Introduction
The American Association of Zoo Veterinarians’ mission is to empower our members to advance our profession and enhance wild animal health, welfare, and conservation. These guidelines are designed to guide zoos and aquariums in their design and implementation of veterinary programs and hospitals to advance the health and welfare of animals in their 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, reproductive management, exhibit design, and conservation programs.

In the United States, the Animal Welfare Act mandates that there will be an attending veterinarian that will provide and have the authority to ensure adequate veterinary care and to oversee the adequacy of other aspects of animal care and use. Animal Welfare Act, Title 9, Part 2.40. As such, the veterinarian, in consultation with 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.

I. Veterinary Care
The veterinary medical program must prioritize 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.

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. When indicated and under the direct supervision of the attending zoo or aquarium veterinarian(s), collaboration with other veterinary and human specialists is encouraged and recommended.

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. On-call veterinarian(s) should be available to provide emergency care in a reasonable response, as dictated by the location of the zoo or aquarium, time of day, current weather conditions, nature of the emergency, animal collection and budget. A reasonable response time is 30 to 60 minutes. Initial emergency stabilization may be provided by veterinary support staff, under the direction of the on-call veterinarian and in accordance with local, state/provincial, and federal laws. With a valid veterinarian-client-patient relationship in place, when the veterinarian(s) is not on site, in certain situations, they may be able to recommend diagnostic testing, diagnose illness, and prescribe treatments or medications for collection animals, in accordance with local, state/provincial, and federal laws.

A. Staff/Personnel
1. Education and Expertise of Veterinary Personnel
Veterinarians and veterinary technicians providing medical care for zoo and aquarium animals should possess adequate education and experience working with exotic taxa or similar species to provide a level of care that meets or exceeds the standards of care in other fields of veterinary medicine.

In all jurisdictions, veterinarians practicing veterinary medicine are required to be licensed by the appropriate governing body, graduates of an AVMA accredited college (or have obtained a license to practice veterinary medicine after completing an equivalent foreign education program), and obtain regular approved continuing education. In addition to these minimum requirements, zoo practitioners are encouraged to pursue specialty certification by the American College of Zoological Medicine through completion of formal residencies and/or internships, or study under more experienced colleagues, and participate regularly in continuing education that relates to the field of zoo/aquatic/exotic/wild animal medicine. Zoo and aquarium veterinarians are encouraged to remain up-to-date regarding the most recent advances in diagnosis and treatment of disease in zoo/aquatic/exotic/wild animal species by reading and studying professional journals and participating in continuing education opportunities that relate to the field.

In many jurisdictions, the practice of veterinary technology is regulated through veterinary practice laws. Zoos and aquariums must comply with any relevant local/state/federal law regarding the practice of veterinary technology. The AVMA defines a veterinary technician or veterinary technologist as a graduate of an accredited veterinary technology program. Many jurisdictions require veterinary technicians to receive regular continuing education to maintain credentialing. In addition to minimum requirements to practice veterinary technology, zoo and aquarium veterinary technicians are encouraged to pursue certification by the Academy of Veterinary Zoological Medicine Technicians, complete formal internships, study under more experienced colleagues, and participate regularly in continuing education that relates to the field of zoo/aquatic/exotic/wild animal medicine. Zoo and aquarium veterinary technicians are encouraged to remain up-to-date regarding the most recent advances in diagnostic and treatment of disease in exotic
animals by reading and studying professional journals and participating in education conferences that relate to the field.

Institutions should prioritize continued learning for zoo and aquarium veterinarians and veterinary technicians by supporting membership in appropriate zoo, aquatic, and wildlife organizations, and through journal study, educational conference attendance, and other collaborative learning opportunities.

2. Veterinary Coverage
Veterinarians are 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 size and diversity and medical needs of the collection should dictate the size of the veterinary staff, including the number of veterinarians, veterinary technicians and associated support staff. The veterinarian(s) 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, agreed-upon financial compensation rates for on-call service, and expectations of service should be agreed upon and communicated to zoo or aquarium management. The regular and back-up veterinarian must be familiar with the application of currently accepted diagnostic procedures, methods of anesthesia and restraint, and therapeutic options appropriate for each species or have access to sources of this information. In accordance with local, state/provincial, and federal laws, the part-time veterinarian must create complete medical records for the collection animals promptly after evaluating medical cases and sufficient time to allow this should be built into the veterinary coverage.

If a contract service is provided by a group veterinary practice, there should be one veterinarian designated as 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 role is not a replacement for the zoo or aquarium veterinarian(s) and their job requirements should not include making diagnoses, prescribing medications or treatments, or performing surgery, in accordance with local, state/provincial, and federal laws regarding veterinary medicine. 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 the dispensing and administration of 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. In accordance with local, state/provincial, and federal laws, the part-time veterinarian must create complete medical records for the collection animals promptly after evaluating medical cases; thus, sufficient time to allow this should be built into the veterinary coverage schedule. It
is important that the veterinary program coordinator 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 credentialed veterinary technician or animal health technician. The coordinator should implement the preventive medicine programs established by the veterinarian.

3. Veterinary Personnel and Functions
A veterinary care program utilizes staff to establish and maintain the programs and facilities as described in this guide. 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 laws. Legal requirements may necessitate additional support staff beyond these recommendations.

Veterinary Functions include:
1. Veterinarian(s) are responsible for implementing and maintaining standards of veterinary care through professional oversight of medical care and wellbeing of animals in the facility. This may include medical and surgical techniques, disease prevention and management, anesthesia, pathology, nutrition, and emergency animal health care. Large or diverse collections will need more than one veterinarian to provide adequate care to all animals. Institutions may choose to share all duties among veterinarians or divide work by specialty or interests (e.g., pathologist, radiologist, veterinary nutritionist).

2. Veterinary Technician(s)/Nursing staff assist in veterinary care to the extent deemed necessary by the attending veterinarian and allowed by law. No guidelines exist for an appropriate ratio of veterinarians to technicians. However, veterinary technicians are recognized as an integral component of a veterinary medical program and utilization of veterinary technicians enhances patient care. Therefore, it is expected that a trained and credentialed veterinary technician may be utilized for tasks including: anesthesia delivery and monitoring, medical equipment maintenance, phlebotomy, medical laboratory analysis and sample processing, medication dispensing and administration, surgical assisting, and general nursing care.

3. Veterinary Assistants and Husbandry Staff (animal care staff/keepers) perform routine care for hospitalized animals and assist with facility maintenance, cleanliness, and order.

4. Clerical Staff perform duties including, but not limited to, maintenance of medical and animal records, scheduling, inventory management, and other administrative functions.

A facility with a large diverse animal collection requires support personnel for all veterinary support functions. A small facility would have correspondingly fewer personnel to perform these tasks, but assignments of these tasks to specific personnel are important. A facility that does not employ a full-time veterinarian or credentialed veterinary technician should ensure the Veterinary Program Coordinator can perform, oversee or delegate all necessary veterinary support functions while maintaining local, state and federal regulations.

Veterinary and veterinary technician students, interns, and residents may also fill veterinary support function roles. However, activities of these individuals should always be under the supervision of the attending veterinarian(s).

Many zoo and aquarium veterinary programs often utilize human and veterinary specialists and consultants. This is encouraged as it can be highly beneficial to collaborative learning and the health and
welfare of zoo and aquarium animals. However, zoo and aquarium veterinarians should oversee case management and have a policy to advise non-zoo or non-aquarium veterinary professionals on zoonotic risks associated with medical cases. Specialists and consultants can be an important component of the overall veterinary medical program depending on an institution’s specific animal collection and expertise. Visiting specialists and consultants must comply with local/state/provincial/federal regulations regarding the practice of veterinary medicine and always work under the supervision of the attending veterinarian.

4. Infection Control and Personnel Safety
Zoo and aquarium veterinary facilities encounter many, if not more, of the infection and control challenges that face domestic veterinary and human healthcare facilities. Each zoo or aquarium veterinary program should have a documented infection control program; however, the scope and complexity of this program may vary with the nature of the practice. This may vary from a simple written document containing basic infection control practices to a more formal manual with specific training, monitoring, surveillance and compliance programs (https://www.oahn.ca/resources/ipc-best-practices/). Annual staff training on hand hygiene, zoonotic diseases and blood borne pathogens is recommended.

Infection control programs have many functions: to protect collection animals, prevent introduction of new pathogens, prevent transmission of pathogens within and between groups, and to protect personnel and the public (cite https://www.oahn.ca/resources/ipc-best-practices/). Infection control programs should incorporate information on surveillance practices, antimicrobial stewardship, routine practices (hand hygiene, PPE), isolation facilities, plan(s) on how to deal with a zoonotic disease outbreak(s), disinfection protocols, biohazard waste and sharps disposal management, and protocols on staff safety (a bite protocol, TB testing, rabies and tetanus vaccination).

Surveillance is the ongoing, systemic collection, analysis, and interpretation of health events with the goal that this analysis will result in the implementation of response procedures to control adverse outcomes (cite https://www.oahn.ca/resources/ipc-best-practices/). For most zoo and aquarium veterinary practices, in the absence of an infectious disease outbreak, passive surveillance practices utilizing readily available data (endemic disease rates, bacterial culture and susceptibility rates, monitoring for surgical site infections, etc.), may be adequate. Further, infection control principles, particularly engineering control measures of infection, should be incorporated into the construction of new or modification of pre-existing zoo and aquarium veterinary hospitals.

Engineering control measures of infection are built into the design of a facility (e.g., sink placement, heating and ventilation air conditioning system, floor plan design) and can greatly facilitate use of routine infection control measures.

All staff who work in multiple animal areas of a facility, including hospital staff, must take special precautions to prevent cross-contamination between animal areas as they move about the zoo or aquarium. Hospital keepers who move back and forth from the hospital to other animal areas, as is the case in many smaller facilities with shared duties, should employ biosecurity and disinfection protocols to prevent lateral transmission of disease. Risk assessment of potential zoonotic disease should be conducted as needed and at the discretion of the attending veterinarian(s). Recommendations for mitigating zoonotic disease should be developed and implemented under the leadership of the veterinarian or Veterinary Program Coordinator. Risk assessments and recommendations may be made with consultation with zoo or aquarium administrators, including human resources professionals, occupational health physicians, infectious disease experts, and animal and public health authorities.
Personnel safety standards should conform to all local, state/provincial, and federal regulations concerning occupational health and safety in the workplace. Workers must be aware of the potential physical 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 potential infectious agents, allergens, etc., and other physical hazards (radiation, heavy equipment, 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. All veterinary hospital employees should receive regular safety training regarding job-specific hazards. Rabies and tetanus vaccinations is recommended for all veterinary personnel (https://www.oahn.ca/resources/ipc-best-practices/).

Employees who may be exposed to radiation from x-ray producing machines while at work should monitor exposure through industry and OSHA (or analogous) accepted standards (e.g., dosimeters). Dosimeter reports should be reviewed regularly and made available to individuals monitored. All local/state/provincial/federal regulations regarding radiation exposure, including personnel monitoring, equipment testing, warning signs, and facility licensing must be followed.

B. Veterinary Program
1. General Considerations
Veterinary medical and surgical care must be available and provided for all animals in zoos and aquariums. This care must meet or exceed contemporary practice standards of zoo and aquarium veterinary care, which due to the extreme value of zoo and aquarium animals in general, should exceed standards of care provided to domestic animals. 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 (animal and human), and must be done only in consultation with the veterinarian, and in accordance with local, state/provincial, 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. With the rise in antimicrobial resistance (AMR) and associated hospital-acquired infections noted in human and increasingly in domestic animal veterinary practices, zoo and aquarium veterinary programs should strive to implement an antimicrobial stewardships program (cite https://www.oahn.ca/resources/ipc-best-practices/). 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, stored separately from all other drugs, and disposed of properly, in accordance with local, state/provincial, and federal laws. Drugs used in zoos and aquariums on fishes must be administered in compliance with the U.S.
Food and Drug Administration (or similar national agency) so as to prevent contamination of human water supplies.

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 non-domesticated species; conscious sedation can reduce stress and morbidity 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 and aquarium immobilizations have occurred from animal attacks, drug exposure and environmental hazards. An appropriate schedule for inspections of anesthetic equipment to ensure the proper functioning should be standard operating procedures for veterinary facilities that use inhalant anesthetics. Routine evaluations of historical anesthetic practices that could expose staff to anesthetic waste gasses unnecessarily should be performed and efforts to modify these practices should be undertaken, if feasible.¹ ²

Monitoring
Anesthetic monitoring should follow guidelines generated by the American College of Veterinary Anesthesia and Analgesia (ACVAA, www.acvaa.org) 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. Monitoring of oxygenation, ventilation (carbon dioxide excretion), cardiac electrical activity, and blood pressure will 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 acepromazine maleate, propofol, midazolam, alfaxalone and isoflurane, which affect or facilitate immobilization and anesthesia, do not provide analgesia and should be used in conjunction with an appropriate analgesic agent. Use of long-acting opioids, local anesthesia, and multimodal protocols can provide a variety of techniques in zoological species. Guidelines for the recognition and treatment of pain in animal patients are provided by the ACVAA, [www.acvaa.org](http://www.acvaa.org).

**3. Surgery**
All zoos and aquariums must have access to surgical facilities for major surgical procedures that are in a surgical suite that is clean, isolated from excessive noise and unnecessary pedestrian traffic, have adequate lighting, ventilation, and temperature controls, and that can be easily cleaned and disinfected. Ideally, the operating room suite shall be designed or modified to preclude compromising aseptic technique. 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, 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. 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. In such cases, every effort should be made to maintain cleanliness of the surgical area and use aseptic technique.

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. Hospitals should also have the capability to run a PCV and total solids (hematocrit tubes and a centrifuge). Equipment should be properly maintained and calibrated. A preventive health diagnostic laboratory program (consisting of fecal exams, skin scrapes and gill clips, blood work) should be in place and implemented depending on the needs of the institution. 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 cooler for holding dead animals and a freezer for holding necropsy samples and animal remains 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 or building 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.

Each institution should have a separate isolated necropsy room or facility. Preferably, a necropsy facility should be designed and built as a standalone building separated from animal husbandry, normal veterinary functions or procedures. If the necropsy facility must be attached to a hospital or other facility, it should be functionally separated using an anteroom system or outdoor access only. Attached necropsy facilities should have separate air handling systems to prevent air exchange with other portions of the building. Necropsy buildings must follow local, state/provincial, and federal regulations and may require special treatment of waste water before it is discharged into municipal sewer systems or specially-designed septic systems for non-municipal waste water handling.

Ideally the building should be designed to be self-sufficient, with a laundry, rest room, equipment cleaning, specimen preparation and storage, and janitorial facilities to prevent movement of fomites. A changing room with lockers, boot rack, and shower is useful for changing before and after the necropsy and to prevent contamination of work clothes and shoes.

Facilities should be designed with ease of cleaning and disinfection; such as depressed floor spaces with drains, flanged tables with drains, non-porous floor and wall coverings, and convenient equipment storage and flow patterns to reduce contamination. Separate foot wear or foot baths with antimicrobial disinfectant should be encouraged at entry and exit points to prevent tracking of infectious agents out the necropsy facility.

If animals are too large to examine inside the necropsy facility, a designated area of the institution should be planned out to perform a full necropsy. These areas should be ideally in an isolated region, away from animal exhibits and water planes to prevent disease transmission.

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/provincial 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 abnormalities not evident grossly.

Many AZA programs have extensive necropsy protocols developed for the species, so the appropriate 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 AZA program 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 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/provincial, and federal regulations. For large carcasses (e.g., megavertebrates), appropriate equipment such as a backhoe should be available to dig an appropriate hole for burial. On site burial should follow all local and state ordinances. After burial, lime salt or other deterrents should be applied to discourage wildlife from exhuming remains based on local and state recommendation. This is not only to prevent the spread of diseases to local wildlife but to also prevent the ingestion of medications such as antibiotics, NSAIDs, or euthanasia solutions.

Ideally 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. Storage of tissues should be based on SSP programs, necropsy findings, veterinary discretion, and space availability. Veterinarians should maintain up to date tissue logs and should discard samples based on state and federal regulations. All gross necropsy and pathological reports should be stored in a database for institutional access. The attending veterinarian should perform a yearly review of necropsy results to monitor trends and allow for risk assessment.

6. Medical Records
Complete medical records must be maintained for all animals in the collection that have received veterinary attention. The records must indicate all treatments (types of medication, dosage, duration), surgical procedures, medical procedures, anesthetic procedures (type of agent, dosage, effect), results of all laboratory tests (parasitology, hematology, serology, molecular diagnostics, bacteriology, 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. Medical records must be kept current with daily entries when possible and at least kept up to date within two weeks.

Electronic or hard 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. The medical records should be computerized for easy retrieval and the institution must have access to records at any given time and should not rely solely on medical recordkeeping software maintained by an off-site contract veterinarian. 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 at another site, or in fireproof storage on site.

All animals should have some form of permanent identification when practical. Various methods of identification, such as transponders, ear tags, wing tags, neck chains, visible implant elastomer, leg bands, tattoos, brands, ear notching, horn branding and photography are available. Permanent individual identification facilitates trace back of exposure to regulatory disease and other pathogens (e.g., tuberculosis, Chronic Wasting Disease, Johnes's disease). Some jurisdictions may require specific forms of identification in certain species undergoing interstate transport. Many AZA animal programs require individual animals in the plan to receive transponders or be tattooed with their studbook or other permanent identification number. The appropriate SSP coordinator or animal care manual may be consulted regarding the placement location for transponders or tattoos. Typically, transponders are placed on the animal's left side of its body, where possible, and in a place that is easily accessed for reading. Additional resources are available through the Association of Zoos and Aquariums. [www.aza.org](http://www.aza.org) (Institutional Data Management Scientific Advisory Group)

7. Preventive Medicine

Preventive medicine programs must be established at every zoo and aquarium forming the cornerstone of modern zoo and aquarium veterinary practice. Preventive medicine is particularly important in this field because it is often difficult to recognize illness in non-domestic animals. These programs should include quarantine as required, periodic, risk-based health assessments (utilizing visual examination techniques or physical examination under sedation/anesthesia), parasite surveillance and control, immunization, infectious disease screening, dental prophylaxis, and periodic reviews of diets, husbandry techniques, and pest control. An institution's preventive medicine plan should be evaluated on a regular basis to assure that guidelines are up-to-date and the plan is being implemented as intended.

Antimicrobial resistance (AMR) is an emerging problem in human and veterinary medicine.\(^4\) To mitigate the emergence of AMR, zoo and aquarium preventative medicine programs should add an antimicrobial stewardship program with a multifaceted approach based on:

1) Routine retrospective evaluation of antimicrobial cultures from clinical cases (particularly chronic cases necessitating long term antimicrobial use) and if indicated, prospective surveillance in areas of potential concerns (e.g., surgical suites).

2) Restrict use of antimicrobials considered “critically important” to public health and create criteria to guide “appropriate” use of these critically important antimicrobial drugs when necessary

**Parasite Detection, Control, and Prevention**

A program of parasite management shall be developed by the veterinarian. This plan should include screening for and treating organisms that may pose risks to animal and/or human health. This plan should be tailored to the institution based on the history of the animal residents, taxonomic susceptibility differences, and in consideration of any human health implications.

Fecal examinations should be conducted routinely on every individual or group of animals to detect and direct treatment of parasitic infections before clinical signs appear. The veterinarian should determine frequency and type of fecal exams based on animals' histories and/or susceptibilities, recognizing that this technique may not be feasible with all taxa (e.g., fish, invertebrates). If treatment measures are required based on diagnostic results and clinical signs, fecal examination should be repeated as necessary following treatment to evaluate efficacy.

Other samples may be needed to provide a full picture of parasitic disease status in the collection. This may include routine testing for hematologic organisms and checking for external parasites during routine physical exams or other tests depending on parasite tissue tropism (e.g., tongue scraping to identify Gongylonema in Callitrichids). Substrate or water samples may be beneficial in determining risk of reinfection and whether habitat-focused control techniques may be indicated.

Clinicians should also consider diagnostics that focus on parasite detection and identification at the time of necropsy. This will complement data collected pre-mortem and provides a unique opportunity to assess parasite risks, especially in cases of diseases for which pre-mortem testing can be challenging.

Based on diagnostic results, veterinarians should design appropriate parasite control measures to prevent transmission, reduce morbidity/mortality, and improve overall animal health. These control measures should balance the risk of promoting parasite resistance. Care must be taken in the movement of animals or cage furniture from one exhibit to another to prevent exposure or spread of parasites. Integrated pest management is essential in preventing transmission of parasitic disease from free-ranging animals that may have access to animal resident habitats or food sources.

**Immunization**
The veterinarian will determine which 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; clinicians are encouraged to consult AZA TAG and SSP recommendations when available as well as primary and secondary literature sources. The brand name, serial and/or lot number of the product, expiration date, volume, as well as site of vaccination should be recorded in the individual animal's medical records. Frequency of vaccination may be determined based on data from primary literature, local incidence of disease, VSAG recommendations, domestic animal protocols, and/or antibody titer evaluation depending on the disease of concern and species being vaccinated.

**Disease Surveillance**
Specific screening protocols for infectious and non-infectious diseases will depend on the nature and prevalence of disease either in the vicinity of the facility, specific species management group recommendations, and government regulations. Veterinary advisors for various species and taxonomic groups can be contacted for information on the diseases of concern for the specific species.
Behavioral Training
Modern zoological facilities should utilize training techniques, such as operant conditioning, to enhance preventive medicine efforts whenever possible. This may include training animals to allow examination, phlebotomy, hand-injection, medication administration, diagnostic imaging, transport crating, or various husbandry techniques (e.g., weighing, hoof trimming) that may reduce the frequency of anesthetic events necessary in an animal’s lifetime while allowing for the provision of an excellent level of care.

8. Quarantine
Upon arrival all animals should be weighed, identification verified as it pertained to the health certificate, and inspected for injuries or disease.

During the appropriate quarantine period the following procedures should be performed: visual examination or physical examination (depending on risk assessments), body weight, vaccination as appropriate, clinical and laboratory tests, treatment for external and internal parasites as needed, evaluation of psychological well-being, and transition of dietary items.

The length of the animal's quarantine period should be determined by risk analysis, state/provincial, and local requirements, behavioral and nutritional guidelines established prior by the veterinary team.

Disease risk analysis, as applied to the transfer of animals between institutions, consists of pathogen hazard identification, risk assessment and risk management, and risk communication. 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. 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.\footnote{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.}

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 should be performed to lower the risk of pathogen introduction into the receiving collection.

Risk mitigation can involve pre-shipment procedures and diagnostics, pre-shipment isolation, post-arrival isolation (quarantine), and post-arrival procedures and diagnostics (e.g., quarantine exam and testing). Ideally risk mitigation should focus on the pre-shipment 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.

The zoo or aquarium’s attending veterinarian should perform risk analysis for animals entering the collection. Where documented hazard identification, risk assessment, and sufficient risk mitigation are
performed prior to transfer, the animal may be transferred directly into the collection without the
need for quarantine isolation and further testing as long as state and local requirements are
satisfied and animal is nutritionally and behaviorally acclimated to make the transition safely.

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

Risk communication is an essential part of the disease risk analysis throughout the process and
should include animal health and animal husbandry staff at both the sending and the receiving
institutions in order determine what is best for the health of other animals within the collection
and the incoming animals behavioral, welfare, and nutritional needs.

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.

If the 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. If an animal’s health status is unknown, then traditional quarantine should be used.
Traditional quarantine periods usually consist of 30 days for mammals, fish, and birds and up to
60-90 days for reptiles and amphibians. 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. If new animals are introduced
to the facility during a similar animal quarantine period, the period should be reset based on risk
analysis. Local, state/provincial, or federal regulations may also dictate quarantine length and
procedures.

Quarantine Facilities
Each institution should have facilities for isolation and quarantine and the space should be
reserved for its intended purpose and not used as routine animal holding space. If the space is
temporarily utilized for another purpose, a plan should be in place for a quick transition back to
quarantine should it be needed at short notice. Facilities should be designed to be easily
cleaned and disinfected and to meet the needs, care, and underlying husbandry of the animal
collection. Facilities should also have separate air handling systems/filters to prevent the
spread of aerosolized diseases. For aquatic animals, separate water and filtration systems
should also be in place. 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. If a bactericidal/virucidal foot bath is used, it should be placed near the entrance to
the quarantine area to prevent spread of potential pathogens by footwear. This foot bath must

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
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). If specific quarantine personnel are unavailable, quarantine animals must be serviced last in order to prevent diseases from entering the collection.

Any animal that is overly stressed in quarantine (e.g., social isolation, confinement, prolonged anorexia, etc.) may require additional risk assessed and harm/benefit analysis for early releases as long as it is approved by the veterinarian and appropriate agencies.

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, which require 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. Marine mammals and other aquatic species should be quarantined in separate pools with separate water circulation when possible.

**Fish and Aquatic Invertebrates Quarantine**

Fish and aquatic invertebrates may be quarantined either as individuals or in groups such as schools or colonies. Separate water systems should be used to isolate animals. 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. Quarantine protocols should also address etiopathogenic causes of disease, such as viruses, bacteria, parasites, and fungus. 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.

**Necropsy during Quarantine**

If an animal dies during quarantine, a complete postmortem examination including histopathology should be performed as soon as possible. Fresh frozen samples should be held until the pathological report has been received.

**Specialized requirements for Quarantine**

Certain animals must meet national requirements and/or have recommendations for the safety of the animals and institution. Below are links for imported nonhuman primates, quarantine and isolation of elephants, and marine mammal requirements. Similar requirements are present in other countries, and federal agencies should be consulted.
Quarantine facilities for newly imported nonhuman primates must meet specialized requirements of the Centers for Disease Control and Prevention www.cdc.gov (Importation division)

Quarantine or isolation of elephants should follow the recommendations for the diagnosis, treatment, and management of tuberculosis (Mycobacterium tuberculosis) in elephants in human care 2017 www.aazv.org

Quarantine of marine mammals must adhere to Marine Mammal Protection Act and must be administered by the veterinarian www.noaa.gov

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 position, 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 (e.g., state/provincial veterinarian, county public health department, etc.)

A preventive health program for all employees working with animals should be developed in consultation with an occupational health physician, infectious disease specialist, or public health veterinarian 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 global pandemic involving SARS-CoV-2, or COVID-19, increased awareness of the need to use personal protective equipment (PPE) for disease control. Animal husbandry staff that work with susceptible species must take precautions to decrease the spread of disease during periods of heightened risk by wearing appropriate PPE, such as disposable gloves, N-95 masks, face shields, coveralls, boots, etc. Each facility must tailor its protocols for specific zoonotic disease concerns present in their location.

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. Further information is provided by the National and State Public Health Veterinarians in the Compendium of Measures to Prevent Disease Associated with Animals in Public Settings. www.nasphv.org

Animal Management
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/manager and/or nutritionist, depending on the issue. This is required by the Animal Welfare Act (CFR title 9, chapter 1, subchapter A, subpart D, 2.40)

1. Animal Shipments
The veterinarian is responsible for completing 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/province 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

Animal feeding strategy guidelines have been established and are available through the Nutrition Advisory Group, www.nagonline.net. AAZV concurs with their guideline recommendations that diets should:

- Aim to provide nutritionally balanced diet
- Provide a diet that reasonably stimulates natural feeding behaviors
- Provide a nutritionally balanced diet that the animal consumes consistently
- Provide a diet that meets all of the above criteria, and is practical and economical to feed

Diets for individual animals should consider nutrient recommendations, physiological status, husbandry, behavior, enrichment, medical needs, welfare, individual/group intake, social dynamics, and natural history of the animal, among other factors. When feasible it should be based upon data obtained from peer reviewed publication or dietary guidelines established in animal care manuals. It is important to assess specific nutritional protocols based upon total nutrient intake rather than solely on the total diet offered. For example, fruits and vegetables grown for human consumption are often high in soluble carbohydrates and low in dietary fiber and overconsumption of these items can result in nutritional disorders such as obesity and diabetes. Muscle meat does not typically reflect the nutrient composition or physical form of whole prey, and requires supplementation to prevent deficiencies. Commercially available and species-appropriate manufactured products such as supplemented meat and pelleted feeds can be useful in formulating a well-balanced diet. Current and historic diets on all animals should be recorded and maintained in a database.

To ensure nutritional efficacy, regularly scheduled review of dietary husbandry practices including routine sampling and testing via commercial laboratory of hay, fish, and/or other whole prey items should be conducted by qualified individuals in consultation with a nutritionist and/or veterinarian. 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.

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 is an important staff member to ensure to assist in rapid diagnosis and interpretation of nutritional disorders. Ideally, there should be a nutritionist on staff to assist with the complexities of integrating nutrition with behavior, husbandry and medical needs and ensure follow-through. A qualified contracted nutritionist can also offer case advice, but the institution will need to provide follow-up and evaluation.

Food should be stored in a manner to prevent contamination, contact with pests, and avoid poor food hygiene. This can include storage in barrels, bins, and/or air-tight containers, and
should not be in contact with the floor. Refrigerators and freezers should be maintained in a manner that ensures all food is kept within the desired temperature at all times and ideally should have a backup power system to ensure uniform power supply. Dry good storage should be designed to prevent ingress of rodents and other pests while ensuring feed is not exposed to temperature extremes. Hay should be supplied in a manner so that an adequate supply is always available and pest control performed. The standard of rotation of food inventory should be applied to all feedstuffs to minimize potential for feeding outdated products. Where indicated, expiration dates should be monitored.

Guidance for all of these topics and more can be found via a keyword search of the Nutrition Advisory Group’s website (https://nagonline.net) and additional assistance can be provided by any member of the NAG Steering Committee.

3. Sanitation and Disinfection
Sanitation and disinfection protocols for zoo and aquarium animal areas 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. Toxicity of disinfectants should be considered and reviewed by the veterinarian. The frequency and amount of cleaning and disinfection will vary depending upon the area and items being disinfected as well as 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 regularly.

Veterinary facilities should be cleaned and disinfected routinely. The frequency of disinfection is dependent on many factors, but all areas of the animal hospital should be maintained as clean and sanitary. Special attention should be made to animal holding areas, surgical suites, treatment rooms, necropsy areas, and laboratories.

Monitoring of water quality for aquatic animals should be developed in consultation with veterinary staff. Consultation with aquarists and aquatic life support professionals is beneficial. Water quality testing parameters for marine mammals should meet federal guidelines.

4. Pest Control
Each institution should 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 with special emphasis on animal holding and food/bedding storage areas. The program should prevent, control, or eliminate pests such as rodents, insects, and nuisance wildlife. Pesticides must be used and documented in accordance with local/state/federal regulations. Additional records, including non-pesticide product use, pest monitoring, and control techniques should also be maintained. Whenever possible, less toxic or non-toxic agents should be given preference. When selecting a pest control method, consideration should be given to potential secondary poisoning and non-target delivery.

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. Protocols should describe who is
involved in the decision to euthanize an animal and under what circumstances (if any) that decision-making hierarchy may differ. If practiced, euthanasia for population control must be performed with the same standard-of-care as euthanasia for medical purposes.

Zoo and aquarium veterinarians are encouraged to follow guidelines and principles outlined in the current AVMA Guidelines for the Euthanasia of Animals and utilize peer reviewed literature to guide their practices. Euthanasia must be performed by personnel who are knowledgeable of currently accepted humane methods and skilled in performing the procedure. Staff members who perform euthanasia at the facility must have access to the euthanasia policy and be fully trained about differences in techniques between taxonomic groups.

Euthanasia techniques should not interfere with postmortem examinations, when possible. Disposition of animal remains after euthanasia must adhere to all applicable regulations.

II. Veterinary Facilities
A. On-Site

All zoos and aquariums with employed veterinary staff 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, instrument preparation, necropsy, animal holding, laboratory, biological sample storage, radiology, pharmaceutical storage, animal food preparation and/or storage areas, equipment storage areas, and a staff locker-room with showers and restroom facilities. These areas need not always be independent from each other but design and workflow should consider efficiency as well as the mitigation of communicable and nosocomial infections. Animal holding and food preparation areas should always be physically separated from the clinical and necropsy parts of the animal hospital.

Medical supplies and equipment should be stored in the hospital. Diagnostic equipment (radiology, advanced imaging systems, endoscopy, ultrasound) should be of appropriate size and power for the animal collection, and its installation must meet local and state/provincial regulations. Pharmaceuticals should be kept in a secure location (locked cabinet or locked pharmacy room). When necessary, controlled substances must be stored in a safe that meets the standards set by national regulatory bodies (e.g., Drug Enforcement Administration (DEA). Proper biohazard and sharps storage and disposal should be maintained.

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. National Institutes of Health Office of Laboratory Animal Welfare 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, sealed, 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 caregivers.

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, dedicated cooler available for the temporary storage of refrigerated 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 off-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 regulatory 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


Acknowledgement
We thank the Nutrition Advisory Group steering committee for their work in updating this document. We also appreciate the help of numerous reviewers and subject matter experts in their contributions to this document.

Resources
AAZV (American Association of Zoo Veterinarians) www.aazv.org
  • Management of Tuberculosis (Mycobacterium tuberculosis) in Elephants in Human Care (available in members only portal)
ACVAA (American College of Veterinary Anesthesia and Analgesia) Guidelines and Position statements www.acvaa.org
  • 2013 ACVAA Waste Anesthetic Gas Recommendations
  • ACVAA position of treatment on Pain
  • Small Animal Monitoring 2009
AZA (Association of Zoos and Aquariums) www.aza.org
  • Guidelines for Transponder Placement and Recording (available in members only portal)
CDC Centers for Disease Control www.cdc.gov
  • Bringing an Animal into U.S. | Importation | CDC
FDA (Food and Drug Administration) Aquaculture Drugs www.fda.gov
  • FDA Approved Aquaculture Drugs
MMPA (Marine Mammal Protection Act) of the NOAA (National Oceanic and Atmospheric Administration) Marine Mammal Protection | NOAA Fisheries
  • NMFS Standards for Rehabilitation Facilities
National Institutes of Health Office of Laboratory Animal Welfare Institute for Laboratory Animal Research
  • Guide for the Care and Use of Laboratory Animals 8ed
NSPHV (National State Public Health Veterinarians) www.nasphv.org (Compendia and Guidance documents)
  • Compendium of Measures to Prevent Disease Associated with Animals in Public Settings
Nutrition Advisory Group https://nagonline.net
Keyword search can be performed on their website for specific resources