CONSULTATION ON THE DEATH OF THE GORILLA “BANTÚ” OF THE CHAPULTEPEC ZOO

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Introduction

This report was drafted by the consulting group based on their experience with veterinary aspects of the North American SSP (Species Survival Plan) Gorilla population. This report is the work of the consultants and does not represent an official report from either the Association of Zoos and Aquariums (AZA), or the Gorilla SSP (Species Survival Plan) ®.

The consultants were contacted by the Secretaría del Medio Ambiente (SEDEMA) and this report is a reply to their request for an external review. The purpose of this document is to review the information provided regarding the death of “Bantu” to determine the cause of death as well as any additional information that may assist with the care of gorillas in the future.

Post Mortem Protocols and results of the Post Mortem exam and Histopathology findings

The following materials were available for review of the pathology aspects:

1) The gross pathology report from Chapultepec Zoo, which used the US gorilla SSP (Species Survival Plan) pathology report format, in both English and Spanish;

2) 13 gross images including: thoracic cavity in situ with lungs retracted to show effusion, exterior of the heart, anterior view with pericardium removed, abdominal cavity in situ with effusion, three images of the opened heart including mitral valve, left ventricle and longitudinal cut surface of ventricular wall; one kidney cut longitudinally and laid open, liver and opened gall bladder, a piece of liver,

stomach mucosa, two images of small intestinal mucosa, and one image of colonic mucosa.

3) 3 addition gross images: spleen, dorsal view of brain, whole body in dorsal recumbency before the post mortem examination.

4) 2 additional gross images in newspaper article Yucatan Times of the gorilla during the necropsy.

5) Histopathology report (in Spanish and English) from the Autonomous University of Mexico faculty of Veterinary Medicine (UNAM).

6) Histopathology report from the Institute of Forensic Sciences.

7) Response to additional questions about heart measurement procedures.

8) Necropsy performed by the Staff of Chapultepc Zoo.

9) Results of the viral tests performed by VRL Laboratories.

10) Videos and images containing management of gorilla occurred on July 6, 2016.

Note: Dr Lowenstine has not yet reviewed the slides and is relying on descriptions from the pathology reports, gross images from Chapultepec Zoo pathology and the images provided from the veterinary school histology report.

Evaluation of the necropsy procedure

The purpose of performing a post mortem examination on a gorilla (or any animal) is not only to determine the cause of death, but also to contribute to our understanding of other processes affecting the animal's health and ultimately to lead to improved veterinary and husbandry techniques.

In order to do a complete post mortem examination (necropsy or autopsy) one has to open the body from chin to pelvis and remove all the internal organs. Each organ is examined and sampled. Excess tissue is disposed of. The skull must be opened to remove the brain.

This usually necessitates decapitation, especially in large bodied animals, or ones with thick neck muscles, like gorillas. Joints must be opened or disarticulated to examine for arthritis. It is not uncommon for museums to request skeletal remains and in that case extensive dis-articulation of all limbs is performed to allow for de-fleshing of the bones.

If the skeleton is not destined for a museum, and to be thorough, the spine is isolated from the rest of the body, examined for arthritis and opened using power tools to remove the spinal cord. Bone marrow is usually acquired by cutting through one or more long bones.

This is not a delicate or pretty process. It is bloody, especially if the animal is freshly dead. With larger animals, like gorillas, there is much physical work involved. It is not done callously, but rather with due respect for what the process can tell us to help other animals. Further processing of the carcass, through dis-articulation, may be necessary to facilitate disposal of the animal's remains by incineration, digestion, or burial.

Great ape necropsy protocols, including special protocols for examination of the heart are available through the Association of Zoos and Aquariums (AZA), Gorilla SSP (Species Survival Plan) and the Ape Taxon Advisory Group (Ape TAG) and on the Great Ape Heart Project website (https://greatapeheartproject.org/projects/postmortem/).

These protocols were developed by clinical veterinary advisors and veterinary pathology advisors to guide others in performing a thorough research-oriented postmortem examination (the research being primarily directed toward answering questions determined to be significant to gorilla health, medicine, husbandry and conservation).

NOTE: THESE ARE RECOMMENDATIONS AND NOT MANDATES FOR AZA INSTITUTIONS PARTICIPATING IN THE GORILLA SSP.

Conclusion: The prosectors followed the format of the standard necropsy protocol from the Association of Zoos and Aquariums (AZA), Gorilla SSP (Species Survival Plan) including morphometrics, organ weights, various measurements of the heart, and photographic images. The report is very thorough**.** Review of the images in the newspaper article: These images show the opened partially disarticulated body of the gorilla on a necropsy table and the isolated head of the gorilla, which has been partially skinned, to facilitate removal of the brain.

Conclusion: The appearance is as would be expected during a thorough post mortem examination.

Postmortem findings

Based on all available data from images and reports, the most significant findings were related to the heart.

Heart: The image of the whole heart shows a globoid flaccid heart. The shape is very abnormal. There are many pale streaks in the myocardium visible through the epicardium, which can represent fibrosis or fatty infiltration. The images of the cut surface of the ventricular walls show similar streaking. The heart weight was 1480gm. The circumference was 44cm.

Normal values have not been definitively established for gorilla heart weights and measurements. Establishment of ranges for normal and abnormal heart is one of the future functions of the pathology part of the Great Ape Heart Project (GAHP) database, which is currently being populated.

Benirschke and Adams (1980) found adult male (12 years and older) heart weights (n=9) ranging from 231 gm to 1140 grams, with hearts of 805, 875, and 1134 being abnormal due to disease affecting the organ. The heart that weighed 1140 grams was from a 23 yo obese animal. (Benirschke K, Adams FD. Gorilla diseases and causes of death. J Reprod Fertil Suppl. 1980; Suppl 28:139-48. Review).

From preliminary data analysis from the Species Survival Plan (SSP) mortality data-base male gorilla hearts ranged from 449-1600 grams (Great Ape Heart Project (GAHP) unpublished data). Males with no evidence of heart disease (N=5) range was 449-720gm. Mild fibrosis or hypertrophy (N=4) 720-820gm. Moderate to severe fibrosis or hypertrophy (n=1) 801gm. Definite cardiac disease (n=16): 725-1600gm. Heart weight in one gorilla with aortic dissection was 680gm and one anesthetic death with no evidence of cardiac disease, the heart weighed 680 gm. Cardiac circumference is available for 9 adult males: Range: 27.5-36 cm.

Histologically, there was interstitial myocardial fibrosis, marked karyomegaly (myofiber polyploidy/hypertrophy) and lipofuscinosis all of which are similar to other gorillas dying of heart disease.

Anesthesia and Transport planning

From the materials provided, it appears that the planning was adequate. The transport crate met the standards of the International Air Transport Association (IATA) which makes recommendations for live animal transport containers for a wide variety of animal species. The Convention on International Trade in Endangered Species (CITES) has found that due to the regular review and requirements of IATA standards that “IATA LAR (live animal regulations) are appropriate for the non-air transport of all species of animals” that do not exceed 48 hours. (CITES 16 Committee II. 12.)

Anesthesia:

There are no current Standards of Practice which establish specific recommendations for gorilla anesthesia including agents to be used, minimal monitoring procedures and anesthesia management.

Injectable anesthetic agents and dosages are constantly evolving and may be determined based on experience within the zoo community or published recommendations.

The three immobilizing agents used in the case of Bantu, are all widely used in gorilla immobilizations and may be selected in combination to allow for the use of lower dosages of each individual agent. The drug dosages administered were compared to global anesthetic dosages for Western Lowland Gorillas obtained from the Species 360 ZIMS medical data from a total of 1,670 anesthetic events on 395 individual animals.

The total dosages of Ketamine, tiletamine/zolazepam and medetomidine administered (including the initial and supplemental dosages) were all still below the median dose for each of these drugs in any combination reported in the ZIMS data.

One of the agents, medetomidine, has been the cause of concern in discussions following the death of “Bantu”. Medetomidine is one of the most widely used immobilizing agents in gorillas and included in two of the most common protocols reported in ZIMS. Medetomidine has previously been reported to have “minimal cardiovascular effects” *(Cerveny, S., and J. Sleeman. 2014. Great apes. In: West, G., Heard, D. and Caulkett, N. (eds.) Zoo animal and wildlife immobilization, John Wiley and Sons, Ames, Iowa. Pp.573-584 2nd Ed.).*

Data from a limited echocardiographic study however, showed that there was a significant effect on cardiac echocardiographic parameters and suggests caution for the use of medetomidine in gorillas with cardiovascular disease *(Napier, J.E., I.B. Kutinsky, D.L.Armstrong, D. Orton, C. Hicks, J. Waldoch, and W.H. Devlin. 2013. Evaluating*

echocardiogram and indirect blood pressure results in male western lowland gorillas (Gorilla gorilla gorilla) during three phases of an anesthetic protocol. Journal of Zoo and Wildlife Medicine, 44(4): 875-881.)

From the total dosages used on Bantu, it is the opinion of the group that Bantu did not receive an overdose of immobilizing agents.

At some time during the transport procedure Bantu suffered respiratory and cardiac depression and resuscitation attempts were not successful. The extent of abnormal findings seen on postmortem examination of Bantu, including advanced cardiac disease, indicates that this animal had serious underlying health issues before this immobilization and transport procedure.

It is not possible to determine the exact timeline by which the advanced cardiovascular disease developed but given these postmortem findings and the expertise and experience of the consulting panel, we believe that even in the unlikely event that he could have been successfully resuscitated, Bantu had a grave prognosis given his end-stage cardiac disease. Gorillas at this advanced stage of cardiac disease have very short life-expectancies, even if given aggressive treatments.

Gorilla Cardiovascular Disease

Cardiovascular disease is commonly seen in great ape species and is reported in 41% of adult gorillas. *(Lowenstine, L.J., R. McManamon, and K.A. Terio. 2016 Comparative pathology of aging great apes: Bonobos, Chimpanzees, Gorillas, and Orangutans. Veterinary Pathology, 53(2): 250-276; McManamon, R. and Lowenstine, L.J. 2012. Cardiovascular disease in great apes. In: Miller, R.E. and M.E. Fowler (eds.) Fowler's Zoo and Wild Animal Medicine, Elsevier Saunders, St. Louis, Missouri. Pp.408-415.Vol. 7))*

Clinical signs are often subtle or non-existent in gorillas that have cardiovascular disease. Historically, cases of advanced cardiac disease in great apes was diagnosed

after sudden death with no history of clinical signs associated with this advanced stage of heart disease. While cardiovascular disease may occur in females, it is primarily a disease of males with changes noted on echocardiograms as early as 11 years *(Murphy, H.W., P. Dennis, W. Devlin, and T. Meehan. 2011. Echocardiographic parameters of captive western lowland gorillas (Gorilla gorilla gorilla) Journal of Zoo and Wildlife Medicine, 42(2): 572-579).*

The etiology of this disease is unknown and has been the subject of much research including the development of the Great Ape Heart Project (GAHP). Full physical examinations done on apes placed under general anesthesia are needed to do complete health assessments and to look for any signs of disease. For those animals that are felt to be good anesthetic candidates, a thorough echocardiogram is most dependably performed in this setting, and can often be done as part of a regularly scheduled examination.

The current recommendation is to have complete echocardiographic exams done every 1 to 3 years in adult great apes (*Murphy, H.W. 2015. Great apes. In: Miller, R.E. and M.E. Fowler (eds.) Fowler's Zoo and Wild Animal Medicine, Elsevier Saunders, St. Louis, Missouri. Pp.336-354. Vol. 8)*. Overall, the collective experience of the Great Ape Heart Project (www.greatapeheartproject.org) is that echocardiograms performed on anesthetized animals yield a noticeably higher image quality than those performed on non-anesthetized animals.

The risk of anesthesia, particularly in apes that already may have or are confirmed to have cardiac disease, needs to be analyzed on an individual basis and is up to veterinary discretion. The Great Ape Heart Project (GAHP) encourages institutions that hold great apes to perform fully diagnostic echocardiographic evaluations on anesthetized apes. For the purposes of risk reduction in compromised apes, and to monitor progression of cardiac disease frequently, Great Ape Heart Project (GAHP) also endorses training of great apes to provide supplementary cardiac information between anesthetized examinations.

Performing an echocardiogram on a non-anesthetized great ape requires a significant amount of training for the animal, the sonographer, and other personnel assisting with this procedure. These efforts are relatively new in some Association of Zoo and Aquarium (AZA) institutions and the studies being generated are still very limited in quality and diagnostic scope.

Conclusions

- Bantu's heart was grossly abnormal, in weight and circumference. The gross appearance is that of end stage dilation. Myocardial fibrosis was noted histologically. Fibrosis in gorilla hearts has been associated with a syndrome termed "fibrosing cardiomyopathy" (reviewed in McManamon and Lowenstine). Evidence of cardiac insufficiency included the fluid accumulation in thorax and abdomen, the evidence of chronic passive congestion in the lungs and spleen and centrilobular fibrosis in the liver. Additional findings contributing to morbidity of this individual included: obesity, chronic ongoing enterocolitis with colonic balantidiasis, pericholangeal/periportal hepatitis with biliary hyperplasia, and glomerulonephropathy.

- Death subsequent to immobilization for transport, may have been related to the heart no longer being able to compensate for the chronic underlying disease, but given the extent of cardiac failure seen at necropsy, likely did not hasten Bantu's death by a significant amount.

- At the time of death, Bantu had not been immobilized for a medical examination for 6 years and had never had a cardiac echocardiographic exam. The recommendation of the Association of Zoo and Aquarium (AZA) accredited zoos is to have a preventative medicine program that includes routine medical examinations to monitor for and prevent / treat diseases of concern. Risk assessments based on reviews done in Lowenstine et al Vet Path 2016; McManamon, Lowenstine, Fowler 7 ,Murphy et al JZWM 2011 and the Great Ape

Heart Project (GAHP) indicate that great apes, including mature male gorillas, are at high risk for developing cardiac disease.

- There is inherent risk in any general anesthesia, whether being performed on a human or any other species. In many zoo animals, including gorillas, veterinarians are not able to perform the various tests that could be done in a human or domestic animal patient

- The current guidelines established for Association of Zoo and Aquarium (AZA) zoos include routine examination under anesthesia to look for underlying disease. Early detection of disease provides an opportunity for treatment, allows monitoring of disease progression, and facilitates adjustment of anesthetic protocols to compensate for underlying disease.

  While we do not know how to prevent cardiovascular disease in gorillas, diagnosing the problem at a younger age can help in treatment plan development, monitoring disease progression over time, and assessment of anesthetic risk.

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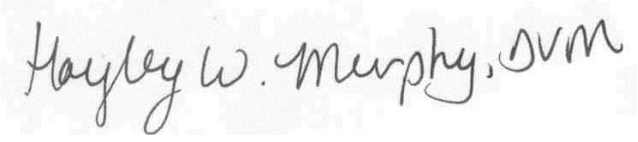
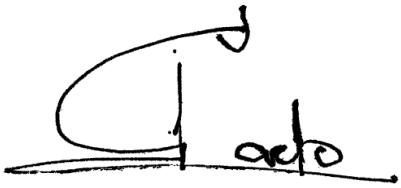


Hayley W. Murphy, DVM

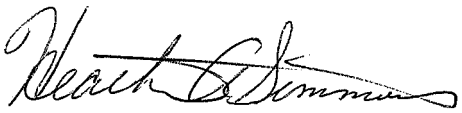
Consultation on the death of the Gorilla “Bantu” of the Chapultepec Zoo.

MVZ. MSc. David Espinosa Aviles

MVZ. Claudia Lewy Sánchez Aldana



MVZ. Enrique Yarto Jaramillo



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