCOPIC GASTROSTOMY (PEG) TUBE PLACEMENT IN A VICTORIAN KOALA (Phascolarctos cinereus victor)

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Abstract

In July 2005, a routine urinalysis on a 10-yr-old intact female Victorian koala (Phascolarctos cinereus victor) revealed hemorrhagic cystitis. Medical treatment over the following 6 mo guided by serial urine culture and sensitivity results was incompletely effective. An abdominal ultrasound exam found two uroliths present in the urinary bladder. A cystotomy was successfully performed and analysis of the uroliths found them to be composed of calcium phosphate. Post-surgical anorexia led to significant weight loss so a percutaneous endoscopic gastrostomy (PEG) tube was placed as a means to deliver nutritional support. The koala was periodically supplemented through the feeding tube with a blend of eucalyptus leaves, water, and a human nutritional powder (Portagen®, Mead Johnson, Evansville, IN 47721 USA). After 8 mo, the koala’s appetite stabilized enough to allow removal of the feeding tube.

Due to persistent dysuria, a repeat ultrasound exam in January 2007 found two additional uroliths and a mass associated with the urinary bladder. During a second cystotomy, the soft tissue mass was located at the trigone making complete surgical removal impossible. Histopathologic evaluation identified a soft tissue sarcoma, likely a fibrosarcoma or fibroleiomyoma. At the time of this writing, the koala remains well following the second cystotomy.

Two postmortem cases of cystitis with fragmented calculi have been reported in koalas but to our knowledge, this is the first antemortem report and first cystotomy performed in this species. Application of a PEG tube in a koala has also not been previously reported.

LITERATURE CITED

CUTANEOUS MELANOMA IN A CAPTIVE SOUTHERN BLACK RHINOCEROS
(Diceros bicornis minor)

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Abstract

A 10-yr-old, male, captive-bred southern black rhinoceros (Diceros bicornis minor) presented with a several day history of a firm to slightly fluctuant, black cutaneous mass on the dorsal midline. Fine needle aspirate cytology was consistent with a melanocytic neoplasm. Recumbent anesthesia was achieved with 1 mg etorphine and 120 mg azaperone (ZooPharm, Fort Collins, CO 80522 USA; i.m.). The mass was excised via a partial thickness skin incision with 2 cm circumferential margins and the site was left to heal by second intention. Histopathology confirmed melanoma with no evidence of vascular invasion. Five months later, no local recurrence of the tumor was present, but a second comparable nodule was found on the inner thigh. This smaller mass was similarly excised and submitted for histopathology.

To the authors’ knowledge, this is the first report of a melanoma in a black rhinoceros. A case of interdigital melanoma has been reported in a greater Asian one-horned rhinoceros (Rhinoceros unicornis).4 In veterinary medicine, melanoma diagnosis typically carries a grave prognosis, and the tumors tend to recur after excision.5 They are frequently resistant to therapeutics, can be very aggressive clinically, and have a predisposition to rapidly metastasize to regional lymph nodes.2 However certain presentations have a more favorable prognosis; 90% of cutaneous melanomas in grey horses are benign at presentation, with slow progression to malignancy in approximately two-thirds of cases3 and less than 5% of canine cutaneous melanomas are malignant.1 Although histologically classified as malignant, thus far, the tumor behavior in this case has not appeared to be aggressive.

LITERATURE CITED

TREATMENT OF A LOUSE (Haematomyzus elephantis) INFESTATION IN A CAPTIVE HERD OF AFRICAN ELEPHANTS (Loxodonta africana)

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Abstract

A captive herd of six African elephants (Loxodonta africana) was diagnosed with a louse (Haematomyzus elephantis) infestation. Clinical signs of pediculosis included dry skin and pruritis. Infested elephants demonstrated pruritis by increased rubbing of their bodies on walls and objects. This led to pustular dermatitis along the dorsolateral truncal aspects in one elephant. Adult lice were primarily located along the dorsal surface of the pinna and base of the ears, while nits were found attached to hairs in various locations.

The Haematomyzus sp. of chewing louse has been reported in African elephants, Asian elephants (Elephas maximus), warthogs (Phacochoerus aethiopicus), and bush pigs (Potamochoerus porcus). Based on a published dosage for elephants, oral treatment with 0.07 mg/kg ivermectin (Promectin 1% solution, Vedco, St. Joseph, MO 64507 USA) was initiated. This treatment regimen, including repeat ivermectin doses, failed to eliminate the ectoparasitism. Higher doses of oral ivermectin along with topical 0.5% carbaryl baths (Mycodex shampoo with carbaryl, Veterinary Products Laboratories, Phoenix, AZ 85067 USA) were then instituted. An oral ivermectin pharmacokinetic study was also undertaken to determine whether the dosage of ivermectin was reaching therapeutic blood levels. Other treatments, including fipronil (Frontline spray, Merial Animal Health, Duluth, GA 30096 USA) and topical human delousing products, were considered, but deemed impractical. A dosage of 0.2 mg/kg ivermectin administered orally every 3 wk for five treatments along with weekly insecticidal baths proved safe and effective in eliminating this irritating parasite from the elephant herd.

LITERATURE CITED

BROMADIOLONE SECONDARY TOXICITY AND TREATMENT IN A SECRETARY BIRD (*Sagittarius serpentarius*)

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Abstract

A 15-yr-old, female secretary bird (*Sagittarius serpentarius*) was evaluated following a 2-day episode of lethargy and anorexia. On the third day, lime-green hair pellets were found in the enclosure. Rodent bait stations containing 0.005% bromadiolone (Contrac®, Bell Laboratories, Madison, WI 53704 USA) were located in the vicinity, but not within the enclosure. Clinical signs consistent with anticoagulant rodenticide toxicity were noted on examination including lethargy, bruising, petechial hemorrhages, and prolonged clotting time at the venipuncture site. Diagnostic tests were supportive of a coagulopathy with prolonged OSPT (one-stage prothrombin time), APTT (activated partial thromboplastin time), and PIVKA (proteins induced by vitamin K1 absence or antagonism), compared to canine values. The bird was treated with oral and parenteral vitamin K1 (The Butler Company, Columbus, OH 43228 USA; 0.5 mg/kg), fluids, and antimicrobials for 46 days, at which time the bird died while under anesthesia related to prior disease.

Anticoagulant rodenticide toxicity was suspected in this case based on clinical signs and evidence of green discoloration of the regurgitated pellet. Therapy was instituted prior to a definitive diagnosis, and seemed to have a slow but progressively positive effect. The diagnostic tests revealing prolonged clotting times supported a coagulopathy diagnosis.

Bromadiolone is a second generation anticoagulant rodenticide commonly used in rodent baits that has a single feeding mortality rate of 90%.3 The recommended treatment in birds following ingestion, either by primary or secondary exposure, is 0.2-2.2 mg/kg vitamin K1 i.m. every 4-8 hr until the condition stabilizes, followed by once daily dosing for 2-3 wk.1,2 Treatment with antimicrobials and supportive care may also be indicated.

LITERATURE CITED

SQUAMOUS CELL CARCINOMA IN THE SINUS OF TWO PRZEWALSKI’S WILD HORSES (Equus caballus przewalskii)

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Abstract

In 2002, a 27-yr-old captive female Przewalski’s wild horse (Equus caballus przewalskii) at the Denver Zoological Foundation presented with a decreased appetite, epistaxis, and clinical signs of sinusitis similar to those observed in the domestic horse. These include facial asymmetry, chronic to intermittent unilateral nasal discharge, exophthalmia, abnormal respiratory noise, ipsilateral ocular discharge, and fistula formation.¹ Following 3 wk of empirical oral antimicrobial therapy, the horse was immobilized for an examination, blood work, and radiographs. Trephining to explore the caudal right maxillary sinus revealed extensive bony necrosis as well as a large, firm, space-occupying mass within the sinus. Due to the likelihood of neoplasia and a poor prognosis for recovery, the horse was humanely euthanatized. Histopathologic results on the large sinus mass removed at necropsy revealed a squamous cell carcinoma (SCC).

In 2006, a 15-yr-old captive male Przewalski’s wild horse presented with a decreased appetite, epistaxis, and clinical signs compatible with sinusitis. The horse was immobilized for an examination, blood work, and radiographs. Radiographs revealed a large, soft tissue density occupying the left frontal sinus. The horse died due to complications during anesthetic recovery. At necropsy, a 900 gm sinus tumor was discovered, and histopathology again confirmed SCC.

To the authors’ knowledge, these are the first reports of sinus neoplasia in this species. Squamous cell carcinomas are the most common sinus tumors in domestic horses and prognosis is generally poor due to cases typically presenting after there is already advanced localized invasion and destruction.²

LITERATURE CITED

KYPHOSIS AND METABOLIC BONE DISEASE IN AN INFANT LOWLAND GORILLA (Gorilla gorilla gorilla)

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Abstract

An 8-mo-old, hand-raised, female, lowland gorilla (Gorilla gorilla gorilla), was diagnosed with kyphosis by radiographs and magnetic resonance imaging (MRI). The degree of deformity was considered severe by orthopedic specialists consulted on the case. Infant humans with kyphosis, depending on severity, have the potential of developing instability, narrowing of the spinal canal and cord compression as the misshapen hemi-vertebrae grow. Posterior paresis or paralysis, and urinary or bowel incontinence can result. Treatment in infant humans often involves stabilization surgery where the affected vertebral bodies are fused with a bone graft, limiting the potential for narrowing of the spinal canal during growth. Because the gorilla weighed only 4.2 kg, the procedure for her would require both a ventral and dorsal surgical approach. External fixation in a body cast would also be necessary, likely for 6 mo, as the gorilla was too small to accommodate internal fixation devices. Naturally there were concerns about the serious surgical risks involved and the postoperative management.

Concurrently the gorilla suffered from metabolic bone disease (generalized demineralization), indicated on survey radiographs. A dual energy X-Ray absorptiometry (DEXA) was performed to quantify bone density. On the initial DEXA, the lumbar bone mineral density was 0.25 g/cm². This is below the 1st percentile for 10 kg human infants (mean = 0.40 g/cm², 1st percentile = 0.31 g/cm²).

Surgery was postponed until the bone density problem could be addressed. Serum parathyroid hormone (PTH), 25-hydroxycholecalciferol, and 1,25-dihydroxycholecalciferol levels were 161 pg/ml, 9 ng/ml, and 250 pg/ml, respectively. These values were consistent with vitamin D deficiency (diagnosed by low 25-hydroxycholecalciferol level; human reference ranges for serum parathyroid hormone, 25-hydroxycholecalciferol, and 1,25-dihydroxycholecalciferol are 7.0-53 pg/ml, 8.0-36 ng/ml, and 22-67 pg/ml respectively) which can cause poor calcium absorption and diminished calcium and phosphorous incorporation into bone. The suspected etiologies of her vitamin D deficiency were likely to have been insufficient vitamin D intake and diminished sunlight exposure. Metabolic bone disease, when caused by insufficient vitamin D, calcium and phosphorous intake, can usually be corrected with high levels of calcium and vitamin D supplementation. The milk formula was adjusted to increase the daily calories and was supplemented with calcium glubionate (Calcionate syrup, Rugby Laboratories, Duluth, GA 30097 USA; 3.6 g, p.o.) and ergocalciferol (Calciferol drops, Schwarz Pharma, Inc., Milwaukee, WI 53201 USA; 16,000 IU, p.o.). The keeper staff also made an effort to move the gorilla outdoors to facilitate sun exposure for short periods as weather permitted. After 3 mo the serum PTH level had returned to normal (46 pg/ml).
A repeat DEXA 5 mo later showed improvement in bone density (0.31 g/cm²). Periodically, radiographs and MRI of the spine were repeated. Overall bone density continued to subjectively improve during this time. Narrowing of the spinal canal did not occur as the gorilla grew. No symptoms of spinal cord damage (incontinence, hind limb weakness) were observed. Surgical stabilization was therefore postponed indefinitely with the caveat that it may become necessary in the future if symptoms developed.

At 6 yr of age and weighing 30 kg, no outward signs of spinal cord compromise have been observed. The gorilla has always behaved and ambulated normally. At this time, it is thought that surgery will be unnecessary. Destabilization of the spine may be less likely to occur in gorillas due to their quadrupedal stance and more horizontal posture compared to humans. Metabolic bone disease may affect gorillas in captivity and must be considered in any assessment of treatment of bone disease in this species.

ACKNOWLEDGMENTS

The authors wish to thank the gorilla keepers and Zoo Hospital staff, and all of the specialists for their generous help with the management of this case. Special thanks to Dr. Joe Donovan who assisted with anesthesia and to Kathy Boston for providing MRI support.
SURGICAL REPAIR (PARTIAL PULPOTOMY) OF BILATERALLY FRACTURED TUSKS IN AN AFRICAN ELEPHANT (Loxodonta africana)


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Abstract

A 3-yr-old, 1,030 kg, male African elephant (Loxodonta africana) was anesthetized with etorphine (Wildlife Pharmaceuticals, Inc., Fort Collins, CO 80522 USA; 3 mg, i.m.) and azaperone (Stresnil, Merial Canada, Inc., Baie d’Urfe, Quebec H9X 4B6 Canada; 20 mg, i.m.) on two separate occasions, 27 days apart, for the repair of bilaterally fractured tusk tips with pulpal exposure (Class III fractures). Due to positioning, a separate procedure was necessary for each tusk repair. The anesthetic protocols following induction included orotracheal intubation after administration of propofol (Hospira, Inc., Lake Forest, IL 60045 USA; 500 mg bolus, i.v.), and the maintenance of anesthesia utilizing isoflurane (AErrane, Baxter Pharmaceutical Products, Inc., Deerfield, IL 60015 USA; 0.5-2.0%) in oxygen, intravenous propofol (150-500 mg boluses), or intravenous etorphine (0.2 mg). Positive pressure ventilation was provided as needed during the procedures. Recovery was uneventful after intravenous administration of naltrexone (Wildlife Pharmaceuticals, Inc.; 150 mg).

After determination of the depth of the contaminated pulp tissue insult utilizing a hand held portable x-ray unit (Nomad 75, Aribex, Inc., Orem, UT 84097 USA) and a digital radiology screen (EDR3, Eklin Medical systems, Inc., Sunnyvale, CA 94089 USA), the tip of each fractured tusk was repaired utilizing a modified partial pulpotomy technique. The tip of each tusk was transected at the appropriate level utilizing a water-cooled rotary cut-off tool after which the pulp canal was enlarged with an industrial carbide burr in an air driven die grinder. The coronal tip of the exposed pulp horn tissue was amputated with a surgical curette and hemorrhage was controlled by direct pressure. The pulp canal was then decontaminated by simultaneous lavage with 3% hydrogen peroxide and 5.25% sodium hypochlorite followed by 3 min of laser decontamination therapy utilizing a YSGG laser (Waterlase MD, Biolase Technology, Inc., Irvine, CA 92618 USA) in the sterilization mode. The canal was then filled with a layer of synthetic particulate bone graft material (Consil, Nutramax Laboratories, Inc., Edgewood, MD 21040 USA) followed by a layer of light cured flowable composite resin (Premise Flowable, Kerr Corporation, Orange, CA 92867 USA). Finally, the coronal portion of the tusk was restored with a hybrid dental resin composite material (Herculite XRV, Kerr Corporation) polymerized with a plasma arc curing unit (Demetron Curing Light, Kerr Corporation). The irregular fractured tip of each tusk was then re-contoured into a rounded profile with an abrasive sanding disk on a hand held electric grinder. After modification of the elephant’s enclosures (securing loose chains, etc.), no further tusk damage has occurred.
COMPARISON OF WEST NILE VIRUS TITERS IN FOUR SPECIES OF PENGUINS VACCINATED WITH A DNA PLASMID VACCINE OR A KILLED WHOLE VIRUS VACCINE

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Abstract

West Nile virus (WNV) has caused morbidity and mortality in numerous captive and free ranging avian species worldwide, including African penguins (Spheniscus demersus) and Humboldt penguins (Spheniscus humboldti) (Glaser, personal communication). Many zoological facilities have initiated WNV vaccination protocols to at risk or endangered avian species. Knowledge regarding immunologic response by penguins to WNV vaccines is limited. One study has shown variation in humoral response to an inactivated vaccine between two penguin species.3 DNA vaccines have shown promising results in stimulating both cellular1 and humoral response4 to WNV. In avian species, however, humoral responses have varied between species.4,5 In this study, humoral immune responses to two WNV vaccines were compared within and between four species of penguins housed indoors with minimal potential for natural exposure induced titers. Pre- and post-vaccination WNV titers were determined and compared in Humboldt, Magellanic (Spheniscus magellanicus), Gentoo (Pygoscelis papua), and Rockhopper (Eudyptes chrysocome) penguins immediately prior to and for set intervals up to 1 yr following vaccination with a commercially available equine killed virus vaccine (West Nile-Innovator, Fort Dodge, Fort Dodge, IA USA) or a newly developed DNA plasmid vaccine (experimental, not currently available). Additionally, methods were followed2 to isolate and cryopreserve lymphocytes from penguins at each sampling interval to allow for future cellular immune testing. Preliminary results demonstrated difference in humoral response to the two vaccines with the inactivated vaccine appearing to induce stronger and/or longer lasting antibody titers in more birds than the DNA vaccine. Inter-species differences were also observed.

ACKNOWLEDGMENTS

We thank the Chicago Board of Trade Endangered Species Fund, the Penguin Taxon Advisory Group, and Brookfield Zoo for their funding of this project. We thank the animal husbandry and veterinary services departments at Brookfield Zoo, Shedd Aquarium, and John Ball Zoo for their many hours of assistance. We also thank Dr. Tom Meehan, Dr. Patty McGill, Dr. Branson Ritchie, Dr. Amy Glaser, Dr. Kathryn Gamble, Gail Nachel and Edward Davis.
LITERATURE CITED


A FATAL DISEASE CAUSED BY A *Coxiella*-LIKE BACTERIA IN PSITTACINES

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Abstract

This report describes *Coxiella* infection in two Swainson’s Blue Mountain Rainbow lorikeets (*Trichoglossus haematodus moluccanus*) and one bronze-winged pionus parrot (*Pionus chalcopterus*). The lorikeets were housed in an indoor/outdoor multi-species exhibit at the Oklahoma City Zoo and were in the same age cohort. Ages ranged from 6-8 mo at the onset of clinical signs, which included fluffed appearance, lethargy, weakness, and inappetance. The birds did not respond to various combinations of antibiotics, fluids or steroids. The birds were euthanatized following development of progressive neurologic signs that included head pressing, ataxia, hyperesthesia, intention tremors, hemiparesis, and seizure-like activity. The pionus was 1-yr-old female from a large aviary and had a 2-wk history of illness prior to death.

Necropsy of the lorikeets revealed thin body condition (2), hepatomegaly (2), and splenomegaly (1). Necropsy of the pionus revealed hemorrhage in the lungs and airsacs. Histologic examination revealed disseminated micrgranulomatosis in liver and spleen (3), nonsuppurative encephalitis with microgranulomas (3), and mild lymphohistiocytic enteritis (2). Iron sequestration was occasionally seen in the splenic and hepatic microgranulomas. Gimenez and PAS stains identified single to multiple approximately 1 micron intracytoplasmic inclusions within macrophages of the brain in all birds. Fite’s acid fast, Warthin Starry, Brown and Brenn, and Giemsa stains did not identify organisms in the lesions. Electron microscopic examination of brain from one bird identified spherical to rod shaped prokaryotic organisms within lysozomes. These organisms were approximately 400 nm in diameter and had a trilaminar cell wall similar to that of Gram-negative bacteria. Immunohistochemistry for *Coxiella burnetti* was negative in 1 bird. The PCR sequence had 97% homology with *Coxiella burnetti* when compared with the sequence in GenBank. This likely represents a previously unknown species of *Coxiella*. The *Coxiella* genus has recently been reclassified within the *Legionellaceae*.

LITERATURE CITED


Tonometry and Tear Production Assessment in a Colony of Screech Owls (Megascops asio)

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Abstract

Approximately 30% of raptors admitted to the Wildlife Center of Virginia from 1996-2005 had ocular injuries. Almost half of these cases were screech owls (Megascops asio). Few avian ophthalmology publications have focused on the family Strigidae. Therefore, the objective of this study was to report ophthalmic findings in the screech owl. Twenty-three, apparently healthy, adult captive screech owls received complete ophthalmic examinations. One randomly assigned eye of each bird was measured by phenol red thread tear test (PRT), and the other eye by Schirmer tear test (STT). TonoVet® (Jorgensen Laboratories, Loveland, CO 80538 USA) rebound tonometry and TonoPen-XL® (Bio-Rad Inc., Santa Ana, CA 92705 USA) applanation tonometry were performed in each eye to measure intra-ocular pressure (IOP). Median STT result was ≤2 mm/min, ranging from ≤2-6 mm/min, and mean ± standard deviation (SD) PRT was 15±4.3 mm/15 sec. In this study, PRT provided more consistently measurable values than STT-I and is recommended for this species. Mean ± SD IOP were 9±1.8 mm Hg TonoVet®-P, 14±2.4 mm Hg TonoVet®-D, and 11±1.9 mm Hg TonoPen-XL®. There are no published manometric studies of IOP in screech owls or other reports of rebound tonometry in birds, so interpretation of which measurement technique is most accurate is not possible at this time. This is the first report of rebound tonometry and PRT in owls. Further studies in tonometry with concurrent manometry are necessary to determine the most accurate IOP measurement technique in this species.
ALASKA TO NEW ZEALAND AND POLYNESIA: TRANS-HEMISPHERIC MIGRATIONS OF SHOREBIRDS FOLLOWED USING A NEW IMPLANTABLE SATELLITE TRANSMITTER

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Abstract

Until recently, the size of the smallest satellite transmitter suitable for implantation into birds weighed 42 g, limiting deployment to birds weighing greater than 840 g (at 5 % of body weight) or 600 g (at 7 % of body weight). In June of 2005 and 2006, using a new satellite transmitter weighing about 24 g (1.9 × 1.6 × 4.2 cm, with a 23-cm antenna), transmitters were implanted into the right abdominal air sacs of bristle-thighed curlews (Numenius tahitiensis) and bar-tailed godwits (Limosa lapponica), captured on their Alaskan nesting grounds. An anesthetic combination of propofol and bupivacaine and lidocaine was used. Hyperthermia was a complication, but all birds survived anesthesia and surgery. For implanted birds, mean loading ratios (transmitter weight/body weight × 100 %) were: bar-tailed godwit: 6.7 % (range: 6.4-7.5 %), and bristle-thighed curlew: 6.0 % (range: 5.5-6.2 %).

In 2005, all five transmitters implanted in godwits failed due to premature battery failure just prior to migration but two of the five implanted godwits were identified subsequently on the wintering grounds in Australia and New Zealand and again in 2006 on the nesting grounds in Alaska. In 2006, four bar-tailed godwits and eight bristle-thighed curlews were implanted. Three godwits and seven curlews were tracked during migration to over-wintering sites in the South Pacific or until signals stopped. Calculated nonstop flight durations and distances were up to 8.3 days and 9,725 km for curlews and 9.6 days and 10,800 km for godwits. Godwits may have the longest non-stop migration of any land bird.
HORNED GUAN (Oreaphasis derbianus) CAPTIVE MEDICAL MANAGEMENT

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Abstract

The horned guan (Oreaphasis derbianus) is currently a critically endangered species; the remaining populations are very small, severely fragmented and presumably declining. It is a cracid that is endemic to Guatemala and Mexico, inhabiting the few cloud forests remaining in the area. Mature animals can weight up to 2 kg. The earliest records of horned guans in captivity came from the 70’s, and it was not until 1994 that the first successful captive reproduction took place. The international Studbook currently reports 60 captive live animals. Africam Safari Zoo located in Puebla Mexico houses 26 individuals.

At Africam Safari, horned guan enclosures are spacious and contain several perches for roosting due to their arboreal nature, as well as vegetation to provide cover. Generally, breeding pairs are maintained together all year through with exception of aggressive individuals. Some degree of visual isolation of breeding pairs from each other and also from humans is desirable. Nesting boxes are placed high in the enclosure, and breeding generally occurs in the beginning of the year (January through April). The clutch size is usually 2 eggs and the incubation period is approximately 32 to 34 days. Artificial incubation and hand rearing chicks has been successful; resulting in two clutches from each pair per year.

Behavioral observations have revealed that fruit (82%) and leaves (17%) make up the majority of the diet in the wild, and invertebrates may also be eaten occasionally. In captivity 9 different vegetables including avocado are the base of the diet plus a commercial poultry concentrate.

Horned guans tolerate capture with handheld nets and handling for induction of inhalation anesthesia (isoflurane). Struggling may produce hyperthermia and procedures should be planned for cooler times of day. It is common for them to lose feathers if not handled carefully. Stress produced with these procedures is variable between animals but it is common to see a decrease in food intake for several days after handling, and severe weight loss in cases where periodic handling is needed. The standard method of identifying the gender is by direct laparoscopic visualization of gonads.

In general, horned guans are hardy birds and are not prone to disease. Similar to other cracidae, it is believed, that horned guans are susceptible to most of the diseases affecting poultry. Viral diseases have not been diagnosed in horned guans at Africam Safari. A fatal case of tracheal granuloma (aspergillosis) was diagnosed during quarantine in one individual. Low numbers of endoparasites have been found and included ascarids, Trichomonas spp., Amidostomum spp., Capillaria spp., Strongyloides spp., Heterakis spp., and coccidia. Bacterial species found in routine surveys in adult animals for enteric pathogens include, Serratia spp., Klebsiella pneumoniae, Enterococcus faecalis, Enterobacter spp., Escherichia coli, Micrococcus spp.,

Horned guans presented for medical attention for non-infectious diseases were found to have general clinical signs such as emaciation, weight loss, abnormal behavior, and lethargy. Dystocia was the most common medical problem presented so far (n=5), affecting mature hens and first time egg layers. This condition presumably arises due to stress and low environmental humidity compared to their natural habitat. One animal was presented with uterine prolapse, and others with chronic dystocia with severe tissue pressure necrosis (n=3). In birds where treatment could be initiated early, good results were obtained although the effect on the long term reproductive status of the affected individuals is unknown.

Stress and trauma due to cage mate aggression especially during introduction of new pairs, can lead to fractures, integument lacerations, weight loss and death (n=1). The known tendency in cracids to pick objects off the ground, has produced one case of foreign body related problem. One case of bilateral cataract was surgically treated with partial success. No neoplasias have been diagnosed.

Abnormal hatching has been observed with artificial incubation, including malpositions (n=3) and malformations of the yolk sack with entrapment of one or both hind limbs (n=5). Variations in the frequency of rotation are possibly the etiology for these conditions. There was one case of lateral leg rotation and two neonates died of egg yolk contamination and septicemia.

LITERATURE CITED

EVALUATION OF THREE DIFFERENT ANESTHETIC DELIVERY SYSTEMS IN INDIAN PEAFOWL (Pavo cristatus)

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Abstract

Three different anesthetic delivery systems, facemask (FM), endotracheal tube (ETT), and laryngeal mask airway (LMA™ North America Inc., San Diego, California 92121 USA) were compared in Indian peafowl (Pavo cristatus). Fifteen birds were randomly divided into three groups of five for each delivery system and immobilized with isoflurane (AErrane®, Baxter Healthcare Corporation, Deerfield, Illinois 60015 USA) delivered in 100% oxygen. Birds were induced via facemask and maintained for 20 min for initial set-up, then changed to the assigned delivery system for approximately 40 min, during which the following values were monitored and compared: heart rate, spontaneous respiratory rate, body temperature, saturation of peripheral oxygen (SpO2), and end-tidal carbon dioxide (ETCO2) (Table 1). Intermittent positive pressure ventilation was provided at 6-10 breaths/min. SpO2 values were obtained using the SurgiVet® pulse oximeter (BCI, Inc., Waukesha, Wisconsin 53186 USA) and ETCO2 values were obtained using the TIDAL WAVE® Sp handheld capnograph/oximeter (Novametrix Medical Systems, Inc., Wallingford, Connecticut 06492 USA). Arterial samples were obtained for blood gas analysis performed by the i-STAT® Portable Clinical Analyzer (i-STAT Corporation, East Windsor, New Jersey 08520 USA) (Table 2). Radiographs were performed at the end of the procedure with no birds demonstrating excessive air within the gastrointestinal system. Anesthetic depth and recovery were subjectively similar across groups. Tracheoscopy was performed in all birds 13-20 days after initial immobilizations to evaluate tracheal mucosa. There was no evidence of tracheal damage in the FM and LMA groups, but one bird in the ETT group developed a tracheal stricture requiring surgical resection and anastomosis.

ACKNOWLEDGMENTS

This study was approved by the Institutional Animal Care and Use Committee and financially supported by a grant from the Species Survival Fund of the Wildlife Conservation Society. The authors thank the veterinary technicians at the Bronx Zoo for their assistance with the anesthetic procedures, and the staffs of the Ornithology and Pathology Departments for their contributions.
Table 1. Comparative physiologic parameters for Indian peafowl (*Pavo cristatus*) during isoflurane anesthesia via three different anesthetic delivery systems (n = 5 in each group). Values are reported as mean ± standard deviation.a

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<tr>
<th></th>
<th>HR (beats/min)</th>
<th>RR (breaths/min)</th>
<th>T (°C)</th>
<th>SpO₂ (%)</th>
<th>ETCO₂ (mm Hg)</th>
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<tr>
<td>FM</td>
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<td>39.1 ± 0.7</td>
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<tr>
<td>ETT</td>
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<tr>
<td>LMA</td>
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<td>38.9 ± 0.6</td>
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</table>

*a FM, facemask; ETT, endotracheal tube; LMA, laryngeal mask airway; HR, heart rate; RR, spontaneous respiratory rate; T, temperature (cloacal); SpO₂, saturation of peripheral oxygen; ETCO₂, end-tidal carbon dioxide.

Table 2. Comparative blood gas analysis for Indian peafowl (*Pavo cristatus*) during isoflurane anesthesia via three different anesthetic delivery systems (n = 5 in each group). Values are reported as mean ± standard deviation.a

<table>
<thead>
<tr>
<th></th>
<th>Lac (mmol/L)</th>
<th>TCO₂ (mmol/L)</th>
<th>pH</th>
<th>PCO₂ (mm Hg)</th>
<th>PO₂ (mm Hg)</th>
<th>HCO₃⁻ (mmol/L)</th>
<th>BEecf (mmol/L)</th>
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<td>FM</td>
<td>0.68 ± 0.29</td>
<td>38 ± 3</td>
<td>7.376 ± 0.105</td>
<td>62.8 ± 17.7</td>
<td>342 ± 135</td>
<td>35.6 ± 2.7</td>
<td>11 ± 3</td>
<td>99 ± 1</td>
</tr>
<tr>
<td>ETT</td>
<td>1.10 ± 1.19</td>
<td>40 ± 2</td>
<td>7.287 ± 0.107</td>
<td>81.3 ± 20.3</td>
<td>224 ± 121</td>
<td>38.2 ± 2.1</td>
<td>12 ± 3</td>
<td>98 ± 2</td>
</tr>
<tr>
<td>LMA</td>
<td>0.41 ± 0.18</td>
<td>38 ± 4</td>
<td>7.332 ± 0.067</td>
<td>70.2 ± 16.5</td>
<td>316 ± 128</td>
<td>36.4 ± 4.0</td>
<td>10 ± 3</td>
<td>99 ± 1</td>
</tr>
</tbody>
</table>

*a FM, facemask; ETT, endotracheal tube; LMA, laryngeal mask airway; Lac, lactate; TCO₂, total carbon dioxide; pH concentration; PCO₂, partial pressure of carbon dioxide; PO₂, partial pressure of oxygen; HCO₃⁻, bicarbonate; BEecf, extracellular fluid; sO₂, oxygen saturation.
THE EFFECT OF BODY POSITION ON THE RESPIRATORY SYSTEM OF ANESTHETIZED RED-TAIL HAWKS (Buteo jamaicensis)

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Abstract

It has been hypothesized that when birds are anesthetized in dorsal recumbency, it may cause the lungs and air sacs to be compressed by visceral organs and that sternal recumbency can restrict the movement of the keel which is essential for respiration, therefore resulting in hypoventilation and hypoxemia.

This study tested the hypothesis that different patient positions would differentially affect air sac volume, lung volume and density and physiologic parameters during anesthesia. Six adult, gender unknown red-tailed hawks (Buteo jamaicensis) were evaluated under isoflurane anesthesia while spontaneously breathing in three different positions: dorsal, right lateral and sternal recumbency. Lung volume, lung density and air sac volume were calculated from helical computed tomography (CT) images using software designed for volumetric analysis of CT data. ANOVA was used to compare the effect of position while controlling for replicates. When differences were significant (p≤0.05), a paired Student’s t-test was used to compare the results.

Out of the three body positions commonly used during avian anesthesia, sternal recumbency allowed for significantly greater lung and air sac volume and significantly lower lung density in red-tailed hawks.

In a second phase of the study, the birds were anesthetized in right lateral and dorsal recumbency in similar manner for 75 min. Tidal volume, end tidal CO2, heart rate, respiratory rate, direct and indirect blood pressure were measured every 5 min. Blood was drawn every 15 min for gas analysis. There was no significant difference between the two groups for most of the variables and at the time of writing this abstract, it is inconclusive whether the trends are physiologically significant. Our results provide clinically important insight into the potential for respiratory compromise associated with patient positioning during avian anesthesia.
ACKNOWLEDGMENTS

This study was funded by the Center for Companion Animal Health, Veterinary Medical Teaching Hospital, School of Veterinary Medicine, UC-Davis.
VENTRICULOTOMY AND POST-SURGICAL MANAGEMENT OF VENTRICULAR DIVERTICULA IN CAPTIVE PARAKEET AUKLETS (Aethia psittacula)

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Abstract

Three parakeet auklets (Aethia psittacula) at the North Carolina Zoological Park were evaluated independently for weight loss, lethargy, abnormal buoyancy, and dyspnea. Survey radiographs revealed enlarged stone-filled ventriculi. Ventriculotomies were performed to remove the foreign bodies. Due to multiple adhesions, the ventriculus of the first bird was inaccessible through a ventral midline incision, necessitating a left lateral approach. The koilin layer appeared irregular with multiple embedded stones. The bird died shortly after surgery and a ventricular diverticulum was discovered at necropsy. Because the diverticulum was composed of mature granulation tissue with minimal inflammation, it was hypothesized that it gradually developed from weakening of the ventricular wall due to contractions of the stone-filled ventriculus.

The two additional birds that developed clinical signs also underwent ventriculotomies using similar surgical procedures. The birds were premedicated with butorphanol (2.0 mg/kg, i.m.) and anesthetized with isoflurane. A 2.7mm 30° rigid laparoscope, passed through a ventral midline incision, was used to visualize the ventriculus; a ventricular diverticulum was identified in one bird. Stay sutures were placed in the ventriculus or diverticulum, and the ventriculus was elevated to the incision. An incision into the ventriculus/diverticulum and endoscopy allowed for removal of the stones with forceps. The ventriculus and the body wall/skin were closed in a simple interrupted pattern using 5-0 PDS and 4-0 PDS, respectively. Post-operatively, the birds were treated with sucralfate (75mg/kg p.o., b.i.d.), ranitidine (2.0mg/kg i.m., b.i.d.), enrofloxacin (15mg/kg p.o., s.i.d.), terbinafine (10mg/kg p.o., b.i.d.), and meloxicam (0.5mg/kg s.c., s.i.d.). The birds were gavage-fed Hill’s a/d® (Hill's Pet Nutrition, Inc., Topeka, KS 66601 USA) (3% body weight) for several days following surgery. Both birds showed improvement and remain asymptomatic.

ACKNOWLEDGMENTS

The authors thank the North Carolina Zoological Park’s alicd husbandry staff Nicole Hauch, Sarah McRory, and Nicole Petersen. We are grateful for the technical support of Julie Osborne and Christine Poindexter (College of Veterinary Medicine, North Carolina State University) as well as the North Carolina Zoological Park’s veterinary technicians. Special thanks to Philip Ruckart (Biomedical Communications, College of Veterinary Medicine, North Carolina State University) for his video editing expertise.
MASTER CLASS: ANESTHESIA

Alan Klide, VMD, Dipl ACVA and Lin Klein, VMD, Dipl ACVA*

University of Pennsylvania, School of Veterinary Medicine, 3900 Delancey Street, Philadelphia, PA 19104 USA; University of Pennsylvania, New Bolton Center, 382 W Street Rd, Kennett Square, PA 19348 USA

Abstract

This master class will review anesthesia practices, including anesthesia equipment, monitoring, and environmental effects of inhaled anesthetics, sevoflurane, etomidate and other agents, epidurals, fentanyl patches, and respiratory control during anesthesia with an emphasis on hypercarbia, hypoxemia and hemodynamic effects of immobilizing and anesthetic agents including treatments of hemodynamic depression. Class notes will be available for downloading from the AAZV website members section for a limited period of time.
MASTER CLASS: WOUND HEALING

Mark W. Bohling, DVM, PhD, Dipl ACVS

Department of Small Animal Clinical Sciences, College of Veterinary Medicine, University of Tennessee, Knoxville, TN 37996 USA

Abstract

Zoo veterinarians see a large number of wounds of wide variety; management of these wounds often presents special challenges not seen with domestic species. Many different products and techniques are available for the management of wounds; a sound understanding of wound healing physiology is useful to guide the decision-making process as to the ideal way to manage each wound. This course will begin with a review of wound healing physiology including a discussion of species differences and how those differences may affect wound management. A number of wound healing products, old and new, will be described along with their indications. Surgical management of wounds (primary and delayed closure) is often the most expeditious method of wound management. Practical surgical techniques for wound management will be described and illustrated with cases. Finally, several cases will be presented for class participation in wound management planning. Attendees are invited to bring case histories of their own for this portion of the class.
MASTER CLASS: EMERGENCY AND CRITICAL CARE

Steven L. Marks, BVSc, MS, MRCVS, Dipl ACVIM

Department of Clinical Sciences, North Carolina State University, 4700 Hillsborough Street, Raleigh, NC 27606 USA

Abstract

This will be a case-based discussion concentrating on emergency and critical care management of the trauma patient.

Areas of discussion will include, triage, fluid therapy, CPR, and management of head trauma and thoracic trauma.
MASTER CLASS: ADVANCES IN MOLECULAR DIAGNOSTICS: THEIR APPLICATIONS AND CHALLENGES

Stephen Kania, PhD

Department of Comparative Medicine, College of Veterinary Medicine, University of Tennessee, Knoxville, TN 37996 USA

Abstract

Recent technologic advances have dramatically changed diagnostic testing. With these changes come opportunities, challenges, and ethical dilemmas. For example, nucleic acid amplification combined with fluorescent probes provides a highly sensitive and specific method for pathogen detection. Extensive sequence information deposited in public databases facilitates the design of tests for ever increasing numbers of pathogens. Nucleic acid analysis has been extended to gender determination, speciation of unculturable pathogenic organisms and detection of antibiotic resistance genes and other genes associated with pathogenesis. These advances permit the early detection of infection and identification of carriers. This high level of sensitivity, however, can yield positive results from vaccination, non-pathogenic organisms, and subclinical infections creating problems for clinicians and regulators. In addition, important issues have arisen from new technologies. These include patenting of microbial organisms and genes, disputes over sample ownership, and profit driven gene discovery. New diagnostic technologies present new challenges to test interpretation, ethical considerations, and the challenge of keeping pace with ever changing technology. Understanding the basic concepts behind these tests enables clinicians to effectively apply and interpret them and to contribute to the ethical dialog regarding their licensing and applications.
CONTRACEPTION IN ZOO MAMMALS: RUMORS AND REALITIES

Lisa A. Harrenstien, DVM, Dipl ACZM, Anneke Moresco, DVM, Cheryl S. Asa, PhD, Ingrid J. Porton, MS, Sally M. Boutelle, MS, and the AZA Contraceptive Advisory Group

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Abstract

Contraception is the deliberate prevention of production of offspring. The simplest or most permanent methods of contraception can include housing males and females separately, or surgical alteration of anatomy such that sperm and ova cannot combine (vasectomy, ovarian or uterine removal, testicular removal, or tubal ligation). Temporary contraception is commonly employed in zoological species, retaining the ability to resume reproduction of genetically valuable individuals if management conditions change over time. Choices between the various available contraceptive techniques all involve assessment of risks, benefits, financial costs, behavioral costs, ethical considerations, practical limitations, technical abilities and resources. An additional, very real component of contraceptive decision-making is the anecdotal or data-based information that colleagues provide to the discussion. Each situation generates a different set of considerations when deciding upon the most appropriate contraceptive.

Contraceptive data summaries and recommendations are available via internet and in affordable published texts, but rumors contrary to the data still abound. Examples of the concerns and questions posed to the AZA Wildlife Contraception Center include: Are melengestrol acetate (MGA) implants now contraindicated for use? Are porcine zona pellucida vaccines effective for contraception? Can an animal that is administered a gonadotropin-releasing hormone (GnRH) agonist for contraception (leuprolide or deslorelin) be housed immediately and safely back with other animals? Can any male mammal be given a GnRH agonist for contraception or aggression control? Temporary contraception might be expensive; is it worth it?

Decades of available data and expertise should be incorporated into responsible decisions regarding contraceptive usage.

LITERATURE CITED

REPRODUCTIVE TRACT LESIONS IN CANIDS CONTRACEPTED WITH MELENGESTROL ACETATE (MGA)

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Abstract

Many species, including canids, are effectively contracepted with progestins, and melengestrol acetate (MGA) has been widely used for zoo species. Chronic use of progestins has been associated with significant gynecologic lesions in felids. This project investigates whether progestin contraceptives also affect reproductive health in canids by comparing uterine lesions in MGA-treated and untreated (control) zoo canids. Reproductive tracts from adult canids at United States zoos were obtained from submissions to the Association of Zoos & Aquariums' Wildlife Contraception Center Health Surveillance Program. Reproductive tracts were sampled following standard protocols and processed routinely for histopathology. Microscopic evaluations were performed without knowledge of treatment. Ovaries were examined for tertiary follicles or corpora lutea and uteri were evaluated for endometrial hyperplasia (EH), metritis, pyometra, hydrometra, mineralization, endometrial atrophy, and adenomyosis. Lesion prevalence was compared between treated and control groups, controlling for age and parity. Ninety-one cases (68 controls and 23 treated) representing 13 species were included. Advanced EH, hydrometra, and mineralization were more prevalent in treated than control groups (39% vs 9%; 70% vs 22%; 52% vs 0% resp). An additional 47% of treated animals (vs 3% controls) had such severe hydrometra or pyometra that EH could not be graded. Endometrial hyperplasia, mineralization and hydrometra were associated with MGA exposure. Because these lesions can permanently impair the fertility of females, long-term use of MGA for contraception of genetically valuable canids is not recommended.

ACKNOWLEDGMENTS

The authors thank all participating institutions, as well as the veterinarians, curators, technicians, and registrars that have sent reproductive tracts as well as the information necessary to include the cases in this study. This project was partially funded by the Association of Zoos and Aquariums Conservation Endowment Fund.
INVESTIGATION OF THE GONADOTROPIN RELEASING HORMONE AGONIST, DESLORELIN, AS A CONTRACEPTIVE FOR VARIABLE FLYING FOXES (Pteropus hypomelanus)

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Abstract

Effects of gonadotropin releasing hormone (GnRH) superagonist implants, deslorelin (Suprelorin®), on circulating luteinizing hormone (LH) concentrations and semen quality were examined in variable flying foxes (Pteropus hypomelanus). Plasma was collected from treated (n = 3 male; n = 5 female) and untreated (n = 3 male; n = 8 female) bats. Semen was collected from all males and a bachelor group (n = 7) before and after treatment. Treated males were housed with untreated females and untreated males were housed with treated females. A GnRH challenge revealed serum LH concentrations increased in control, untreated bats (n = 2 female; n = 2 male) but not in deslorelin-treated bats (n = 2 female; n = 2 male). Mean serum LH concentrations did not significantly decrease (P > 0.05) after deslorelin treatment in males (pre = 1.4 ± 0.9 ng/ml, post = 1.2 ± 0.7 ng/ml) or females (pre = 2.1 ± 1.1 ng/ml, post = 1.6 ± 0.8 ng/ml) and were comparable with untreated males (pre = 1.2 ± 1.1 ng/ml, post = 1.7 ± 0.9 ng/ml) and females (pre = 1.4 ± 0.5 ng/ml, post = 1.3 ± 0.5 ng/ml) during the same time period. Variability in ejaculate quality was observed in treated, untreated, and bachelor males. It appears that deslorelin implants are ineffective for male P. hypomelanus contraception as spermic ejaculates, sustained by tonic LH secretion, were obtained. However, results of the GnRH challenge suggested pulsatile LH was eliminated, so deslorelin should be a useful contraceptive in females by preventing the preovulatory LH surge. Results of offspring production later this year will provide further practical results.
PALLAS’ CATS (Otocolobus manul) COMING AND GOING: PUBERTY AND REPRODUCTIVE SENESCENCE IN A SEASONALLY-BREEDING FELID

William F. Swanson, DVM, PhD,1* Jason R. Herrick, PhD,1 Mark Campbell, DVM,1 Helen L. Bateman, MSc,1 Jennifer B. Bond, BS,1 Genevieve M. Magarey, BVSc, PhD,1 Barry P. Fitzgerald, PhD,2 Raymond F. Nachreiner, DVM, PhD,3 Charlotte E. Farin, PhD,4 and Suzanne Kennedy-Stoskopf, DVM, PhD, Dipl ACZM5

1Center for Conservation and Research of Endangered Wildlife, Cincinnati Zoo & Botanical Garden, Cincinnati, OH 45220 USA; 2Department of Veterinary Science, University of Kentucky, Lexington, KY 40546 USA; 3Diagnostic Center for Population and Animal Health, Lansing, MI 48910 USA; 4Department of Animal Science, North Carolina State University, Raleigh, NC 27606 USA; 5School of Veterinary Medicine, North Carolina State University, Raleigh, NC 27606 USA

Abstract

The physiologic basis for puberty and reproductive senescence is virtually unknown in felids. For many nondomestic cat species, studbook records listing the youngest and oldest ages for reproduction represent the only information available on reproductive maturity and age-related decline but even these limited data can be confounded by management practices. In this study, we investigated the waxing and waning of reproductive function in the Pallas’ cat (Otocolobus manul), a small-sized felid native to Central Asia that exhibits pronounced reproductive seasonality restricted to the winter months. Our specific objectives were to 1) characterize pubertal changes in morphologic, hormonal and seminal traits in juvenile male and female Pallas’ cats and 2) compare ovarian responsiveness, oocyte metabolism and embryo development in young versus old females. For the puberty study, juvenile cats (n=four males, two females) were anesthetized bimonthly beginning in late fall for blood sampling, body measurements ± electroejaculation for semen analysis. Fecal samples were analyzed for testosterone, estrogen and/or progesterone metabolites and serum was assessed for leptin, thyroxine (T4) and luteinizing hormone (LH). For the reproductive senescence study, female Pallas’ cats (n=4) in two age cohorts (1-4 yr and >6 yr) were treated during two breeding seasons with exogenous gonadotropins (300 IU eCG followed 86 hr later with 150 IU hCG) and subjected to laparoscopy to evaluate ovarian follicular responses and recover oocytes for metabolism assessment (glycolysis, pyruvate oxidation), in vitro fertilization and embryo culture.

Spermic ejaculates were recovered from all males by 7-10 mo of age, corresponding to increases in fecal testosterone beginning 1-2 mo earlier and concurrent with increases in body mass and leptin levels. T4 (range, 17-37 nmol/L) and LH (range, 1.99-3.80 ng/ml) concentrations were variable throughout puberty. Male body mass peaked from December to February before declining rapidly by May. Both females displayed estrous cyclicity and mating behavior by 10-11 mo of age, with both showing increases in fecal progesterone indicative of ovulation. One female became pregnant and gave birth to six viable kittens after a ~68-day gestation. Comparing young to old cats, there were no differences (P>0.05) in mean (± SEM) number of...
ovarian follicles (16.3 ± 3.3 vs. 12.8 ± 2.9) or % of good-quality oocytes (89.2% vs. 87.8%), and high (67-90%) fertilization percentages were obtained in both cohorts. Oocyte glucose metabolism was similar (P>0.05) between age groups but pyruvate oxidation was increased (P<0.001) in oocytes from older (1.46 pmol/oocyte/3 hr) vs. younger (0.52 pmol/oocyte/3 hr) females. Fewer (P < 0.05) IVF embryos from older (29%, 5/17) than younger (80%, 16/20) cats developed to morulae during culture. These results indicate that both male and female Pallas’ cats can become reproductively mature by 10 mo of age with mating and offspring production during their first breeding season following birth. Findings also suggest that alterations in oocyte metabolism and embryo development may be responsible for decreased fecundity after 6 yr of age. These findings may have important implications for reproductive management of captive Pallas’ cat populations as well as improving our understanding of the ecology of Pallas’ cats in the wild.

ACKNOWLEDGMENTS

The assistance of the veterinary and animal care staff at the Cincinnati Zoo & Botanical Garden and North Carolina State University is gratefully acknowledged. This study was funded, in part, by a grant (D04ZO-30) from the Morris Animal Foundation.
EFFECTS OF FLUPHENAZINE DECANOATE ON REPRODUCTIVE CYCLICITY AND CORTISOL LEVELS IN CENTRAL CHINESE GORAL (Naemorhedus goral)

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Abstract

Long-acting neuroleptics (LANs) have been used for behavioral management of ungulates in captivity and for translocation for many years. 1,3,5 With half-lives ranging from hours to days, LANs can aid behavioral management by decreasing aversive and aggressive behaviors and, potentially, stress responses in ungulates under intensive management conditions. Theoretically, their use could augment breeding situations in species prone to stress or intraspecific aggression. However, their mechanism of action is competitive antagonism of dopamine, which is associated with alteration of prolactin and gonadotropin release. 2,4,6 Little is known about LAN effects on the luteinizing hormone (LH) surge and ovulation in artiodactylids. This study was designed to assess the effects of fluphenazine decanoate on ovulation and stress in a small antelope species undergoing intensive handling by measuring serum LH, progesterin and cortisol, and monitoring daily follicular development by ultrasound. Seven central Chinese goral (Naemorhedus goral) were randomly assigned to two groups: A) treatment with 1 mg/kg fluphenazine decanoate i.m. (n = 4), or B) control, saline injection i.m. (n = 3). Reproductive cyclicity in both groups was synchronized using 7-day controlled internal drug release devices (CIDR-G; Pfizer AG, Karlsruhe, Germany) containing 330 mg progesterone, combined with 8 mg i.m. prostaglandin F2α at CIDR insertion. Beginning 24 hr following CIDR removal, blood was collected from each animal every 6 h for 96 hr, and ultrasound examinations were performed every 24 hr. Serum cortisol concentrations were lower in the treatment group (P<0.05), however, fluphenazine decanoate appears to affect ovarian response to synchronization in this species.

LITERATURE CITED

Fecal Steroid Assays for Assessing Reproductive-Endocrine Function in the Genus Tragelaphus

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Abstract

The genus Tragelaphus has been minimally investigated in terms of its reproductive endocrinology. Studies on this genus to date have focused on serum, which carries more risk in animal handling than noninvasive endocrine methods. 3,4 Additionally, no studies have been performed to establish normative annual reproductive parameters in these species. This study investigated fecal hormone parameters in multiple species in the genus: greater kudu (Tragelaphus strepsiceros), bongo (T. eurycerus), sitatunga (T. spekii), lesser kudu (T. imberbis), and nyala (T. angasii). Fecal samples were collected serially from both males and females for 1-12 mo from each animal. Samples were collected a minimum of three times per week for females and once per week for males. Fecal extracts were assayed using enzyme immunoassay (EIA) and selected samples were further assayed using radioimmunoassay (RIA). Hormones validated and tested using EIA were progesterone, estradiol, and testosterone. Progesterone was validated and tested using RIA.

Despite methodic validation (parallelism to standard curve, linear recovery, and high pressure liquid chromatography), fecal progestins measured using EIA did not yield clear estrous cyclicity. Early pregnancy (confirmed by later birth) was also not clearly demonstrated. By contrast, RIA was able to detect seasonal estrous cycle changes. While non-specific fecal progestins have been successfully employed to monitor annual reproductive parameters in other members of the family Bovidae, specifically the subfamilies Hippotraginae and Antilopinae, they do not appear to be effective for the genus Tragelaphus. 1,2,5,6 Instead, more specific progesterone assays seem to be of greater benefit.

Acknowledgments

The authors wish to thank Niki Presley and the laboratory staff of the Conservation and Research Center, the laboratory staff at the St. Louis Zoo, the animal care staff and keepers at Como Zoological Garden and the St. Louis Zoo, and the staffs of all the participating institutions.

Literature Cited


DEVELOPMENT OF TECHNIQUES FOR SUCCESSFUL ARTIFICIAL INSEMINATION IN THE INDIAN RHINOCEROS (Rhinoceros unicornis)

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Abstract

Assisted reproductive techniques developed in the Indian rhinoceros have resulted in the first pregnancy established from artificial insemination (AI) with frozen-thawed spermatozoa. Semen was collected by electroejaculation from anesthetized males and cryopreserved in equine extender (EQ) with glycerol or dimethyl sulfoxide (DMSO). Estrous cycles were monitored through Doppler ultrasonography, urinary estrogen conjugates (E1C), progesterone (P4) concentrations and behavioral observations. Animal conditioning permitted inseminations without anesthetics, and custom-made equipment enabled intrauterine semen deposition. Two AI techniques were developed, one involving manual insertion of the insemination rod and the other utilizing endoscopy. The method chosen depended on the tolerance of the individual females to vaginal manipulations. Both females conceived following AI, but one pregnancy ended in early embryonic loss. The established pregnancy occurred in a 15-yr-old, nulliparous cow. Insemination timing was based on ultrasound evidence of a preovulatory follicle measuring 13 cm in diameter, urinary E1C concentrations above baseline for 12 days and a pre-ovulatory spike in urinary P4 concentrations. Two inseminations of 8 ml each were performed via the manual insertion method at 72 and 48 hr prior to ovulation. Ultrasonographic imaging verified semen deposition directly in the uterine body and uterine horn ipsilateral to the preovulatory follicle. Post-thaw sperm motility averaged 55% and mean total motile sperm per inseminate was $620 \times 10^6$. Pregnancy was diagnosed by rectal ultrasound 18 days post-ovulation. These proven techniques could facilitate gamete exchange between disparate populations, surmount behavioral incompatibility between rhinoceros pairs and effectively utilize sperm banks for enhancing genetic diversity in endangered rhinoceroses.
ACHIEVING POPULATION GOALS IN LONG-LIVED WILDLIFE WITH CONTRACEPTION

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Abstract

The ultimate goal of any wildlife contraceptive effort is some alteration of the target population, either through a slowing of growth, or stabilization or reduction of the population. Early population models suggested that short-term contraceptive agents applied to long-lived species would not achieve significant population changes.¹,²,³,⁴ Native porcine zona pellucida vaccine (PZP), a short-term contraceptive vaccine, was applied to a herd of wild horses inhabiting Assateague Island National Seashore, USA, over a 13-yr period, with the immediate goal of achieving zero population growth, a secondary goal of reducing the population from 175 to 150, and a tertiary goal of reaching 120, all without the physical removal of animals. Contraceptive efficacy ranged from 92-100% on an annual basis, and the percent of adult females that was treated on any given year ranged from 42-76%. The first goal of achieving zero population growth was achieved in 2 yr, and the initial decline of the population became apparent in 8 yr, and by year 11 the population had declined to 137, a decrease of 21.7%. The lengthy period required for achieving a population decline was caused by increasing body condition scores, reduced mortality and significantly increased longevity among treated females.

ACKNOWLEDGMENTS

This project was funded in part by Assateague Island National Seashore, The National Park Service, the National Institutes of Health, The Science and Conservation Center at ZooMontana, and carried out under the U.S. Investigational New Animal Drug file 8857-G0002 with the U.S. Food and drug Administration. Special thanks to the late Frances Velay and the Panaphil Foundation, for many years of support for this project.

LITERATURE CITED

LAPAROSCOPIC VASECTOMY IN FREE RANGING AFRICAN ELEPHANTS (Loxodonta africana)

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Abstract

Elephant population management has become a significant conservation issue in most of Southern Africa. The breeding behaviors of free ranging elephants indicate that several dominant bull elephants are responsible for the majority of breeding within the various matriarchal herds. A vasectomy of these bull elephants would decrease population growth rates but maintain normal social and breeding behaviors. Anatomically, elephants have intra-abdominal testes. Advances in minimally-invasive laparoscopic techniques have allowed this type of surgery to be realistic in very large animals and in field conditions.

Introduction

Elephant population control is one of the most critical conservation issues facing southern Africa. Growth in protected elephant populations in Botswana, Swaziland and South Africa are causing negative changes to the ecosystem and to the diversity of plants and animals it supports. Without a long-term population management plan, ecosystem destruction is expected to worsen and have potential irreversible consequences.

Historically, wildlife officials have utilized culling and translocation as the primary methods of population control. Currently, translocation is no longer an option because most parks are not able to accommodate additional animals. Large scale culling was discontinued in the 1990’s, but has been proposed to restart by wildlife officials in South Africa. Other methods of population control such as immunocontraception have shown some utility in small parks where vaccines can be administered to elephant cows.

Surgical sterilization is a permanent contraceptive technique, and is one of the most common methods of birth control in both animals and humans. For free ranging animals, a vasectomy has the advantage of maintaining normal hormone levels and thus breeding and natural social behaviors are preserved. Elephants that have been vasectomized will continue to go into musth, breed (without being fertile), and maintain their social status among other elephants.
Unlike most terrestrial mammals, elephant testes are intra-abdominal and are located just caudal to the kidneys. Therefore, to access the testes and spermatic cord, the abdomen must be entered.

Advances in medical technology have provided laparoscopic instrumentation, which can be used for this minimally invasive surgery (i.e., laparoscopy). This has many advantages for free ranging animals. A much smaller incision is required with laparoscopy, which then translates to less chance of infection, less post-operative pain and quicker healing times. When working with free ranging animals, this is critical because the animals will not be hospitalized or have the ability to be treated with antibiotics or analgesics after the surgery.

**Immobilization**

Using a helicopter, specific breeding bulls are identified and darted with a combination of etorphine (M99®, Wildlife Pharmaceuticals Incorporated, 1401 Duff Drive, Fort Collins, CO 80522 USA) and azaperone (Stresnil®, Wildlife Pharmaceuticals Inc.). After induction, an endotracheal tube is placed in the elephant’s trachea and the elephant’s respirations are assisted using a portable ventilator system. While anesthetized, the elephant’s blood pressure, oxygen saturation, end total carbon dioxide, body temperature, heart rate, respiratory rate and blood gas analysis are all monitored. Throughout the procedure additional small boluses of intravenous etorphine are administered as required. Intravenous azaperone is also utilized as an anesthetic agent, and to assist in decreasing etorphine induced hypertension. At the completion of surgery, the elephants are reversed with intravenous naltrexone hydrochloride (Trexonil®, Wildlife Pharmaceuticals Inc.) and diprenorphine (M5050®, Wildlife Pharmaceuticals Inc.).

**Patient Positioning**

A crane truck is utilized to move the elephant to a suitable surgical location and then suspend the animal in an upright standing position throughout the surgery. This position enhances the safety of the anesthesia and allows improved visualization of the testes with the laparoscope.

This modified upright standing position is accomplished using a series of five-ton capacity, padded, rope slings. These are looped around each leg and tusk. At the front legs, the ropes are positioned in the axillary region. In the rear, the ropes are positioned in each inguinal space. The tusk ropes attach at the base of each tusk just at the gingival margin. The end of each loop of rope is joined together and attached at a single point on the crane. The crane can lift or lower the elephant so that each foot rests squarely on the ground. Once the elephant is in a suspended position, wooden splints are attached to the legs and are used to lock each limb in extension. In this way, the elephant’s legs continue to support the majority of its weight and there is minimal pressure on the suspension ropes.

After the elephant has been placed in a standing position, surgical equipment is moved into place. A 14-inch flat screen monitor is placed in a specialized cradle on the elephant’s caudal dorsum for laparoscopic viewing. The flat bed portion of the crane truck is transformed into a field operating room with surgical tables and electrical equipment powered by a portable generator.
Surgical Procedure

The surgical sites on both sides of the elephant are cleaned and scrubbed for surgery. Initially a firm bristled scrub brush is used to clean the skin, followed by a complete surgical scrub with alternating applications of betadine scrub and alcohol. After the surgical scrub, each site is drapped steriley for surgery. The primary incision is approximately 15 cm long and is located just cranial to the tuber coxae. The incision is carried through the body wall, and the fibro-elastic peritoneum is identified. A modified human chest Finnochetto retractor is utilized to separate the sides of the incision and provide visualization of the fibro-elastic peritoneum. Tumor forceps are utilized to firmly grasp the fatty connective tissue that covers the peritoneum and withdraw it through the incision. In general, a 14 × 14 × 14 cm portion of this fatty connective tissue must be resected before the peritoneum can be isolated and incised. A 3.5-cm incision is placed through the peritoneum and a laparoscopic cannula is inserted. The abdomen is insufflated with ambient air using a specifically designed device capable of rapid and regulated air flow. In general, a high intra-abdominal pressure of 1 psi (52 mm Hg) is required to provide operating space and enhance visualization during surgery. An elephant laparoscope, designed by Karl Storz Endoscopy (175 Cremona Dr. Goleta, CA 93117, USA), is inserted through the cannula for visualization of the abdominal viscera. This laparoscope has a 10 mm instrument operating channel and thus minimizes the number of additional instrument ports that need to be placed. The testis is identified just caudal to the kidney, suspended from the dorsum. From the caudal pole of the testis, the epididymus and deferent duct can be visualized traveling in the mesorhchium. A secondary instrument portal is created approximately 15-20 cm from the primary incision by making a 2-cm incision through the skin and body wall. A hooked scissor is placed within this cannula and penetration through the peritoneum can be visualized traveling through the laparoscope directly.

A section of the deferent duct approximately 15 cm from the epididymus is identified and grasped via the second portal. A 6-10 cm section of deferent duct is resected using laparoscopic scissors through the operating scope. The transected duct is transferred to a grasping forceps with the operating scope and removed from the abdomen. This tissue is placed in formalin and sent for histopathologic confirmation.

While the laparoscopic surgeons are working, a second set of surgeons make an incision on the contralateral side. Once the vasectomy is complete on side one, the elephant is lifted in its standing position and rotated 180 degrees. The laparoscopic surgeons will now complete the vasectomy on the second side while the other surgical team closes the incision from the completed side. The peritoneum is closed with a simple continuous pattern using an absorbable suture material. The external muscle layers are also closed with a simple continuous suture pattern and absorbable suture material. The skin is then closed with #2 nylon in a modified far-far-near-near (tension relieving) suture pattern. During the procedure the patients receive a long-acting penicillin injection and a single dose of a nonsteroidal anti-inflammatory drug. After the closure is complete, the animal is rinsed with water and lowered from the crane for anesthetic reversal.
Post Operative Monitoring

During the surgery, each animal is fitted with a VHF biotelemetry collar. On-site elephant researchers, along with ranger staff, follow the elephants after their surgery. During the first 2 wk the animals are viewed every 1-2 days. Digital photographs are taken to document wound healing and any change in body condition. Other behavioral data is collected including activity, appetite, and social interactions. After the initial 2-wk monitoring period, observations are done weekly. A full year of digital images and behavioral data is recorded.

Findings

In July 2006, at the Welgevonden Game Reserve, four adult bull elephants had complete laparoscopic vasectomies performed on four consecutive days. Surgical times were approximately 2.5 hr, and total anesthetic times were approximately 3.5 hr. All four animals recovered from anesthesia and were ambulatory within 5 min. The incisions on all four animals have healed and no significant complications were noted from the laparoscopic vasectomy procedure. Behavioral observations have documented normal behaviors since the surgery, including maintenance of social status and breeding.

Conclusion

Laparoscopic vasectomy of free ranging bull elephants is a viable surgical option for reproductive sterilization. This management tool is probably not realistic for very large elephant populations (> 10,000), but should be considered for small and medium size elephant populations. Further research is currently underway to make this an efficient and practical field technique and to fully understand any negative impact this procedure may have on the individual elephant, the elephant population or the ecosystem.

This is an international collaborative effort which brings together conservation organizations, universities, government entities and private industry to address this complex problem. It is our hope that this work may provide a useful management tool which balances ecosystem health and animal welfare concerns.

ACKNOWLEDGMENTS

We are indebted to the Karl Storz Company for the design and manufacture of the elephant laparoscopic equipment. We would also like to thank and acknowledge the following individuals for their participation and support of our work through the years: Beth Ament, LVT, Nancy Boedeker, DVM, Lidia Castro, LVT, Greg Fleming, DVM, ACZM, Don Neiffer, VMD, ACZM, Mark Penning, BVSc, MSc, PK Robbins, MRCVS, Anne Savage, PhD, Cora Singleton, DVM, Julia Sweet, LVT, Scott Terrell, DVM, ACVP, and Laura Wheeler, LVT. This work would not have been possible without key partnerships with conservation groups in Africa, including CC Africa/Phinda (Kevin Pretorius and Helene Druce), the Makalali Game Reserve (Audrey Delsink and Ross Kettle), and the Welgevonden Game Reserve (David Powrie and Hanno Kilian).
COLOR VISION IN OLD WORLD AND NEW WORLD PRIMATES: GENETICS AND BEHAVIOR

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Abstract

Humans and Old World (OW) primates have rich trichromatic color vision because they have three classes of retinal cone photoreceptors: short-wave-sensitive (SWS, blue), middle-wave-sensitive (MWS, green) and long-wave-sensitive (LWS, red). Like most mammalian species, most New World primates have dichromatic color vision that is based only on SWS and MWS classes of cones. Trichromacy in OW primates was acquired due to duplication of the X-chromosome linked gene encoding the MWS photopigment, followed by divergence to form X-linked MWS and LWS pigment genes. This happened about 40 million yr ago after separation of the NW from the OW lineages. Interestingly, an independent MWS gene duplication occurred in the howler monkeys (Alouatta spp.) that similarly gave rise to trichromatic color vision in this species. Trichromacy also exists among females of other species of NW monkeys. This is because their single pigment gene on the X-chromosome is highly polymorphic in relation to the spectral sensitivity of the encoded pigment. Females who are heterozygous for two spectrally different forms of the pigment have trichromatic color vision. X-chromosome inactivation in such females ensures expression of only one pigment per photoreceptor cell, which is critical for color vision. There is good evidence that evolution of trichromatic vision among primates involved selection for the ability to distinguish between young and adult leaves and between ripe and unripe fruits.

LITERATURE CITED

CAPTIVE ORANGUTAN RELEASE PROGRAM: SUMATRAN ORANGUTAN CONSERVATION PROGRAM AND VETERINARY CONSIDERATIONS

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Abstract

In November 2006, in a world first pilot project, a 14-yr-old captive born Sumatran Orangutan from Perth Zoo was released into the protected Bukit Tigapuluh National Park in Sumatra as part of a reintroduction program.

Veterinary preparations for the release began approximately 12 mo prior to her departure and included assessment of disease risk and general health, as well as dietary planning.

More specifically, a disease reference spreadsheet (Table 1) was developed and a risk analysis approach was taken to complete the table. Decisions as to what action was required for each disease was based upon specific criteria which included pathogenicity of disease versus risk of exposure; known effectiveness and/or safety of vaccine protocols in non human primates (NHP’s); interpretation of serology results and vaccination; and/or disease testing protocol for release site staff.

Health assessment indicators and monitoring sheets were developed by Perth Zoo for the staff tracking the orangutan post-release. These were designed to provide good consistency to the recording of observations.

The orangutan was placed on a dietary program which gradually reduced caloric intake while introducing a wide variety of tropical fruits into the diet. The nutrition plane was then stabilized and the orangutan was given access to a large fig tree to encourage climbing, foraging and increased fitness.

At the date of writing this abstract, the released orangutan – who was born and raised naturally by her mother at Perth Zoo – was continuing to do well, adapting to the wild environment rapidly and successfully. Supplementary feeding was being provided in the forest once per week. Trackers continue to follow her progress.
Table 1. Orangutan release - disease reference spreadsheet.a

<table>
<thead>
<tr>
<th>Disease</th>
<th>Risk of individual having disease</th>
<th>Pathogenicity of agentb</th>
<th>Risk of exposure on release</th>
<th>Outcome of Diseasec</th>
<th>Availability of Preventiond</th>
</tr>
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<tbody>
<tr>
<td><strong>Viral</strong></td>
<td></td>
<td></td>
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<tr>
<td>SIV/HIV</td>
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<td>low</td>
<td>F</td>
<td>3</td>
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<td>low</td>
<td>F</td>
<td>3</td>
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<tr>
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<td>low</td>
<td>I</td>
<td>3</td>
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<tr>
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<td>2</td>
<td>High</td>
<td>PD</td>
<td>1</td>
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<td>moderate to high</td>
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<td>low</td>
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<td>moderate</td>
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<td>moderate</td>
<td>SR</td>
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<td>low</td>
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<td>Rubella</td>
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<td>Mumps</td>
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<td><strong>Bacterial</strong></td>
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<td>moderate</td>
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<td>low</td>
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<tr>
<td>Enteric Bacteria</td>
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<td>3</td>
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<td>SR</td>
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<td>Diphtheria</td>
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<td>low to moderate</td>
<td>SR</td>
<td>1</td>
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<tr>
<td><strong>Fungal</strong></td>
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<td></td>
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<td>Blastomycosis</td>
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<td>SR</td>
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<td>Malaria</td>
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<td>low</td>
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<td>External parasites</td>
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<td>3</td>
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<td>I</td>
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<tr>
<td>External insects</td>
<td>Moderate</td>
<td>3</td>
<td>moderate to high</td>
<td>I</td>
<td>1</td>
</tr>
</tbody>
</table>

bPathogenicity of Agent: 1=Infests immunosuppressed animals, 2=Infests some contact animals, 3=Infests all contact animals.
cOutcome of disease: F=Usually fatal, PD=Causes permanent disability, SR=Serious but full recovery usual, TD=Temporary disability (mild disease), I=Usually inconsequential.
dAvailability of prevention: 1=Effective, easily administered vaccine/treatment available, 2=Vaccine/treatment available but limited effectiveness/difficult to administer/not tested in NHP, 3=No vaccine or treatment available.
ILIOPSOASITIS IN TWO WESTERN LOWLAND GORILLAS (*Gorilla gorilla gorilla*)

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Abstract

A 13-yr-old female Western lowland gorilla (*Gorilla gorilla gorilla*) presented with chronic intermittent purulent discharge around the vulva and perineum presumed to be due to a previous bite wound. An abscess isolated to the iliopsoas muscle was diagnosed by magnetic resonance imaging (MRI) and *Proteus mirabilis* was cultured. A 45 yo female Western lowland gorilla presented with acute onset posterior paresis caused by discospondylitis. A large retroperitoneal abscess involving the iliopsoas muscle was subsequently identified on computed tomography (CT) scan and *Klebsiella pneumoniae* was cultured. Both cases exhibited a leukocytosis, neutrophilia, anemia, hypocalcemia, and hypoalbuminemia. The gorilla with the isolated muscle abscess was treated medically long term with enrofloxacin and amoxicillin-clavulanate. The gorilla with discospondylitis and large retroperitoneal abscess was treated with surgical drainage and long term chloramphenicol and cefuroxime. Both gorillas recovered however, the gorilla with the isolated abscess continues to have intermittent purulent drainage from the left inguinal lymph node.

Iliopsoas abscess is a rare condition in humans. It can be primary, from hematogenous spread of bacteria, or secondary to an infectious focus in the abdomen.¹ The most common causes of iliopsoas abscess in humans are primary hematogenous spread, postoperative infection, Crohn’s disease, neoplasia, or spondylitis.¹ Captive female gorillas appear to have a high prevalence of intraabdominal abscesses.² Iliopsoas infection can lead to peritonitis and sepsis in human and may be a source for intraabdominal abscessation in captive gorillas.

LITERATURE CITED

PRESUMPTIVE HYPERTENSION RELATED BLINDNESS (OCULAR DISEASE) IN SLENDER LORIS (*Loris tardigradus*)

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Abstract

Renal disease, especially polycystic kidney disease, has been documented in slender lorises. Hypertension, anemia and gastritis are common secondary findings in individuals with chronic renal disease, contributing to morbidity in these patients. At Brookfield Zoo, two slender lorises with documented renal disease presented with acute hyphema and suspected retinal detachment. Presentation and lesions were consistent with hypertensive lesions (renal hypertensive retinopathy) seen in other species. A survey was sent out to institutions that currently house or have previously housed slender lorises to determine the prevalence of renal and ocular disease in the North American captive population. Four institutions (Brookfield Zoo, Bronx Zoo, Cincinnati Metroparks Zoo, and Duke Primate Center) responded to the survey; 42 individuals are included in this report. Ocular disease (including: cataracts, retrobulbar abscesses, corneal ulcers, synechiae, and retinal degeneration) was diagnosed in ten animals. Seven animals exhibited evidence of renal disease (including: interstitial nephritis, polycystic kidney disease, and chronic glomerular nephritis). Five animals showed signs of ocular and renal disease, however only two of these animals (mentioned previously) had ocular lesions suspected to be secondary to systemic hypertension. Hypertension was not routinely monitored for nor diagnosed in slender lorises.

LITERATURE CITED

A FATAL CASE OF Herpesvirus papio 2 IN A BLACK AND WHITE COLOBUS MONKEY (Colobus guereza)

Brigid V. Troan, 1 Ludmila Perelygina, 2 Irina Patrusheva, 2 Arnaud van Wettere, 3 Julia Hilliard, 2 Michael Loomis, 1 and Ryan De Voe 1

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Abstract

Herpesvirus papio 2 (HVP-2) was diagnosed in an eastern black and white colobus monkey that was presented for acute onset of ataxia and inappetence, which rapidly progressed to apnea followed by fatal cardiac arrest. During the clinical course of the disease, abnormalities were limited to a precipitous decline in white cell numbers and a spinal tap consistent with an acute viral infection (marked lymphohistiocytic inflammation). At necropsy, there were numerous petechiae within the white matter tracts of the brain; microscopic lesions of acute multifocal necrosis and hemorrhage with prominent inclusion body formation in the brain and adrenal gland were strongly indicative of an acute herpesvirus infection. A specific etiologic diagnosis of HVP-2 was made based on serology, PCR of post-mortem tissues, live virus isolation from the lung, and identification of the virus in histologic lesions with immunocytochemistry. Phylogenetic tree analysis grouped the colobus monkey isolate of HVP-2 with neuroinvasive strains of the virus. This virus was naturally transmitted to the colobus monkey from a nearby colony of baboons, the natural host of HVP-2. To the author’s knowledge, this is the first documented case of natural transmission of HVP-2 from a baboon to a non-host species. HVP-2 should be considered a differential in cases of acute encephalopathy in animals, particularly primates, exposed to baboons.

LITERATURE CITED

PHYSICAL AND SOCIAL ASPECTS OF LONG-TERM RECOVERY IN A CHIMPANZEE (*Pan troglodytes*) WITH A PRESUMPTIVE CEREBROVASCULAR ACCIDENT

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Abstract

While cardiovascular disease has been indicated as an important cause of disease in chimpanzees, the incidence of stroke or cerebrovascular accident is less well documented.1 In this case, a 36-yr-old chimpanzee (*Pan troglodytes*) presented with acute onset of left hind limb paresis that progressed to left sided paralysis within 24 hr. Complete blood count, chemistry, and computed tomography (CT) failed to indicate a definitive cause for the clinical signs. Magnetic resonance imaging (MRI) was not available at the time. A presumptive diagnosis of cerebrovascular accident was made. Prompt medical treatment was initiated and the animal was started on aspirin and a tapering dose of prednisone. In accordance with human guidelines, aspirin therapy was continued long term, while oral contraceptives were discontinued.2,3

Gross motor movement did not return in the 8-wk time frame offered by another case report,4 however, steady improvement was observed over the 6 mo following onset of clinical signs. Physical therapy has been encouraged by stimulation from the keepers using operant conditioning. Ropes and other materials have been used to facilitate movement in enclosures. Gradual reintroduction to other members of the troop has allowed for resumption of group participation. The individual care of this animal provided by the keeper staff was an important factor in the successful outcome of this case. The continued dedication and persistence of the keepers in encouraging movement and adapting to the needs of a handicapped animal have made reintroduction and rehabilitation possible. This case offers an example of long-term recovery from a presumptive cerebrovascular accident.

LITERATURE CITED

A COMPARATIVE STUDY OF BLOOD LIPIDS AND STRESS LEVELS BETWEEN CAPTIVE AND SEMI-CAPTIVE ORANGUTANS (*Pongo pygmaeus*) UNDER TROPICAL CONDITIONS

Choy Foon Seng,* Goh Yong Meng, DVM, PhD, and Rasedee Abdullah, MSc, PhD

Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400, Serdang, Selangor Darul Ehsan, Malaysia

Abstract

Blood samples were collected from 27 orangutans (*Pongo pygmaeus*) (14 captive and 13 semi-captive) and were analyzed for triglycerides, total cholesterol, high density lipoprotein cholesterol (HDLC), low density lipoprotein cholesterol (LDLC), glucose, cortisol levels, total red blood cells (RBC), white blood cells (WBC) and WBC differential count. There were significant differences (P<0.05) in total cholesterol and HDLC level between groups where semi-captive males had the highest level while the lowest were the captive male orangutans. When the blood lipid values were compared across age groups, the triglyceride, total cholesterol and HDLC levels of adult animals differ significantly (P<0.05) from the younger age groups. Finally, captive orangutans had higher (P<0.05) serum cortisol level and N:L ratio as compared to semi-captive orangutans suggesting that captive orangutans are in more stressful states. Based on the results, captive orangutans tend to have “less” desirable blood lipids and are “potentially” more stressed than semi-captive orangutans. In this study, it is evident that nutrition plays a sizable role in determining the blood lipid levels. Other factors that affect blood lipids are gender and age. It was postulated that the lack of stimulating environment and enrichment programs in captive environment, may have lead to the increase in stress indicators.

Introduction

The major challenge that is faced by keeping any animal in captivity would be to simulate a diet and habitat that is as natural as possible. However, limited knowledge of the physiology and natural diet of the orangutan has led to the feeding of a diet that is quantitatively and qualitatively different from their natural diet. Many captive orangutans had been fed an urbanized diet that is typically high in fat and carbohydrate. Captive orangutans may also be subjected to an unenriched and non-stimulating environment that may result in stressful states. Consequently, many captive orangutans end up being overweight and suffer from excessive boredom. Obesity, hypercholesteremia, HDLC/ LDLC imbalance and chronic stress are among the risk factors for atherosclerosis, coronary heart disease, hypertension, diabetes mellitus and myocardial infarction that have been identified in human populations. However, these risk factors have never been studied or identified in orangutans. Therefore, this study was conducted to assess and compare the blood lipid profile and stress levels of captive and semi-captive orangutans as well as to contribute towards the database for blood lipids and stress levels in captive orangutans kept under tropical conditions.
Materials and Methods

Animals and Blood Collection

A total of 27 Bornean orangutans (Pongo pygmaeus) of various sex and age were included in this study where 14 animals were sampled from captive location (National Zoo of Malaysia & Sabah Zoological and Botanical Garden, Malaysia) while 13 animals from a semi-captive location (Sepilok Orangutan Rehabilitation Center, Malaysia). General anaesthesia was induced by using tiletamine and zolazepam/ Zoletil 100® (Virbac Laboratories, NSW, Australia) at the dosage of 3-5 mg/kg intramuscularly via hand syringe, blowpipe or air-pressured pistols. Following immobilization, a physical examination was performed to ensure the good health of the animal. 10 ml of blood were collected from either the brachial, cephalic or femoral vein and 3 ml of blood are placed in EDTA (Vacutainer® K2 EDTA, Becton-Dickinson & Co, Franklin Lakes, NJ, USA) and the remaining in serum separator tubes (SST™, Becton-Dickinson & Co, Franklin Lakes, NJ, USA), stored in 4°C and processed within 24 hr. Serum was obtained after centrifuging the blood samples at 5000 G for 5 min. The serum samples were kept at -20°C in 1.5 ml microcentrifuge tubes (Eppendorf®, Hamburg, Germany) for subsequent serum biochemistry and cortisol assay.

Hematology and Serum Biochemistry

Total white blood cells (WBC) were manually quantified using the hemocytometer techniques. Thin blood films were also made, air dried and stained with Wright’s stain (Sigma®, Sigma-Aldrich Corporation, MO, USA). WBC differential count was performed after Wright staining. The neutrophil: lymphocyte (N:L) ratio was calculated from the differential counts. Serum biochemistry results were obtained by processing the thawed frozen serum on an automated analyzer (Hitachi® 902, Roche Diagnostics, GmBH, Germany). The parameters that were analyzed included total cholesterol, triglyceride, high density lipoprotein cholesterol (HDLC) and low density lipoprotein cholesterol (LDLC), sodium, potassium, chloride, calcium and phosphate. Serum cortisol was measured using a cortisol test kit (Coat-A-Count®, Diagnostic Product Corporation, Los Angeles, USA). Glucose was measured using a portable glucometer immediately after the blood samples were collected.

Statistics

Differences in blood lipid values were compared across management status, gender and ages using one way ANOVA procedure meanwhile differences in stress indicators were compared using two tailed t-test. Significant different means were then elucidated using Duncan’s New Multiple Range test. All statistical analyses were performed using SPSS version 14.0 at 95% confidence level.
Results

Lipid

The blood lipid values of orangutans segregated according to management system and sex are shown in Table 1. There were significant differences (P<0.05) in total cholesterol and HDLC levels between groups where semi-captive males had the highest level while the lowest was in the captive male orangutans. When the blood lipid values were compared across age groups, the triglyceride was found to be significantly higher (P<0.05) while the total cholesterol and HDLC levels were significantly lower (P<0.05) in adult orangutans. In fact, there was a strong correlation of triglyceride with the age of the animal (Pearson’s correlation = 0.493, P = 0.009). A trend was seen in the blood lipid profiles in male and female orangutans. Male orangutans had higher levels of triglyceride, total cholesterol, LDLC and Chol/HDLC ratio compared to female orangutans. These results will be compared to the ISIS normal ranges.5

Stress Levels

Captive orangutans had significantly higher (P<0.05) levels of serum cortisol and neutrophil: lymphocyte ratio (N:L ratio) as compared to semi-captive orangutans (Table 2). The serum cortisol level of captive orangutans was almost two times higher than semi-captive specimens. However, there were no differences in glucose and cholesterol levels. These results will be compared to the ISIS normal ranges.5

Discussion

Lipids

The differences in the lipid profile of the captive and semi-captive orangutans could be mainly due to the differences in nutritional management. One of the captive locations feeds the animal with high carbohydrate and triglyceride food items such as coconut, cocoa bread, milk and sugar cane. Carbohydrates tend to raise serum triglyceride and decrease LDLC levels especially if it comprises at least 60% of the total calories.4 The cocoa bread and milk contains butter and milk fat which can potentially elevate the triglyceride and cholesterol levels. Furthermore, coconut is a major source of myristic and lauric acid, both potent cholesterol-raising fatty acids.3 Meanwhile, only bananas and milk are offered as a supplementary feed only in the semi-captive location. The amounts offered were designed not to fulfill daily caloric requirements. This would promote more foraging activities and help in achieving the objectives of the rehabilitation program.

Semi-captive orangutans have an easier access to food items that are high in dietary and structural fibers. There is a strong inverse correlation between dietary fiber and coronary heart disease. Soluble fibers such as β-glucan (found in oats, barley and yeast), psyllium (found in husks of blonde psyllium seed) and pectin (found in fruits) have been demonstrated to effectively lower blood cholesterol levels.4 When compared across age groups, older orangutans have higher triglycerides, LDLC and Chol/HDLC ratio and lower HDLC/LDLC ratio. It is believed that the
Aging of the patient reflects the cumulative exposure to atherogenic risk factors throughout its life.

Stress Levels

Responses to stressors often involve changes in physiologic function (biochemical, neuroendocrine, metabolic), immunity, reproductive, histopathology, psychologic state, behaviour and toxicology status. In this study, only endocrine (cortisol), immunology (N:L ratio) and to a certain extent, metabolic (glucose and cholesterol) and behavioural parameters were measured and evaluated. However, behavioural changes were only subjectively accessed by comparing the natural behaviour between semi-captive and captive orangutans and therefore were not conclusive in this study. One of the factors that could have elevated the stress indicators in captive orangutans is the lack of stimulating environment and activities. By nature, the orangutan’s feet are adapted to life in the tree than on the ground. Many zoo managements fail to provide the orangutans with sufficient vertical space and structures that allow arboreal locomotion. Besides that, captivity has removed much of the complexity and seasonality of food sources. Without understanding the importance of seasonal availability of food in the feeding ecology of an animal, captive animals are typically fed discrete meals at predictable times, year in and year out. In this study, the influence of the diet that differs dramatically from their natural diet in terms of quantity and quality on the stress levels of the animals has yet to be investigated.

Conclusion

In conclusion, captive orangutans had “less” desirable blood lipids and are “potentially” more stressed than semi-captive orangutans. In this study, it is evident that nutrition plays a sizable role in determining the blood lipids. Other factors that affect blood lipids are gender and age. As for the stress levels, it was postulated that the lack of stimulating environments and the limited enrichment programs may have lead to the increased stress indicators seen among captive orangutans in this study.

LITERATURE CITED


Table 1. Blood lipid values of orangutans based on management system and sex (values expressed as mean ± SEM).

<table>
<thead>
<tr>
<th>Blood Lipid Values</th>
<th>Male (n=4)</th>
<th>Female (n=10)</th>
<th>Male (n=9)</th>
<th>Female (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglyceride</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mmol/L</td>
<td>1.70 ± 0.36</td>
<td>1.01 ± 0.22</td>
<td>0.92 ± 0.09</td>
<td>0.84 ± 0.31</td>
</tr>
<tr>
<td>(mg/dL)</td>
<td>(150.40 ± 31.76)</td>
<td>(89.40 ± 19.08)</td>
<td>(81.81 ± 8.37)</td>
<td>(74.20 ± 27.27)</td>
</tr>
<tr>
<td>Total Cholesterol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mmol/L</td>
<td>4.58 ± 0.50a</td>
<td>5.16 ± 0.28ab</td>
<td>5.69 ± 0.24b</td>
<td>4.74 ± 0.19ab</td>
</tr>
<tr>
<td>(mg/dL)</td>
<td>(177.15 ± 19.41)</td>
<td>(199.50 ± 10.67)</td>
<td>(220.12 ± 9.28)</td>
<td>(183.44 ± 7.37)</td>
</tr>
<tr>
<td>HDLC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mmol/L</td>
<td>1.38 ± 0.10a</td>
<td>1.95 ± 0.17ab</td>
<td>2.16 ± 0.15b</td>
<td>1.74 ± 0.25ab</td>
</tr>
<tr>
<td>(mg/dL)</td>
<td>(53.50 ± 3.73)</td>
<td>(75.50 ± 6.56)</td>
<td>(83.46 ± 5.95)</td>
<td>(67.14 ± 9.70)</td>
</tr>
<tr>
<td>LDLC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mmol/L</td>
<td>2.65 ± 0.45</td>
<td>2.75 ± 0.19</td>
<td>3.08 ± 0.24</td>
<td>2.59 ± 0.19</td>
</tr>
<tr>
<td>(mg/dL)</td>
<td>(102.56 ± 17.31)</td>
<td>(101.46 ± 7.19)</td>
<td>(119.07 ± 9.20)</td>
<td>(100.33 ± 7.36)</td>
</tr>
<tr>
<td>HDLC/LDLC ratio</td>
<td>0.57</td>
<td>0.72</td>
<td>0.75</td>
<td>0.70</td>
</tr>
<tr>
<td>Chol/HDL ratio</td>
<td>3.31</td>
<td>2.73</td>
<td>2.72</td>
<td>2.89</td>
</tr>
</tbody>
</table>

a,b  Means in the same row with different superscripts are significantly different (P<0.05).

Table 2. Stress indicators of orangutans based on management system (values expressed as mean ± SEM).

<table>
<thead>
<tr>
<th>Stress Indicators</th>
<th>Captive (n=14)</th>
<th>Semi-captive (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Cortisol µg/dL</td>
<td>11.60 ± 1.62a</td>
<td>6.93 ± 0.94b</td>
</tr>
<tr>
<td>Neutrophil: Lymphocyte ratio</td>
<td>1.71 ± 0.24a</td>
<td>1.08 ± 0.18b</td>
</tr>
<tr>
<td>Glucose mmol/L</td>
<td>5.26 ± 0.24</td>
<td>5.15 ± 0.19</td>
</tr>
<tr>
<td>Cholesterol mmol/L</td>
<td>5.0 ± 0.24</td>
<td>5.57 ± 0.21</td>
</tr>
</tbody>
</table>

a,b  Means in the same row with different superscripts are significantly different (P<0.05).
DEVELOPMENT OF THE GORILLA HEALTH PROJECT

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Abstract

Cardiac disease is a major cause of death for adult gorillas in AZA institutions. In November 2006 a workshop including physicians, veterinarians, pathologists, and keepers was held to review what is known about gorilla cardiac health, as well as to discuss how to address gorilla health issues. This workshop marked the beginning of the Gorilla Health Project, an initiative to improve our understanding of gorilla health and ways to manage and prevent disease in this species. The meeting identified a critical first step in understanding disease issues of captive gorillas -- the formation of a comprehensive database incorporating information from individual gorillas' medical, nutrition and husbandry records. This database is essential for the identification of risk factors associated with cardiac disease and other disease syndromes seen in the captive population. Compiling data on the health and husbandry of captive gorillas will increase our current understanding of the health issues of the captive population, and provide a means to examine disease trends over time. This database will provide the foundation for future prospective studies focusing on the etiology of disease syndromes, improved treatment protocols, and effective means of preventing disease in the captive population.

In order to support this effort, a new structure was proposed for the veterinary advisory role within the SSP. The new structure will consist of a team of three veterinary advisors along with four regional coordinators. This structure is intended to improve the collection and dissemination of health information within the Gorilla SSP population.
METAPHYSEAL OSTEOPATHY IN CAPTIVE CHEETAHS (*Acinonyx jubatus*)

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Abstract

Metaphyseal osteopathy affecting the antebrachii was diagnosed in seven (five male, two female) captive bred cheetahs (*Acinonyx jubatus*) from four separate litters housed at two zoological institutions. Affected cheetah developed unilateral or bilateral forelimb lameness and valgus deviation of the fore paws between 6–10 mo of age. Radiographic evaluation of both antebrachii was performed in all cheetahs. The principal abnormality was a core of lucent tissue in the distal ulna metaphysis, present bilaterally in six of the seven affected animals. Progressive cranial curvature of the distal radius and asymmetric thickening of the caudal cortex of the distal radius accompanied outward rotation and valgus displacement of the fore paws in each affected animal.

Hematologic and serum biochemistry parameters assessed in four animals were within normal limits for captive cheetah. Serum parathyroid hormone levels and Vitamin D levels were within normal ranges for domestic cats. A lesional biopsy from the distal ulna metaphysis of one animal revealed cartilage and osseus necrosis and metaphyseal dysplasia. Unilateral or bilateral ulna ostectomies were performed in all affected animals to correct the radial curvature and valgus limb deformity. The clinical signs and radiographic lesions evident in affected cheetahs resembles a poorly understood condition seen in rapidly growing large breeds of dogs termed retained enchondral cartilage cores.1 Possible etiologies for metaphyseal osteopathy in cheetahs include excessive dietary calcium supplementation, hypernutrition and a genetic predisposition in affected animals.

ACKNOWLEDGMENTS

The authors thank Dr Helen McCracken for supplying historic records and radiographs from Melbourne Zoo.

LITERATURE CITED

HIP DYPLASIA IN NORTHERN KOALAS (Phascolarctus cinereus adustus)

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Abstract

A retrospective-prospective study has documented 54 cases of moderate to severe hip dysplasia, with varying degrees of shallowing of the acetabulum, flattening or loss of the femoral head, widening or loss of the femoral neck, and curvature of the femur, in northern koalas (Phascolarctus cinereus adustus) in the San Diego Zoo collection. For the retrospective study, historic radiographs were examined where available. For the prospective study, three standard views (ventrodorsal extended, ventrodorsal frogleg, and lateral extended) were used. A scoring system was developed using four areas (acetabulum, femoral head, femoral neck, and femur) and ranges of 0 to 5 (0 = not affected, 5 = severely affected) for a total score out of 40. Scores were graded as follows: Excellent = 0-2, Mild = 3-6, Moderate = 10-19, Severe = 20+.

Twenty-nine koalas were graded as severe, 25 koalas as moderate, 38 koalas as excellent or mild. Preliminary examinations of pedigree charts were inconclusive due to multiple missing data points. Preliminary reports of serum vitamin D levels appear low (normal values from free-ranging koalas are pending). Affected koalas may or may not demonstrate gait abnormalities. Mild to severe degenerative joint disease may develop and symptoms may be alleviated with glucosamine / chondroitin sulfate (half a capsule p.o. s.i.d. [Cosequin® DS, Nutramax Laboratories, Inc., Edgewood, MD 21040 USA]) for mild to moderate clinical cases, plus non-steroidal anti-inflammatory drugs (meloxicam, 0.1-0.2 mg/kg, p.o. s.i.d. [Metacam® Oral Suspension; Boehringer Ingelheim Vetmedica, Inc., St. Joseph, Mo, 64506-2002 USA]) long term for severe clinical cases.

ACKNOWLEDGMENTS

The authors thank the many veterinarians, veterinary technicians, keepers, and koalas at the Zoological Society of San Diego who have contributed to this study.
Cryptococcus neoformans PNEUMONIA IN SLENDER TAILED CLOUD RATS (Phloeomys pallidus): A REVIEW OF SEVEN CASES

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Abstract

Medical records from 68 slender tailed cloud rats, Phloeomys pallidus, housed at the Bronx Zoo between July 1985 and September 2006 were reviewed. Thirty-one animals (45.6%) survived to adulthood (> 2 yr) and remained at the Bronx Zoo. Seven of these animals (22.5%) were diagnosed with cryptococcal pneumonia.

Affected animals ranged in age from 5.5 - 13 yr at time of presentation. Three cases presented clinically; fungal serology was positive in all three. Clinical signs and physical examination findings included dyspnea, thin body condition/muscle wasting, harsh lung sounds, and lethargy. Diffuse interstitial pneumonia was demonstrated radiographically. Clinical pathology abnormalities included leukocytosis (mature neutrophilia), hyperkalemia, and azotemia. One geriatric animal had concurrent pulmonary neoplasia and was euthanatized. Treatment in the other two consisted of oxygen therapy, antibiotics, and one or more antifungals (Flucytosine/Ancoban, Valeant Pharmaceuticals, Costa Mesa, CA USA 92626, 75 mg/kg p.o. b.i.d.; Fluconazole, Greenstone, Peapack, NJ USA 07977, 12 mg/kg p.o. b.i.d.; Amphotericin B, X-Gen Pharmaceuticals, Northport, NY, USA 11768, 0.25-0.5 mg/kg/day i.o. and 1-5 mg nebulized b.i.d.); however neither case survived. Diagnosis in the majority of cases was made after death (n=4). Gross necropsy findings included granulomatous pneumonia and thoracic lymphadenomegaly. Histologic lesions consistent with cryptococcosis were noted in the lungs of all cases. Additionally, infection of lymph nodes, gastrointestinal tract, liver or pancreas was seen in some cases.

C. neoformans is an opportunistic saprophyte with worldwide distribution in which immunocompromise often predisposes to infection.1,3,4 It most commonly colonizes the respiratory tract but has also been shown to affect the gastrointestinal tract and can invade directly via skin wounds.2 Based on the large numbers of cases seen in this species at the Bronx Zoo, compared to very infrequent cases in all other species necropsied, cloud rats appear to be unusually susceptible to this pathogen.

LITERATURE CITED

OPTIC NEURITIS AND PYOGRANULOMATOUS ENCEPHALITIS CAUSED BY WEST NILE VIRUS IN AN AGED MOUNTAIN LION (Puma concolor aztecus)

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Abstract

A 16-yr-old mountain lion (Puma concolor aztecus) with a history of chronic renal failure presented with signs of disorientation, lethargy, and impaired vision. Over the course of the next 24 hr the animal exhibited signs of incoordination, circling to the left, bumping into walls, and bilateral mydriasis. Diagnostic evaluation included a complete ocular examination, a magnetic resonance brain scan, cerebral spinal fluid analysis (with anaerobic, aerobic, and fungal cultures), complete blood count, serum chemistry, and serology (feline infectious peritonitis, canine distemper, West Nile virus, St. Louis encephalitis, and coccidiodomycosis). The animal was treated supportively with antibiotics, steroids and fluids as needed. Significant findings by the neurologist were a bilateral optic neuritis, pyogranulomatous encephalitis, and an elevated WNV titer [1:640 by hemagglutination inhibition (HI)].

The animal recovered over the course of 1 mo and remained clinically normal for 11 wk except for impaired vision that developed after corticosteroids were discontinued. Over the next several months the animal intermittently exhibited episodes of ataxia, lethargy, circling, disorientation, nystagmus, bilateral mydriasis, bumping into walls, muscle tremors, and a possible seizure. The animal responded to steroids with or without antibiotics.

Mosquito trapping in the area at the time of the initial signs showed no evidence of WNV infected mosquitoes; although, in an adjacent enclosure, a male pronghorn was diagnosed with a WNV infection 1 mo prior to the mountain lion’s infection.
NOVEL VIRAL SYNDROMES IN FERRETS (*Mustela putorius furo*)

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Abstract

Two new viral syndromes have been detected in domestic ferrets (*Mustela putorius furo*) from Spain. Unsanitary conditions in multi-species facilities and immunosuppression due to early weaning, neutering, vaccination, microchip placement and shipment to foreign countries may have played an important role in the development of these conditions.

1. Granulomatous inflammatory syndrome (GIS)

Affected ferrets were generally younger than 9 mo, had a common origin in a multi-species farm, and presented 0-5 mo after having been purchased by private owners. Clinical signs included diarrhea, lethargy, weight loss and hind limb weakness. Clinicopathologic findings consisted of mesenteric lymphadenopathy, splenomegaly, hypergammaglobulinemia and non-regenerative anemia. Hypergammaglobulinemia (>1.8 g/dL) and abnormal abdominal palpation were common in all affected ferrets. The condition was progressive and fatal despite several different treatments; however, temporary improvements were common during the course of the disease. Post-mortem examinations revealed disseminated granulomatous lesions in several organs, mainly lymph nodes and mesentery. Histologic lesions consisted of granulomatous inflammation similar to that characteristic of feline infectious peritonitis (FIP). Tissues from affected ferrets were positive for group 1 coronavirus antigen by immunohistochemistry. The ferret is the first non-felid species in which a syndrome similar to FIP has been diagnosed.

2. Natural outbreak of canine distemper (CD)

Affected ferrets were all younger than 6 mo and had a common origin in a multi-species farm. Clinical signs included anorexia, lethargy, dyspnea, cough, sneezing, mucopurulent ocular and nasal discharge, and facial and perineal dermatitis. Diarrhea, splenomegaly and fever were occasionally seen. General desquamation and pruritus, and crusting dermatitis in lips, eyes, nasal area, footpads, and perineal area were seen late in the disease. None of the ferrets developed neurologic signs. Non-regenerative anemia and increased α and β-globulins were the most common laboratory findings. Most animals died or were euthanatized due to respiratory
complications. Necropsy revealed lack of lung collapse in all ferrets. Distemper was diagnosed ante-mortem by direct immunofluorescence of conjunctival swabs or post-mortem by histopathology of several organs. Minimum incubation periods calculated for 6 ferrets ranged 11-56 days. In addition, *Enterobacter cloacae* was isolated from the lung of one ferret, and inclusion bodies compatible with infection by herpesvirus were found in the lung of another ferret. This report demonstrates that strains causing natural CD may differ from those used to describe experimental or vaccine induced CD, and therefore other courses with signs such as generalized pruritus, long incubation periods, lack of neurologic signs and pneumonia as a main cause of death may be expected.
LONG TERM MANAGEMENT OF LYMPHOPLASMACYTIC EOSINOPHILIC GASTRITIS AND ENTERITIS IN A SOUTHERN TAMANDUA (*Tamandua tetradactyla*)

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Abstract

The captive United States tamandua (*Tamandua tetradactyla*) population currently consists of 18 males and 23 females housed in 26 zoos across the country, most often kept singly or in pairs. Diseases of the gastrointestinal system and inconsistencies in captive husbandry and nutrition are common causes of morbidity in the captive population. A 2.5-yr-old, hand-raised female tamandua at the Houston Zoo had a 1-yr history of intermittent diarrhea and vomiting. After multiple attempts at empiric treatment, mucosal biopsies of her stomach and duodenum were collected endoscopically. Biopsies demonstrated mild lymphoplasmacytic, eosinophilic gastritis and moderate lymphoplasmacytic, eosinophilic enteritis. At the time of diagnosis, the tamandua had ascites and marked hypoproteinemia (total serum protein 3.9 gm/dL, albumin 1.0 gm/dL). Initially medical management was attempted with metoclopramide (0.55 mg/kg p.o. b.i.d.), tylosin (28 mg/kg p.o. b.i.d.), sucralfate (0.05 gm/kg p.o. t.i.d.) and famotidine (0.44 mg/kg p.o. s.i.d.). Oral prednisolone (0.95 mg/kg p.o. b.i.d.) was initiated 2 mo later when hypoproteinemia persisted and clinical signs failed to resolve. Over the following 20-mo period, her prednisolone dosage has been adjusted as we have attempted to wean her off prednisolone and clinical signs have returned. Repeatedly when prednisolone is weaned down below a total daily dosage of 0.4 mg/kg, ascites, diarrhea, lethargy and hypoproteinemia return. She is currently down to a prednisolone dosage of 0.25 mg/kg p.o. b.i.d., as well as metoclopramide (0.55 mg/kg p.o. s.i.d.), tylosin (28 mg/kg p.o. b.i.d.), sucralfate (0.05 gm/kg p.o. b.i.d. and famotidine (0.44 mg/kg p.o. s.i.d.). Her condition is monitored through weekly body weights and blood samples collected from the ventral tail vein every 4-6 wk. Her total serum protein (7.0 gm/dL) and albumin (2.5 gm/dL) remain normal and diarrhea and vomiting have resolved. Thus far she has demonstrated no adverse clinical effects from chronic prednisolone therapy, and clinical condition and quality of life are vastly improved since treatment was initiated. Though the cause of chronic or recurrent vomiting and diarrhea in captive tamandua is likely multifactorial, the presence of these clinical signs warrants endoscopic evaluation to better characterize underlying etiology and guide treatment.
HYPOTHYROIDISM AND SUSPECTED DIETARY HYPERSENSITIVITY IN A CAPTIVE MANED WOLF (Chrysocyon brachyurus)

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Abstract

A captive 7-yr-old female maned wolf (Chrysocyon brachyurus) was immobilized for examination due to a 3-mo history of loose stool, decreased appetite, occasional regurgitation of quail and undigested quail in feces. Her coat was thin and grey, with a dull, rough appearance. Thyroid levels were consistent with hypothyroidism characterized by low normal serum T4 (0.7 ug/dl), low free T4 (1.54 pmol/l), and high TSH (>12 ng/ml) compared to canine reference ranges (T4 0.7-2.2 ug/dl, free T4 12-34 pmol/l, and TSH 0.1-0.4 ng/ml) and banked serum from 10 clinically healthy captive maned wolves (T4 0.5-0.96 ug/dl, free T4 1.9-21.62 pmol/l, and TSH 0.03-0.26 ng/ml). She was supplemented with levothyroxine sodium (0.4 mg b.i.d., Thyrozine®, Phoenix Pharmaceutical Inc., St. Joseph, MO USA). Four months later, thyroid levels were more normal [T4 (1.3 ug/dl), free T4 (16.73 pmol/l), and TSH (0.66 ng/ml)], and her coat was improved.

One year after thyroid supplementation began, she was immobilized due to the recurrence of clinical signs. Thyroid levels were normal (T4 1.4 ug/dl, free T4 12.87 pmol/l, and TSH 0.06 ng/ml). Based on clinical presentation, skin biopsies consistent with inflammatory skin disease, and hyperglobulinemia, a presumptive diagnosis of food hypersensitivity was made. Her diet of ProPlan Natural Lamb and Rice Formula (Purina, St. Louis, MO USA), quail, and fruit, was changed to a limited ingredient diet of canned canine Venison Formula and dry canine Potato and Venison Formula (Royal Canin Veterinary Diet™, St. Charles, MO USA), quail and fruit. The new diet was highly palatable, her food intake increased and 10 days later her stools were more firm. One month after the diet change her coat appeared thicker and redder; 4 mo later her coat was normal.
SINGLE-INJECTION INULIN CLEARANCE FOR ROUTINE DETERMINATION OF GLOMERULAR FILTRATION RATE IN CHEETAHS (*Acinonyx jubatus*)

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Abstract

A high prevalence of four unusual diseases has been seen among captive cheetahs from the United States and the Republic of South Africa (RSA).1,9 Of these four conditions, two are renal diseases. Renal disease is considered the leading cause of mortality in captive cheetahs.8 The diagnosis of renal disease in cheetahs is achieved, in most cases, once the kidneys have reached an end-stage. The presence of azotemia is the most common laboratory abnormality observed in cats with renal disease. When azotemia is present, at least 75% of the nephrons of the kidneys are non-functional already.4 At this point, treatment is unrewarding. Glomerular filtration rate (GFR) is considered a more sensitive test for the detection of early-stage renal disease.5 GFR is also considered to be the best single parameter for assessing overall renal function because GFR is directly related to functional renal mass.3 A simple technique for the assessment of GFR via the determination of inulin clearance from serum or plasma after a single intravenous injection has recently been described in domestic cats and dogs.2,6,7 The studies in domestic carnivores concluded that the inulin excretion test, using a single blood sample at 3 hr after the administration of intravenous inulin, is a valuable tool for the determination of GFR in these species. In summary, animals with suspected renal disease or confirmed renal disease had lower GFR values than control animals.6,7 Using this technique we determined the glomerular filtration rate on three populations of cheetah managed under different conditions. The determination of GFR in captive cheetahs offers the possibility of establishing baseline parameters that could potentially help in the diagnosis of renal disease in early stages.

LITERATURE CITED


Improved Husbandry and Nutrition Results in Successful Reproduction in the Thailand Clouded Leopard (Neofelis nebulosa)

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Abstract

Scientists from the Smithsonian’s National Zoological Park have been working with clouded leopards (Neofelis nebulosa) in North America and Thailand for over 20 yr. Studies have demonstrated the importance of good husbandry and nutrition for successful reproduction in felids. In 2002, a consortium of North American and Thailand zoological institutions initiated a clouded leopard breeding program at the Khao Kheow Open Zoo in Chonburi, Thailand aimed at applying this new knowledge to optimize breeding success. Clouded leopards were moved from enclosures in Thailand zoos known to induce stress (small size, lack of hiding places, adjacent to large carnivores) to large, vegetation-rich enclosures with nest boxes. Nutritionally poor diets were altered to include whole prey, chicken meat and vitamin/mineral supplementation. Since 2002, 26 clouded leopard cubs have been born (22 surviving) to six successful male-female pairs. In addition to the breeding success, this program has documented the impact of management changes on reproduction. Daily fecal samples were collected from eight adult females and six adult males before and after improvements, shipped to the U.S.A. and fecal reproductive hormones measured. Results show that one of eight (12.5%) adult females was not cycling at the start of the project, but began cycling within 6 mo of management changes. In addition five of eight (62.5%) females showed more frequent cycling and one female (12.5%) bred and carried a successful pregnancy to term also within 6 mo. Thus, seven of eight (87.5%) female clouded leopards in the study had improved reproductive status following diet and husbandry changes. Similarly, males showed higher (p < 0.05) testosterone concentrations within 6 mo of improvements. These results show the importance of good diet and management to reproductive success in captive clouded leopards.
ESTABLISHING A MULTI-NATIONAL, COOPERATIVE, ZOO-BASED, CONSERVATION PROGRAM IN THE RAPIDLY CHANGING ARID SOUTHWEST

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Abstract

Global warming may have a serious impact on human population within this century. Changes in local and regional weather patterns will most likely degrade human and environmental health. At present rates of biodiversity loss, 25% of all species on earth may become extinct within 50 yr. Causes of loss of biodiversity include encroachment and destruction of forested areas, savannas, freshwater wetlands, marine resources and other ecosystems; high consumption of natural resources, introduction of alien invasive species, pollution, acid precipitation, and widespread use of toxic substances and pesticides. Climatologic changes will likely affect water-stressed arid ecosystems.

The arid Southwestern United States is a region of environmental concern. Encroaching and ever-expanding communities and sub-urban development, strained renewable freshwater resources, compromised riparian systems, changes in land use, political border issues, and an 11-yr drought are rapidly changing the regional environment. Western aquatic biologic communities are being transformed by water diversion, heavy grazing of streamside vegetation, degradation of river banks, catastrophic wildfires, waste water dumping, introduced diseases, and the introduction of non-native competitor and predator species.

The Arizona Zoological Society (AZS) is committed to inspire people to live in ways that promote the well-being of the natural world. The Society’s conservation plan involves direct and indirect participation in local, regional, national, and international wildlife conservation projects. Current programs occur in two distinct modalities at the landscape, life zone, and watershed level. The focus is on ecosystem conservation.

1) Active participation – Conservation efforts are directed at preserving, restoring, or sustaining a set of habitats, as well as determining the effect of rapid change on the species they support. Most programs are multi-faceted, diverse, comprehensive, and occur simultaneously. The focus of the program is the arid and semi-arid Southwest, with all the species it contains. Recent changes to the global environment, the fact that nearly one-quarter of the entire surface of the earth’s land could be defined as arid, and our location in a rapidly changing arid ecosystem, give incentive to create or participate in
collaborative regional plans, as well as interpret the most productive aspects of those plans to other institutions. The concept of environmental medicine is key to the overall goals of the program. International programs support ecosystems represented in the collection, and yet will occupy only ten percent of our annual departmental expenditures. Their impact in the long run, however, may be considerable. Our goal is to promote effective conservation, as measured by the preservation of viable, genetically diverse, and self-sustaining healthy populations of wildlife in viable habitats. Our basic objective is to keep wild animals living in the wild.

2) **Zoo Experience/Collections** – Visitors to the zoo are engaged through cognitive, emotive, and behavioral activities in the recognition of environmental issues and their direct effects on all beings. The focus of our programs is the link between the environment, health and the species that inhabit diverse ecosystems. The goal is to affect the way our visitors behave towards their environment. We seek to promote responsible stewardship of natural resources at a local and regional level. It would be advisable when developing the regional exhibits in the zoo’s Master Plan, that regional conservation efforts be highlighted. A strong emphasis on the Southwest and the species we seek to preserve in their native habitat should be pre-eminent. The Native Species Conservation Center (NSCC) will help connect our guests with the many conservation activities we are involved with beyond our gates. Ideally, visitors could do a “short trail” with non-native tropical interpretation, and a “long trail” visiting the American Southwest and our proposed animal sanctuary, should they wish to do so. Developing our Master Plan properly should allow us to showcase an “exotic” component for return visitors, and an important regional component for those interested in our activities in the region. Active guest participation through technologically advanced exhibits and interactive electronic materials are in the works. Our goal is to inspire guest and staff alike into proactive community and regional conservation roles.

**Zoo-based Programs**

All single species programs are currently scheduled for 2 and 5 yr reviews. Goals are set at the inception of each program, and documents of agreement and budgets are to be reviewed fully at that time. Status reports are to be presented to the Director, the Conservation Committee, and the Board of the Arizona Zoological Society.

**Species Currently in Preferential or Priority Programs**

**Programs on Zoo Grounds**

*Narrow-headed Garter Snake* – An informal agreement with Arizona Game and Fish (AZGF), US Fish and Wildlife (USFWS), and the Phoenix Herpetological Society is in place. The zoo has committed verbally to accept up to five individual narrow-headed garter snakes with the goal of producing a management, care, and breeding manual. Once a husbandry manual is produced for the species, they will be transferred to the Phoenix
Herpetological Society as an ex-situ population is formally established. A twin project exists for the Sonora Desert Museum with Mexican garter snakes.

**Black Footed Ferret (BFF)** – Program in place since 1992. Currently being evaluated for cost, productivity and merit. Participation with the USFWS programs is expected throughout 2007 and beyond. Paul Marinari (USFWS) has been actively monitoring and consulting with staff during the current breeding season. Some retired BFF may be placed in the NSCC for training and programs purposes.

**Chiricahua Leopard Frog** – An assurance colony of the last remaining animals from the Buckskin area has been established at the zoo. Currently the two remaining males and the one remaining female have produced a fertile embryo mass that is being head-started on grounds. A second part of the program involves in-house head-starting of select egg masses collected from the wild by AZGF. The goal is the release of successfully head-started animals into managed recovering environments. Over 1100 tadpoles and morphs were released into the Tonto National Forest last fall, and are currently being monitored for success by AZGF. The plan is to build up populations in managed landscapes with a goal of full species recovery in the southern area of distribution. The plan is in support of the AZGFD Recovery Plan, and is reviewed every 5 yr.

**Proposed Programs for Zoo Grounds**

**Lowland Leopard Frog** – A discussion to head-start of partial or complete egg masses collected from the wild by a bi-national project with Mexico has begun. Once established, the release of successfully head-started animals into managed recovering environments will take place in Sonora, Mexico.

**Three Forks and San Bernardino Springsnails** – Refugia for severely endangered invertebrates proposed by AZGFD. Set up at NSCC. Both species restricted to single spring sources currently in need of management in the Apache-Sitgreaves National Forest and Cochise County, respectively. Appendix I.

**Off Site Animal Programs**

**Jaguar** – Camera trapping of animals through ongoing support of the Sky Island Alliance, the Borderlands Jaguar Detection Project, and the Northern Jaguar Project is currently being considered. Technical support has been given to all projects, as was direct participation in the Mexican Jaguar Population and Habitat Viability Assessment (PHVA), in support of the AZGF Non-Game Department.

**Masked Bobwhite Quail** – Currently supporting with USFWS to discuss future long term projects. The Buenos Aires Refuge is receiving technical support and husbandry advice on their captive flock.
**Mexican Grey Wolf** – Adaptive Management Oversight Committee evaluation of current protocols in association with numerous national and regional conservation groups. Evaluation of program and current progress through regional, environmental, and land based groups. Participation in the current Freedom of Information Act process, along with numerous groups and the AZA.

**Sonoran Pronghorn** – Support of Arizona based USFWS programs for monitoring and release of managed populations. Cooperative work with peninsular pronghorn research is under consideration. On site support of non-invasive research with northern pronghorn to determine basic behavior in coordination with Arizona State University School of Living Sciences.

**California Condor** - Medical support and treatment of chronically injured or poisoned re-introduced birds. Aggressive treatment of severely chronically lead poisoned birds and development of novel surgical techniques to resolve chronic GI stasis, as well as to allow nutritional support. Seven cases of severe toxicosis treated in the past year.

**Native Amphibians** – Assessing current status and programs through AZA

**Native Invertebrates**– Assessing current status and programs through AZA

**Secondary Regional Programs**

**Pygmy Owl** – Participating in a habitat and nesting study in Buenos Aires National Wildlife Refuge, in agreement with USFWS and University of Arizona.

**Gunnison’s Prairie Dog** – Participating in annual planning meetings.

**Native fish** – Emergency holding of native fish when required by AGFD or USFWS during fires or landscape improvement actions. A small group of Gila Top Minnow are currently held in the lower Anuran building, along with the remaining Buckskin Chiricahua Leopard Frogs.

**Thick-billed Parrot** – Participation in bi-national meetings regarding the translocation of birds from Mexico to the Chiricahua Mountains in Southeastern Arizona. A release is presently planned for the current year. Potentially involved in field activities or research with technical support, if requested.

**Preferential International Projects**

**Pichi Armadillo** – Argentina – Granted funds for histopathology as basis of zoonotic study. Expected to produce numerous peer reviewed papers in recognized journals. Currently expanding study area to the dry Chaco of Northern Argentina and serving as a
model for a regional giant anteater release and tracking program through the University of Corrientes, Argentina.

**Arabian Oryx** – Static. Limited to exhibition and controlled breeding.

**Elephant Sanctuary and Reserve** – under consideration and planning for southern Arizona. Currently hosting an international workshop on elephant footcare.

ACKNOWLEDGMENTS

The authors are grateful to Emil McCain e of the Borderlands Jaguar Detection Program, and to Sergio Avila, of the Sky Island Alliance for their expertise, support, and the materials shared in the preparation of this paper.

LITERATURE CITED

DETRIMENTAL IMPACT OF AN ALPHA2-ADRENERGIC AGONIST ON SEMEN COLLECTION IN THE GIANT PANDA (*Ailuropoda melanoleuca*)

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Abstract

Many male giant pandas (*Ailuropoda melanoleuca*) in breeding centers do not breed naturally. As a result, the few breeding males are genetically over-represented in the global ex situ population. To maintain and improve genetic diversity, semen collection and artificial insemination are crucial techniques for proper giant panda genetic management. Historically in China, ketamine alone has been used as the anesthetic agent for semen collection in the giant panda, but poor muscle relaxation and vomiting during the procedure (possibly related to insufficient dosage of ketamine) have led to recent changes. To develop an optimal protocol for semen collection by electroejaculation, alternative anesthetic dosages and combinations were assessed. Adult (> 6 yr) male giant pandas were anesthetized with either: 1) ketamine (8 - 10 mg/kg, i.m.) for induction and isoflurane gas (1 - 5%) for maintenance (n = five males); or 2) combined ketamine (6 mg/kg, i.m.) and xylazine (0.8 mg/kg, i.m.) for induction and isoflurane gas (1 - 5%) for maintenance (n = five males). Both protocols resulted in safe and effective anesthesia in the giant pandas. Anesthesia using ketamine/xylazine/isoflurane improved the speed of anesthetic induction (5 to 8 min) and overall muscle relaxation, but resulted in a lower (P < 0.05) number of ejaculated sperm (915 ± 300 × 10^6 total sperm) compared to ketamine/isoflurane (8 - 12 min; 3,155 ± 800 × 10^6 total sperm). Examining urine samples collected by cystocentesis immediately after induction of anesthesia and before electroejaculation revealed that sperm were lost into the bladder within 10 min after ketamine/xylazine administration (41 ± 11 × 10^6 sperm/ml of urine) compared to ketamine (1 ± 0.6 × 10^6 sperm/ml of urine). These results indicate that the addition of the alpha2-adrenergic agonist xylazine causes muscle relaxation and subsequent sperm loss into the bladder. Therefore, to ensure maximal sperm quality using electroejaculation, ketamine combined with xylazine is not the optimal anesthetic protocol when semen collection is the primary purpose of the procedure.
CHARACTERIZING AGREEMENT OF HEMAGGLUTINATION INHIBITION ASSAYS USING FOUR DIFFERENT OPHIDIAN PARAMYXOVIRUS ISOLATES IN WILD EASTERN MASSASAUGA RATTLESNAKES (*Sistrurus catenatus catenatus*) FROM ILLINOIS

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Abstract

Hemagglutination inhibition (HI) assay is the sole serologic method currently available to detect exposure to ophidian paramyxovirus (OPMV) in snakes. HI tests are rapid, easy to perform, and do not require species-specific antibodies. The inherent limitations of HI assays are cross-reactivity between similar viruses and moderate specificity, which could result in false-positive samples. 1 This could explain the variability in testing found between different OPMV isolates. Three laboratories perform these assays in the United States, each using a different isolate, with one laboratory using two distinct isolates. But to date, no study has evaluated agreement among the assays.

Blood was collected from 26 wild eastern massasauga rattlesnakes (*Sistrurus catenatus catenatus*) from Illinois in 2006. Each blood sample was divided into three aliquots, packaged similarly, shipped the same day to each laboratory, and assayed using the available OPMV isolate(s) at each laboratory. Findings from these assays included: San Lucan rattlesnake (SLR) isolate 100% positive (26/26), green tree python (GTP) isolate 100% positive (26/26), western diamondback rattlesnake (WDR) isolate 56% positive (14/25), and Aruba Island rattlesnake isolate zero positives (0/26). The kappa statistic for the SLR-GTP isolates demonstrated substantial agreement, the SLR-WDR and GTP-WDR isolates had slight agreement, and the AIR-SLR, AIR-GTP, and AIR-WDR had less than chance agreement. In light of the lack of agreement among the assays, we propose that at present the HI assay is not a reliable indicator of infection or exposure to OPMV in the eastern massasauga rattlesnake.

ACKNOWLEDGMENTS

We gratefully thank the Morris Animal Foundation for support of this project. We thank Dr. Arturo Angelo at the Texas Veterinary Medicine Diagnostic Laboratory, Ms. April Childress at the University of Florida, and Dr. Melissa Kennedy at the University of Tennessee for their assistance in relevant methods descriptions.
LITERATURE CITED

DIAGNOSIS AND TREATMENT OF Babesia odocoilei IN CAPTIVE REINDEER (Rangifer tarandus tarandus) AND RECOGNITION OF THREE NOVEL HOST SPECIES

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Abstract

Two captive reindeer (Rangifer tarandus tarandus) in New York were diagnosed with Babesia odocoilei. Both animals developed acute clinical signs consistent with babesiosis including fever, hemoglobinuria, and hemolytic anemia. Diagnosis was confirmed by visualization of intraerythrocytic parasites on blood smears, polymerase chain reaction (PCR), and speciation of the Babesia by sequencing a hypervariable region of the 18S rRNA gene. One animal died with gross and histopathologic lesions including pigmentary nephrosis with severe acute tubular degeneration and necrosis secondary to intravascular hemolysis. The other was successfully treated with supportive care and a babesiacide, imidocarb dipropionate (Imizol®, 12%, Schering-Plough Animal Health, Union, New Jersey 07083, USA) at 3 mg/kg s.c or i.m. s.i.d. on days 1, 2, 6, 9, and 21. Two other reindeer in the exhibit tested negative for Babesia by PCR and were treated prophylactically with imidocarb. Additionally, B. odocoilei was identified in three previously unknown asymptomatic host species within the collection: yak (Bos grunniens), muntjac (Muntiacus reevesi), and markhor goat (Capra falconeri).

Babesia are protozoan parasites in the phylum Apicomplexa, order Piroplasmida, and are transmitted by Ixodid ticks. The course of infection is more severe in naïve, stressed, or otherwise immune-compromised animals.1 Acute babesiosis demands immediate treatment since 75% of RBCs can be lysed within a few days.2 Prognosis is guarded after the onset of hemoglobinuria. After treatment, the animal’s hemogram must be closely monitored as infected cells will continue to be removed from circulation, which may necessitate blood transfusions.

LITERATURE CITED

PRELIMINARY FINDINGS OF LONG-BILLED HAWK SYNDROME IN OREGON RED-TAILED HAWKS (Buteo jamaicensis)

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Abstract

Reports of raptors, especially red-tailed hawks (Buteo jamaicensis), with beak abnormalities have been increasingly frequent in the Pacific Northwest during the past few years. The possibility of an underlying environmental toxin has been promoted in the communications media. In an effort to identify some of the factors that may be contributory to “long-billed hawk syndrome”, four Oregon red-tailed hawks with beak abnormalities and two hawks with grossly normal beaks were necropsied. A variety of histopathologic changes were observed in the beaks but the main features were epithelial hyperplasia and parakeratosis, with various degrees of inflammation and damage to supportive connective tissues. Toxicologic, parasitologic, and bacteriologic findings revealed a several potential causative factors but none common to all affected birds. Beak lesions in wild raptors may be more common than previously recognized, making identification of any subset caused by environmental toxins more difficult.
EXTREME HYPERCALCEMIA IN PREHENSILE-TAILED SKINKS (*Corucia zebrata*)

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Abstract

Hypercalcemia in reptiles is generally associated with egg production in females, but may also be associated with excess supplementation, primary hyperparathyroidism, and osteolytic conditions. We noted extreme (>50 mg/dl) hypercalcemia in a singly-housed, approximately nine yo female prehensile-tailed skink (*Corucia zebrata*) and further investigated its significance. No evidence or notation of this condition was found in ISIS (International Species Information System) values or any other reference. In one species, the indigo snake (*Drymarchon corais*), it has been determined that hypercalcemia is a normal finding of healthy animals.\textsuperscript{1} By using data submitted by five institutions and analyzing the data using a mixed model analysis (variants are sex, health, season, and total protein), this study demonstrates that hypercalcemia in prehensile-tailed skinks is highly correlated with elevated total protein levels (p<0.0001). The main effects of sex and season were not significant factors in the model, but health and total protein were. However, the interactions between health and sex, sex and season, and health and season were significant. The etiology of the hypercalcemia is unknown, but is suspected to have a hormonal influence. *Corucia zebrata* is a viviparous species that is found in a tropical environment, where seasonal temperature variation is minimal (23-31°C), and it is undetermined if temperature, light cycle, or other factor is the seasonal "trigger." Additionally, it is unknown if the seasonal hypercalcemia demonstrated by this study occurs in free-ranging skinks, and will be an element of consideration for further study.

ACKNOWLEDGMENTS

The authors thank the AZA institutions that supplied data for this study, including the Lincoln Park Zoo, the Columbus Zoo and Aquarium, the Philadelphia Zoo, the Wildlife Conservation Society, and the Cleveland Zoo.

LITERATURE CITED

SEMEN COLLECTION AND SPERM PARAMETERS IN RING-TAIL LEMURS (Lemur catta)

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Abstract

Semen collection in lemur species is notoriously challenging as the ejaculate forms a coagulum. Following natural mating, this coagulum forms a copulatory plug, designed to give a genetic advantage to the breeding male by preventing copulation with other males. However, during semen collection using electroejaculation the semen may coagulate during or after emission. The coagulum can become lodged in the urethra and lead to chronic urine retention. A new technique has shown promise for preventing urethral plug formation following electroejaculation in lemurs. As semen collection has not been conducted routinely, sperm parameters are not well-known. Other factors that may influence sperm quality and production, such as seasonality, are also relatively unknown.

Four ring-tail lemur (Lemur catta) males of breeding age were collected according to an IACUC approved protocol in late January 2007, at the end of the established breeding season. Animals were anesthetized and collected using a previously described electroejaculation protocol. Urethral catheters were passed on all males and the urethra and bladder flushed with ascorbic acid and saline until a steady stream of urine was easily manually expressed. No urethral plugs were formed. All animals were monitored during recovery until normal urination was observed. All animals urinated within hours post-collection. Semen was evaluated for motility, concentration and progressive motility. Testes measurements were also recorded. Samples were cryopreserved, however, post-thaw yield was disappointingly low indicating that further investigation into semen preservation and seasonal effects on sperm quality are warranted. The absence of urethral plugs following semen collection is quite encouraging and is further evidence that semen collection in lemurs can develop into a conservation tool for these unique animals. The low post-thaw yield may be related to seasonal differences in sperm viability and further investigations are warranted.
MITOCONDRIAL ACTIVITY EVALUATION OF THE RED-WINGED TINAMOU (Rhynchotus rufescens) SPERM

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Abstract

The intention with this research was to validate the mitochondrial coloration technique within 54 red-winged tinamou (Rhynchotus rufescens) sperm samples obtained through manual massage and excitation and to quantify the reduction of the mitochondrial activity of these animals’ sperm, after the dilution and preservation, under refrigeration, for 24 and 48 hr, using the 3,3’ diaminobenzidina (DAB) tint. After concluding this research, we observed that there was no correlation during the expected time we had tested for. For this reason, it was not possible to validate the coloration or to quantify the reduction of the mitochondrial cells’ sperm activity of this species through the process of dilution and cooling. Possible reasons for this result are: 1) That motility is not as vital to the bird’s spermatozoon as it is to mammal’s (in some bird species females have sperm host glands that maintain sperm for fertilization for a variable period of time); 2) It is possible that avian spermatozoon may have unknown properties or behaviour different from mammal spermatozoa, like the fact that they acquire motility just after ejaculation. Therefore, the coloration technique described here may not be used to measure or to be related to motility and could not be validated in this specie (Rhynchotus rufescens). Consequently, it was not possible to quantify the percentage reduction of mitochondrial activity during the sperm dilution and refrigeration processes.
USE OF DMSO SOLUTION AND AMIKACIN TO TREAT BLISTER DISEASE IN THE ANACONDA (Eunectes murinus) AT FUNDAÇÃO PARQUE ZOOLÓGICO DE SÃO PAULO

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Abstract

Blister disease is characterized by raised, dermal, fluid-filled lesions. Sick animals develop serious septicemic conditions by secondary infections, depressed immunity, and feeding difficulty as a result of the inflammatory process. Thirty baby ancondas (Eunectes murinus) were born at Fundação Parque Zoológico de São Paulo (FPZSP) and all of them developed clinical signs associated with blister disease. The culture results identified a large number of bacteria sensitive to amikacin, a nephrotoxic antimicrobial agent that can have diminished action in inflamed tissues. On the other hand, some research has shown that dimethylsulphoxide (DMSO) topical applications provide relief of pain and considerable reduction of tissue inflammation, improving tissue absorption of other medicine molecules. The intention with this research was to verify the effects of a topical application of an amikacin-dimethylsulphoxide solution for treatment of blister disease in baby ancondas. In the study, thirty baby ancondas with blister disease were topically treated daily with a 2.5% amikacin dimethylsulphoxide (DMSO – 99.78%) solution during one hundred twenty consecutive days. Initially, seven amikacin treatments (5 mg/kg, i.m., q 72 hrs) were given as well, and the enclosure’s humidity was decreased. After the end of the treatment the animals showed a large improvement in locomotive activity, skin wounds that were quickly healed, reduction of the appearance of new vesicles, and had begun to eat. Only two snakes died. We may conclude that the use of these two drugs has had the desired effect and might be suggested as a treatment for blister disease in anconda babies.
EVALUATION OF BLOOD CHEMISTRY VALUES FOR POSSIBLE RELATIONSHIP TO TUBERCULOSIS INFECTION STATUS IN CAPTIVE ASIAN ELEPHANTS (Elephas maximus) IN NEPAL

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Abstract

One hundred fifteen captive elephants (Elephas maximus) were examined in Nepal as part of a tuberculosis (TB) survey in January 2006. Blood chemistry analysis was performed at Disney’s Animal Kingdom laboratory (USA). Trunk wash cultures were performed both in Nepal and in the USA, and serologic TB tests were performed in the USA. Based on culture and serology results, the elephants were grouped as follows: Group 1 (high risk, suggestive or confirmatory for TB infection) and Group 2 (low risk, equivocal or negative for TB infection). Within these groups, subgroups were created based on specific tests results.

Blood chemistry results were analyzed to reveal any relationships between these values and TB infection status. Student t-tests were performed on each value between Groups 1 and 2. The only significant difference was a higher BUN/creatinine ratio (p=0.047) in Group 1. ANOVA analysis was performed on each value between the various groups. Significant differences were found in the albumin level (p=0.015) within the Group 1 subgroups and in the albumin level (p=0.002), alpha globulin 1 level (p=0.030), and A/G ratio (p=0.012) within the Group 2 subgroups.

This study did not reveal an association between certain chemistry values and TB infection. However, this may be due to a variety of age, reproductive statuses, stages of infections, and other possible medical conditions. Future testing of this population will help better define the TB infection status of elephants and may provide additional information to more precisely determine any association between blood chemistry values and tuberculosis infection in Nepal elephants.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the cooperation of the Nepal Department of National Parks and Wildlife Conservation, support from the Abraham Foundation, the Mazuri Fund, the Walter J. Ernst Memorial Fund, the
American Veterinary Medical Foundation, and the Dodge Foundation, and research contributions from Konstantin Lyaschshenko, Dr. Scott Larsen, Dr. Janet Payeur, and Dr. Ray Waters.
MORE THAN JUST A FLUKE: IS THE AIR SAC TREMATODE (FAMILY CYCLOCOELIDAE) MORE PREVALENT IN ZOOLOGICAL AVIARIES THAN PREVIOUSLY THOUGHT?

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Abstract

A novel species of trematode (Szidatitrema yamagutii, Family Cyclocoelidae) was identified in the air sacs of a deceased bearded barbet (Lybius dubius) and a white necked mynah (Streptocitta albicollis) from an indoor aviary at a zoo in Louisiana. A similar air sac trematode (Family Cyclocoelidae) was found post mortem in two Indian Hill mynahs from a zoological facility in Hawaii. At a zoo in Tennessee, a similar trematode (Family Cyclocoelidae) has been seen in ten different species of birds from an indoor aviary. Antemortem diagnosis is challenging. Routine fecal examination is often negative, although sedimentation can increase the likelihood of finding the parasite eggs. The most reliable antemortem test is endoscopy to visualize adult trematodes. Various treatment regimens have been attempted with variable success. These include injectable and nebulized praziquantel and manual removal of parasites from air sacs. Because the trematode completes its life cycle using a snail intermediate host, control of this invertebrate is also important for reducing the parasite burden. This parasite may be more prevalent in captive birds than previously thought and opportunistic screening of birds is recommended.
REFINEMENT OF A COMMERCIAL BENCH-TOP RELAXIN ASSAY FOR PREGNANCY DIAGNOSIS USING URINE FROM DOMESTIC AND NON-DOMESTIC FELIDS

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Abstract

Relaxin, a 6 kDa polypeptide hormone, is excreted in the urine during pregnancy in several mammalian species.1,4 A recent study showed that detection of urinary relaxin using a bench-top serum assay (Witness® Relaxin kit, Synbiotics Corporation, San Diego, CA 92127 USA) can be diagnostic for pregnancy in domestic cats (Felis silvestris catus).2 In non-domestic felids, current methods used to diagnose pregnancy are invasive and/or nonspecific; however, with the exception of the Arabian leopard, (Panthera pardus), it is unknown if relaxin is present in measurable amounts in urine of most cat species during pregnancy or if the bench-top relaxin kit is applicable with urine across species.3 The objectives of this study were to 1) examine modifications in urine sample processing to improve the reliability of the relaxin kit in pregnant cats, 2) evaluate the impact of concentrating urine via filtration on relaxin detection, 3) assess the effect of sample freezing on relaxin concentrations, and 4) begin quantifying relaxin levels in urine of pregnant non-domestic felids. Urine and/or serum samples were collected from pregnant and nonpregnant domestic cats and non-domestic cat species (Pallas’ cat [Otocolobus manul], sand cat [Felis margarita], cheetah [Acinonyx jubatus], and lion [Panthera leo]) at several time points after breeding. Urine samples, subjected to various processing methods, were tested using the bench-top kit, and relaxin levels were later quantified via radioimmunoassay (RIA).3 For domestic cat urine samples, filtration and/or the addition of protein and phosphate buffer (or nonpregnant cat serum) improved the consistency of the relaxin kit for early pregnancy diagnosis. Urine freezing caused a slight (~13%) but significant (P < 0.05) decrease in relaxin concentrations; however, all frozen/thawed urine samples from pregnant females still tested positive with the bench-top kit. In non-domestic felids, urinary relaxin concentrations in most pregnant females were variable but peak values were comparable to that of pregnant domestic cats, suggesting that relaxin is a reliable cross-species marker of pregnancy. Urinary relaxin was detectable using the bench-top kit in one non-domestic species, the Pallas’ cat, but multiple urine samples from other felid species tested negative on the kit assay, regardless of sample processing methods. These findings suggest that measurement of urinary relaxin is a promising approach as a non-invasive, non-stressful method of pregnancy diagnosis in exotic felids. Further assessment of urinary relaxin profiles among cat species and refinement of the bench-top relaxin kit are warranted to improve cross-species utility and provide zoos with an invaluable in-house tool for diagnosing pregnancy in their non-domestic felids.
ACKNOWLEDGMENTS

The authors thank Helen Bateman and Dr. Genevieve Magarey for support with laboratory procedures and the animal keeper staff at the Cincinnati Zoo & Botanical Garden and the Denver Zoological Gardens for providing urine samples from non-domestic cats. We also would like to thank Dr. Florine de Haas van Dorsser for sharing information and advice on using the bench-top relaxin kit.

LITERATURE CITED

ANTIMICROBIAL SUSCEPTIBILITY IN WILD ANIMAL PRACTICE AT SAO PAULO ZOOLOGICAL PARK FOUNDATION

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Abstract

Antimicrobial drugs resistance has become a major problem in human and veterinary medicine practice as a consequence of the intensive, and sometimes, indiscriminate use of antimicrobial drugs. The objective of this study was to evaluate the antimicrobial susceptibility of bacteria isolated at Sao Paulo Zoological Park Foundation from 2003 to 2006. We included 26 bacterial isolates recovered from reptiles, 35 bacterial isolates recovered from birds and 82 bacterial isolates recovered from mammals. Bacterial identification and the susceptibility tests (utilizing 14 antimicrobial drugs) were performed following international standards¹.

Of 143 isolates studied, 43.3% were characterized as Enterobacteriaceae (35.5% of Escherichia coli and 29% of Proteus spp.). The second major group consisted of Streptococcus spp. (22.4%) and Staphylococcus spp. (17.7%). More than 90% of the E. coli strains were susceptible to trimethoprim-sulfonamide, none were susceptible to penicillin and 1% to streptomycin. The majority of the non-Enterobacteriaceae isolates were susceptible to amoxicillin (79%), amikacin (63%) and ampicillin (63%). Around 50% of the strains were susceptible to most of the remaining antibiotics except that only 28.4% were susceptible to either penicillin or streptomycin. It is essential to perform culture and sensitivity testing when choosing antimicrobial drugs to treat zoo animals in order to provide effective treatment and to decrease the potential development of antimicrobial resistance to antibiotics.

LITERATURE CITED

MODIFYING BREEDING SEASON ONSET IN ASIAN HOUBARA BUSTARD (Chlamydotis macqueenii) BY LIGHT AND TEMPERATURE PROGRAM

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Abstract

Artificial lighting is widely used to synchronize breeding in domestic bird species. Conservation programs can benefit from the breeding synchronization of captive flocks outside of the natural breeding season. In our houbara bustard program, it is believed that achieving production of chicks prior to the natural breeding season would enhance re-introduction success.

Environmentally controlled buildings are used at the National Avian Research Centre (NARC) to breed Asian houbara bustards (Chlamydotis macqueenii). Eighteen males and 51 females were randomly selected for a 15 mo experiment encompassing 3 successive short seasons of 3 mo each alternating with 2 resting seasons of 3 mo each. A control group of houbara comprising of 217 females and 216 males was bred during the natural breeding season (January to June). By artificially managing day length and temperature, we hoped to desynchronize the birds from the natural breeding season, trigger breeding outside of the normal breeding season and test the breeding performance of houbara subjected to accelerated breeding and molting seasons.

Results showed that breeding in houbara bustards can be triggered by controlling light and temperature parameters and can be desynchronized from the natural breeding period. The annual number of eggs and chicks per layer and the average number of sperm per ejaculate were not statistically different between groups. However, the persistence of breeding activity through the 3 successive short seasons differed for males and females. Whereas males showed good sexual performance in the 3 short seasons, females (notably 2-yr-old females) showed inconsistent breeding performance.
POTENTIAL FACTORS AFFECTING INFECTIVITY OF *Escherichia coli* O157:H7 IN AMERICAN BULLFROGS (*Rana catesbeiana*)

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**Abstract**

*Escherichia coli* O157:H7 is a foodborne pathogen that may be contracted by eating contaminated vegetables or undercooked contaminated beef products.1,2 Cattle are known reservoirs of this pathogen but it remains unclear how this pathogen is maintained in the environment.4,6 Infected cattle may defecate in farm ponds resulting in contamination of the pond water and may result in infection of its inhabitants.6 It has not been established whether amphibians can be infected by *E. coli* O157:H7 and perhaps serve as ‘spill-over’ hosts, or whether they may act as transport hosts upon metamorphosis. Therefore, we orally inoculated tadpole and metamorph American bullfrogs (*Rana catesbeiana*) with *E. coli* O157:H7 to determine their potential role as hosts for this pathogen.3 Tadpoles were housed in flow through systems and did not become infected; however, metamorphs were housed in stagnant systems and did become infected. These differences may be reflective of water system, developmental stage, or both. Stagnant water systems are likely more reflective of the farm pond system and offer greater opportunity for pathogen exposure than flowing systems. Additionally, stress is markedly increased in amphibians during metamorphosis as the larval immune system is disassembled to prepare for building of the adult immune system.5 Compromised immunity at this stage would support increased likelihood of infection by a pathogen. These data suggest that amphibians may play a role in the epidemiology of *E. coli* O157:H7 if exposed to contaminated water.

**LITERATURE CITED**

ELECTRICAL ACTIVITY OF THE BRAIN IN TORTOISES DURING BRUMATION MONITORED WITH BISPECTRAL INDEX (BIS)

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Abstract

Bispectral index (BIS) (BIS A-2000XP®, Aspect Medical Systems), a monitor validated in human patients, was used to document brumation in tortoises. The bispectral analysis is a statistical technique that evaluates interfrequency phase relations of the electroencephalogram (EEG) and combines them into a single index of electrical activity with a dimensionless variable from 0 (cortical silence) to 100 (maximal cortical activation). BIS measurements have been empirically obtained in anesthesized horses,4 pigs,8 goats,1 dogs,3 cats,6 rabbits,7 and dolphins.5

Ten adult Hermann’s tortoises (Testudo graeca) were, as part of their routine husbandry, allowed to brumate for 4 mo. BIS values and heart rate were recorded before and after the brumation period (>17ºC at room temperature), during the 2 wk of adaptation period at 7ºC, and every 2 wk (total of seven measurements per animal) during the hibernation period at 3-4ºC in a high relative humidity hibernaculum. Measurements were taken continuously for 10 min per animal. The tortoises showed the same cerebral activation (BIS values between 90 and 100) before and after brumation and during the adaptation period. During brumation, the BIS score showed a pattern of deep suppression (20-30), interrupted at 0.5 to 2.0 min intervals by bursts of high cerebral cortex activation. This mechanism to maintain the brain alive during a hypometabolic state has been described during brumation in anoxia-tolerant freshwater turtles (Trachemys and Chrysemys).2, 9

We conclude that during brumation, land tortoises display similar brain activation pattern as freshwater turtles. The results indicate possible use of the BIS Monitor as instrument to monitor specific brain activity of brumating tortoises.

LITERATURE CITED


LONGITUDINAL SERUM PROGESTERONE ANALYSIS TO ASSESS REPRODUCTIVE SUCCESS IN FEMALE WHITE RHINOCEROS (Ceratotherium simum)

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Abstract

Rhinoceros species can be conditioned with food treats for voluntary blood sampling from leg or ear veins. Blood sampling allows real time analysis of endocrine events, and in this study was employed over a period of approximately 5 yr to assess the reproductive status of a herd of female white rhinoceroses (Ceratotherium simum; n = 6). Serum was collected (1 – 4 times per month) from five adults and one juvenile and stored frozen (-70°C) until analysis for progesterone by enzyme-linked immunoassay using a polyclonal anti-progesterone antibody. Results described 11 pregnancies from 4 females, established onset of puberty in the juvenile female, and identified the remaining non-reproductive adult female as a ‘flatliner’ (where undetectable concentrations of progesterone were measured over an extended period of time). Interestingly, this female showed variable serum progesterone concentrations consistent with ovarian activity at the beginning of the study, together with observed mating by the male, but after 4.5 yr serum progesterone decreased, and eventually declined to undetectable levels that lasted for 14 mo. For the pregnant females, although serum progesterone steadily increased until shortly before parturition when it declined rapidly, variable monthly serum progesterone concentrations precluded a single sample pregnancy diagnosis until month 13 (P < 0.05). However, multiple samples with most values exceeding 15 ng/ml over a 2 - 3 wk period would likely reliably confirm pregnancy after month 5. No differences in mean serum progesterone were noted between pregnant females (P > 0.05), but one female had lower mean progesterone non-pregnant concentrations (P < 0.05) than the other three females. Lastly, a 1 yr period of cycling activity with no pregnancies during the study ended abruptly with the replacement of a diagnosed infertile male with a proven breeder and four pregnancies occurred within 3 mo.
CHROMOMYCOSIS OF THE SHELL IN AN ALDABRA TORTOISE (Geochelone gigantea)

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Abstract

An adult male Aldabra tortoise (Geochelone gigantea) presented with large flaking areas of the carapace, and biopsy of these areas revealed chromomycosis. After initial debridement, underlying tissue was brown. Histopathology revealed variably degenerative keratin extensively colonized by short beaded brown pigmented fungal elements consistent with chromomycosis. The disease progressed rapidly and spread to numerous sites on the carapace. After several weeks of regular debridement, bone involvement was evident. Histopathology then revealed necrotic bone colonized by pigmented spherical fungal elements, some of which were associated with elongated hyphae-like pigmented structures. Fungal culture grew Fonsecaea pedrosoi, a common pathogen of chromomycosis in humans. Initial treatment included oral itraconazole (Patriot Pharmaceuticals, Plymouth Meeting, PA 19462 USA) and topical terbinafine hydrochloride (Lamisil AT, Novartis Pharmaceuticals, Parsippany, NJ 07054 USA). Oral terbinafine hydrochloride (Lamisil, Novartis Pharmaceuticals) and a 2.5% fluconazole in dimethyl sulfoxide topical suspension (compounded by Nora Apothecary, Indianapolis, IN 46240 USA) were used later in treatment. The animal has been scheduled for a nuclear scintigraphy bone scan to determine the extent of the lesions with possible subsequent deep surgical debridement.

This disease is commonly reported in amphibiaisl and humans4 but has rarely been reported in chelonians.1,2 This is the first reported case of chromomycosis in a tortoise shell.

LITERATURE CITED

MANAGEMENT OF A PECTORAL SPINE FRACTURE IN A BLUE CATFISH (Ictalurus furcatus)

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Abstract

A subadult, wild-caught, captive blue catfish (Ictalurus furcatus) was presented with abnormal motion to the right pectoral spine. Radiographs performed under manual restraint confirmed loss of the tip of the spine and an open mid-diaphyseal short oblique fracture of the primary spine of the right pectoral fin. The fish was anesthetized with tricaine methanesulfonate (100 mg/L water) buffered to a neutral pH and maintained under the same anesthetic concentration using a recirculating water pump. Surgical reduction of the fracture was attempted but was unsuccessful and an amputation of the distal segment was performed. The fish was medicated daily in a 1,135 L tank with suspended trimethoprim/sulfamethoxazole at a dose of 20.3 mg/L of water for 12 hr/day. Two months later a second surgery was performed due to dehiscence of the initial surgical site. Additional bone was removed and an alternative method of closure was used. Upon recovery the fish was placed directly into the exhibit tank to decrease further injury to the surgical site. The fish has slightly altered hydropulsion to compensate for the loss of the primary pectoral spine and is currently on display at the Kansas City Zoo. The anatomy, anesthesia and post-surgical care presented unique diagnostic and therapeutic challenges.
VITILIGO IN A SUB-ADULT EASTERN BLACK RHINOCEROS (Diceros bicornis michaeli)

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Abstract

In the United States, skin disease is a major cause of morbidity in the adult black rhinoceros (Diceros bicornis) population.1,2 While the majority of dermatologic conditions in black rhinoceroses appear to be secondary, this case represents a primary dermatopathy. A captive born, female, sub-adult, eastern, black rhinoceros (Diceros bicornis michaeli) began to develop areas of depigmentation around her nares at 2 yr of age. The depigmentation progressed over the next 12 mo to include facial fold crypts, interdigital skin, lip, ventral abdomen, ventral neck, axilla, lateral brachium and antebrachium, lateral thigh, ventral tail and perineal region. The symmetric, multifocal, depigmented macules are flat, non-ulcerated, non-puritic and, other than the color change, appear grossly normal. Complete blood counts, serum chemistry panels, ANA testing and select endocrine panels have been performed and appear within normal limits. Facial fold skin biopsies performed under behavioral restraint and site-specific analgesia were obtained and submitted for histopathology and bacterial culture. Histopathology revealed multifocal hypopigmentation with melanin incontinence, epidermal edema, lymphocytic exocytosis and mild perivascular lymphohistiocytic dermatitis. Microbiology results from the biopsies demonstrated normal skin flora. The gross appearance and histopathologic changes of these lesions are most consistent with a diagnosis of vitiligo. Skin biopsies obtained from clinically normal conspecifics demonstrated normal histology except for the paternal relative. Due to the rare occurrence of vitiligo in non-domestic animals, this case represents an interesting addition to the already reported dermatopathies in captive black rhinoceroses.

LITERATURE CITED

ENTOMOPHTHOROMYCOSIS IN AN EASTERN LOWLAND GORILLA (*Gorilla gorilla graueri*)

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Abstract

Introduction

Entomophthoromycosis, also known as zygomycosis, is caused by the fungus *Conidiobolus coronatus* (formerly named *Entomophthora coronata*).6,7,9,10 Although this fungus has a worldwide and ubiquitous distribution, it is much more prevalent in warm, humid subtropical and tropical climates.9,10 Entomophthoromycosis is a rare disease involving facial structures in man9,10 and animals.6,13 There are five reports of the disease in nonhuman primates1,8,11,12,15 including a case description in a chimpanzee. The present study reports the clinical aspects, diagnosis and treatment of entomophthoromycosis in an Eastern lowland gorilla.

Case Report

On 18 August 1994 an orphaned female Eastern lowland gorilla, estimated age 4 yr, arrived at the Antwerp Zoo. This wild born animal had been confiscated in Africa, where it was confined to a small cage with a dog. Since arriving at the zoo it was claustrophobic and refused to enter small quarters making veterinary interventions difficult. Apart from occasional protozoal diarrhea and a slight cough, the animal had no major health problems.

In September 2004, an intranasal tumor was not noticed on the right side. The animal had no discomfort and a tentative diagnosis of polyposis was made. Treatment for human nasal polyposis consists of topical corticosteroids.16 Topical application was not possible so a systemic corticosteroid was chosen based on an approximated body weight of 150 kg. The animal was started on oral methylprednisolone (Medrol – Pfizer, B-1050 Brussels, Belgium) at an anti-inflammatory dosage of approximately 0.21 mg/kg s.i.d.1,2 The intranasal polyp was no longer visible after 7 days of treatment, but within 3 – 4 days after discontinuing methylprednisolone the swelling reappeared. This regimen was repeated twice over a 1-mo interval and each time the swelling reappeared. As a result, the animal was placed on continuous treatment of methylprednisolone at the previously mentioned dosage; however, the swelling reappeared in July 2005. In August 2005 the animal was anesthetized for a polypectomy. Microbiologic cultures were negative, but histopathologic analysis showed a fungal granuloma. In December 2005 the dose of methylprednisolone was gradually reduced. However, within 14 days of reducing the methylprednisolone to 0.05 mg/kg s.i.d., the swelling was noted to again be gradually enlarging. In May 2006, a second surgery was performed, but more diffuse
granulomatous tissue was present and could not be removed completely. This time microbiologic cultures grew *Conidiobolus coronatus* and histopathology of the tissue confirmed that it was a fungal granuloma. One month later the swelling worsened and treatment with methylprednisolone was restarted. Two weeks later the swelling was gone, but reappeared in August 2006. This time, the animal was treated with ketoconazole (Nizoral - Janssen-Cilag, B-2600 Berchem, Belgium) at a dosage of 1.33 mg/kg p.o., b.i.d.. The dosage was gradually increased to 4 mg/kg b.i.d.. Methylprednisolone treatments were gradually decreased and were ended by mid-March. In February 2007 another swelling was noticed on the nose ridge just ventrally of the medial right eye corner. At the beginning of April 2007 the size of the intranasal swelling was reduced.

**Discussion**

Although fungi of the Order Entomophthorales occur worldwide, the preliminary clinical diagnosis of polyposis in this gorilla seemed most probable in our temperate north-western European environment. However, histopathology did not confirm this diagnosis. Much of the swelling consisted of cell-rich mesenchymal tissue which contained numerous young fibroblasts and capillaries along with a mixture of many macrophages and giant cells and many eosinophils. PAS (Periodic acid-Schiff) staining showed hyphae partly contained in the giant cells. Ziehl-Neelsen staining was negative. Immunohistochemistry for cytokeratin was only positive for superficial epithelium and some serous glands. Immunohistochemistry for MAC 387 (a human histiocyte-monocyte marker) was considered negative. Due to negative microbiologic culture results, we concluded that the fungus was not the primary cause of the swelling, but rather secondary contamination.

Tissues obtained from the second surgery provided positive fungal culture results. Glabrous and waxy colonies, which became radially folded grew on Sabouraud’s dextrose agar. The culture contained numerous spherical conidia with prominent papillae. The conidia were forcibly expelled, covering the lid of the petri dish. Histopathologic results were obtained from two independent laboratories. The first laboratory’s diagnosis was granulomatous fungal rhinitis with aggregates of macrophages and giant cells with numerous lymphocytes in between and many neutrophils at the surface in the nasal tissues which was comparable to the previous diagnosis. PAS staining showed many irregularly branched and segmented fungal hyphae. Again, Ziehl-Neelsen staining was negative. The diagnosis from the second laboratory was rhinoentomophthoromycosis and histopathology was described as diffuse granulomatous inflammation with granulomas consisting of multinuclear giant cells, histiocytes, lymphocytes and neutrophils. Many hyphae were present in the multinuclear giant cells and in the intercellular spaces. Hyphae were irregularly wide, septated and branching in 90° angles. Furthermore, *Conidiobolus coronatus* was also isolated, as described by Coremans-Pelseneer, from wood shavings used as bedding material in the gorilla’s cage.

In human patients, *Conidobolus* may cause leukocytosis and eosinophilia. This gorilla only showed leukocytosis (17.4 G/l; reference values: 4.67 - 11.8 G/l), and a neutrophilia (13.2 G/l; reference values: 2.13 – 8.49 G/l). All other blood values were within normal limits. It has not been determined whether *Conidobolus* infections are more prevalent in immunocompetent or -
compromised patients;\textsuperscript{5,9} however, this animal tested negative for HIV1/HIV2 antibodies in an enzyme immunoassay.

Apart from massive doses of iodide, used in 1974 for treating a chimpanzee,\textsuperscript{11} there has been no treatment regimen for rhinoentomophthoromycosis in nonhuman primates described in recent veterinary literature.\textsuperscript{1,8} Human medical literature recommends a combination of itraconazole (Sporanox - Janssen-Cilag, B-2600 Berchem, Belgium) and fluconazole (Diflucan - Pfizer, B-1050 Brussels, Belgium) along with continued blood monitoring for hepatotoxicity.\textsuperscript{14} We decided not to use this combination of drugs because monitoring of blood parameters was not possible in this animal and the long-term use of itraconazole with fluconazole has not been reported in nonhuman primates. We decided to use ketoconazole as there is a report of its successful long-term use in the treatment of entomophthoromycosis in a man.\textsuperscript{4} We treated this animal with gradually increasing doses of ketoconazole while monitoring for side effects. After 7 mo of treatment, the granuloma is reduced. It is possible therapy may need to be changed in the future.

LITERATURE CITED

WILD BIRD WINDOW STRIKES IN A ZOO SETTING: LESIONS, PREDISPOSITIONS, AND ABATEMENT PRACTICES

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Abstract

Endeavors to create an enhanced zoo visitor experience have often resulted in enclosures lined by clear glass panels that create an unobstructed view of the exotic species within these walls. This clear view also, unfortunately, appears to birds to be physically unobstructed and often results in fatal, in-flight collisions. In the 17 mo from November 2005 through March 2007, window strike fatalities comprised 74 of the 226 (32.7%) wild birds submitted for necropsy at the National Zoo. The most common lesions observed in birds that struck windows included fractures of the liver and rupture of the pericardium with subsequent hemorrhage into the coelomic cavity. Gross head and neck trauma was relatively uncommon. Seasonal peaks of activity have occurred in December-January and February-March. A sharp rise was seen in the number of window strike bird deaths after 19 untreated glass panels were installed in a new sloth bear habitat in September, which is outside of migratory season. The next migratory season, recorded window strike fatalities in the area were reduced to zero following application of UV-reflecting stickers to the panes in an esthetically pleasing, vertical gradient pattern. The same year, a regular mortality spike was recorded during the December-January peak in a “control” enclosure around lemurs treated with only one hawk silhouette per pane. UV-reflecting stickers are effective in abating avian mortality due to window strike when applied in an appropriate concentration and pattern and may even enhance the zoo visitor experience.

LITERATURE CITED

PERSISTENT BUOYANCY DEFECTS IN TWO CLOWN FISH (*Amphiprion ocellaris*)

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Abstract

In the autumn of 1996, two clown fish (*Amphiprion ocellaris*; approximate length = 80 mm and width = 38 mm) at the London Zoo were observed exhibiting signs of buoyancy deficits and signs of being hydrodynamically unsound. These clinical abnormalities were noted after they were attacked by a damsel fish (*Abudefduf oxyodon*; approximate length = 110 mm and width = 75 mm). Physical examination revealed moderately distended coelomic cavities in both animals. Both fish were anesthetized to obtain lateral and dorsoventral radiographic views utilizing mammography film. Their moderately distended swim bladders were deflated at this time utilizing a 27-ga needle on a tuberculin syringe and the radiographs were repeated. Enrofloxacin was administered i.m. at 14 mg/kg for antibacterial prophylaxis. Morphometric measurements indicated the swim bladders of these fish were multiple times larger prior to deflation than after deflation. When fully recovered from anesthesia, both fish were hydro-dynamically sound.

Introduction

The swim bladder of fish is utilized to regulate buoyancy and maintain gravitational equilibrium at various depths in the water column. Fish are classified into four major groups based on the macromorphology, the micromorphology, and the physiology of their swim bladders.18 There are four major classes of swim bladders.2,15,17 Physostomes have a tubular connection between the swim bladder and the digestive tract that is retained in adult life. Physoclists have no communication between the swim bladder and the digestive tract. Euphysoclists (sub-classification of physoclists) have separate compartments for gaseous secretion and gaseous resorption. Paraphysoclists (sub-classification of physoclists) have no distinct compartments for gaseous secretion and gaseous resorption.

The clown fish (*Amphiprion ocellaris*) has a well developed musculo-skeletal system, making it denser than water. The density of seawater is 1.025 g/cm³ and while muscle is 1.05 g/cm³ and fat is 0.9 g/cm³. Marine fish inhabiting depths above 950 meters usually have swimbladders while they are less frequently found in fishes inhabiting depths deeper than 1000 meters.1,16 Gas bladders or swimbladders are only used by ray finned fishes (sub-class Actinopterygii). Other species of fish such as sharks use their propulsive motion of swimming to remain buoyant at specific depths. (The swimbladder on average occupies 5% of the total body volume of a fish,18 but follows Boyle’s Law within a wide range of temperature and pressure.2,3 A fish can remain effortlessly poised with an air-filled swimbladder.9 The gas filled swimbladder enables the fish
to have a density less than water and by varying the volume of gas in the swimbladder, the fish is able to remain at specific depths.

The swimbladder wall consists of multiple membranes with an abundance of nerves and vessels. The external connective tissue or tunica externa has a glistening white to silvery serosal surface and contains dense connective tissue with collagen fibers. The submucosa is a loose, gelatinous tissue through which nerves and vessels pass to the mucosa. The mucosa of a euphysoclist fish consists of secretory and resorbent components. The epithelium of the secretory component has gas gland cells and that of the resorbent component consists of flat thin cells. The muscularis mucosa is usually thicker in the area of the secretory component compared to the muscularis mucosa in the area of the resorbent component. The mucosal surface of the resorbent part has flat epithelial cells while the mucosal surface of the secretory part has cuboidal epithelial cells. The gas gland or diffuse layer of glandular cells is associated with the counter-current capillary system.

The rete on the serosal surface of the swimbladder is well developed in most physoclists. It is formed by multiple distinct capillary bundles. The arterial and venous supply of the rete to the bladder are in intimate contact with each other. Electron microscopic analyses have demonstrated that the rete capillaries support passive diffusion of blood. Higher PO$_2$ in rete venous blood in comparison to post-rete arterial blood results in a venous to arterial diffusion of O$_2$. This cumulative process is the counter current mechanism (CCM). The CCM is one of the biophysical means by which oxygen and other gases are concentrated in the swimbladder. Blood flows into the rete with arterial pH and PO$_2$ values. During passage through the rete it receives O$_2$ and acid (CO$_2$ and H$^+$) from the venous blood draining the swim bladder. In addition to the CCM, oxygen and other gases are concentrated in the swimbladder by processes described by the Root effect, by the Bohr effect, and by salting out. Fish inhabiting depths close to the surface have swimbladders with a gas composition approximating that of air. In deep water fish, the PO$_2$ and PN$_2$ can be as high as 100 and 25 atmospheres, respectively. Fish can concentrate oxygen into the lumen of the swim bladder by a factor of 500. Swimbladder volume is homeostatically controlled by two reflex mechanisms; an inflatory reflex (gas deposition) and a deflatory reflex (gas reabsorption). The swimbladder is innervated by branches of the vagi and the coelic ganglia.

**Case Report**

On the October 17, 1996, two clown fish at the London Zoo were attacked by a damsel fish. Both clown fish were more than 2 yr old. Fish #1 was observed floating upside-down on the surface of its aquarium tank. Fish #2, was able to swim upright and could swim downwards vertically in the water column. However, it was only able to bob its head to the surface. This fish also had deformed fins.

Fish #1 was anesthetized by immersion in a solution of tricaine methanesulphonate (Thompson & Joseph, T & J House, 119 Plumbstead Road, Norwich, NRI 4JT, England) at a concentration of 0.1 g/L of artificial sea water. A stage III level of anesthesia was achieved and lateral and dorso-ventral radiographs were taken utilizing mammography film (Agfa-Gevaert Osray M3 13
The swim bladder of fish #1 was observed to be distended with gas and was pressing ventrally against the visceral organs. Approximately 0.6 ml of gas was aspirated with a 27-ga needle and 1 ml tuberculin syringe (Monoject, Sherwood, N. Ireland) from the right side. Enrofloxacin (14 mg/kg, i.m., Bayer, Shawnee, Kansas, USA) was administered. It was returned to fresh artificial seawater and recovered from the anesthetic. It was able to swim normally and also submerge to the bottom of the container, remain submerged and balance with its pectoral fins. Unfortunately, this fish died two days after the procedure.

Fish #2 was anesthetized and radiographed utilizing the same methods employed for fish #1. Approximately 0.6 ml of gas was aspirated from the left side of the coelomic cavity. Towards the end of the aspiration a small amount of blood was withdrawn into the syringe. This fish also received enrofloxacin at 14 mg/kg i.m. Upon recovery, the fish was positioned at the bottom of the recovery container and exhibited signs of hydrodynamic soundness and normal buoyancy.

Discussion

Based on the radiographic examinations both fish had over-inflated bladders most likely due to trauma induced damage of the duct or blockage or dysfunction of the muscular valve. The valve controls the release of gas from the swim bladder into the alimentary tract.19

Clownfish have physoclist swim bladders. The protracted hyperinflated swim bladder of fish #1 was most likely due to ductal stenosis or a malfunction of the valve controlling the release of gas into the alimentary tract from the swim bladder.7,8

Fish #1 most likely suffered damages to its lateral lines, neuro-cranial trauma, and spatial disorientation of its auditory ossicles.3,6,10 Fish #2 has only exhibited mild symptoms following its second deflation treatment and has been monitored daily by visual observation. Angiographic studies with radio-opaque dyes or radioisotopes such as technetium 99 may aid in detecting vascular malfunctions. Ultrasonography may detect tumors,4 abscesses, granulomas or larval migrans obstructing the exit of gas from the swim bladder.8 A microprobe for small fish ultrasonography was unavailable for use on the surviving fish. A pneumocystectomy was unable to be performed on fish #2 due to its small size, but may have corrected the persistent condition and improved its prognosis.11-15,17

ACKNOWLEDGMENTS

The authors would like to thank the staff of the London Zoo; including the zookeepers. Thanks are especially extended to Dr. Sue Thornton for her support and encouragement in the diagnostic work and documentation of this case. Thanks are also extended to Mr. George Stadusky for his assistance in the image analysis and processing and to Christine Dean, VN (London Zoo). My gratitude are extended to Drs. Mark Fox and Tony Sainsbury, the directors of the MSc Wild Animal Health Program at the Royal Veterinary College, University Of London.

LITERATURE CITED

EFFECTS OF PROPOFOL ADMINISTERED VIA THE SUPRAVERTEBRAL SINUS IN RED-EARED SLIDERS (Trachemys scripta)

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Abstract

Propofol (DIPRIVAN®, Zeneca Pharmaceuticals, 1800 Concord Pike, Wilmington, DE 19850 USA) is used extensively in reptilian anesthesia.¹ It has been shown to be a safe and rapid agent in iguanas and tree snakes,²³ but requires vascular access. The only published investigation in turtles used the intraosseous route,⁴ but the high dose requirement combined with cumbersome catheterization protocols has reduced its practicality. The supravertebral sinus has been described as a safe alternative for i.v. injections in chelonians.⁵ This study investigated the anesthetic effects of propofol administered at 10 and 20 mg/kg via the supravertebral sinus in 10 adult red-eared sliders (Trachemys scripta) in a blinded, randomized cross-over design.

Patterns of reflex and muscle tone loss and recovery were characterized. Parameters recorded were spontaneous movement, extremity relaxation (head, forelimb, hind limb, tail tone), jaw tone, response to deep pain, and corneal, palpebral, and spinal reflexes. Observations were made every 60 sec until no changes in parameters were observed for 5 min. Data was compared between dosages using paired t-tests and Wilcoxon-Rank Sum tests.

Significant differences between the two doses were found for anesthetic depth, anesthetic duration, and in times to recovery of muscle tone. Additionally, a greater proportion of subjects in 20 mg/kg trials experienced loss of palpebral reflexes and sensation of deep pain, while corneal and spinal reflexes remained highly conserved at both doses. No significant differences were seen in the time to maximal relaxation or reflex loss. Total anesthetic time was 63 and 91 min, for 10 and 20 mg/kg respectively.

Results suggest that propofol administration via the supravertebral sinus can be a reliable means of achieving anesthesia in healthy chelonian patients.

ACKNOWLEDGMENTS

The authors thank J. Hounsgaard, G.S. Jacobsen, and W. Sears for their valuable assistance.

LITERATURE CITED


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