

**GUIDELINES FOR
ZOO AND AQUARIUM VETERINARY MEDICAL PROGRAMS
AND
VETERINARY HOSPITALS**

6th edition prepared by:

American Association of Zoo Veterinarians

2016

Nancy Carpenter, Sathya Chinnadurai, Kelly Helmick, Thomas Meehan, Michael
Murray, Joe Smith, Jeff Wyatt

I. INTRODUCTION

“The mission of the American Association of Zoo Veterinarians (AAZV) is to optimize the health, welfare, and conservation of zoo animals and wildlife through education, scientific study, collaboration, and advocacy”. The purpose of these Guidelines is to improve the health and welfare of the animals in zoos and aquariums through advances in the standards of veterinary care.

Zoological parks and aquariums have humane and legal obligations to provide proper husbandry, veterinary medical treatment, and preventive medical and nutritional programs for their animals. Zoos and aquariums in the United States are required to employ an attending veterinarian who will provide adequate veterinary care for the animal collection and to assure that certain minimal standards of veterinary care are in place according to the Animal Welfare Act of 1966 and the subsequent amendments that are enforced by the United States Department of Agriculture (USDA). Maintaining standards of veterinary care requires professional oversight of laboratory, clinical, and nutritional services including the supervision of the veterinary medical programs by a licensed veterinarian who has special training or experience in non-domestic animal medicine.

Animal health is not solely the responsibility of the veterinary staff. Animal health is ensured by those who provide husbandry, prepare diets, monitor behavior and maintain environmental quality. By the same token, veterinary care cannot simply be limited to providing medications and treating emergencies. Veterinarians are stakeholders in all aspects of animal health and welfare and must be integrated into the overall management of zoo and aquarium animals including behavior, husbandry, nutrition, reproduction, exhibit design, and conservation programs.

In the United States, the Animal Welfare Act states that “Each zoo and aquarium shall assure that the attending veterinarian has appropriate authority to ensure the provision of adequate veterinary care and to oversee the adequacy of other aspects of animal care and use” (See Animal Welfare Act, Title 9, Part 2.40).

http://www.aphis.usda.gov/animal_welfare/publications_and_reports.shtml

As such, the veterinarian, with consultation of the other animal management staff, is responsible for the design, implementation, and surveillance of the veterinary care program for the zoo or aquarium.

The additional staff required to support the veterinary medical care programs depends on the type and size of the institution, the nature of the physical facilities, the number of animals, and the extent and difficulty involved in maintaining each species. Professional and supporting personnel are necessary to implement portions of the veterinary medical program concerned with veterinary medical care. Zoos and aquariums must provide full administrative, technical and husbandry support for the veterinary medical programs. In all cases, one full-time staff member at the institution must be responsible for the medical care program.

The following document is the sixth edition developed by the American Association of Zoo Veterinarians to be used as a guideline for zoos and aquariums in developing and evaluating the medical programs in their institutions. The Veterinary Medical Program encompasses the routine medical and surgical care of the collection and the preventive medicine program. In order for the veterinary staff to support these programs of veterinary care, a hospital facility appropriate to the collection's needs is required. It is hoped that this document will be an aid in the accreditation of zoos and aquariums by the Association of Zoos and Aquariums.

II. VETERINARY CARE

The veterinary medical program must emphasize disease prevention and animal well-being to include nutritional, behavioral, and reproductive health. In order to promote population sustainability, trends in the overall health of the animals must be monitored over time. All animals in the collection must be observed daily either by the person in charge of animal management, or by someone working under the direct supervision of this person. All keepers must be trained to recognize abnormal behavior and clinical signs of illness and must be knowledgeable concerning the diets, husbandry, and restraint procedures for the animals under their care. Diseased, injured, or stressed animals must be reported promptly so that they can be assessed for their need for veterinary medical care. Collection animals that die should receive a complete necropsy and the carcass should be disposed of properly (see Necropsy Section II.B.5).

All procedures and treatments performed on animals must employ current professionally accepted methods of diagnosis and treatment. There should be a standard operating policy of providing appropriate medical care for all sick and injured animals.

Veterinary coverage must be available 7 days/week, 24 hours/day for any zoo or aquarium regardless if a full-time or part-time veterinarian supplies the coverage. Appropriate contractual and schedule arrangements must be made at all zoos and aquariums to permit this availability.

A. Staff/Personnel

1. Veterinary Coverage

The veterinarian is responsible for the medical and surgical care of the animals and must be fully acquainted with the entire animal collection care staff and animal facilities. The veterinarian must arrange for the availability of other suitably experienced veterinarians to be on call when they themselves are unavailable. In the case of institutions using the services of a part-time veterinarian, the veterinarian must make regularly scheduled visits to the facility in order to become familiar with the clinical cases and to closely supervise their veterinary care.

The zoo or aquarium must have back-up emergency veterinarians, selected by the veterinarian. The regular and back-up veterinarian must be familiar with the application of currently accepted measures of therapy, methods of anesthesia and restraint, and prophylaxis appropriate for each species or have access to sources of this information.

If a contract service is provided by a group veterinary practice, there should be one veterinarian who is responsible for the medical program at the zoo or aquarium and the other veterinarians in the group practice should be considered as back-up veterinarians.

2. Veterinary Program Coordinator

Any zoo or aquarium in which a part-time veterinarian provides veterinary coverage must have one staff person who serves as the veterinary program coordinator, and supervises the veterinary care program under the direction of the veterinarian.

The veterinary program coordinator makes note of which animals require examination by the veterinarian, and should accompany the veterinarian during rounds and treatments. The program coordinator is also responsible for overseeing prescribed treatments, maintenance of hospital equipment, and supervising drug inventories.

It is essential that the veterinary program coordinator be trained to deal with emergencies until the veterinarian arrives, be able to direct the restraint of the animals, be responsible for administration of post-surgical care, and be skilled in maintaining appropriate medical records. It is important that the veterinary program coordinator should communicate frequently and directly with the part-time veterinarian to ensure that there is a timely transfer of accurate information about medical issues. Ideally, this individual should be a licensed veterinary technician or an animal health technician. The coordinator should implement the preventive medicine programs established by the veterinarian. These programs are described in section B "Veterinary Programs".

3. Support Personnel

A veterinary care program requires support staff to establish and maintain the programs and facilities as previously described. It is important that tasks assigned to veterinary support staff or other zoo or aquarium personnel are within the requirements of the appropriate local, state or federal veterinary practice guidelines.

A facility with a large diverse animal collection requires support personnel in three areas:

1. Husbandry (animal keepers) - to perform routine care for hospitalized animals.
2. Technical (preferably a Registered, Certified or Licensed veterinary technician, following pertinent State regulations) - to assist in veterinary care, equipment maintenance, and laboratory functions.
3. Clerical – including but not limited to oversight of medical records.

A small facility would have correspondingly fewer personnel to perform these tasks, but assignments of these tasks to specific personnel are important.

4. Infection Control and Personnel Safety

All hospital staff must take special precautions to prevent cross-contamination between animal areas as they move about the zoo or aquarium. Keepers working in the hospital should not work in the exhibit areas to avoid cross-contamination. If there must be shared duties as in smaller facilities, appropriate measures must be taken to prevent lateral transmission of disease between the hospital and exhibit areas. Personnel safety

standards should conform to all local, state, and federal regulations concerning occupational health and safety in the workplace. Workers must be aware of the potential hazards associated with handling dangerous animals (bites, envenomation, scratches, etc.). In addition, they must be familiar with the chemicals (anesthetic agents, medications, disinfectants, etc.), microbiological (including allergens) and physical hazards (radiation, etc.) found in the workplace. Safety and personal protective equipment must be properly maintained and routinely calibrated. Safety Data Sheets (SDS) must be available for staff use on-site for all drugs and chemicals used in the facility. Specific protocols should be developed as needed for different zoonotic diseases that may be present based on a risk assessment of the facility.

B. Veterinary Program

1. General Considerations

Veterinary medical and surgical care must be provided for all animals in zoos and aquariums. This care must meet or exceed contemporary practice standards of zoo and aquarium veterinary care. Animal collection size or budgetary constraints may influence the location where such care is provided but may not prevent the provision of these minimum care standards. Veterinarians and support personnel must be knowledgeable about the humane aspects of animal treatment.

Medical procedures, including those conducted without the use of anesthetics, analgesics, or tranquilizers, must be supervised by a person qualified to assess the risks involved, and must be done only in consultation with the veterinarian, and in accordance with local, state and federal laws.

Medications must be used in accordance with local, state, regional, provincial, and federal regulations and must be administered in accordance with the relevant veterinary practice act. Procedures for the use of animal drugs should include at minimum the following: those persons authorized to administer animal drugs, situations in which they are to be utilized, location of animal drugs and those persons with access to them, and emergency procedures in the event of accidental human exposure. All controlled substances must be stored in a securely locked container of substantial construction appropriate for the types of drugs in the inventory. Schedule II drugs such as ultra-potent narcotics must be stored in a safe or steel cabinet equivalent to a U.S. Government Class V security container. Outdated drugs must be marked as such and stored separately from all other drugs. Drugs used in zoos and aquariums on fishes must be administered in compliance with the Food and Drug Administration (<http://www.fda.gov/cvm/minortoc.htm>) so as to prevent contamination of human water supplies and to be in accordance with the Association of Zoos and Aquariums(AZA) policy (<http://www.aza.org/uploadedFiles/Accreditation>.)

2. Anesthesia

In a zoological setting, anesthesia is often necessary for both invasive (e.g., surgical) and noninvasive (e.g., blood collection, collaring, metabolic) procedures. Anesthesia for noninvasive procedures is commonly utilized for the safety of the staff and the animals.

Physical restraint without sedation or anxiolytics should be limited to short, nonpainful procedures or longer procedures in species that are exceptionally tolerant to manual restraint. Physical or mechanical restraint can be stressful to nondomesticated species and conscious sedation can reduce stress in the animal and decrease risk of injury to the animal and humans. In the case of invasive procedures, restraint without consideration for analgesia may be grossly inappropriate and anesthesia or local analgesia should be used.

Characteristics of general anesthesia include (1) complete unconsciousness, (2) analgesia, (3) muscle relaxation, and the (4) absence of reflex responses. Anesthesia should not be mistaken for simple immobilization and recovery, without regard for the importance of monitoring and maintaining a stable patient during the procedure. All anesthetic plans must take into account human and animal safety. Human injuries during zoo immobilizations have occurred from animal attacks, drug exposure and environmental hazards.

Monitoring

Anesthetic monitoring should follow guidelines generated by the American College of Veterinary Anesthesia and Analgesia (ACVAA; http://www.acvaa.org/docs/Small_Animal_Monitoring_2009.doc). Physiologic parameters are monitored to help the anesthetist achieve and maintain a surgical plane of anesthesia, anticipate and detect when changes in delivery of anesthetic drugs are required, and promptly identify preoperative, intraoperative, and postoperative complications. The most basic anesthetic monitoring consists of measuring heart rate, respiratory rate and body temperature (homeotherms) and should be performed and recorded for each anesthetized patient. While expensive instruments are available for specialized situations, these parameters are easily measured with the eyes and ears of the anesthetist, a stethoscope, and a rectal thermometer. Monitoring of oxygenation, ventilation (carbon dioxide excretion), and blood pressure require additional monitors. This monitoring is considered ideal, and should be used when feasible. Pulse oximeters, capnographs, electrocardiograms (ECG), and oscillometric blood pressure monitors are the commonly used "standard anesthetic monitors" in veterinary anesthesia, but require some accommodation for non-domestic species. It is important to remember that even though these devices are widely used in wildlife medicine, few have been objectively evaluated in nondomestic species.

At a minimum, the anesthetist should have equipment available for endotracheal intubation and vascular access in species for which those techniques are possible. The decision to intubate or place an intravenous catheter should be based on the well-being of the patient and the safety of the human personnel. In addition, appropriate drugs for emergency response in the species commonly anesthetized in the collection should be maintained in appropriate quantities.

Analgesia

Analgesia should be provided for any penetration of the skin by a tool larger than a hypodermic needle, including biopsy instruments. When general anesthesia is not used, preemptive analgesia is of paramount importance. Many drugs, such as propofol and isoflurane, which affect or facilitate immobilization and anesthesia, do not provide

analgesia and should be used in conjunction with an appropriate analgesic agent. Guidelines for the recognition and treatment of pain in animal patients are provided by the ACVAA (ACVAA 2006).

3. Surgery

All zoos and aquariums must have access to surgical facilities that are clean, free from excessive noise and unnecessary pedestrian traffic, have adequate lighting, ventilation, and temperature controls, and that can be easily cleaned and disinfected. They must have access to inhalant anesthesia equipment with a gas scavenging system and oxygen, sterilized surgical packs, surgical preparation solutions, intravenous fluids, fluid administration equipment, pulse oximetry, heart monitoring equipment (e.g. electrocardiogram, stethoscope), and emergency drugs. The equipment must be maintained in good working order and be on a program of routine preventive maintenance.

All zoos and aquariums must have an on-site area available for minor surgical procedures. Separate aseptic surgical facilities must be available with preference for on-site locations to limit transport time and animal stress (see Section III.A. On-Site Veterinary Hospital). If an off-site aseptic surgical facility is used, then the availability of an on-site area that can be adapted for occasional or emergency aseptic surgical use is recommended. Aseptic surgical facilities should include separate areas for animal preparation, surgeon's scrub, instrument preparation, and postoperative recovery. These support areas should all be free from excessive noise and pedestrian traffic. It is recognized that surgery must sometimes be performed outside the standard surgical suite, especially in the case of large animals.

Surgery can only be performed by a veterinarian. In an emergency, a veterinary technician appropriately trained by the veterinarian in states or provinces where such action is permitted by veterinary practice acts can perform surgical first aid.

Equipment, facilities, and personnel must be available to maintain an appropriate environment for postoperative care. Post-surgical care should include observation of the animal until it has recovered from anesthesia. Surgical incisions should be observed per veterinary instructions, or as frequently as possible while minimizing stress to the animals, for signs of dehiscence or infection. Analgesics should be administered whenever appropriate.

4. Clinical Pathology

Diagnostic laboratory services must be available to assist with the examination of biological samples and the diagnosis of disease. Diagnostic capabilities should include access to cytology, microbiology, parasitology, hematology, blood chemistry, urinalysis, serology, and other appropriate laboratory procedures. At a minimum, one microscope should be available in-house to perform fecal examinations and diagnostic cytology of blood, tissue, and body fluids when immediate examination is necessary. Equipment should be properly maintained and calibrated. The zoo or aquarium must have the capability to obtain pertinent emergency test results in a timely manner. A veterinary pathologist should be available as a consultant to assist in rapid diagnosis and

interpretation of disease processes. Ideally, there should be a veterinary pathologist on staff.

5. Necropsy

The zoo or aquarium must have a refrigerator for holding dead animals that is physically separate from live animal holding, treatment, medication storage, and surgery areas and from food supply storage or preparation areas. Ideally, there should be an isolated area on the grounds for performing animal necropsies, or the carcass should be transported to a facility for a postmortem examination as soon as possible and no longer than 24 hours after death. It is important that a postmortem examination be performed on all animals that die and are in suitable condition, and also on wild or feral animals found dead on the zoo or aquarium grounds, as deemed necessary by the veterinarian and in accordance with local and state regulations. Histologic examination of tissues from such animals should be performed to evaluate mortality factors if the cause of death is not evident on gross necropsy examination. It is advisable to have histological examinations performed on all dead animals to determine if there were underlying causes not evident grossly.

Many Species Survival Plans (SSPs) have extensive necropsy protocols developed for the SSP species, so the appropriate SSP Veterinary Advisor should be consulted in advance for this information. Many of these protocols are posted on the AAZV web site (www.aazv.org). Based on the size of the animal collection and pathology caseload the support of a full-time veterinary pathologist may be warranted at larger institutions.

A reasonable effort should be made to distribute postmortem specimens to institutions for further research or for museum exhibition. The SSP may also recommend distribution of specific specimens to researchers for further studies and these requests should be filled whenever possible. Special requests of researchers should be considered when possible and if these projects have been approved by the facility. However, higher priority should be given to determining the cause of death rather than to fulfilling SSP or research requests.

If applicable, the remaining specimen should be placed in a museum collection or in the institution's education collection. Disposition of dead animals and their parts must meet all legal restrictions. It is the responsibility of the veterinarian to oversee the distribution of postmortem specimens in order to prevent the distribution of infectious materials. Dead specimens not used should be incinerated or disposed of as deemed suitable by the veterinarian in accordance with local, state and federal regulations.

Zoos and aquariums or their consulting pathologists should maintain collections of fixed tissues, paraffin-embedded blocks, frozen tissues and/or slides from the postmortem examinations for future studies.

6. Medical Records

Complete medical records must be maintained on all animals in the collection that have received veterinary attention. The records must indicate all treatments (types of medication, dosage, duration), surgical procedures, anesthetic procedures (type of

agent, dosage, effect), results of all laboratory tests (parasitologic, hematologic, bacteriologic, etc.), and immunization records with all relevant dates. The same information, when appropriate, should be recorded for groups of animals that are not individually accessioned and are subjected to group treatments or diagnostic evaluations. Copies of these medical records must accompany animals when they are transferred to another institution or be sent in advance of shipment.

Medical records must be maintained under the direction of the veterinarian. Ideally the medical records should be computerized for easy retrieval. Software programs developed for use in zoos and aquariums should be utilized if at all possible. Veterinary staff should have access to an appropriate number of computers, capable of handling the medical record software. Medical records should be kept separate from the inventory records and be easily accessible. Duplicate record sets should be stored electronically or in hard copy at another site, or in fire proof storage on site.

Morbidity and mortality trends should be monitored in order to evaluate animal health and to develop or modify preventive health or husbandry procedures.

All animals should have some form of permanent identification if practical. Various methods of identification, such as transponders, ear tags, wing tags, neck chains, toe clipping, leg bands, tattoo, brands, ear notching, horn branding and photography are available. Permanent individual identification provides critical data used to facilitate trace back of exposure to regulatory disease and other pathogens. (i.e., TB, CWD, Johne's disease, etc.) and it is required for all hoofstock maintained in AZA accredited zoos for tuberculosis surveillance. Many SSPs require that individual animals in the plan receive transponders or that they be tattooed with their studbook or other permanent identification number. The appropriate SSP coordinator should be consulted regarding the placement location for transponders or tattoos.

7. Preventive Medicine

Preventive medicine programs must be established at every zoo and aquarium. Preventive medicine is particularly important because it is often difficult to recognize and treat illness in non-domestic animals. These programs should include quarantine as required, periodic, risk-based health assessments (visual and/or under anesthesia), parasite surveillance procedures and control, immunization, infectious diseases screening (e.g. serology, tuberculosis testing), dental prophylaxis, and periodic reviews of diets, husbandry techniques, and vermin control.

Parasite Control

A program of parasite control shall be developed by the veterinarian. Fecal examinations should be conducted routinely on every individual or group of animals to detect and direct treatment of parasite infections before clinical signs appear. The veterinarian should determine frequency and type of fecal exams based on facilities and animals' history and/or susceptibilities. More frequent exams may be required on those groups recognized to be infected with parasites or considered to be more susceptible to parasite associated disease. Fecal examination should be repeated as necessary following treatment to evaluate efficacy. Care should be taken in the movement of

animals or cage furniture from one exhibit to another in order to prevent exposure or spread of parasites.

Immunization

The veterinarian will determine what vaccinations are appropriate for each species in the collection. Vaccinations administered should be based on the disease status of domestic and wild animals in the area surrounding the facility TAG and SSP recommendations, <http://www.aazv.org/>. The type, serial and/or lot number, and source of product should be recorded in the individual animal's medical records.

Disease Surveillance

Specific screening protocols for diseases will depend on the nature and prevalence of disease either in the vicinity of the facility, SSP recommendations, and government regulations. Veterinary advisors for the SSPs and the Taxon Advisory Groups (TAGs) can be contacted for information on the diseases of concern for the specific species. <http://www.aazv.org/>

Risk analysis

Disease risk analysis as applied to the transfer of animals between institutions consists of a number of individual steps. These include pathogen hazard identification, risk assessment and risk management along with risk communication which occurs throughout the process.

Pathogen hazard identification is performed by the receiving institution for diseases that they wish to keep out of their collection. Knowledge of the receiving institution's pathogen status is critical to this step as there is no need to identify a pathogen that is already present in the receiving collection. If no pathogen hazards are identified, then no risk assessment or risk management is needed and animal transfers can occur without the need for further risk mitigation.

If pathogen hazards are identified, then each hazard undergoes risk assessment to determine the consequences of introducing it into the receiving collection.

Following pathogen hazard identification and risk assessment, risk management using risk mitigation is performed to lower the risk of pathogen introduction into the receiving collection. Risk mitigation can involve preshipment procedures and diagnostics, preshipment isolation, post-arrival isolation (quarantine), and post-arrival procedures and diagnostics (e.g. quarantine exam and testing). Ideally risk mitigation should focus on the preshipment part of the animal transfer. Discovery of transmissible pathogens of concern prior to transfer avoids post-arrival failure requiring return, euthanasia, or other disposition. A complete physical or visual examination with appropriate diagnostic tests should be performed at the zoo or aquarium of origin to assure that only animals of known health are shipped.

Where hazard identification, risk assessment, and sufficient risk mitigation is performed prior to transfer, the animal can be transferred directly into the collection without the need for quarantine isolation and further testing. This can improve animal welfare during

the transfer process. Where risk mitigation cannot be performed prior to transfer, traditional quarantine practices should be used. It should be appreciated that the traditional quarantine and isolation period has acted as a time for newly arrived animals into a collection to acclimate to their new environments, diets, and routines.

The risk analysis process is more robust with knowledge of disease occurrence in the sending and receiving populations. Comprehensive pathology data is superior to individual testing in determining disease prevalence (Wallace et al) therefore the reliability of risk analysis depends on the quality of data developed through clinical veterinary care, preventive medicine programs, and diagnostic pathology programs.

8. Quarantine

Upon arrival all animals should be weighed and inspected for injuries or disease. During quarantine the following procedures should be performed: examination, vaccination as appropriate, clinical and laboratory tests, treatment for external and internal parasites as needed, evaluation of psychological well-being, verification of permanent identification.

Every animal that dies during quarantine should receive a complete postmortem examination including histopathology.

It may be necessary to have additional facilities to provide for the isolation of animals in the collection that are known to be or suspected of carrying disease, and the same precautions used for quarantine animals should be applied in handling these animals.

Quarantine facilities for newly imported nonhuman primates must meet specialized requirements of the Centers for Disease Control and Prevention, <http://www.cdc.gov/>.

The quarantine or isolation of elephants should follow the *Recommendations for the diagnosis, treatment, and management of tuberculosis (Mycobacteria tuberculosis) in elephants in human care 2015*;

<http://c.ymcdn.com/sites/www.aazv.org/resource/resmgr/Files/RecommendationsTBinElephants.pdf> or

https://elephantconservation.org/downloads/pdf/ElephantCareTaskForceResponseUSDA_3-13.pdf and the *Voluntary Guidelines for Control of Tuberculosis in Elephants 2008*

https://www.aphis.usda.gov/animal_welfare/downloads/elephant/elephant_tb.pdf

Marine mammal quarantine must adhere to Marine Mammal Protection Act and must be administered by the veterinarian, <http://www.nmfs.noaa.gov/pr/laws/mmpa/>.

Fish and Aquatic Invertebrates

Traditional “terrestrial animal” quarantine protocols are not necessarily directly applicable to fish and aquatic invertebrates, and a slightly different paradigm must be used. Despite these differences, however, the overarching goal of quarantine, preventing the introduction of disease into an animal collection, still applies. In addition, quarantine often serves an important role in the acclimation of fish and aquatic invertebrates to the captive environment. Many zoos and aquariums may not have

veterinary staff with significant experience in piscine/aquatic invertebrate infectious disease; therefore a heavy reliance on non-veterinarian diagnosticians may be indicated. Despite this, a risk analysis and quarantine protocol should be developed with input from the facility's veterinarian. Fish and aquatic invertebrates may be quarantined either as individuals or in groups such as schools or colonies. While heavy emphasis is traditionally placed on parasitological evaluations of these animals, quarantine protocols should also address other etiopathogenic causes of disease, such as viruses, bacteria, and fungus. Unlike many of the terrestrial vertebrates encountered in quarantine settings, there are significant limitations to the scope and availability of laboratory diagnostics available for use in many fish and aquatic invertebrate species. For that reason, taxon specific risk analysis should be made in order to tailor quarantine protocols to the animals under consideration. Thorough post mortem examinations should be performed opportunistically as a component of a fish/invertebrate quarantine protocol. Development of disease databases should also be maintained as aids in the risk assessment process.

Special considerations for animals that cannot be isolated

Because some animals have unique care and environmental requirements, it may not be feasible to duplicate the appropriate enclosures in a separate location for quarantine. Large or specialized animals such as elephants or marine mammals, requiring facilities that are not practical to duplicate in a quarantine facility, must have a health history and status thoroughly characterized at the sending institution for disease transmission risk assessment since they may have to be kept in close proximity to collection animals. Efforts should be made to prevent direct physical contact, contact by aerosolization or drainage, or potential fomite transmission. Keepers working in that area should tend to the quarantined animal last, when no further contact with collection animals is necessary. A set of cleaning and feeding utensils is to be dedicated to the quarantined animal and not used on other collection animals.

Methods to prevent disease transfer during quarantine

If a risk analysis indicates the need for isolation of the incoming animal(s), the length of that isolation and any disease testing to be done should be based on the specific diseases of concern. The degree of separation should be such that potential communicable disease agents may not be transmitted to other susceptible animals. In most cases this requires facilities remote from the main exhibit areas. Access should be restricted to prevent transport of infectious agents by zoo or aquarium personnel. All personnel working in quarantine facilities must observe established protocols such as personal hygiene and disinfection of footwear, clothing, and equipment. A bactericidal/virucidal footbath should be placed near the entrance to the quarantine area to prevent spread of potential pathogens by footwear. This footbath must be changed regularly as many products are inactivated by organic debris. Alternatively, disinfectant sprays or footwear dedicated to use only in quarantine may be utilized. Animal care in the quarantine facility is to be performed by personnel assigned exclusively to that area, rather than one who will be working in other areas as well. Feeding utensils and containers, cleaning utensils, and any cage furnishings are to remain in the quarantine facility (not used elsewhere). Boots, gloves, masks, personal protective equipment

(PPE) or other protective clothing used while working with the quarantined animal should be dedicated to this area and not used elsewhere. Waste removed from this facility should be disposed of in such a way as to prevent exposure to other areas of the zoo or aquarium (i.e., picked up last and delivered directly to the site of disposal). Although this is the most desirable quarantine design, it may not always be possible due to constraints of cost, facilities, and personnel.

Any animal that is severely stressed by quarantine procedures (e.g. social isolation, confinement etc. may require a risk assessed, harm/benefit analysis for earlier release or modification of the facilities, if approved by the veterinarian in consultation with animal care staff. Local, state, or federal regulations may also dictate quarantine length and procedures.

Prevention of disease introduction into a zoological collection

Quarantine procedures have been used to prevent the introduction of transmissible disease into an animal collection and have been one of the most important features of a preventive medicine program. Retrospective studies have suggested that a risk-based approach to the transfer of animals between zoological collections can also provide protection from disease transfer while benefiting animal welfare. These studies also noted that “Quarantine isolation with testing remains an essential defense against introducing transmissible diseases of concern when there is a lack of health knowledge about the animals being received” (Wallace et al) This risk-based approach to animal transfers should be developed and monitored by the veterinary staff in consultation with facility personnel.

9. Zoonosis

The facility’s veterinarian must be knowledgeable about zoonotic diseases that may affect the collection animals, personnel, and guests to the institution. If a zoonotic disease is diagnosed within the facility the veterinarian, in consultation with the institution’s Human Resources Department, Safety Officer, (or equivalent) should inform and educate personnel about disease transmission and prevention. In the case of a reportable disease, the veterinarian is obligated to inform all appropriate governmental health authorities.

A preventive health program for all employees working with animals should be developed in consultation with an occupational health physician or infectious disease physician, to minimize the possibility of disease transmission between people and animals. A physician with expertise in infectious diseases should be consulted whenever an employee contracts an unusual illness or is exposed to an animal diagnosed with a zoonotic disease.

The veterinarian should consult with pertinent management staff in all areas where the public is allowed physical contact with collection animals to assess the risk for the transfer of zoonotic diseases and plan preventive measures. For further information, see MMWR, Compendium of Measures to Prevent Disease Associated with Animals in Public Settings, 2013 (<http://avmajournals.avma.org/toc/javma/243/9>)

C. Management Issues

Zoo and aquarium management decisions including but not limited to animal shipments, nutrition, husbandry, pest control and euthanasia must involve the veterinarian, who will work closely with the appropriate curator and/or nutritionist, depending on the issue.

APHIS 9cfr chapter 1 part 2-regulations in AWA, subpart D, 2.40(A)

http://www.aphis.usda.gov/animal_welfare/publications_and_reports.shtml

1. Animal Shipments

The veterinarian is responsible for preparing and signing the Certificate of Veterinary Inspection (Health Certificate). Pre-shipment visual or physical examination must be performed by the signing veterinarian to ensure that animals may be safely transported and are free of clinical symptoms of infectious diseases. Any tests required by regulations of the receiving state or country must be performed. The consignor and consignee share the responsibility for health care prior to, during, and after shipment of animals. Complete medical records should be made available to the receiving institution prior to shipment.

2. Nutrition

When possible the use of species specific, commercially prepared animal diets should be utilized as the basis for any nutrition program. To ensure nutritional efficacy, regularly scheduled review of dietary husbandry practices including routine sampling and testing via commercial laboratory of hay and fish should be conducted by qualified individuals in consultation with a veterinarian and/or nutritionist. The data generated from these analyses should be recorded and maintained for future evaluation as part of a preventative animal health care program. This information in combination with blood metabolite testing, e.g., vitamin and mineral status, in many cases enables the establishment of correlations between diet and frequency of disease, mortality rate, and reproductive success. In addition, a comprehensive dietary analysis may provide for early detection of nutritional imbalances and make available baseline data from which more appropriate dietary formulations can be developed. Diets for individual animals should be modified to match physiological status e.g., newborn vs. adult vs. pregnant vs. lactating and when feasible, should be based upon data obtained from peer reviewed publication or dietary guidelines established in Animal Care Manuals. Dietary analysis should also account for consumption. It is important to assess specific nutritional protocols based upon actual intake rather than solely on the total diet offered, especially when incorporating domestically cultivated produce items. Fruits and vegetables grown for human consumption are often high in soluble carbohydrates and low in dietary fiber and over consumption of these items can result in nutritional disorders such as obesity and diabetes. Current and historic diets on all animals should be recorded and maintained in a database. Comprehensive food safety procedures should also be integrated into all dietary protocols and when possible should be based upon Hazard Analysis and Critical Control Points (HACCP) food safety standards. Having food-handling animal staff attend a professional food safety training class may also be beneficial.

A zoo or aquarium nutritionist should be available as a consultant to assist in rapid diagnosis and interpretation of nutritional disorders. Ideally, there should be a nutritionist on staff.

3. Sanitation and Disinfection

Sanitation and disinfection protocols should be developed in consultation with the veterinarian. Sanitation includes removal of soiled materials (bedding, feed, enrichment items, and waste material) followed by thorough cleaning to remove excessive dirt and debris. Once the organic material is removed, the area should then be disinfected to reduce or eliminate microbes. Disinfectants should be chosen based on target organisms and safety of use in the animal or food area being disinfected. The frequency and amount of cleaning and disinfection will vary depending upon the animal's needs and physiological condition. Cleaning utensils should be assigned to specific areas and should not be transferred between areas. All feed and water containers should be routinely cleaned and disinfected. Water storage containers or automatic watering devices should also be disinfected.

Monitoring of water quality for aquatic animals should be developed in consultation with veterinary staff and meet federal marine mammal guidelines, where applicable.

4. Pest Control

Each institution must have a formal integrated pest management program, developed in consultation with the veterinarian. Pest control should be implemented in all areas of the zoo or aquarium. The program should prevent, control, or eliminate pests with documentation of monitoring and control techniques. Pesticides must be used in accordance with government regulations. Whenever possible, less toxic or non-toxic agents should be given preference.

5. Euthanasia

The zoo or aquarium must have a policy on euthanasia that addresses the decision making process as well as the methods for humane euthanasia. Animals must be euthanized in accordance with the most current guidelines. See: AAZV Guidelines for Euthanasia of Non-domestic Animals

http://www.aphis.usda.gov/animal_welfare/publications_and_reports.shtml and

American Veterinary Medical Association (AVMA) Panel on Euthanasia"

http://www.avma.org/issues/animal_welfare/euthanasia.pdf

Euthanasia must be performed by personnel who are knowledgeable and skilled in performing the procedure. Euthanasia techniques should not interfere with postmortem examinations, when possible.

III. Veterinary Facilities

A. On-Site

All zoos and aquariums should have an on-site veterinary facility. An on-site facility allows for isolation of animals receiving medical care and facilitates observation and treatment of sick and injured animals. The size of the facility and its components will depend upon the size and type of animal collection. The facility should be designed with

input from the veterinary staff, with the assistance of individuals knowledgeable about animal hospital facility design. It must meet all local and state building regulations. Traffic within animal areas should be kept to a minimum.

The facility should have designated areas for examination and treatment, sterile surgery (see Section II.B.1.b.), necropsy (see Section II.B.1.d.), animal holding (see Section II.B.2.a.), laboratory, biological sample storage, radiology, pharmaceutical storage including, when necessary, a safe for controlled drugs that meets the standards set by the Drug Enforcement Administration (DEA), animal food preparation and/or storage areas, equipment storage areas, and a staff locker-room with showers and restroom facilities. Capture and restraint equipment, anesthetic equipment, autoclave and basic surgical equipment should be stored in the hospital. Radiology equipment should be of appropriate size and power for the animal collection, and its installation must meet local and state regulations.

Animal holding areas must be physically separated from personnel areas. Animal holding areas should have nonporous walls and floor surfaces that allow for frequent cleaning with water and disinfectants. These surfaces should be nonabsorbent, resistant to impact and resistant to the adverse effects of hot water, steam, and cleaning agents and biological materials such as urine and feces. These surface materials should also have good acoustical properties to keep the noise level to a minimum.

Floors should slope toward drains to facilitate rapid drainage and drying. Floor to wall junctions should be free of cracks, smooth, and impermeable. Drains should be of sufficient capacity in animal holding areas. Drains, which can provide avenues for the spreading of infectious agents, should not connect between contaminated and non-contaminated areas. It is optimal to have anti-backflow devices and automatic disinfection systems in the drains used throughout the hospital.

Office space, animal areas including holding and treatment, and contaminated spaces must have separate air handling capabilities. Contaminated areas include quarantine and necropsy areas, and laboratory diagnostic fume hoods. Contaminated areas should have a filtration of >95% biological effective level on outflow. Animal holding areas should have frequent air changes approximating 10-15 air change/hours or enough to minimize animal odors and control heat loads, and is considered an acceptable general standard for laboratory animal facilities (*Guide for the Care and Use of Laboratory Animals*, Institute of Laboratory Animal Resources 2011). Ideally air should not be recirculated in the hospital, especially from animal areas. The temperature should be capable of independent adjustment in each animal room. A backup electrical generator should be available for hospital use.

Ceilings should be smooth, moisture resistant and easily cleaned. Suspended ceilings are not recommended in animal areas as they can harbor pests and are avenues for animal escape. Exposed ductwork and light fixtures are difficult to clean and can be hazardous during an animal escape and should be avoided. Animal rooms should have doors with viewing windows and dart ports as appropriate. Doors should be large enough so that cages, crates, and equipment can be easily moved into and out of

animal areas. External doors should fit tightly into their frames and should have door sweeps to prevent rodents and insects from entering into the animal rooms. Cages should be constructed to make it possible to load, unload, and shift animals with minimal physical and/or chemical restraint.

Outside pens should be solidly constructed. If slatted wood walls are used, it should not be possible for hooves, legs, wings or horns to be caught in the slats. The wood should be non-toxic and surfaces should be easily cleaned and disinfected. Floor surfaces should offer good traction and have good drainage. If soil surfaces are used, there should be easy access into the pens to remove and replace the soil if it becomes contaminated.

Holding cages with wire mesh fronts must be sturdy enough to contain a wide variety of animals appropriate for the collection. The surfaces should be smooth, easily cleaned, and easily disinfected. The opening in the wire mesh should be small enough to prevent animals from reaching out and grabbing staff and/or other nearby animals. Hospital cage furniture should be cleaned thoroughly and disinfected between uses.

Facilities should be designed with access to all animal areas limited to designated care givers.

Storage areas for equipment, supplies, food, cages, bedding, and refuse should be of adequate size. Bedding and food should be stored separately from cleaning supplies and toxic or hazardous chemicals. Refuse storage should be separately located from all other storage areas. There should be an isolated cooler available for the temporary storage of carcasses prior to their necropsy and eventual disposition.

B. Off-Site

Based on the type of collection and their veterinary needs, some zoos or aquariums may not require an on-site veterinary facility. In these cases, the zoo or aquarium should maintain a contract with a nearby veterinary facility and must take animals off grounds for major medical procedures. The off-site veterinary facility should be located close to the zoo or aquarium and have facilities that meet contemporary practice standards. The zoo or aquarium must have enclosures on-site to house animals for quarantine, for animals with contagious diseases and for animals that need treatment and post-operative care. If it is at all possible, the animal should not be housed at the offsite veterinary facility because of the risk of exposure to domestic animals. Should a zoo or aquarium animal come in contact with domestic animals at the off-site facility, then the risk of exposure to disease must be assessed and the animal may need to be quarantined upon return to the zoo or aquarium.

If the zoo or aquarium uses an off-site veterinary facility for surgical procedures there must be an on-site area for minor treatment and emergency procedures.

There must be pharmaceutical storage on the zoo or aquarium grounds that comply with local, state and federal regulations.

IV. SUMMARY

These guidelines for veterinary medical care and veterinary hospitals are written to conform to the requirements of the Animal Welfare Act, which states that programs of disease prevention and parasite control, euthanasia, and adequate veterinary care shall be established and maintained under the supervision of a veterinarian. Ideally the zoo and aquarium should be providing the best possible veterinary medical care for the animals in their collections. Many of these animals are rare and endangered and the institutions should endeavor both to provide for the long term health and well-being of these animals and to advance the field of non-domestic animal medicine. It is hoped that this publication will aid in this process.

V. LITERATURE CITED

Chinnadurai SK, Strahl-Heldreth D, Fiorello CV, Harms CA. Best practice guidelines for field-based surgery and anesthesia of free-ranging wildlife. I. Anesthesia and analgesia. *J Wildl Dis.* 2016; 52(2): S14–S27.

ACVAA (American College of Veterinary Anesthesia and Analgesia). 2009. Recommendations for monitoring anesthetized veterinary patients, http://www.acvaa.org/docs/Small_Animal_Monitoring_2009.doc .

Bednarski, R, Grimm, K, Harvey, R, Lukasik, V M, Penn, W S, Sargent, B, Spelts, K. AAHA Anesthesia Guidelines for Dogs and Cats. *J Am Anim Hosp Assoc.* 2011; 47:377–385.

Wallace C, Marinkovich M, Morris M, Rideout B, Pye G. Lessons from a retrospective analysis of a 5-year period of quarantine at the San Diego Zoo: a risk-based approach to quarantine isolation and testing may benefit animal welfare. *J Zoo Wildl Med.* 2016; 47(1): 291-296.

Marinkovich M, Wallace C, Morris M, Rideout B, Pye G. Lessons from a retrospective analysis of a 5-Year period of preshipment testing at the San Diego Zoo: a risk-based approach to preshipment testing may benefit animal welfare. *J Zoo Wildl Med.* 2016; 47(1): 297-300.