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Research Article

Retrospective Study of Morbidity and Mortality of Captive Jaguars (*Panthera onca*) in North America: 1982–2002

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One hundred seventy-two medical records of captive jaguars (*Panthera onca*) were examined from 30 American Zoo and Aquarium Association (AZA) institutions housing jaguars between 1982–2002. The study determined common causes of morbidity and mortality, and the influence of age, gender, and melengestrol-acetate (MGA) exposure on these rates. The most common causes of morbidity in captive jaguars were found to be dental, gastrointestinal, integumentary, and musculoskeletal diseases. Prevalence of types of disease varied with age, with older animals experiencing a higher prevalence of multiple types of disease. Females developed reproductive disease more frequently than males, and the data suggest that MGA exposure increased the risk of developing female reproductive disease. The most common causes of mortality were reproductive diseases in females and musculoskeletal diseases in males. There was a high rate of neonate and pediatric mortality, primarily due to stillbirths or unexplained neonatal death, trauma, and pneumonia. Other diseases or clinical signs that seemed remarkable were a high prevalence of episodes of epistaxis among young, as well as old, jaguars. Based on these findings, management suggestions for the captive jaguar population are presented. Zoo Biol 25:501–512, 2006.

Keywords: epistaxis; melengestrol-acetate exposure; reproductive disease; musculoskeletal disease

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INTRODUCTION

The jaguar (*Panthera onca*) is the largest American felid. Although the jaguar was once distributed from the southwestern United States through southern Argentina, its home range and population have diminished in the past century due to habitat destruction and hunting [Seymour, 1989]. In 1973, jaguars were placed on the Convention on International Trade in Endangered Species' Appendix I and are considered "near threatened" by the International Union for Conservation of Nature and Natural Resources. The American Zoo and Aquarium Association (AZA) institutions housed 81 (40.41) captive jaguars in 2004 [Wiese, personal communication], offering an invaluable resource for education on jaguar conservation and protection.

Standard veterinary protocols for captive jaguars are based currently on general felid health concerns and available literature on jaguar diseases. Common noninfectious health problems in jaguars have historically included neoplasia, dental disease, lacerations, renal disease, and musculoskeletal diseases [Deem, 2004]. Routine exams should consist of a complete physical examination, thoracic and abdominal radiographs, and dental work. Recommended vaccinations for captive jaguars include the feline viral rhinotracheitis-calicivirus-panleukopenia and rabies vaccines. Stool samples should be collected routinely to evaluate for endoparasites: jaguars can be safely treated with a variety of antiparasitics [Deem, 2004].

Retrospective studies of morbidity and mortality highlight trends, and are necessary in directing the health care focus of captive animals. This retrospective study is the first to determine causes of morbidity and mortality in a captive jaguar population. The primary objective of this study was to determine the most common causes of morbidity and mortality of captive jaguars held at AZA-accredited institutions in North America between 1982–2002. Additionally, morbidity and mortality were compared between age classes and gender. Prevalence of reproductive disease was compared between females that had melengestrol-acetate (MGA) exposure and those that did not.

MATERIALS AND METHODS

Thirty-nine AZA institutions that housed jaguars during 1982–2002 were solicited for jaguar health records. The medical records of 172 (84.82.6) jaguars housed at 30 AZA institutions were obtained and examined. Disease data were tabulated by body system, age, and gender. Melengestrol-acetate exposure history was reported for females. Body systems that diseases were categorized into included aural, cardiac, dental, endocrine, gastrointestinal, hematologic, hepatic, integument, musculoskeletal or neuromuscular, neurologic (including behavioral), ocular, renal, reproductive, and respiratory. Clinical signs or disease diagnoses were recorded, noting the age of the individual at the time of illness. Prevalence of morbidity within each body system was determined for age and gender.

Jaguars were categorized into four age classes: 0–<2 years (cub to juvenile), 2–<5 years (young adult), 5–<16 years (adult), and 16–25 years (geriatric). Under natural conditions, cubs and juveniles remain with their mothers until 2 years of age. Females reach sexual maturity between 2–3 years, whereas males reach it between 3–4 years [Seymour, 1989]; 2–<5 years of age are categorized as young adults for the

purpose of this study. The adult and geriatric age ranges were based on the total life span of this captive jaguar population (up to 25 years old).

Prevalence of disease within a body system was determined within each age group by tallying each individual that displayed a body system disease during that age range. In those body systems in which >20% of the age class was affected, the diseases reported most commonly in that body system were determined. Comparisons of the total number of males vs. the total number of females with disease within one body system were used to determine whether morbidity differed based on gender. Chi-square analysis was used to determine significant morbidity differences between males and females.

To determine the relationship between MGA exposure and female reproductive disease, the records of 62 adult female jaguars were examined. Jaguars were placed into two groups; one group ($n = 25$) that had been exposed to MGA contraception, and a second group ($n = 37$) that had never been exposed to MGA. Reproductive diseases reported within each group were recorded, and χ^2 analysis was used to determine the significant differences in reproductive morbidity between these two groups.

Reports of death were available for 87 (38.43.6) jaguars. Causes and ages of mortality were recorded for males and females. Cause of death was determined by pathology reports when available. For euthanized animals that did not have available pathology reports, the cause of death was established based on the clinical signs or disease(s) that lead to euthanasia. If the record did not explain the cause of death, it was recorded as such.

RESULTS

Thirty of 39 AZA institutions solicited provided medical records for 172 (84.82.6) jaguars, for a 77% compliance rate.

Morbidity

Prevalence of disease within the 14 body system categories of this study is presented for each age class in Table 1. Disease etiology of the body systems for which >20% of the age class had disease are provided in the text for individual age classes. Finally, for body systems with <20% disease prevalence across all age groups, the etiologies for disease within these body systems are provided for all jaguars. In Table 2, bacterial and fungal agents that were cultured from each organ system in the entire sample population are listed, and the isolated gastrointestinal parasites are listed in Table 3.

Cub to Juvenile (0– <2 Years)

In this age class ($n = 85$), only the gastrointestinal system had >20% prevalence of disease. Among the gastrointestinal diseases, 83% (15/18) were caused by bacterial infection or endoparasites (Tables 2,3). The three remaining cases included gastric mucosal calcification, necrotic enteritis, and pancreatitis.

Young Adult (2– <5 Years)

In the young adult age class ($n = 53$), three of 14 body systems had >20% morbidity; gastrointestinal, integumentary, and neurologic/behavioral. Of the

TABLE 1. Prevalence of disease (%) by body system and within age classes of captive jaguars (*Panthera onca*) housed at AZA accredited institutions 1982–2002

Body system	0–<2 years (N = 85)	2–<5 years (N = 53)	5–<16 years (N = 99)	16–25 years (N = 42)	All ages (N = 172)
Aural	0	1.9	1	0	1.14
Cardiac	1.2	0	13.1	14.3	10.2
Dental	3.5	11.3	41.4[a]	52.4	35.2
Endocrine	1.2	3.8	5.1	9.5	6.8
Gastrointestinal	21.2	22.6	28.3	35.7	36.4
Hematologic	2.3	3.8	9.1	26.2	10.8
Hepatic	2.4	5.7	15.2	21.4	15
Integumentary	11.8	32.1	50.6	59.5	45.5
Musculoskeletal	7.1	9.4	17.2	47.6	25
Neurologic/behavioral	1.2	20.8	15.2	31	18.8
Ocular	3.5	7.6	4.0	16.7	9.1
Renal	3.5	1.9	13.1	45.2	17.6
Reproductive	1.2	1.9	17.2	35.7	17
Respiratory	8.2	0	4.0	26.2	12.5

[a]For those body systems with >20% prevalence of disease within a certain age group, etiologies are presented in the text.

TABLE 2. Bacteria and fungi cultured from each organ system of captive jaguars (*Panthera onca*) housed at AZA accredited institutions 1982–2002

Organ system	Bacteria or Fungi
Aural	*Aspergillus, Citrobacter, Pseudomonas, Streptococcus*
Gastrointestinal	*Aeromonas, E. coli, Klebsiella, Plesiomonas, Proteus, Salmonella, Shigelloides, Staphylococcus*
Hepatic	*Actinomyces israelii, E. coli, Fusobacterium necrophorum, Salmonella, Staphylococcus*
Integument	*Actinobacter, Alcaligenes, E. coli, Klebsiella, Proteus, Pseudomonas, Staphylococcus aureus, Streptococcus*, Dermatophytes
Musculoskeletal	*E. coli, Flavobacterium, Staphylococcus epidermidis*
Reproductive (female)	*Klebsiella, Pasteurella, Peptostreptococcus, Porphyromonas, Prevotella, Streptococcus spp., Pseudomonas*
Respiratory	*Actinomyces israelii, Aspergillus, Candida, Corynebacterium, E. coli, Flavobacterium, Pasteurella, Penicillium, Peptostreptococcus, Porphyromonas, Prevotella, Streptococcus*
Urinary bladder	*Alcaligenes faecalis, Staphylococcus epidermidis, Streptococcus faecalis*

TABLE 3. Gastrointestinal parasites found on fecal examination of captive jaguars (*Panthera onca*) housed at AZA accredited institutions 1982–2002

Parasites[a]	*Ancylostoma* spp., Ascarids, Cestodes, Coccidia, Flagellates, *Haemonchus* spp., *Heterakis* spp., Hookworms, *Nematodirus* spp., *Spirometra* spp., Strongyles, *Toxacara* spp.

[a]As some institutions listed parasites in generic terms (e.g., strongyles, ascarids) and others listed genus, both are noted above.

gastrointestinal diseases, 75% (9/12) were due to endoparasites or bacterial infections. In the remaining three gastrointestinal cases, there was one jaguar with gastrointestinal ulceration, one with pancreatic exocrine insufficiency, and one with chronic vomiting presumed by the primary clinician to be of gastrointestinal etiology. There were 18 cases of disease in the integumentary system with 28% (5/18) due to foot pad lesions (e.g., pododermatitis, cracked pads), 28% (5/18) associated with skin lesions due to conspecific trauma, 11% (2/18) due to skin lesions caused by self-induced trauma, 11% (2/18) from idiopathic abrasions, and 11% (2/18) due to dermatitis of unknown etiology. There was one case each of ingrown nails and a subcutaneous mass of unknown cause. The third body system in which there was $>20\%$ prevalence of disease was neurologic with 100% (11/11) of cases in this category caused by self-mutilation behavior, which was recorded as primarily tail sucking.

Adult (5– <16 Years)

In the adult age class ($n = 99$), three of the 14 body systems had $>20\%$ morbidity; dental, gastrointestinal, and integumentary. Forty-nine percent (23/47) of the dental diseases were due to fractured teeth, 38% (18/47) were recorded as moderate to severe calculus or dental caries, and 9% (4/47) had periodontal disease. There were 37 cases of gastrointestinal disease with 70% (26/37) due to endoparasites or bacterial infections, 16% (6/37) associated with an inflammatory disease (e.g., gastroenteritis, pancreatitis), and one case each of gastrointestinal ulcerations; chronic idiopathic vomiting presumed by the primary clinician to be of gastrointestinal etiology; foreign body ingestion; partial gastric dilatation-volvulus; and exocrine pancreatic carcinoma. Of the 53 cases of integumentary disease, 23% (12/53) were footpad lesions, 21% (11/53) were conspecific trauma, 17% (9/53) self-induced trauma and 17% (9/53) inflammatory skin reactions (e.g., dermatitis, MGA implant reactions). Eleven percent (6/53) of jaguars had ingrown nails, and there was one case each of subcutaneous masses, lipomas, unexplained abrasions, hyperkeratosis, granulomas, and cutaneous lymphosarcoma.

Geriatric (16–25 years)

In the geriatric age class ($n = 42$), 10 of 14 body systems had $>20\%$ prevalence of disease (Table 1). There were 34 cases of dental disease of which 41% (14/34) were tooth fractures, 32% (11/34) were recorded as calculus and caries, and 24% (8/34) were periodontal disease. Seventeen cases of gastrointestinal disease included 35% (6/17) due to endoparasites or bacterial infections, 24% (4/17) associated with an inflammatory process (e.g., peritonitis, gastroenteritis), and 18% (3/17) due to pancreatic carcinomas. There were 13 cases of hematologic disease with 46% (6/13) due to epistaxis, 23% (3/13) anemia, 15% (2/13) splenic diseases (one case of splenic tumor without histopathology report, one case of splenomegaly), and 15% (2/13) associated with prolonged bleeding. Fourteen cases of disease associated with the hepatic system were recorded with 29% (4/14) hepatic lipidosis, 21% (3/14) hepatitis, 14% (2/14) primary hepatic neoplasia, and one case each of cholestasis, ascites, hepatomegaly, steroid hepatopathy, and decreased liver function tests (bile acids). Of 38 cases of the integumentary system, 26% (10/38) were ingrown nails, 26% (10/38) were associated with an inflammatory process (e.g., dermatitis, pododermatitis), 13% (5/38) were due to self-trauma (especially to the tail), 8% (3/38) were due to

cracked pads, 8% (3/38) lipomas, 8% (3/38) focal alopecia, and one case each of sebaceous cysts, ulcerated nares, conspecific trauma and hyperkeratosis. In the musculoskeletal system, there were 25 cases reported with 36% (9/25) due to joint disease (e.g., arthritis, degenerative joint disease, trauma), 36% (9/25) associated with neuromuscular signs (e.g., ataxia, progressive hindlimb weakness, unexplained lameness), 16% (4/25) with diseases of the spinal processes (e.g., intervertebral disc disease, spondylosis), and 12% (3/25) caused by orthopedic lesions (e.g., fractures, osteomyelitis). There were 14 cases recorded in the neurological/behavioral category with 71% (10/14) due to behavioral problems (e.g., psychogenic feline alopecia, tail sucking, pacing), and one case each of encephalitis, head tremors, seizures, and encephalomalacia. There were 21 cases of disease in the renal system. Thirty-three percent (7/21) were glomerulonephritis, interstitial nephritis, or pyelonephritis, 29% (6/21) recorded as idiopathic "renal disease" or "renal failure," 14% (3/21) were renal cysts, 10% (2/21) were hydronephrosis, 10% (2/21) cystitis, and 5% (1/21) renal hypertension. There were 21 cases of disease recorded in the reproductive system and all were in females. Seventy-one percent (15/21) were recorded as neoplasia, 19% (4/21) as hyperplasia or cysts, and one case each of pyometra and mineralization of the uterus. Of 11 cases recorded in the respiratory system, 36% (4/11) were pneumonia, 18% (2/11) were rhinitis, 18% (2/11) were atelectasis, and one case each of emphysema, sinusitis, and granulomas.

All Age Classes (Body Systems With $<$20% Disease Prevalence)

The aural, cardiac, endocrine, and ocular body systems had a $<$20% disease prevalence across all age groups (Table 1). The etiologies of disease within these body systems are as follows. Aural disease had one case each of deafness and of chronic otitis externa (Table 2). Reported cardiac diseases included one case each of chemodectoma, thromboembolism, and a ventricular septal defect, two cases of arteriosclerosis, three cases of endocardiosis, four cases of dilated cardiomyopathy, and five cases of Grade III/VI or higher systolic murmurs of unknown etiology. Reported endocrine diseases included five cases of hypothyroidism, two cases of thyroid adenoma, two cases of pheochromocytoma, one case of diabetes mellitus, one case each of adrenocortical adenoma and carcinoma, and one case of hypoadrenocorticism. Ocular diseases included five cases of cataracts, three cases each of conjunctivitis and eyelid lacerations, two cases each of blindness and corneal opacities, and one case of retinal detachment.

Morbidity: Effects of Gender and MGA Exposure

The data indicate that females (33%) had a significantly higher prevalence of reproductive diseases ($P<0.001$) than did males (5%). Sixty-two females of reproductive age are included in the MGA exposure study. Twenty-five (40%) of these females had MGA exposure history, and 37 (60%) had never been exposed. Sixty percent of females that had any MGA exposure developed some form of reproductive tract or mammary disease, compared with 32% of the unexposed females. Therefore, females who had MGA exposure were significantly more likely ($P<0.05$) to develop reproductive disease than those that were not exposed to MGA. Female reproductive diseases in this population are presented in Table 4.

Mortality

Number and causes of death by age and gender are presented in Tables 5 and 6, respectively. A large number of the captive jaguars in this North America study population (45%) lived to the geriatric age class. These data also indicate that 24% of captive jaguars did not live past 2 years old. Overall, the top three causes of

TABLE 4. Reported female reproductive diseases of captive jaguars (*Panthera onca*) housed at AZA accredited institutions 1982–2002

Organ	Disease	Number
Mammary	Adenocarcinoma	3
	Carcinoma of unexplained origin	1
	Cystic tissue	2
	Squamous cell carcinoma	1
	Tumor (not classified)	5
Ovarian	Cysts	7
	Cystadenocarcinoma	5
	Granulosa cell tumor	1
Uterus	Adenocarcinoma	3
	Hyperplasia	10
	Leiomyoma	3
	Mineralization	2
	Pyometra	4
Vagina	Vaginitis	2

TABLE 5. Causes of mortality by age in captive jaguars (*Panthera onca*) housed at AZA-accredited institutions 1982–2002

Cause of death	0–<2 years n = 21; 24%	2–<5 years n = 6; 7%	5–<16 years n = 21; 24%	16–25 years n = 39; 45%
Stillborn or neonatal (<1 month)	17[a] (81.0%)	—	—	—
Reproductive	—	—	7 (33.3%)	8 (20.5%)
Musculoskeletal/neuromuscular	—	—	1 (4.8%)	10 (25.6%)
Unexplained	—	1 (16.6%)	3 (14.3%)	7 (17.9%)
Multisystemic	1[b] (4.8%)	—	3 (14.3%)	4 (10.3%)
Renal/urinary	—	—	1 (4.8%)	4 (10.3%)
Gastrointestinal and pancreas	—	—	3 (14.3%)	1 (2.6%)
Anesthesia-related	—	1 (16.6%)	2 (9.5%)	—
Trauma	2 (9.5%)	—	1 (4.8%)	—
Endocrine	—	2 (33.3%)	—	—
Immobilization/transport myopathy	1 (4.8%)	1 (16.6%)	—	—
Neurologic	—	—	—	1 (2.6%)
Anaphylaxis	—	1 (16.6%)	—	—
Dental	—	—	—	1 (2.6%)
Cardiovascular	—	—	—	1 (2.6%)
Hematologic	—	—	—	1 (2.6%)
Hepatic	—	—	—	1 (2.6%)

[a]One neonate reportedly died from pneumonia, one neonate had pneumonia and necrotic enteritis, and one neonate had a ventricular septal defect on necropsy.
[b]Pithiosis and pancreatitis.

TABLE 6. Causes of mortality by gender in captive jaguars (*Panthera onca*) housed at AZA accredited institutions 1982–2002

Cause of Death	Total (N = 87)[a]		Males (N = 38)		Females (N = 43)	
Stillborn or neonatal (<1 month)	17	20%	6	16%	5	12%
Reproductive	15	17%	—	—	15	35%
Musculoskeletal/neuromuscular	11	13%	9	24%	2	5%
Unexplained	11	13%	4	11%	7	16%
Multisystemic[b]	8	9%	6	16%	2	5%
Renal/Urinary	5	6%	3	8%	2	5%
Gastrointestinal and pancreas	4	5%	1	3%	3	7%
Anesthesia-related	3	3%	2	5%	1	2%
Trauma	3	3%	—	—	3	7%
Endocrine	2	2%	2	5%	—	—
Immobilization/transport	2	2%	2	5%	—	—
Neurologic	1	1%	1	3%	—	—
Anaphylaxis	1	1%	1	3%	—	—
Dental	1	1%	1	3%	—	—
Cardiovascular	1	1%	—	—	1	2%
Hematologic	1	1%	—	—	1	2%
Hepatic	1	1%	—	—	1	2%

[a]Six stillbirth or neonatal deaths of unknown sex.
[b]Males: pancreatitis and pheochromocytoma; liver disease, peritonitis, and heart disease; lipid pneumonia and amyloidosis; cholecystitis and hemorrhagic gastroenteritis; pithiosis and pancreatitis; actinomyces cultured from liver, lungs, and peritoneum. Females: osteomyelitis, encephalitis, and squamous cell carcinoma; diabetic ketoacidosis, renal failure, and liver disease.

mortality in captive jaguars (Table 6) were stillbirths or neonatal (<1 month old) deaths (20%), reproductive diseases (17%), and musculoskeletal or neuromuscular diseases (13%). Jaguars that died when <2 years old were most often stillborn or unexplained neonatal deaths. Other causes included trauma, pneumonia, and one case of a ventricular septal defect. For males, the most common causes of death were musculoskeletal or neuromuscular diseases (24%) and multisystemic disease (16%). For females, reproductive disease was the leading cause of mortality and accounted for 35% of deaths. Forty-seven percent of females that died from reproductive disease had never been exposed to MGA, whereas 53% had. Therefore MGA exposure did not seem to significantly affect reproductive disease as a cause of mortality ($P \leq 1.0$). Eleven jaguars (13%) died of an unspecified cause not explained in the medical record.

DISCUSSION

This retrospective study offers a valuable overview of captive jaguar morbidity and mortality, as well as the influence of age, gender, and MGA exposure on morbidity and mortality. However, as a retrospective study using data from a number of facilities there are several limitations associated with variations in record-keeping, terminology used, husbandry, health care, and pathologic and medical differences of opinion. The analyses of the data necessitated assuming that if disease was not noted in an organ system it did not exist. However, variations in

examination techniques, diagnostic capabilities, and record-keeping likely failed to report all instances of disease within each organ system. Additionally, some bacterial or yeast cultures may have grown contaminants and not true pathogens. Finally, as post-mortem pathology reports were not always provided, the clinical impressions that led to euthanasia were included within the data on causes of mortality. Despite these limitations, the data collected are useful for identifying trends within the North American captive jaguar population, allowing comparisons with other captive jaguar populations around the world, presenting areas of focus for future captive jaguar studies, and providing solid data for making recommendations for appropriate captive jaguar care.

Overall, the most prevalent causes of morbidity in this study were dental disease, gastrointestinal disease, integumentary disease, and musculoskeletal/neuromuscular disease. However, within different age groups the most frequently diseased body systems varied.

Dental disease was very common in adult and geriatric jaguars. Routine exams should always include a dental exam and treatment when deemed necessary. Chewing on bars and fencing promotes tooth fractures, and enrichment devices should be given to encourage jaguars to chew dental-friendly items.

Gastrointestinal disease represented a significant portion of jaguar morbidity in all age groups. Frequently diagnosed parasitic infections were often successfully treated with anthelminthics before clinical signs became apparent. Some fecal examinations found parasites unlikely to cause morbidity in feline hosts (e.g., *Haemonchus* spp. and *Nematodirus* spp. [ruminant parasites]; *Heterakis* spp. [avian parasites]). The prevalence of inflammatory gastrointestinal diseases such as peritonitis and gastroenteritis increased with the animals' ages. Interestingly, there has been one report of feline infectious peritonitis in an infant jaguar [Fransen, 1972–1973], but no cases were identified in the 172 jaguar records included in the present study. Pancreatic carcinomas were reported in older animals and were a cause of mortality.

Integument diseases comprised a large percentage of diseases in adolescent and adult jaguars, and were often secondary to behavioral problems. Frequently seen integument diseases included pododermatitis, cracked pads, dermatitis, abscesses, trauma from cage mates, and self-trauma. Inflammatory responses to MGA contraceptive devices were reported frequently in adult female jaguars. In the geriatric population, ingrown nails were prevalent, suggesting that sharpening behaviors should be encouraged and veterinarians should be aware that frequent nail trimming might become necessary. Lacerations and bite wounds from cage mates were very frequent in both adolescent and adult jaguars, hence pairing and grouping of animals should be carried out cautiously. Potential solutions to this problem could be housing jaguars separately or providing more space per animal. Pododermatitis, often due to immune-mediated or infectious causes, may also be related to concrete enclosures and pacing, as stated in one case of an individual who healed after being relocated to an outdoor exhibit [Baker, 2004]. Inflamed tail lesions due to self-trauma (e.g., tail sucking) were prevalent in adolescents, adults, and geriatric cats. Enrichment items and activities should be provided, and cats should have adequate space and areas to hide to help prevent self-trauma from boredom or stress. Additionally, fluoxetine and acepromazine have been used successfully in other large cats to eliminate pacing behavior [Baker, 2002], and may be useful in decreasing other self-traumatizing activities.

Musculoskeletal diseases, such as spondylosis, intervertebral disc disease, arthritis, osteomyelitis, and fractures, are common in geriatric jaguars. Previous studies have indicated that progressive spinal diseases such as spondylosis and intervertebral disc disease are not uncommon in large felids [Kolmstetter et al., 2000]. Geriatric felids with decreased activity should be radiographically evaluated for spinal disease and treated appropriately. Arthritis may be related to cement housing [Baker, 2004]. Arthritis cases can be managed with weight control, chondroprotective drugs, and nonsteroidal anti-inflammatory drugs, if necessary.

Epistaxis and anemia were common in geriatric jaguars. The cause of epistaxis was undetermined in all of these animals. Due to the high frequency of epistaxis in the population, and its potential to indicate serious underlying disease processes (e.g., primary bleeding disorder, systemic hypertension, neoplasia), future cases of epistaxis should have full blood work including coagulation panels, blood pressure measurements, and ideally chest radiographs and abdominal ultrasound to screen for neoplasia.

Other common geriatric diseases included urologic, hepatic, and respiratory diseases. The most common report of renal disease was renal failure of unknown etiology. Further characterization of renal disease using ultrasound and biopsies would be beneficial for future management of jaguar renal diseases. Hepatic lipidosis was the liver problem reported most frequently, possibly related to problems of obesity in captive animals. Pneumonia was a common respiratory disease in geriatric jaguars.

Diseases of the aural, cardiac, endocrine, and ocular systems did not contribute largely to morbidity in any age group. However, it is interesting to note that in contrast to domestic cats in which hyperthyroidism is the most common endocrine disorder [Peterson, 2000], these data and previous reports [Snyder and Richard, 1984; Greer et al., 2003] suggest that non-domestic felids may be more prone than domestic cats to developing hypothyroidism. Also, although not presented in these data, there has been one case report of a glucagonoma in a captive jaguar [Ramos-Vara et al., 2000].

Reproductive diseases were highly prevalent in geriatric jaguars, and significantly more prevalent in females vs. males. The majority of reproductive diseases were neoplastic, hyperplastic, or cystic disease. This study supports that MGA exposure may increase the risk of reproductive disease, as indicated in other studies [Munson et al., 2002]. The AZA Contraception Advisory Group states that ovariohysterectomy is the safest method of birth control [AZACAG, 2004]. However, MGA exposure may be used for no more than 4 years, and only 2 years at a time with a break for pregnancy [AZACAG, 2004]. The high prevalence of reproductive disease among female jaguars with no MGA exposure in this study agrees with previous reports suggesting that jaguars are at higher risk than other felids to develop mammary gland and endometrial cancers [Munson, 2004], and may support theories that there is a genetic link to the high prevalence of female reproductive diseases in jaguars [Munson, 1994]. Still, MGA exposure does seem to increase risk of developing a reproductive tract disease, and should be considered seriously before being used as a contraceptive device.

Mortality in jaguars <2 years old tended to be due to stillbirths, trauma, or pneumonia, whereas jaguars >5 years seemed to die from reproductive tract disease

or musculoskeletal or neuromuscular disease. The most common cause of mortality for females was disease of the reproductive tract. Interestingly, although MGA exposure seems to increase the prevalence of reproductive tract disease, whether or not a female had been exposed to MGA in her lifetime had no significant effect on mortality due to reproductive tract disease. Many males were euthanized due to severe musculoskeletal or neuromuscular disease (e.g., arthritis, intervertebral disc disease, and idiopathic paresis).

CONCLUSIONS

This study highlights several causes of morbidity and mortality in the North American captive jaguar population. Overall, older animals show a higher prevalence of disease among all body systems. Below is a summary of major causes of morbidity and mortality in captive jaguars, along with recommendations for improved husbandry and care.

1. Gastrointestinal disease is prevalent across all age groups with parasitic diseases being the most common. We recommend routine fecal examinations and anthelmintic treatment as needed.
2. There is a high prevalence of integument diseases, which are often due to trauma from cage mates or from self-mutilation. We suggest that jaguars should be housed solitarily with constant enrichment and sufficient space to exercise, or in same-gender or sibling pairings.
3. Pododermatitis is a health concern in most age classes. Cases should be worked up thoroughly to determine etiology and to help with prevention. Provide a softer substrate such as wood or sand rather than housing animals on cement to decrease pododermatitis, cracked pads, and arthritis.
4. Dental disease and fractures are very common. Complete dental exams and treatment should be carried out during every routine exam. Also, avoid fencing or bars in enclosures that may contribute to fractured teeth.
5. Epistaxis of unknown etiology occurs fairly frequently in both young and old animals. Because epistaxis may indicate bleeding disorders, hypertension, or neoplasia, it is important for clinicians to determine the etiology of epistaxis cases.
6. Melengestrol-acetate exposure seems to increase the risk of female reproductive disease. When possible, use other contraceptive methods such as separation of males from females or ovariohysterectomy.

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