

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

Prepared by the

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I. INTRODUCTION

Zoological parks and aquariums have humane and legal obligations to provide proper husbandry, veterinary medical treatment, and preventive medical programs for their animals. Zoos and aquariums in the United States are required to maintain certain minimal standards of veterinary care by the Animal Welfare Act of 1966 and the subsequent amendments that are enforced by the U. S. Department of Agriculture. There are similar laws in other countries. Maintaining standards of veterinary care requires professional oversight of laboratory, clinical, and animal husbandry services including the supervision of the veterinary medical programs by a licensed veterinarian who has special training or experience in non-domestic animal medicine. In order to achieve the optimal benefit of the zoo or aquarium animal health program, the veterinarian should be an active participant of the institution's management team.

The employment of one or more full-time veterinarians specifically concerned with the animal health care program is highly recommended for all zoos and aquariums whose budget will support the salaries of such trained individuals. For those facilities that are unable to employ a full-time veterinarian, a contractual arrangement for the maximum supportable time with a part-time veterinarian who has training or experience in non-domestic animal medicine should be arranged. 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 third edition developed by the Veterinary Standards Committee of the American Association of Zoo Veterinarians to be used as a guideline for zoos and aquariums in evaluating the medical programs in their institution. 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. Due to the increasing construction of new veterinary hospitals, the committee decided to expand the section of the document dealing with facilities in this edition. It is hoped that this information will be helpful to both new facilities that are starting up their veterinary medical programs and also to older facilities that are re-evaluating their ongoing programs. It is also hoped that this document will be an aid in the accreditation of zoos and aquariums by the American Zoo and Aquarium Association.

II. VETERINARY CARE

The veterinary medical program must emphasize disease prevention. 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 the animals can either be provided with veterinary medical care or humanely destroyed as soon as possible if so indicated. All collection animals that die should receive a complete necropsy and the carcass should be disposed of properly (see Necropsy Section II.B.1.d.).

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, regardless of value.

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

A. Staff/Personnel

1. Full-Time Veterinary Coverage

The full-time veterinarian is responsible for the medical and surgical care of the animals and must be fully acquainted with the entire animal collection by participation in regularly scheduled rounds within the zoo or aquarium. The veterinarian must also develop and supervise long-term preventive medicine programs as described in Section II.B.2. In addition, the veterinarian must establish disease surveillance and containment procedures. Furthermore, the veterinarian must arrange for the availability of other suitably experienced veterinarians to be on call when they themselves are unavailable.

2. Veterinary Coverage Utilizing a Veterinarian on a Part-Time Basis

Although it is important to have a veterinarian available for emergency coverage at all times, the part-time veterinarian must also make weekly scheduled visits to the facility in order to become familiar with the clinical cases and to closely supervise their veterinary care. The part-time veterinarian in charge of the health program must establish short term disease containment procedures that must be followed until the veterinarian arrives. The part-time veterinarian is also responsible for the development and implementation of the long term preventive medicine programs as described in Section II.B.2.

The zoo or aquarium must have back-up emergency

veterinarians, selected by the part-time veterinarian. The part-time and back-up veterinarian must be familiar with the application of currently accepted measures of therapy 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.

3. Medical Care Program Coordinator

Any zoo or aquarium in which veterinary coverage is provided by a part-time veterinarian must have one staff person, a medical care program coordinator, who supervises the veterinary care program under the direction of the veterinarian, thus ensuring that full-time medical coverage is provided to the collection. The medical care program coordinator must note 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, maintaining hospital equipment, and controlling drug supplies. It is essential that the medical care 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 medical 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 who reports to, or is responsible to, the veterinarian.

The coordinator should implement the preventive medicine programs established by the veterinarian. These programs are described in Section II.B.2.

4. Support Personnel

A veterinary care program requires support staff to establish and maintain the programs and facilities as previously described. 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 (medical technologists, animal health technicians, veterinary technologists, or individuals trained at the zoo in medical care) - to assist in veterinary care, equipment maintenance, and laboratory functions; (3) and clerical (secretaries) - to oversee the medical records. A small facility would have correspondingly fewer personnel to perform these tasks, but assignments of these tasks to specific personnel is important.

5. General Issues, Personnel

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.

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.

Facilities holding macaque species should have a bite and scratch emergency protocol in place because of the risk of infection from Herpes B virus (Holmes, 1995). Material Safety Data Sheets (MSDS) must be available

for staff use on-site for all drugs and chemicals used in the facility.

B. Veterinary Program

1. Medical/Surgical Treatment

Veterinary medical and surgical care that meets or exceeds current standards for domestic animal care must be provided for all animals in zoos and aquariums. 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 compassionate and knowledgeable about the humane aspects of animal treatment, including the proper use of anesthetics, analgesics, and tranquilizers. Procedures conducted without the use of an anesthetic, analgesic, or tranquilizer must be supervised by a person qualified to assess the risk involved in handling the animal and must be done only at the discretion of a veterinarian.

Medications must be used in accordance with local, state, and federal regulations and must be administered in accordance with the state veterinary practice act.

Drugs used in zoos and aquariums on fishes must be administered in compliance with the Food and Drug Administration so as to prevent contamination of human water supplies and to be in accordance with the American Zoo and Aquarium Association (AZA) policy (see Appendix 1).

The veterinarian must use aseptic surgical procedures whenever applicable. Surgical techniques must be performed using standard operating procedures employed on domestic animals.

a. Clinical Pathology

Diagnostic laboratory services must be available to assist with the examination of animals and the diagnosis of disease. Diagnostic capabilities should include cytology, microbiology, parasitology, complete blood counts, blood chemistries, urinalysis, serologies and other appropriate laboratory procedures. Although these services can be performed by outside laboratories, the zoo or aquarium should conduct these tests in-house when possible. At a minimum, one or two microscopes should be available in-house to perform fecal examinations and diagnostic cytology of blood, tissue and body fluids when immediate

examination is necessary to observe pathogens which may not survive a shipment to an off-site laboratory. The zoo must also have the capability to perform emergency tests on site such as the determination of packed cell volume and total protein, stat tests for blood urea nitrogen, serum glucose and urinalysis including urine specific gravity. Quality control checks of the equipment and test procedures should be routinely performed. 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.

b. 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 gas 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 and an on-site location is preferable because this limits 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 also include separate areas for animal preparation, surgeon's scrub and post operative recovery. These support areas should all be free from noise and pedestrian traffic.

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

Post-surgical care should include observation of the animal until it has recovered from anesthesia and received the appropriate supportive fluids and drugs.

Heat lamps, incubators, oxygen sources, and other standard equipment must be available for post-surgical care. Personnel must be available during recovery to provide optimal physical comfort for the animal. Surgical incisions should be observed daily, or as frequently as possible while minimizing stress to the animals, for signs of dehiscence or infection. Analgesics should be administered post-operatively when appropriate.

c. Treatment

An area should be set aside at the zoo or aquarium for minor treatments; this area may also be used for minor surgical procedures.

All zoos and aquariums must have a pharmacy on-site where routinely used drugs, such as emergency resuscitative medications, antibiotics, anthelmintics, fluids, anesthetics, analgesics, tranquilizers, etc. can be maintained according to local, state and federal regulations.

All medications must be distributed only by order of the veterinarian. When distributed to keepers, medications must be properly packaged, medical contents identified with instructions attached for the amount, frequency and duration of administration. This information must also be recorded on appropriate animal medical records.

Basic physical capture and restraint equipment must be available at the facility (see Appendix 2, Fowler, 1978). Key personnel must be able to competently use the equipment in emergencies and must be regularly instructed on such use.

Veterinary personnel must be aware of the potential risk of human exposure to dangerous drugs during any chemical restraint procedure. Staff must be thoroughly versed on emergency treatment procedures including cardiopulmonary resuscitation (CPR) that may be required in the event of an accidental injection of a human with a hazardous drug. Local hospitals must be informed in advance of any special treatment procedures required for human exposures to veterinary drugs (Haigh, 1989).

d. Necropsy

The zoo or aquarium must have a refrigerated area for holding dead animals that is physically separate from live animal holding, treatment, 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 in the collection and also on wild or feral animals found dead on the zoo grounds. Histologic examination of tissues from such animals is required to evaluate mortality factors if the cause of death is not evident on gross necropsy examination. However, 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.

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 or their consulting pathologists should maintain collections of 10% buffered formalin fixed tissues, paraffin blocks and slides from the postmortem examinations for future studies.

e. Medical Records

Complete medical records must be maintained on all

animals in the collection and especially on those that have received treatment. The records must indicate the nature of 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.), plus immunization records with all relevant dates. Copies of these medical records must accompany animals when they are transferred to another institution or they must 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. There is a computerized medical records program, MedARKS, available through the International Species Information System (ISIS), at the Minnesota Zoological Garden in Apple Valley, Minnesota. They should be kept separate from the inventory records and be easily accessible. Duplicate record sets should be stored at another site, or in a fire proof or theft proof safe on site.

Statistics should be tabulated regularly on the rates and nature of illness and mortality in the facility. This information should be regularly used to evaluate animal health at the facility and to develop or modify preventive health and husbandry procedures to decrease the incidence of morbidity and mortality.

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 (Oosterhuis, 1976, Rice, 1996). Permanent individual identification provides critical data used to facilitate trace back of exposure to disease pathogens. (i.e., TB, etc.) and it is required for all hoofstock maintained in AZA accredited zoos for tuberculosis screening (see Appendix 3). 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.

2. 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, parasite surveillance procedures and control, immunization, infectious diseases screening (e.g. using serology and tuberculosis testing), dental prophylaxis, and periodic reviews of diets, husbandry techniques and vermin control (see Appendix 4, Amand, 1993).

a. Quarantine and Isolation of Animals

Quarantine is most broadly defined as the prevention of nose-to-nose contact between newly received animals and those already in the facility until the health of the new animals can be evaluated. This helps to prevent introduction of new pathogens into the collection. It also provides a time to acclimate new animals to different diets and housing and to collect medical data.

A quarantine policy should be developed and stringently enforced by the veterinary staff in consultation with facility personnel. Quarantine procedures as recommended for the American Zoo and Aquarium Association (AZA) accredited institutions should be followed (see Appendix 5, Miller, 1995). Quarantine protocols should be administered by the veterinarian. Length of quarantine varies with the species, disease potential, incubation periods of suspect diseases, facilities availability, and source of the animal (wild vs. farm or commercial; domestic vs. foreign; private vs. zoo source). Many infectious diseases have incubation periods of one week to one month prior to observation of clinical signs; therefore, a minimum of 30 days quarantine is recommended for most mammals including marine mammals, birds, and most reptiles. Minimum quarantine periods of 60-90 days are recommended for primates, and 90 days for snakes (to screen for paramyxovirus). Depending upon the source of the animal, the quarantine period may need to be longer if there is a concern for diseases with longer incubation periods such as Johne's disease. Any animal that is severely stressed by quarantine procedures may require an earlier release or modification of the facilities to avoid stress. Local, state, or federal regulations may also dictate quarantine length and procedures.

All animals should be inspected upon arrival for any injuries or disease and weighed. In addition, during quarantine, the following procedures should be considered: physical examination; clinical and laboratory tests for disease (especially those considered

communicable); treatment for external and internal parasites; immunization; evaluation of age, sex and teeth; and marking for permanent identification (tattoo, leg bands, transponders, ear notches, etc.).

Quarantine facilities should be physically isolated from the rest of the collection. With larger specimens or where separate facilities may not be available, the animal should be housed so as to minimize contact with other animals.

Aquarium and marine mammal facilities should have a separate quarantine pool with its own water system to isolate new arrivals or ill animals. This should be on site but may by necessity be off site. Water quality and size of the pool should meet federally mandated standards.

All personnel working in quarantine facilities must observe established protocols to prevent cross-contamination to other animals in the collection, such as personal hygiene and disinfecting of footwear, clothing, and equipment.

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.

b. Parasite Control

Fecal examinations should be conducted at least annually on all individuals or group of animals. To facilitate the detection and treatment of parasite infections before clinical signs appear, more frequent exams may be required on those groups recognized to be most susceptible. Fecal examination should be repeated following treatment to evaluate efficacy.

Routinely scheduled anthelmintic treatments may be required to control persistent parasitic infestations. Care should be taken in movement of animals or cage furniture from one exhibit to another in order to prevent exposure to aberrant parasites which could cause a fatal infection (e.g., Baylisascaris).

c. Immunization

All susceptible species must be immunized using currently recommended procedures and products. Schedules and products will be dictated by the disease status of domestic and wild animals in the area sur-

rounding the facility. The type, serial number, and source of product should be recorded in the individual animal's medical records (see Appendix 4).

d. Disease Surveillance and Tuberculosis Testing

Specific routine serological screening protocols for diseases will depend on the nature and prevalence of disease either in the vicinity of the facility (e.g., Blastomycosis in the Midwestern U.S.) or in the prevalence of the disease in the population (e.g., FIP in cheetahs). 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. In addition, there are several texts available on disease testing (Castro, 1992, Fowler, 1978, 1986, 1993) and the Infectious Disease Committee for the American Association of Zoo Veterinarians publishes brief monographs on diseases in the American Association of Zoo Veterinarians Infectious Disease Reviews (Amand, 1993). These monographs can be obtained through the association and are periodically updated as newer testing and treatment regimes become available.

Upon arrival at the facility, and prior to shipping, tuberculosis testing should be performed on all animals in which the test produces a valid and interpretable response (e.g., bovids, cervids and primates). Testing should be performed according to currently accepted methods. Susceptible species (e.g., primates, bovines, etc.) and any animal exposed to an animal diagnosed as having tuberculosis should be tested more frequently. Other susceptible specimens in the collection should be tuberculosis tested opportunistically following guidelines such as those developed by the AZA Animal Health Committee for cervids (see Appendix 3).

e. Dental Prophylaxis

Dental examinations should be conducted routinely on all individuals with known dental problems and during physical examinations of all animals (Hinshaw, 1996).

f. Zoonosis

A preventive health program should be developed for employees working with animals to minimize the possibility of disease transmission between people and animals in each zoo and aquarium.

Employees should have tuberculin tests prior to employment and annually thereafter, especially for

staff working with animals which are at risk for acquiring tuberculosis. 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 facility's veterinarian must be knowledgeable about zoonotic diseases that may affect animals in the collection. In addition, the veterinarian should inform and educate personnel when a zoonotic disease is diagnosed within the facility, and inform the appropriate governmental health authorities.

For further information, see Appendix 6, Zoo Personnel Health Program Recommendations, American Association of Zoo Veterinarians, Infectious Disease Committee (Amand, 1993) and Appendix 7, AZA Guidelines for Animal Contact with the General Public.

g. Ongoing Medical Programs to Improve Medical Care

The veterinarian should identify specialists in the local community who can assist in the diagnosis and treatment of appropriate species or illnesses. Veterinarians and human health professionals, dentists, nutritionists, physiologists, animal behaviorists and others can be instrumental in obtaining a positive outcome in a medical case. Staff members should be encouraged to attend continuing education programs to improve their medical care capabilities. Veterinary training programs such as internships and residencies should meet the AAZV guidelines for post-graduate programs in zoological medicine (see Appendix 8).

Systematic investigations of medical problems that arise in the collection should be conducted by the veterinary staff to decrease morbidity and mortality. The results of these investigations, when appropriate, should be published to help improve the knowledge base for the practice of zoo medicine.

C. Management Issues

1. Animal Shipments

The veterinarian is responsible for preparing and signing the health certificate. The consignor and consignee should share in the responsibility for health care prior to, during, and after shipment of animals. Arrangements should be made prior to shipment to insure that each animal is acclimated to transit

temperatures, that the crates are in good condition and meet federal and/or international standards, that adequate facilities are available at the receiving end, and that food items that are familiar to the animal are available. Ideally, animals should be preconditioned to shipping crates (Ott-Joslin, 1998).

Pre-shipment health examination should ideally include a complete physical exam with attention to parasite checks, necessary vaccinations updates, and completion of any tests required by regulations of the receiving state or country (e.g., TB testing, serology for brucellosis or anaplasmosis, etc.).

Health papers including the health certificate, complete medical records, diet and husbandry information (Fig. 1: American Association of Zoo Keepers (AAZK) Animal Data Transfer Form), and any additional shipping papers should accompany the shipment.

2. Diets/Husbandry Reviews

Periodic reviews of the diets and husbandry procedures should be conducted by the veterinarian in consultation with a nutritionist. The review should include an analysis of the relationship of diets to the frequency of disease problems, mortality rate, and reproductive problems. Such reviews and analysis may enable early detection of nutritional problems and can provide baseline data for development of new diets. Diets of individual animals should be modified to match the physiological state of the animal as it changes over time (i.e., newborn vs. adult vs. pregnant vs. lactating, etc.) whenever possible. When analyzing the diet of an animal, it is important to analyze what food the animal actually consumes and not just the diet offered.

3. Sanitation

Sanitation and disinfectants should be used following the guidelines in Zoo and Wild Animal Medicine (Fowler, 1978 b, 1986). 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. The frequency and amount of cleaning and disinfection will vary depending upon the animal's needs and physiological condition. This should be done often enough to keep the animals clean and dry. Cleaning utensils should be assigned to specific areas and should not be transferred between areas. These items should

be cleaned daily and hung up to dry. All feed and water containers should be routinely cleaned and disinfected. Water storage containers or automatic watering devices should also be disinfected.

Cleaning and sanitation should be done under the direction of the veterinarian. The effectiveness of the cleaning should be monitored. Inspection of the areas and utensils should be conducted by visual and/or microbiological procedures.

Monitoring of water quality for aquatic animals should be under the direction of the veterinarian and meet federal marine mammal guidelines.

4. Vermin Control

A formal vermin (insect and rodent) control program should be supervised by the veterinarian (see Appendix 9). Vermin control should be implemented in all areas of the zoo including storage areas for food items. The program should prevent, control, or eliminate vermin with documentation of monitoring and control techniques (Collins, 1996). Pesticides must be used in accordance with government regulations. Whenever possible, less toxic or non-toxic agents such as silica gel or insect growth regulator products should be given preference. The veterinarian should determine the degree of toxicity that products in use have for the collection animals, native wildlife and animal management personnel. Recommended products are listed in Zoo and Wild Animal Medicine (Fowler, 1978 b, 1986).

5. Euthanasia

The zoo or aquarium should have a policy on acquisition, disposition, and euthanasia that addresses the humane and medical aspects of these procedures. Live animals must be euthanized in accordance with the "1993 Report of the American Veterinary Medical Association (AVMA) Panel on Euthanasia" (available from the AVMA). This procedure may be necessary for aged or injured animals or those that are surplus to breeding and exhibit needs. Euthanasia must be performed by personnel who are knowledgeable and skilled in performing the procedure in a compassionate and professional manner. It should be performed so that it avoids distress to the animal. Specific methods for mammals and birds should conform to the AVMA Report on Euthanasia. Guidelines for euthanasia of poikilotherms can be found in Burns, 1995. Euthanasia techniques should not interfere with

postmortem examinations. Decisions regarding euthanasia should be made with thorough consultations among veterinary, curatorial and keeper personnel.

III. Veterinary Facilities

A. On-Site Veterinary Hospital

All zoos and aquariums should have an on-site veterinary hospital. This allows for isolation of new animals arriving to the facility, isolation of animals receiving medical care from the general collection, and facilitates observation and treatment of ill animals. The size of the facility and its components will depend upon the size and type of animal collection. Appendix 10 lists the average square footage for rooms in recently planned or constructed zoo veterinary hospitals and can be used as a reference for new construction.

The hospital should be designed with input from individuals knowledgeable about animal hospital facility design and from the veterinary staff of the facility who will use it. It must meet all local and state building regulations and must be constructed of durable, moisture-proof and fire resistant materials. Surfaces that animals can come in contact with must be nontoxic and be readily disinfected.

The hospital should be located away from areas of heavy public use to minimize the noise levels for the hospitalized animals. It should have separate areas for examination and treatment (see Section II.B.1.c.), sterile surgery (see Section II.B.1.b.), necropsy (see Section II.B.1.d.), quarantine (see Section II.B.2.a.), laboratory (see Section II.B.1.), radiology, pharmaceuticals storage including, when necessary, a safe for narcotics that meets the standards set by the Drug Enforcement Administration (DEA), food preparation areas, storage areas, and a staff locker room with showers. 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 (e.g., office and conference areas). Capture and restraint equipment, anesthetic equipment, autoclave and basic surgical equipment should be stored in the hospital.

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 at least 6 inches in diameter in animal holding areas and at least 4 inches in diameter elsewhere. Drain collector plate covers and baskets in animal areas should be a minimum of 8 inches in diameter. 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.

Air handling systems should be separate for primarily human areas, primarily animal areas including holding and treatment areas, and contaminated areas. Contaminated areas include quarantine and necropsy areas, and laboratory diagnostic fume hoods. Contaminated areas should have a filtration of $\geq 95\%$ biological effective level on outflow. Animal holding areas should have frequent air changes up to 10-15 air change/hr or enough to minimize animal odors, and sterile surgeries should have 20 air changes/hr. The density and size of animals in a confined area will affect the air exchange rate. This can be calculated with the average-total-heat-gain formula as published by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE, 1993). The temperature control should be readily adjustable on the air handling systems. Heating ventilation and air conditioning (HVAC) should be easily adjustable to temperatures of $\pm 1^\circ\text{C}$ with a relative humidity of 30-70%. The temperature should be capable of independent adjustment in each animal room. A back-up electrical generator should be available for hospital use.

The Centers for Disease Control and Prevention (CDC) requires that quarantine facilities for newly imported nonhuman primates house these animals in rooms that are under a negative air pressure relative to surrounding areas. Surgery and clean equipment storage should be under positive pressure. High-

efficiency particulate air (HEPA) filters may be desirable for use in supplying air to the surgery, animal areas and treatment rooms. Ideally air should not be re-circulated in the hospital, especially from animal areas.

Ceilings should be smooth, moisture resistant and easily cleaned. Suspended ceilings are not recommended in animal areas as they can harbor pests. Exposed ductwork and light fixtures are difficult to clean and can be hazardous during an animal escape and should be avoided.

Doors with viewing windows should open into the enclosed animal rooms. Doors should be large enough so that cages, crates and equipment can be easily moved into and out of animal areas. The 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. Corridors should be 6-8 feet wide to facilitate personnel, animal and equipment movements.

Outside hoofstock pens should be solidly constructed. If slatted wood walls are used, it should not be possible for hooves, legs 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 dirt surfaces are used, there should be easy access into the pens to remove and replace the soil if it becomes contaminated. Poured resilient urethane flooring similar to that used for outdoor running tracks is also acceptable. These finishes have good traction, are durable and are easily cleaned and disinfected.

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. Wood perches should be discarded after use.

Proper traffic flow patterns are important in hospital

design for maximum separation of quarantine and other areas. Personnel from outside or from within the facility must not come in contact with animal holding and quarantine areas during routine visits.

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

A locker room with sink, toilet, and shower must be

available for the hospital staff. Personnel should shower and change clothes prior to leaving work at the end of the day to avoid contamination of the community and the employees' families. Clothing worn within the veterinary hospital should be laundered on site, particularly when staff are working with animals that may be infected with zoonotic pathogens.

B. Off-Site Veterinary Hospital

If the zoo and aquarium is not of sufficient size and budget to have an on-site veterinary hospital, the zoo or aquarium should have a contract with a nearby veterinary hospital and must take animals off grounds for major medical procedures. The off-site veterinary hospital should be located close to the zoo or aquarium to minimize transit time for the animal.

The off-site veterinary hospital should have a sterile surgery with anesthetic equipment as described previously for the on-site veterinary hospital (see Section II.B.1.b and III.A.). It should have radiology equipment, a laboratory, and pharmaceutical storage. If necropsies are performed at this facility, there should be a separate area for necropsies and a separate storage refrigerator for storage of carcasses. These facilities should meet the requirement as stated previously in this document (see Section II.B.1.d. and III.A.)

However, the zoo or aquarium needs to have holding cages on-site to house animals for quarantine, for

animals with contagious diseases and for animals who need treatment and post-operative care. If it is at all possible, the animal should not be housed at the off-site veterinary hospital because of the risk of exposure to domestic animals. Should a zoo or aquarium animal come in contact with domestics 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 hospital for surgical procedures then there must be an on site area for minor treatment and minor surgical procedures and there must be an on site area that can be used for the occasional or emergency aseptic surgical procedures, There must also be a pharmacy on the zoo or aquarium grounds.

IV. SUMMARY

These guidelines for veterinary medical care and veterinary hospitals are written to conform with the requirements of the Animal Welfare Act, which states "programs of disease prevention and parasite control, euthanasia, and adequate veterinary care shall be established and maintained under the supervision of a veterinarian." Additional standards are prescribed in "Guide for the Care and Use of Laboratory Animals" (National Research Council, 1996), "Operating Procedures-Veterinary Medical Services" (Robinson, 1982 b), "Design Features-Veterinary Services" (Robinson, 1982 a), and "Veterinary Services in Zoos and Aquariums" (Miller, In Press.).

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.

The Veterinary Standards Committee extends thanks to Charlotte L. Kirk Baer, M.S. and David Lauer, V.M.D. for their editorial assistance, to Susan Walls for typing numerous drafts of this document and to the Board of Directors of the American Association of Zoo Veterinarians for their comments, suggestions and support.

APPENDIX 1: AMERICAN ZOO AND AQUARIUM ASSOCIATION (AZA) POLICY ON DRUGS USED IN AQUARIUMS TO TREAT FISH

The following procedures have been developed to prevent human exposure to drugs used to treat fish diseases by AZA institutions:

1. The drug administration programs at AZA accredited aquariums will be overseen by a licensed veterinarian, and drugs administered by trained personnel.
2. Drugs will not be purchased for or diverted to the food fish aquaculture industry.
3. Approved drugs will be used wherever possible and extralabel use of approved drugs will follow Food and Drug Administration (FDA) Compliance policy Guidelines.
4. Clinical records will reflect source and quantity of medication, medication used, dosage or concentration, duration and dates of treatment, disease and animals treated.
5. Visitors to Aquariums and aquatic zoo exhibits will not be exposed to drugs used to treat fish.
6. Occupational Safety and Health Administration guidelines will be followed to protect staff from exposure to drugs used to treat fish.
7. Disposal of drugs used to treat fish diseases will follow applicable federal and state environmental guidelines.
8. Fishes treated with non-FDA-approved drugs for food fish will not be released into the wild without appropriate depuration.
9. The AZA will monitor its member institutions regarding these matters through its rigorous accreditation process.

APPENDIX 2: BASIC CAPTURE AND RESTRAINT EQUIPMENT

Captive animals	Minimal required	Highly recommended but not required
Large carnivores	Nets, pole syringes, snare, projectile guns and darts, blow dart equipment, crates, squeeze cage	
Small carnivores	Nets, gloves, pole syringes, snare, crates, blow dart equipment, crates, squeeze cage	
Hoofed stock	Lariats, projectile guns and darts, blow dart equipment, crates	Custom designed squeeze cage and chutes
Elephants	Elephant hook, projectile guns and darts, chains	Elephant crush
Small mammals (e.g., primates)	Nets, gloves, pole syringe, snare, plastic tubes, blow dart equipment, crates, squeeze cage	
Large primates	Nets, gloves, pole syringe, projectile guns and darts, blow dart equipment	Squeeze cage
Pinnipeds	Nets, gloves, snare, shield, crates	Squeeze cage
Cetaceans	Nets, stretcher, hoist, foam pads	Lift bottom on pool
Birds	Nets, gloves, towels, pole syringe	
Reptiles	Nets, gloves, snare, plastic shield, bags, plastic tubes, snake tong, snake hook	Squeeze cage
Amphibians and fish	Nets, gloves, pole syringe	Laser dart guns

APPENDIX 3: AMERICAN ZOO AND AQUARIUM ASSOCIATION (AZA) ANIMAL HEALTH COMMITTEE GUIDELINES FOR CERVID TB TESTING

According to the United States Department of Agriculture Animal & Plant Health Inspection Service (USDA APHIS) Tuberculosis Eradication in Cervidae Uniform Methods and Rules effective May 15, 1994 :

“Institutions that have been accredited by the American of Zoo and Aquarium Association (AZA) are exempt from these requirements when movement is between accredited member facilities. All other movement from AZA accredited members must comply with these movement requirements.”

By this ruling AZA accredited zoos are exempt from tuberculin testing of cervidae being transferred between AZA accredited zoos. This discussion was based on AZA agreeing that the member zoos which have cervidae would do the following:

1. Maintain Accurate Records – AZA accredited institutions must maintain animal records. AZA institutions wishing to operate with the exemption must allow the USDA to trace individual animals should an outbreak occur. This includes individual identification of all animals in an institution’s care. This requirement is crucial to the USDA’s ability to perform appropriate epidemiological studies should tuberculosis be identified in a herd.
2. Conduct Necropsies - Complete necropsies must be conducted by a licensed veterinarian on all deaths. This will permit identification of all fatal cases of tuberculosis at post-mortem. As a result, even if testing results are equivocal, this will give us a final and accurate tuberculosis status of our herds.
3. Report Certain Diseases to USDA APHIS - All “reportable” diseases, such as tuberculosis must be reported to the appropriate state and federal authorities as soon as possible. This reporting mandate is already required by law. Furthermore, it is essential to our credibility with state and federal agencies.
4. Follow Separate Shipping Procedures - All cervids shipped between AZA accredited Institutions must be shipped in a manner so that they do not come into contact with other hoofstock destined for non-AZA institutions.
5. Conduct Quarantine - All animals must undergo a 30-day quarantine at the receiving institution.

APPENDIX 4: PREVENTATIVE MEDICINE RECOMMENDATIONS, AMERICAN ASSOCIATION OF ZOO VETERINARIANS (AAZV), INFECTIOUS DISEASE COMMITTEE

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Many factors encompassing a variety of disciplines play important roles in captive animal management and husbandry. Medical management is a vital component of animal care, and establishment of a comprehensive preventive medicine program is fundamental. Preventive medicine in its broadest interpretation includes any medical, husbandry, or management decision or procedure that decreases incidence of disease or injury. The primary focus of this paper will be medical, specifically prevention of infectious diseases. Other areas of preventive medicine will be mentioned, but thorough discussion is beyond the scope of this report. Basic guidelines for the establishment of zoo and aquarium veterinary medical programs have been published by the Veterinary Standards Committee of the American Association of Zoo Veterinarians.¹

The recommendations in this report are based on current medical knowledge and opinion. In some instances, recommendations are extrapolated from medical knowledge of domestic animals. It is understood that individual institutional practices may vary from those proposed in this document.

Basic Medical Care

Preventive medicine programs rely on well designed and properly conducted basic medical procedures. These procedures are vital for continual monitoring of the animal collection, accurate identification of animals and problems, and assimilation of information useful for future reference. Complete and accurate medical records must be maintained on all animals, and include entries describing all medical incidents, treatments, routine procedures, and lab results. Records must be updated in a timely fashion to remain useful. To assure accuracy, all animals must be permanently identified (e.g., tattoo, ear notch, leg band).

Complete physical examinations should be performed on collection animals as opportunities present. In some cases, animals are given annual medical checkups, however this is not always possible. Complete exams should be done when animals are immobilized and in accordance with quarantine programs. This exam should include routine blood work, tuberculin testing in primates and hoofstock, dental exam (see below) and determination of body weight. Serum samples for frozen storage should be taken when possible to allow retrospective surveys or future specific testing. Neonatal examinations are helpful to determine the health status of the newborn, with implementation of necessary supportive care in compromised individuals. Social and behavioral considerations must be taken into account when neonates are concerned. Care must be taken not to disrupt the maternal bonding process or subject the mother/infant to unnecessary stress.

Dental care is important for the maintenance of health. A complete oral examination should be done along with the general physical examination. Appropriate corrective and prophylactic therapy should be done when possible. Removal of plaque and excess tartar from teeth is important for dental health. Ideally, the provision of hard food items or coarse items for chewing will prevent or decrease the accumulation of excessive plaque. Damaged teeth may require extraction; alternatively reconstructive procedures such as root canal procedures or capping may preserve the function of the tooth.

Regular veterinary rounds are necessary to assess the health and condition of animals in the collection receiving medical care. This allows the attending veterinarian to assess patients' progress, but of equal importance, allows observation of animals in their enclosures with exhibit mates and discussion of the animals' status with the keepers. Abnormalities in activity or temperament may be detected, as well as unsafe or unhealthy conditions that may not be apparent to keepers. In most instances it is not possible for the veterinarian to observe the entire collection on a daily basis, therefore animal keepers and curatorial staff should be aware of signs of illness and injury. A specific system of communication between curatorial staff and veterinary staff should be established to insure proper notification of medical staff. In institutions that use a part-time consultant veterinarian, daily care and monitoring may be delegated to a properly trained staff member.

Although all the components of basic medical care and quarantine apply to marine mammals (specifically cetaceans and pinnipeds), some special consideration is warranted. Fundamentals of water quality must be monitored, including pH, nitrate levels, and coliform counts. Also basic to preventive medicine for pinnipeds and cetaceans is the quality of the food (fish). Care must be taken in fish preparation to prevent bacterial contamination and overgrowth and to prevent nutritional deficiencies secondary to improper thawing methods. Ideally, fish should be air thawed under refrigeration and kept cool until fed. The procedure of thawing fish in running warm tap water should be avoided, as this removed many of the vitamins present in the fish. Supplementation of fat soluble vitamins (specifically A and E) has been recommended to prevent dietary deficiencies. Thiamine supplementation (25 mg/kg fish twice weekly) is also recommended to circumvent effects of thiaminase found in some species of feeder fish. Salt supplementation in the food is also recommended for pinnipeds maintained in fresh water (3 gm NaCl/kg fish).² For cetaceans, a blowhole cultures are useful for monitoring the flora of the respiratory tract.

Many pinnipeds and cetaceans in captivity can be trained to perform specific behaviors on command. Often medical examinations, treatments, and sample collections can be accomplished in conjunction with these behaviors. Pinnipeds may be trained to allow blood collection. Dolphins and porpoises are routinely trained to allow blood collection, ultrasonography, blowhole cultures, and passing of a stomach tube. Regular examination of stomach fluid (pH, presence of blood) may be useful in the early detection of gastric ulceration.

Quarantine

Quarantine procedures are designed to prevent the introduction of infectious disease into an animal collection, and as such are one of the most important features of a preventive medicine program. A complete physical or visual examination with appropriate diagnostic tests should be performed at the zoo of origin to assure that only healthy animals are shipped. All newly acquired animals should be housed separately from similar animals in the collection for a minimum of 30 days, as well as being subjected to appropriate diagnostic tests. Quarantine procedures should be under the supervision of a veterinarian. The degree of separation, length of quarantine, and types of tests performed are dependent on the type of animal involved and any special or unique problems of the species or geographical area (recommendations presented below). Attention to the vaccination history is important, and appropriate inoculations should be given during quarantine. Animals of unknown history should be assumed naive and vaccinated appropriately. Vaccination recommendations are included in later sections. Any animal that dies during quarantine should receive a complete postmortem examination including histopathology.

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. The quarantine facility should be isolated in all aspects. Access should be restricted to prevent transport of infectious agents by zoo personnel. Animal care in the quarantine facility is to be done by a keeper 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). Waste removed from this facility should be disposed of in such a way as to prevent exposure to other areas of the zoo (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. It may also not be possible with large or specialized animals, such as elephants or marine mammals, that require facilities that are usually not practical to duplicate in a quarantine facility. In these instances, the animals 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. Boots, gloves, masks, or other protective clothing used while working with the quarantined animal are not

to be used elsewhere. A bacteriocidal/virucidal footbath is to be placed near the entrance to the area to prevent spread of pathogens by footwear. This footbath must be changed regularly as many products are inactivated by organic debris.

Although potentially difficult to quarantine due to size and strength, isolation quarantine should be considered obligatory for great apes. Quarantine at the shipping institution may be acceptable if the receiving institution is unable to hold the animal in isolation. In such cases, attention must be given to the method of shipment to assure that no exposure to disease will occur. The animal must be isolated, and no association should occur with other animals during shipment. Contact with humans should be minimized.

Other species that may be quarantined near conspecifics are amphibians, fish, and invertebrates, if complete isolation can be achieved even in close proximity to other similar animals. Because these animals have unique care and environmental requirements, it may not be feasible to duplicate the appropriate enclosures in a separate location for quarantine. Again, care must be taken to insure proper isolation of implements, waste, and equipment used in the care of the quarantine individuals. It is possible for fish pathogens to be transmitted by aerosolization, therefore resident fish tanks must be protected from this route of infection as well.

Length of quarantine should reflect the length of time required for disease entities common to the species to be detected, either via diagnostic procedures or clinical manifestations. Although it is impossible to consider every potential pathologic agent, general guidelines may be proposed. A quarantine period of a minimum of thirty days is recommended.

Animal identification

All animals should be identified with some permanent type of device. Standard methods include ear tags or notches for hoofstock, leg bands for birds, and tattoos for a variety of animals. When properly applied, microchip transponders provide permanent, unalterable identification without outwardly altering the appearance of the animal. Microchip transponder implantation is currently being recommended by many Species Survival Plan coordinators and by the Captive Breeding Specialists Group for identification of valuable animals. This procedure is recommended for genetic founder animals, animals of commercial value, and any other animal in which identification might be difficult or questioned. The procedure has not been associated with any detrimental effects.

All animals

When possible, animals should receive a complete physical examination, including body weight. If possible, blood should be drawn for complete blood count and differential, serum biochemical profile, and any appropriate diagnostic tests. An extra aliquot of blood should be saved frozen for future reference or testing. All animals should have three consecutive negative fecal flotations. Blood work and weight may be repeated at the end of quarantine to further assess the animal's condition, as well as to establish baseline normal values. Special or unique requirements of animal groups are discussed below.

Primates

Primates have traditionally had stringent quarantine requirements due to the potential zoonotic diseases that they may carry. Primates should be quarantined at least 30 days after arrival. This length of quarantine has been set at 60 days at many institutions, and should be lengthened to 90 days with animals of unknown medical histories, known exposure to infectious diseases, or imported (especially wild-caught) animals. Primates should have three negative tuberculin tests at two week (minimum) intervals, using a product with at least 1500 tuberculin units per test dose (i.e., Cooper's Mammalian tuberculin, Coopers Animal Health, Kansas City KS). If length of quarantine

is greater than 30 days, monthly TB tests should be done. The diagnosis and control of tuberculosis is an extensive subject and will be dealt with separately. It should be noted that orangutans frequently exhibit false positive reactions to intradermal tuberculin testing, and further diagnostic evaluation is necessary to determine their true status. Please consult the AAZV Infectious Disease Committee recommendations on tuberculosis testing in general and with regard specifically to orangutans. Primates should have three consecutive negative fecal examinations before release. Freshly collected fecal samples should be examined by routine flotation or sedimentation procedures for parasite ova and direct wet mount preparation for protozoa. Fecal samples from New World primates should be examined by sedimentation to increase the likelihood of detecting *Prosthenorchis* ova, which are shed intermittently in small numbers.³ If possible, a centrifugation technique should be substituted for the flotation procedure, as this technique is more sensitive and will detect ova in smaller quantities than standard flotations. Fecal cultures for *Salmonella*, *Shigella*, *Campylobacter*, and *Yersinia* may be advisable based on the history of the animals and the institution of origin. All macaques should be tested for titers to herpesvirus simiae (B virus, herpes B). Herpes B virus infection is common in macaques, with infection rates of up to 100% in some collections. In many cases, there are few or no distinct clinical signs in macaques, and serology is necessary to make a diagnosis. Macaques may shed virus intermittently, and seronegative animals may still be latent carriers. Due to the potential of undiagnosed carriers in macaque species, the recommendation has been made that all macaques be handled as carriers. Serological testing should be done when the opportunity arises and used to monitor exposure and incidence in a collection. Precautions should be taken to prevent exposure of other primates (including humans) to the disease due to its lethal potential. Institutions that have not detected herpes B in their collection should test quarantined macaques and may wish to refuse or permanently isolate any animals with positive titers. For further discussion of testing, monitoring programs, and management, please refer to the herpes B recommendations of the Infectious Disease Committee of the American Association of Zoo Veterinarians.

Other primate serology required during quarantine should be determined based on history (e.g., retroviruses, parainfluenza, measles, cytomegalovirus). Titer results should be used to determine exposure of the animals in the collection. By determining the antibody status of animals at entry, subsequent changes in titer may be properly evaluated. All great apes should be tested for hepatitis B.

Quarantine requirements for importation of nonhuman primates have been established by the Centers for Disease Control (CDC), and include specific regulations regarding employee health and education, isolation, disease testing, documentation, and reporting. Institutions interested in importing nonhuman primates are advised to contact CDC Division of Quarantine (404-639-8108).

Hoofstock

Hoofstock should be quarantined 30 days. Tuberculin testing should be done whenever possible. In most instances, this will require immobilization which may not be warranted in some cases (i.e., giraffes, hippos). All animals should have three negative fecal flotations. Depending on the history of both the receiving and sending institutions, serologic testing may be appropriate, including brucellosis, leptospirosis, infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), and malignant catarrhal fever (MCF), anaplasmosis, and blue tongue. State veterinary regulatory officials should be consulted for state requirements for testing exotic hoofstock for diseases transmissible to domestic livestock. Wild sheep, goats, and wildebeest are recognized carriers of MCF and should be tested.¹⁴

Carnivores

Quarantined 30 days with three negative fecal flotations as described above. All should be current on vaccinations as recommended in the vaccination section of this paper. Felidae should have titers determined for feline immunodeficiency virus (FIV) and antigen testing for feline leukemia virus (FeLV). Both diseases (FIV, FeLV) have been documented in nondomestic felids^{5,6} although not well associated with clinical disease. Titers (especially

paired titers with an increase) should be interpreted as indication of exposure, and animals with positive titers could be infectious to other felids in the collection. Repeated serology should be done to monitor persistent infections, and introduction to collection animals should not be done while serological evidence of viremia exists. Please consult the report of the Infectious Disease Committee of the American Association of Zoo Veterinarians for further recommendations concerning FIV.

In addition to FeLV and FIV, cheetahs should be tested for feline infectious peritonitis (FIP) due to the high mortality in this species. Positive titers indicate exposure to a feline coronavirus (either infectious peritonitis virus or enteric coronavirus). Unfortunately, the type of feline coronavirus to which the animal has been exposed can not be determined with current serologic tests. History of exposure and clinical signs must be considered, and serology repeated to indicate persistence of infection. Animals that show signs of disease typical of FIP (abdominal distension, ascites) with high coronavirus titers should be held in isolation. High titers in the absence of disease indicate exposure. If cheetahs in the collection are naive (to feline coronavirus), animals with persistent titers should not be introduced due to the potential catastrophic results of clinical FIP in this species.

Canidae and pinnipeds are susceptible to heartworm disease⁷ and should be tested for *Dirofilaria immitis* by standard methods. Other carnivores have been identified as incidental hosts of *Dirofilaria*^{7,8} and may be tested in endemic areas at the discretion of the attending veterinarian. In incidental hosts, *Dirofilaria* is usually nonpathogenic and treatment is not necessary unless clinical disease develops.

Small Mammals (Rodentia, Insectivora, Chiroptera, Edentata, and others not included elsewhere).

Quarantine 30 days with three consecutive negative fecals. Vaccinate as appropriate for individual species.

Birds

Quarantine 30 days with three negative fecals. With birds, direct examination of feces for protozoa should also be done. Psittacosis testing (serology supported by cloacal culture for positive cases) should be done on appropriate groups (e.g., psittacines, columbiformes).

Reptiles & amphibians

Reptiles other than snakes should be quarantined 30 days with three negative fecals, including direct examinations.

Based on recent research into paramyxovirus infection, quarantine for snakes should be 90 days. Specimens should be housed separately, and a virucidal footbath and instrument wash should be used. Any animals in poor condition should not be released from quarantine, and should be euthanized if improvement is not seen. Any snakes dying in quarantine should have a complete necropsy performed, and serum (if available) and tissue (lung, liver, kidney, spleen) saved frozen for future virus isolation if paramyxovirus infection is suspected. *Paramyxovirus* has been isolated from snakes from the families Viperidae, Colubridae, Elaphidae, and Boidae. Please consult the recommendations of the Infectious Disease Committee of the American Association of Zoo Veterinarians for further information on paramyxovirus infection of snakes.

Boid family snakes should be monitored for signs of Inclusion Body Disease of boid snakes. This condition appears to be caused by a retrovirus, and has been documented in a variety of boa and python species.¹⁰ Currently there is no diagnostic test for this readily transmissible disease. Boids dying in quarantine should receive a complete necropsy with particular attention to evidence of viral hepatitis, pneumonia, and encephalitis and histological examination for the characteristic eosinophilic intracytoplasmic inclusion bodies.¹⁰

Fish

Quarantine recommendations for fish are similar in principle to those of other vertebrates. All incoming stock should be placed in isolation (quarantine aquarium), allowed to acclimate to the new environment, examined for signs of disease and treated appropriately, and have complete postmortem examinations done on any fish that die. Fish should be quarantined a minimum of 4 weeks to allow parasite life cycles to be completed.¹¹ For tropical marine fish the quarantine regime includes initial acclimatization (3 days), fresh water dips (days 3, 5, 7), copper therapy between days 8 and 31, and two or three fecal examinations between days 3 and 31. The entire procedure, including gradual increase and decrease of copper concentration and post-treatment recovery, takes 42 to 56 days. Details of the treatment regime are provided elsewhere.¹² Efforts should be made to reduce stress so as to decrease the incidence of disease. Quarantined fish should not be crowded, and lights may be kept off for the first 12 to 24 hours to reduce stress.

Fish should be screened for internal parasites before exiting quarantine. Fecal samples may be collected from the water if freshly passed (still formed). If fresh water dips are used, the water can be filtered of sedimented and the residue examined for external parasites.¹¹ Approximately two to five percent of fish in a quarantine tank should be examined for external parasites by skin scrapings, and gill and fin biopsies.¹¹ Details of treatment regimes may be found in fish medicine references.^{11,12}

Aquatic invertebrates

As many fish parasites utilize aquatic invertebrates as intermediate hosts, these animals should be quarantined. A holding period of two weeks should be adequate to rid invertebrates of intermediate stages of common parasites.

Vaccination Programs

Vaccination programs vary widely among animal collections, based on endemic disease, composition of the collection, and potential for exposure. Vaccines and vaccination schedules have been developed for domestic animals with extensive research involving development of titers and response to virus challenge. For obvious reasons, recommendations for exotic species must in most cases be made via extrapolation rather than experimentation.

The extra-label use of live or modified live vaccines should be avoided if possible due to the potential for vaccine-induced disease that has occurred. The possibility of viral shedding also exists when modified live vaccines are used. Origin of the vaccine (i.e., cell line of viral culture) should also be considered, and specific cautions will be addressed below. The families listed below have specific vaccine recommendations. Families not listed do not have standard vaccine programs. In certain instances, the need to vaccinate an exotic animal other than those listed may arise. These situations must be approached cautiously, and if done, efforts should be taken to evaluate the vaccine for effectiveness and safety for future reference.

Rabies. Vaccination of exotic animals with a killed rabies vaccine has been shown to induce a rise in antibody titer.¹³ This is interpreted as indicating protection, although viral challenges have not been done. Exotic animals may be vaccinated in rabies-endemic areas (killed vaccine only) if likelihood of exposure is high. Should bites to humans occur, the animal should be treated as nonvaccinated, and appropriate quarantine procedures initiated in accordance with local legal requirements. Initial vaccine may be given at four to six months of age, and repeated annually. In all cases, regulatory officials should be consulted regarding the legality of extra-label use of rabies vaccine, as some areas may have restrictions. The recommendations from

the AAZV Infectious Disease Committee should be consulted for further information.

Poliomyelitis. Oral vaccine for great apes (chimpanzees, gorillas, orangutans) at three, six, and nine months and two years for juveniles. Adults of unknown history should be vaccinated three times at two month intervals.

Tetanus. As all primates are susceptible, tetanus vaccination is recommended; standard human tetanus toxoid is acceptable. The combination human vaccine is frequently used, containing diphtheria, pertussis, and tetanus (DPT), however nonhuman primates are not susceptible to diphtheria and pertussis, and vaccination is not necessary. Immunizations are given at three, six, and nine months of age. Tetanus boosters may be given at three to five year intervals, or in case of injury.

Measles. Due to high mortality in some species (i.e., colobus, silver leaf monkeys, new world monkeys) vaccinations in newly imported wild caught animals is recommended. Vaccination of captive born animals should be reserved for infants with high exposure risk. Juvenile monkeys have prolonged maternal antibody protection, and should be vaccinated after six months of age and boosted in five to seven months. In great apes, maternal antibody may persist until the infant is approximately 15 months of age, therefore vaccination series should be done after that time. Products designed for humans may be used.

Rabies. As all mammals, primates are susceptible to rabiesvirus infection. Vaccination should be done for animals with high chance of exposure, such as those housed outside in rabies-endemic areas. Only killed virus preparations should be used.

Canidae¹⁶

Vaccines for members of the family Canidae reflect recommendations for domestic dogs. Vaccinations should be given at weaning and repeated every two to three weeks for three inoculations. In special cases (i.e., early weaning, ill juveniles, or high probability of exposure to disease) the vaccination series may be extended to four or five vaccinations to insure adequate protection.

Rabies. Recommended based on degree of exposure. See recommendations above.

Canine distemper. Distemper vaccination is recommended for all canids. No killed vaccine is presently commercially available. The modified live virus vaccine of canine cell line origin has been associated with vaccine-induced distemper in exotic canids.¹⁷⁻²¹ Modified live virus avian cell line products have provided protective titers and have not been associated with vaccinal induced disease in canids.^{19,21}

Canine infectious hepatitis. Vaccination with canine adenovirus type 2 vaccine recommended to avoid the risk of corneal opacity. Only modified live virus vaccine available. Annual revaccination is recommended.

Leptospirosis. Annual vaccination with multivalent bacterin recommended.

Canine parvovirus. Parvovirus enteritis has been documented in several exotic canid species,²³ and all should be considered susceptible. Bush dogs (*Speothos veraticus*) have developed parvovirus enteritis when vaccinated on a regular canine regime, and repeated vaccination is recommended until protective titers develop. In experimental trials, protective titers did not develop until 23 weeks of age.²⁴ Annual vaccination is recommended, utilizing an inactivated vaccine.

Felidae

Nondomestic felids are routinely vaccinated annually with a three-way combination killed vaccine for rhinotracheitis, calicivirus, and panleukopenia. As with all carnivores, vaccinations should begin at weaning and be repeated at least twice (total of at least three injections) at two week intervals.

Feline panleukopenia (feline distemper). All should be vaccinated as kittens and annually thereafter.

Feline calicivirus. All felids should be vaccinated with a killed product as kittens and annually thereafter.

Feline herpesvirus (rhinotracheitis). Initial kitten series with annual boosters. Killed product only. In species with apparent increased sensitivity (i.e., sandcats) and in situations of high incidence of exposure, revaccination should be done every 6 months.

Rabies. All felids are susceptible. See above recommendations.

Feline leukemia. The disease has been reported in exotic felids, and an appropriate antibody response to subunit vaccination demonstrated. As infection remains uncommon in nondomestic felids, vaccination is not commonly done.⁶

Canine distemper. Canine distemper has been documented in captive lions, tigers, leopards, and a jaguar²⁵ and free-ranging lions.²⁶ As this disease is uncommon and the efficacy and safety of vaccination is not known, it is not recommended that exotic felids be vaccinated for canine distemper at this point.

Procyonidae- Raccoons, coatimundi, kinkajou, red panda

Canine distemper. All members are susceptible.²⁷ Annual vaccinations recommended, using a modified live vaccine of avian cell line origin. However, a MLV avian cell line product, when administered as part of a multivalent vaccine, resulted in disease in red pandas and viverrid species.²⁸ Based on the possibility of immunosuppressive effects of multivalent vaccines, it is recommended that the distemper vaccine be given separately at a reasonable interval from the other components.²⁸

Red pandas *Ailurus fulgens* should be vaccinated ONLY WITH A KILLED VACCINE. The American Association of Zoological Parks and Aquariums Red Panda Species Coordinator should be consulted for the current vaccine recommendation.

Feline panleukopenia. Feline panleukopenia has been reported in raccoons and coatis.²⁹ Vaccination with a killed product is recommended. A killed panleukopenia vaccine is available by utilizing the panleukopenia fraction of a multivalent feline vaccine.

Rabies. All species are susceptible. See above recommendations.

Leptospirosis. Reported in raccoons.³⁰ Annual vaccination with multivalent vaccine recommended.

Mustelidae- Mink, ferret, skunk, otter, weasel

Canine distemper. All members are susceptible, some (ferret) extremely so. All should be vaccinated with a product not of ferret cell line origin. Vaccines of avian cell lines have been shown to be safe and effective, and are recommended. Annual boosters recommended. Vaccinal disease has been reported in black-footed ferrets from modified live virus vaccines.³¹ However, a MLV avian cell line product, when administered as part of a multivalent vaccine, resulted in disease in red pandas and viverrid species.²⁸ Based on the possibility of immunosuppressive effects of multivalent vaccines, it is recommended that the distemper vaccine be given separately at a reasonable interval from the other components.²⁸

Institutions housing blackfooted ferrets (*Mustela nigripes*) are advised to consult the SSP coordinator or veterinary advisor for most current recommendations of which killed product to use.

Feline panleukopenia. All except domestic ferret (*Mustela putorius*) susceptible.³² Vaccinate with killed vaccine, such as domestic cat vaccine without respiratory virus components.

Rabies. All are susceptible. See above recommendations. A killed vaccine virus (Imrab, Pitman Moore, Washington Crossing, NJ) has been tested and found to be safe and efficacious, and has been approved for use in domestic ferrets (*Mustela putorius*) by USDA.³³

Botulism. Commercially raised mink are routinely vaccinated with toxoid against *Clostridium botulinum* type C. This practice is not routinely done in other situations or with other mustelids.³⁴

Leptospirosis. Reported in mustelids.³⁰ Annual vaccination with a multivalent bacterin recommended.

Viverridae- Civets, mongooses, meerkats

Canine distemper. Recommended annual vaccine for all members. Avian cell line modified live vaccine.³⁴ However, a MLV avian cell line product, when administered as part of a multivalent vaccine, resulted in disease in red pandas and viverrid species.²⁸ Based on the possibility of immunosuppressive effects of multivalent

vaccines, it is recommended that the distemper vaccine be given separately at a reasonable interval from the other components.²⁸

Feline panleukopenia. Recommended annual vaccine for all members.

Leptospirosis. Reported in mongooses.³⁰ Annual vaccination with multivalent bacterin recommended.

Hyaenidae

Canine distemper. Annual vaccination recommended.^{16,35} Vaccines of avian cell line origin should be used.

Feline panleukopenia. Although some difference of opinion exists about susceptibility, annual vaccination is recommended.^{16,35}

Ursidae

Canine infectious hepatitis. Naturally occurring disease has been reported in black bears (*Ursus americanus*).³⁶ Vaccination of bears in controlled collections is not routinely done.

Cetaceans

Erysipelas. Cetaceans are susceptible to systemic and dermatologic disease from infection with *Erysipelas rhusiopathiae*.³⁷ Recommendations for vaccination vary. Reports of side effects include clinical disease with a live bacterin, and swelling or anaphylaxis with a killed bacterin. In some cases, animals that had been repeatedly vaccinated failed to produce a protective antibody titer.³⁷ In controlled collections with no history of erysipelas and minimal chance of exposure, vaccination is probably not warranted.

Artiodactyla

Most artiodactyla are not routinely vaccinated, however vaccination for tetanus and rabies may be warranted (see rabies discussion above). Serologic surveys and diagnostic virology have indicated that various exotic artiodactyla are susceptible to infectious bovine rhinotracheitis (IBR), bluetongue (BT), epizootic hemorrhagic disease (EHD), bovine virus diarrhea (BVD), parainfluenza type 3 (PI-3), malignant catarrhal fever (MCF) and rotavirus.^{38,39} Due to low incidence and controlled exposure, vaccination is rarely warranted. The use of an oral rotavirus vaccine formulated for cattle has reduced neonatal mortality in a hoofstock nursery.³⁹ In any situation in which vaccination programs for exotic hoofstock are being considered, animal regulatory authorities should be consulted. The effect of vaccine on the ability to detect disease by serology must also be considered. If a vaccinal titer can not be differentiated from an exposure titer, the ability to monitor the collection may be compromised.³⁸

Clostridium. South American camelids are routinely vaccinated with tetanus toxoid and toxoid for *C. perfringens* C and D (enterotoxemia). Pregnant females should be vaccinated two months before parturition and repeated three weeks later.⁴⁰ Other artiodactyla may be vaccinated for clostridial diseases based on local exposure and

history.

Suidae/Tayassuidae

Leptospirosis. Annual vaccination with a multivalent bacterin may be done based on history and probability of exposure.

Erysipelas. Annual vaccination may be done based on history and probability of exposure.

NOTE: Veterinarians are advised to consult local vaccination practices for domestic pigs when vaccinating varieties of *Sus scrofa* (i.e., potbellied pigs).

Equidae

Vaccinations for equids are based on recommendations for domestic horses⁴¹ except where noted otherwise. The three diseases listed below are considered the primary risks. Other available equine vaccines (rabies, strangles, Potomac Fever, botulism) may be used in endemic areas or in cases of exposure, but are not usually part of routine prophylaxis.⁴¹

Tetanus. Annual vaccination against tetanus should be done on all equids. Tetanus antitoxin should be given in the event of an injury. Vaccination of foals should be done initially at three months of age, repeated in four weeks, and given annually thereafter.

Equine herpesvirus type-1 (rhinopneumonitis). Neonatal death and abortion has been associated with EHV-1 infection in exotic equids.⁴² Based on history and exposure, annual vaccination with a killed vaccine is recommended. In addition, pregnant mares should be vaccinated at five, seven, and nine months of gestation, and foals should be vaccinated at 3-4 months of age and again 4 weeks later.

Encephalomyelitis. Equine viral encephalomyelitis is transmitted via mosquitoes, therefore exotic equids have the potential for exposure. A multivalent killed vaccine should be administered to foals at 3-4 months of age and boosted 4 weeks later. A multivalent killed vaccine should be administered annually in endemic areas.

Rhinocerotidae

Leptospirosis. Leptospirosis has been associated with fatal hemolytic anemia in black rhinos.⁴³ Current recommendations are that black rhinos be vaccinated every six months with a multivalent leptospirosis bacterin including *L. icterohaemorrhagiae*. Serological evaluation has shown that a vaccinal response occurs in animals vaccinated with Leptoferm^R (Norden Labs, Lincoln, NE).

Parasite Control

Regular monitoring and treatment of both internal and external parasites should be part of the preventive medicine protocol. Fecal examinations should be done for all mammals, birds, and reptiles in the collection at least twice

annually, and should be part of the quarantine protocol as well (see above). Standard flotation techniques will identify most parasitic infestations by identification of the shed ova. Direct examination of fresh feces suspended in saline is necessary to detect and identify protozoan parasites. Direct examinations should be done routinely on primates and reptiles, as well as any groups with recurrent episodes of diarrhea. Concentration methods (i.e., formalin-ether centrifugation) are more sensitive than flotations, and allow detection of low numbers of ova and ova that don't readily float (trematodes, *Prosthenorchis*).

After a diagnosis of parasite infestation, appropriate anthelmintic therapy should be initiated. Upon completion of treatment, fecal exams should be repeated to assure that the therapy was successful. The first post-treatment fecal exam should be done two to three weeks after cessation of treatment, and repeated in two weeks.

Examination for external parasites may be more difficult in many instances due to the unhandleable nature of the animals. Examination for external parasites should be included as part of a complete physical exam. Often characteristic clinical signs such as pruritus, hair or feather loss, and evidence of discomfort will alert the veterinarian to the possibility of external parasitism. Birds and reptiles should also be carefully examined, as external parasitism, although less common, can occur. In mammals, external ear canals should also be examined carefully for evidence of ear mites or other parasites. As with internal parasites, the identity of the organism will determine the method of treatment.

In cases of repeated infestation with either external or internal parasites, attention must be given to the environment as well as the individual animal. If reinfestation is occurring due to environmental contamination, efforts should be undertaken to break the parasite life cycle by removing the stages that exist outside of the animal. In many cases, control of insect or rodent intermediate hosts is vital for control of the parasite (please consult following pest control recommendations). In individuals or species which have chronic parasite infestation problems, a routine periodic (e.g., quarterly) worming program should be initiated to control the parasite. Veterinary extension services may be helpful in establishing pasture management procedures to reduce parasite loads in hoofstock.

Included in parasite control should be examination for and prevention of dirofilariasis in susceptible species. The filarid *Dirofilaria* has been identified as a cause of disease in nondomestic canids as well as pinnipeds.⁵ Detection is by examination of blood by standard concentration or filtration techniques available for domestic dogs. Once it has been determined that the animal is not microfilaremic, preventative therapy should be initiated as established for domestic canines. Daily treatment with diethylcarbamazine has been effective in canids and pinnipeds. Once monthly treatment with ivermectin has been successful in preventing heartworm infection in pinnipeds and canids, however long-term effects may not yet be known.

Husbandry Procedures

Exhibit Design and Animal Management

Preventative medicine programs should include objective and detailed evaluation of exhibit design and animal management programs. Exhibits should be designed with animal (and keeper) safety and well-being, as well as public viewing, in mind. Barriers, holding facilities, access areas, substrates, and other physical characteristics of the display areas should be carefully evaluated, considering animal temperament, social system, and territoriality. These and other parameters will determine size and composition of the group, proximity to and type of adjacent animals, amount of seclusion, type and size of off exhibit holding, and so on. Types of native or ornamental vegetation should also be identified to avoid potential toxicoses, especially for herbivores. In this area the veterinarian and animal curatorial staff should work together, contributing individual expertise, to develop the animal enclosure and management procedures.

Nutrition

Proper nutrition is essential for maintenance of health in animal collections. Depending on the situation, the responsibility for evaluation and determination of diets may be delegated to the veterinarian or other staff member. In any situation, the provision of complete and balanced diets acceptable to the animals is a significant part of preventative medicine. Knowledge of specific nutritional needs with medical implications (e.g., the provision of vitamin D₃ to birds, new world primates, and some reptiles, Ca:P imbalances of exclusively meat diets fed to carnivores or unsupplemented insectivorous diets) requires the veterinarian to take an active part in diet formulation. Quality of diets is also important, especially for vitamin content of stored feeds (grain, hay, frozen fish). A number of "medical" problems may be related directly to diet, such as gastritis/enteritis from feeding spoiled feeds or poor hair coats from vitamin or mineral deficient diets.

Attention to nutrition and diet is especially important for animals that have been recently captured or moved to a different institution. Care must be taken to assure that the diet provided at the receiving institution is accepted. Changes in appearance, taste, presentation, social grouping, and other factors may affect intake. Animals that have been recently captured or moved may already be compromised by stress, and nutritional inadequacies may be magnified. In situations of specialized diets or sensitive animals, it may be appropriate to send a supply of the animal's food to the receiving institution to ease the transition.

Sanitation

Procedures that provide for cleanliness of exhibits, food preparation and storage areas, and animal holding areas, are important for control of infectious agents, including parasites, viruses, and bacteria. Although routine sanitary procedures are the duty of keepers staff under curatorial supervision, the veterinarian should oversee and review procedures to be sure that cleaning agents are appropriately used. Quaternary ammonium compounds, phenolics, chlorhexadine solutions, and iodophores are all effective bacteriocidal agents, and are virucidal for many common agents. In some cases specific compounds should be used, for instance phenolics in areas contaminated with tuberculosis or dilute (3%) sodium hypochlorite solution in outbreaks of resistant viruses. Feed and water containers and utensils should be cleaned and disinfected daily if possible. In exhibits with water components, water quality must also be monitored and be in accordance with federally mandated guidelines when applicable (i.e., Marine Mammal Act standards for captive marine mammals). Food wastes and excrement should be removed at least daily and disposed of in such a way as not to attract insects or rodents.

Pest control

Control of vertebrate and invertebrate pests is an important part of preventive medicine because of the significance of pests as vectors or reservoirs of disease. Arthropod vectors may transmit a variety of viral, bacterial, and parasitic agents. Bird and mammal pests may shed infectious agents, serve as wildlife reservoirs of diseases that affect zoo animals, or provide an appropriate host for sustaining parasitic life cycles, thus increasing exposure to animals in the zoo collection. Vermin are also harmful because of the loss that occurs from damage to stored food. Veterinarians should be aware of the types of diseases in their area that are pest-transmitted. Veterinarians should also be aware of the types of pesticides being used for vermin control, as well as the signs of exposure to nontarget (i.e., collection) animals or native wildlife. Veterinary staff should be consulted and approve any potentially harmful product to be used in or around the zoo.

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APPENDIX 5: QUARANTINE PROCEDURES RECOMMENDED FOR AMERICAN ZOO AND AQUARIUM ASSOCIATION (AZA) ACCREDITED INSTITUTIONS

Quarantine Facility: A separate quarantine facility, with the ability to accommodate mammals, birds, reptiles, amphibians and fish should exist. If a specific quarantine facility is not present, then newly acquired animals should be isolated from the established collection in such a manner as to prohibit physical contact, to prevent fomite transmission, and to avoid aerosol and drainage contamination. Such separation should be obligatory for primates, small mammals, birds, and reptiles, and attempted wherever possible with larger mammals such as large ungulates and carnivores, marine mammals and cetaceans. If the receiving institution lacks appropriate facilities for isolation of large primates, preshipment quarantine at an AZA or AALAS accredited institution may be applied to the receiving institution's protocol. In such a case, shipment must take place in isolation from other primates. More stringent local, state or federal regulations take precedence over the recommendations of this report.

Quarantine Length: Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). Mammals: If during the 30 day quarantine period, additional mammals of the same order are introduced into a designated quarantine area, the 30-day period must begin again. Birds, reptiles, amphibians or fish: The 30-day quarantine period must be closed for each of the above Classes. Therefore, the addition of any new birds into a bird quarantine areas requires that the 30-day quarantine period begin again on the date of the addition of the new birds. The same applies for reptiles, amphibians and fish.

Quarantine Personnel: A keeper should be designated to care only for quarantined animals or a keepers should attend quarantined animals only after fulfilling responsibilities for resident species. Equipment used to feed and clean animals in quarantine should be used only with these animals. If this is not possible, then equipment must be cleaned with an appropriate disinfectant (as designated by the veterinarian supervising quarantine) before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal personnel to zoonotic diseases that may be present in newly acquired animals. These precautions should include the use of disinfectant foot baths, wearing of appropriate protective clothing and masks in some cases, and minimizing physical exposure in some species, e.g., with primates, by the use of chemical rather than physical restraint. A tuberculin testing/surveillance program must be established for zoo/aquarium employees in order to ensure the health of both the employees and the animal collection.

Quarantine Protocol: During this period, certain prophylactic measures should be instituted. Individual fecal samples or representative samples from large numbers of individuals housed in a limited area (e.g., birds of the same species in an aviary or frogs in a terrarium) should be collected at least twice and examined for gastrointestinal parasites. Treatment should be prescribed by the attending veterinarian. Ideally, release from quarantine should be dependent on obtaining two negative fecal results spaced a minimum of two weeks apart either initially or after parasiticide treatment. In addition, all animals should be evaluated for ectoparasites and treated accordingly.

Vaccinations should be updated as appropriate for each species. If the animal arrives without a vaccination history, it should be treated as an immunologically naive animal, and given an appropriate series of vaccinations. Whenever possible, blood should be collected and sera banked. Either a -70 degree C freezer or a -20 degree C freezer that is not frost-free should be available to save sera. Such sera could provide an important resource for retrospective disease evaluation.

The quarantine period also represents an opportunity to, where possible, permanently identify all unmarked animals when anesthetized or restrained (e.g., tattoo, ear notch, ear tag, etc.). Also, whenever animals are restrained or immobilized a complete physical, including a dental examination, should be performed.

Complete medical records should be kept and available for all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed under the supervision of a veterinarian and representative tissues submitted for histopathologic examination.

Quarantine Procedures: The following are recommendations and suggestions for appropriate quarantine procedures for several animal groups:

MAMMALS

Primates

Required

1. Direct and flotation fecals as described above
2. A minimum of 2 negative tuberculin tests using a tuberculin containing at least 1500 units/.1ml (e.g., Mammalian Human Isolate, Coopers Animal Health, Kansas City, KS) or other appropriate regimen as necessary for the species in question (e.g., orangutans, New World primates, etc.).
3. CBC/sera chemistry panel
4. culture of feces for salmonella/shigella/Campylobacter
5. for appropriate species, (e.g., Old World monkeys), serology for Herpesvirus simiae (Herpes B).

Strongly Recommended

1. chest radiographs
2. appropriate viral panels (SIV, retrovirus type D)
3. urinalysis

Hoofstock

Required

1. direct and floatation fecals
2. TB test whenever possible

Strongly Recommended

1. CBC/sera profile
2. appropriate serology (e.g., leptospirosis, brucellosis, MCF, IBR, BVD, etc.), paired titers whenever possible
3. urinalysis
4. Johnes diagnostics if history of disease in herd of origin
5. Coggins test for equids
6. vaccinate as appropriate (See Zoo and Wildlife Animal Medicine, ME Fowler, WB Saunder Co., Philadelphia, 1986, pp 884-1036.)

Small Mammals/Carnivores

Required

1. direct and floatation fecals
2. vaccinate as appropriate (See Fowler as under hoofstock recommendations, pp 800-811; and recommendations for small exotics in upcoming Current Veterinary Therapy XI WB Saunders Co., Philadelphia).

Strongly Recommended

1. CBC/sera pro 4. heartworm testing in appropriate species file
2. urinalysis
3. appropriate serology, FIP, FeLV, FIV
4. heartworm testing in appropriate species

Birds

Required

1. direct and floatation fecals as above
2. evaluate for ectoparasites
3. appropriate serological tests for psittacosis and if positive, confirmed by culture

Strongly Recommended

1. CBC/sera profile
2. fecal culture for *Salmonella sp.*
3. fecal gram stain

Reptiles/Amphibians

Required

1. direct and floatation fecals
2. evaluate for ectoparasites

Strongly Recommended

1. veterinary examination
2. CBC/blood chemistries
3. Paramyxo-viral titers for viperids, incoming after being quarantined for 30 days
4. full post-mortem examination and histopathology on all specimens dying while in quarantine

Fish

General Comments: Quarantine standards for other zoo and aquarium animals cannot always be applied to fish, and adaptations must be made to the proposed procedures as they apply to fish populations. Proper and appropriate fish quarantine is a vital component of any successful health management program for fish. Quarantine procedures must be tailored to individual species and require greater variation than quarantine for other zoo and aquarium animals. It is in the interest of accredited institutions to carry out quarantine procedures that are both effective and practical, leading to improved animal health.

Fish are usually acquired as populations, not as individual specimens, and individual identity may be impractical to establish. Few aquariums have the facilities and/or space to properly maintain large fish specimens in separate life-support systems, making individual quarantine of these specimens difficult. Aquariums may operate as open or semi-open systems, and specimens acquired from the surrounding waters of these institutions may not benefit from rigid quarantine procedures due to the constant introduction of potential disease organisms. Veterinarians may be part of the team supervising quarantine, but the institutions should appoint staff it feels has the best expertise to supervise and operate the quarantine program. It is appropriate to note that state and federal fish hatcheries do not often employ veterinarians, yet have well-established and internationally recognized fish health programs of which quarantine is an important factor.

Specific recommendations:

Quarantine Facility: Where appropriate, separate life support systems (LSS) with the ability to quarantine fishes should exist. The LSS should be operated in such a way as to preclude disease transfer from one system to another and/or introduction into natural waters. Quarantine tanks should have viewing that is adequate to observe fish for behavior and signs of pathology, the LSS should be adequate to maintain the health of the quarantine population. If an aquarium does not have a separate LSS, it should have the ability to divert flow through the quarantine systems, bypass the common filter, and discharge the water. Disinfection of the discharge water prior to release is advisable. In addition, discharge of this water must comply with federal, state and local environmental regulations.

Quarantine Length: A quarantine period of 30 days is an adequate standard; however, it must be recognized that certain species or disease problems may require more or less time.

Quarantine Personnel: The institution will appoint the staff it feels has the most expertise to supervise and operate the quarantine program. All equipment (boots, nets, cleaning equipment, etc.) should be confined to the quarantine area. Access to and from the quarantine area should be restricted so as to minimize cross-contamination. Precautions must be taken to minimize the risk of zoonotic disease to personnel.

Quarantine protocol: Each institution must have a written quarantine protocol. During quarantine, appropriate prophylactic measures should be instituted. Complete medical records should be maintained for the species during the quarantine period. Fish that die during quarantine, or a representative sample thereof, should be necropsied. Care must be taken that all equipment use with quarantined fish is separate from other systems (if this is not possible, adequate disinfection procedures must be employed before equipment is used for post-quarantine fish).

Required quarantine protocol: Due to the great diversity of fish, required quarantine procedures are difficult to establish. The institution should follow the guidelines stated in the above sections to fashion a quarantine program best suited to their needs.

Marine Mammals

All AZA member zoological parks and aquariums should have a quarantine program for new marine mammal arrivals at the institution. A facility should be available which can provide for the isolation of newly acquired marine mammals in such a manner as to prohibit cross-contamination resulting from physical contact, disease transmission, aerosol spread, waste drainage, or the reuse of untreated water. Ocean pens must be located in a way that prevents the spread of any disease from animal to animal through natural water movement and at a distance from other penned animals deemed adequate by the supervising veterinarian. If a receiving institution does not have appropriate isolation facilities, the staff should arrange for quarantine at an acceptable alternate site or only receive animals that do not require quarantine. More stringent local, state or federal regulations relating to marine mammal quarantine take precedence over these recommendations.

Isolated practices should be instituted based on the prior medical history of the newly arrived animals. Those situations where isolation is recommended would have one or more of the following characteristics:

1. Recently collected (less than 30 days prior to arrival).
2. Recently exposed to a new arrival for which an adequate medical history is not available (less than 30 days prior to arrival).
3. Lack of a documented medical history.
4. Apparent medical problems at the time of arrival.
5. At the direction of the supervising veterinarian.

Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). If during the 30-day quarantine, additional marine mammals are introduced into the isolation facility, the 30-day period must begin again for all animals already in quarantine and exposed to the new arrivals.

Attendants should be designated to care only for quarantine animals or to attend to quarantined animals only after fulfilling their responsibilities for resident species. Attendants provided with quarantine clothing and washing facilities designed to prevent disease transmission may be allowed to attend to non-quarantine animals after working with quarantined specimens if approved by the supervising veterinarian. Equipment used to feed and clean animals in quarantine should be used only with those animals or should be thoroughly cleaned and disinfected, as designated by the supervising veterinarian, before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal personnel to zoonotic diseases that may be present in newly acquired animals if the attending veterinarian deems that such risk exists. These precautions should include using disinfectant footbaths, wearing appropriate protective clothing, and minimizing physical contact.

During the quarantine period, certain prophylactic measures should be instituted with some species. Individual fecal samples should be collected, if required, at least twice during the quarantine period, and examined for gastrointestinal parasites. When indicated, treatment should be prescribed by the attending veterinarian. Successful parasiticide therapy may or may not be necessary prior to removal of the animal from quarantine. This determination should be made by the attending veterinarian based on the potential for contagion. Where indicated, the animals should also be evaluated and treated for ectoparasites.

In those species for which vaccines are available and recommended, vaccinations should be given as appropriate. If the animal arrives without a vaccination history, it should be treated as an immunologically naive animal and given an appropriate series of vaccinations. Whenever possible, blood should be collected and sera banked. Either a -70°C freezer or a -20°C freezer that is not frost free should be available to store the sera. Such sera can provide an important source for retrospective disease evaluation.

Where desirable, the quarantine period may present opportunities to permanently identify unmarked animals. A complete physical examination should be performed during entrance into and prior to exit from quarantine.

Complete medical records should be kept and be available on all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed on them under the supervision of a veterinarian, and representative tissues should be submitted for histopathological evaluation.

Following are recommendations and suggestions for appropriate medical procedures to be performed during or immediately prior to the quarantine period, by animal group:

Cetaceans

Required

1. CBC/sera chemistry panel
2. physical examination

Recommended

1. direct and floatation fecal examination
2. urinalysis
3. blowhole and stool culture and cytology
4. blood zinc levels

Pinnipeds

Required

1. CBC/sera chemistry panel
2. physical examination

Recommended

1. direct and flotation fecal examination
2. urinalysis
3. morbillivirus titer
4. leptospiral titer
5. heartworm test (if appropriate)
6. stool culture and cytology
7. blood zinc levels

Sirenians

Required

1. CBC/serum chemistry panel
2. physical examination

Recommended

1. direct and floatation fecal examination
2. stool culture and cytology

Carnivores (polar bear, sea otter)

Required

1. direct and floatation fecal examination
2. CBC/serum chemistry panel
3. physical examination
4. vaccination for canine distemper, feline

Recommended

1. urinalysis
2. blood zinc levels

panleucopenia, canine parovirus, and rabies as deemed necessary by the attending veterinarian

Additionally, others have made initial inquiries about regulations for vertebrate quarantine. It is anticipated that the above regulations will be changed and updated as new findings refine our knowledge of disease transmission and testing, and thus, appropriate quarantine protocols.

APPENDIX 6: ZOO PERSONNEL HEALTH PROGRAM RECOMMENDATIONS, AMERICAN ASSOCIATION OF ZOO VETERINARIANS (AAZV) INFECTIOUS DISEASES COMMITTEE

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I. INTRODUCTION

A personnel health and preventative medicine program for zoological parks, aquariums and wildlife personnel has a 3-fold purpose:

1. To protect human health (employee and public).
2. To protect the health of the animal collection.
3. To comply with legal and ethical institutional standards on a federal, state and local level.

It should be included as one of several important components of an institution's basic Occupational Health and Safety Program^{3,25,29} designed to promote the health and well-being of its' employees.

Persons working with captive or free-ranging wild animals, domestic animals, or in animal facilities are at increased risk over that of the general population in one particular area (aside from the obvious physical dangers inherent in working with animals) - exposure to zoonoses. Zoonotic diseases or zoonoses are defined as those infections and infestations shared in nature by humans and other vertebrate animals. These include viral, bacterial, protozoal and other parasitic infections. There are over 200 different zoonotic diseases known to date which are transmissible under various conditions. It is therefore vitally important that those people working with animals or animal tissues are made aware of the most common zoonoses likely to be transmitted by the species they work with and the means for preventing and/or minimizing their transmission.

The first step in developing a health program is to identify a core group of individuals best equipped to handle the different health related and legal issues which may arise. This network of people may include, but is not limited to: the institution's director or his or her representative, the zoo veterinarian, a consulting physician or human medical advisor, a public health representative, the institution's attorney, the personnel officer, a union representative, a bio-safety officer, a representative from the emergency room of the hospital most likely to be used, and/or any others deemed appropriate to the situation.

The hospital and emergency room facilities to be used by the zoo should be designated before an emergency or health situation arises. They should be selected not only on the basis of convenience and location, but on their ability to handle problems often unique to the zoo community, for example, venomous snake bites, nonhuman primate bites (Herpes-B), and M-99 or other dangerous drug exposures. As part of a complete occupational health and safety program, protocols for dealing with these and other specific situations should be formulated and in place before the need arises (see examples, Attachment I).^{3,6,9,25} The consulting physician(s) and emergency room/hospital staff involved should be provided with these protocols and become familiar with them beforehand to insure the most expedient and best possible care.

The consulting physician or medical advisor is preferably someone with a sound knowledge of zoonoses and infectious diseases and some background in occupational health and lab animal (nonhuman primate) medicine. He or she should be made aware of the types of animals in the institution's collection, the secular problems that might

be associated with them, and the established protocols for dealing with them as mentioned above.

The personnel health program including vaccination and T.B. testing schedules, physical exams and treatment protocols is ultimately based on the consulting physician's recommendations and is subject to his or her approval. It is therefore in the institution's best interest to have well established lines of communication, especially between the zoo veterinarian and the consulting physician, to ensure exchange of most recent zoonoses and treatment information as it becomes available.

The guidelines provided in this report pertain specifically to one aspect of a zoonoses prevention program, the personnel health program. They serve as a review of the most current recommendations drawn from state and national health organization protocols as well as those of individual facilities with successful programs.^{1,2,3,4,6,7,29} They are provided with the understanding that individual institutions may want to modify the guidelines to conform to their own needs based on the types of animals they house, the number of employees involved, local and state regulations (e.g. serum banking at the facility) and their own financial capabilities.

II. ELIGIBILITY & ORGANIZATION

The extent of medical procedures and surveillance included in an individual employee's health program is based on the type and extent of animal contact he or she will have. This includes exposure to the animals themselves, their viable tissues and/or body fluids, and wastes. It is recommended, therefore, that the personnel department devise a categorizing system based on animal contact that it can apply to all employees. This system will then help determine the level of participation in the health program required by each employee. A very basic breakdown of animal contact categories is provided in Table I.

TABLE I
Physical Exam Categorization

Code	Type of Animal Contact
1	Small Animal (rodents, lagomorphs, etc.)
2	Large Animal (canids, felids, hoofstock, ursids, etc.)
3	Nonhuman Primates (marmoset, monkeys, apes, etc.)

Some institutions may want to categorize even further, for example: Great ape vs. other nonhuman primates, hoofstock vs. carnivores, etc., depending on their collection. Further categorization based on frequency of animal contact is also advised, for example: occasional (2 days per month), infrequent (2-4 days per month), regular (once per week).^{1,2,8} This should help determine the level of participation employees such as the director, curators, grounds keepers, maintenance, education staff, interns, administrative/office staff, concession staff, etc., should have in the health program. Volunteers and seasonal staff who handle animals in the collection should ideally be included in the program as well.

A separate high risk category with minimal to no animal contact includes those personnel specifically designed to handle human medical emergencies and/or body fluids. These employees should also be provided with specific training (blood-borne pathogens), be considered for testing (T.B., serum banking), and vaccination protection

(hepatitis A & B) as recommended in the OSHA standards.³⁹

III. BASIC INFORMATION & COMPONENTS

Table II. lists the basic components recommended for a personnel health and preventative medicine program. It also illustrates how the employee coding system discussed in Table I. might be applied to aid in determining which procedures should be required for each employee.

TABLE II
Personnel Health Program Components

Medical Procedure	Participation Level			
	Employee Code *	1	2	3
1. Physical Exam & Medical History		x	x	x
2. Employee Health Education		x	x	x
3. Serum Storage for Reference		x	x	x
4. Serum Storage for Screening:				
- Q Fever			x	
- Hepatitis A, B & C				x
- Toxoplasmosis			x	
- Rabies Titers			x	x
- Measles Titers				x
5. Fecal Analysis:				
- Ova/Parasites		x	x	x
- Shigella, Salmonella, Campylobacter & Yersinia		x	x	x
6. Tuberculin Screening:				
- Annual		x		
- Bi- Annual		x	x	
7. Immunizations::				
- Tetanus Prophylaxis		x	x	x
- Rabies Prophylaxis			x	x
- Measles Prophylaxis				x
- Hepatitis A Prophylaxis				x

- Hepatitis B Prophylaxis			X
- Polio Prophylaxis			X

* See Codes, Table I.

To reiterate, this information should serve as a guide for the institution's medical advisor from which he or she can make more specific recommendations based on the animal collection, frequency of contact, and incidence of disease in that facility or region of the country. Individual components are discussed further in the text that follows.

A. Physical Exam & Medical History

A general physical exam, clinical screening and medical history (including allergy and family health history, work history, vaccination records) should be required of all employees. Ideally it occurs prior to the employee's exposure to animals, their viable tissues, body fluids or wastes (pre-placement exam). The components of the exam should be based upon the functional requirements of the position, the type of animal(s) contacted, and the individual's prior medical history. The frequency of subsequent physical exams is at the discretion of the attending physician but should also be based on medical history, risk of exposure to zoonotic disease or recent illness which may be work related. Recommended schedules for monitoring and boosters of the specific medical procedures listed are included in the appropriate sections that follow. Some consideration should be given here as to how to incorporate personnel employed before the initiation of the health program. This insures that long term employees also have a current health exam and medical history as well as being included in the periodic medical surveillance procedures (vaccinations, serum banking) recommended for the animal contact category in which they fall.

B. Employee Health Education

All employees should be provided with informational materials, standard operating procedures and safety/emergency protocols which may pertain directly to them or their work. The materials should provide important information regarding job-related injuries and reasons for performance of the medical procedures required by the personnel health program. Those with anticipated animal exposure should also be advised of potential zoonotic risks and be given specific zoonoses information and preventive measures which pertain to the type of animal contact they will have (e.g., nonhuman primates and Herpes B). In some instances formal training sessions may be indicated to insure complete communication and understanding of information provided.

C. Serum Collection, Storage & Testing.

There are several common zoonotic diseases which, upon exposure and/or subsequent infections cause a significant rise in serum antibody titers or changes in serum chemistries. These include Hepatitis A, B, and C, Herpes B-virus, Q fever, measles, brucellosis, and toxoplasmosis, to name a few. Protective vaccination titers may also be determined and monitored via serology, namely rabies and measles titers. For these reasons, it is advisable to establish an employee serum bank with protocols for collection, storage, and testing whenever possible.

Before undertaking such a project, however, it is important to note that there has been some controversy over keeping employee serum samples on site at the zoo or other place of employ, including informed consent issues regarding tests to be run on samples saved. It is therefore recommended that the personnel department, employees' union, consulting physician, and the institution's attorney(s) be consulted in this regard prior to start of an employee serum bank to help define the best location and any confidentiality issues. Some state regulations may actually prohibit serum banking on site.

1. Serum Collection

A minimum of 10 ml of blood (5 ml serum) should be collected and processed by a licensed phlebotomist or other

individual specifically trained in handling human blood samples. Serum is separated and stored as advised below. Recommended sampling times include:

- a. At the pre-employment physical,
- b. During the report of a bite or scratch injury,
- c. During the report of an illness that may be job related (if advised by consulting physician),
- d. During periodic vaccination or disease titer monitoring (usually every 2 to 5 years; e.g., rabies titers, toxoplasmosis, Q fever).

2. Serum Storage

All serum samples should be allocated into appropriate storage vials, labeled with the employee's name, date of collection and any other pertinent storage and identification information. It should be frozen at 20°C for 24 hours, then transferred to an ultralow freezer set at -20°C or lower (-70°C) for long term storage. It is recommended that pre-employment samples be stored for at least as long as the person is employed at the facility. Subsequent specimens should be kept for at least two years. These may become useful in estimating the dates of infection in the face of an outbreak or may be used as "acute" sera following possible B-virus or other disease exposure.

3. Serum Testing

The type and number of tests performed on the serum samples is left to the discretion of the attending physician or medical advisor (with informed consent of the employee in question). It should be based on the type of animal exposure and potential disease resulting from it. All results and information should be kept confidential in accordance with state and federal regulations. Follow-up testing and treatment are also based on the consulting physician's recommendations. More specific screening schedules for rabies titers, Q fever, and toxoplasmosis titers are covered in the appropriate sections that follow.

D. Fecal Analysis

Most sources recommend a minimum of one pre-employment fecal examination for all new employees as a standard screening, including testing for intestinal ova and parasites (*Giardia* and *Balantidium* spp. also), and culturing for *Salmonella*, *Shigella*, *Campylobacter* and *Yersinia* organisms. Note that there is some debate as to the value of doing a one-time examination for diagnostic purposes. Many physicians feel that a minimum of three consecutive exams and cultures are needed for a "valid" test (most of the above mentioned organisms are shed intermittently and may not be picked up on one examination). The decision to include fecal analysis (whether it's one or 3 or more tests) in the pre-employment medical exam is ultimately that of the institution's human medical advisor.

Employees should be counseled in any event to report any illness suggestive of bacterial or parasitic disease, chronic diarrhea, or other gastrointestinal disease especially if they resemble signs or symptoms of infections in the animals under their care (in particular nonhuman primates and reptiles). A series of fecal exams may be recommended at that time to aid in diagnosis and rule out infection.

It should be noted that many reptiles are known to be asymptomatic carriers of certain *Salmonella* serotypes which can cause serious disease in man. Institutions are advised therefore to have specific guidelines for prevention of transmission of *Salmonella* from reptiles to humans available and in use for all staff having contact with reptiles (education, volunteer, and keeper staff.)³⁶ Staff education and compliance with guidelines are vitally important to preventing disease in these cases. All illnesses suggestive of gastrointestinal disease should, again, be reported in exposure situations. Necessity of follow-up diagnostics and treatment can be determined by the consulting physician.

E. Tuberculosis Screening

Tuberculosis is an infection that occurs worldwide and is caused primarily by one of three different organisms: Mycobacterium tuberculosis, M. bovis, or M. avium ("atypical" tuberculosis). Other strains are known, but are much less common. Exposure is primarily via fecal-oral route or aerosolization and inhalation of organisms. M. tuberculosis is the most important cause of human and nonhuman primate tuberculosis, causing progressive pulmonary disease in most advanced cases. Cattle and other livestock species (including deer, elk, bison, etc.) are the primary hosts for M. bovis. Disease does occur in man, however, and occurrence of human M. bovis has shown a direct correlation with prevalence of disease in cattle and livestock in the areas in which its found.^{5,7,19,24}

M. avium causes progressive tuberculosis primarily in avian species, but has been known to infect humans, swine and other domestic and exotic livestock species. Notably, it is emerging as an important secondary infection in acquired immune deficiency syndrome (AIDS) patients. M. avium is ubiquitous in nature and exposure to the agent in immunologically deficient hosts may cause fatal disease. Healthy immunocompetent individuals, however, are at very low risk of infection.^{5,7} Comparative tests specifically for M. avium are not routinely included in a T.B. screening program, but there is some cross reactivity in humans with the PPD skin test which would aid in detection in the event of infection.

This basic information is provided to point out those employees at greatest risk of exposure to tuberculosis organisms - namely nonhuman primate and hoofstock keepers, quarantine and veterinary personnel, immunocompromised individuals and those in areas where animal T.B. cases have been identified. It is recommended that these high risk individuals have a PPD tuberculin intradermal skin test at least annually, and in most instances biannually to screen for tuberculosis. Some physicians are now recommending a 2-step PPD intradermal test for new employees or those not skin-tested within 5 years. This includes retesting again in 1 week if the first test is negative. This may detect those exposures with false negative reactions on the first test.

The specific schedule, type of test, and employees to be screened should be determined by the personnel department and the consulting physician. A tuberculosis screening program flow chart is provided (see Attachment II) as a basic guideline for courses of action based on test results.

The skin test is an indicator of exposure primarily to M. tuberculosis or M. bovis. Follow-up testing (chest x-rays, cultures) is required to determine active infection. The skin test should be administered and checked by a qualified individual.

A positive test result (10mm or greater of induration at 48 hours) can occur with recent exposure, active infection, or BCG vaccination (used to help prevent M. bovis infection in man in some countries and in some high risk research or exposure situations). The medical advisor should then be consulted regarding the next course of action. Chest x-rays are recommended following all positive reactions, and are usually performed on an annual basis thereafter to monitor for signs of active infection. Further testing and treatment are based on the consulting physician's interpretation of results and subsequent recommendations. Note that if active infection is present, the individual is considered contagious until given medical treatment for at least ten days, and appropriate precautions to prevent further exposure should be taken until the infection is under control. (Schaub, personal communication.)

F. Immunizations

Table II. lists the primary vaccinations recommended for employees to render protective titers against the zoonotic diseases indicated.

1. Tetanus Prophylaxis

Clostridium tetani is the etiological agent of tetanus and is found worldwide as a soil microorganism and in feces of animals and man. It infects open wounds and produces a neurotoxin which results in severe, often fatal disease. Immunizations are usually given in infancy or young childhood as part of the diphtheria-pertussis-tetanus (DPT)

combination vaccine series. A separate diphtheria-tetanus (Td) vaccine is recommended for adolescents and adults due to frequent reactions to the pertussis component of the DPT vaccine. A series of three vaccinations with the Td are recommended if no DPT vaccines were received as a child. The first two are given at intervals of 4 weeks apart with the third dose given 6 to 12 months after the second. Booster doses should be given every 10 years thereafter or when a particular tetanus-prone injury occurs in an employee and more than 5 years have elapsed since the last vaccination. Passive immunization with antitoxin is usually reserved for persons with no previous active immunization who have sustained a potentially infection-prone wound.^{6,35}

2. Rabies Prophylaxis

Rabies is a zoonotic disease caused by a rhabdovirus transmitted primarily through contamination of a bite wound by the infected animal's saliva. The virus infects the neurological system and produces progressive, reportedly agonizing and eventually fatal disease. It occurs with variable frequency in wildlife worldwide. State and local authorities can be consulted for information on endemicity of rabies in the natural wildlife of a particular institution's area.²⁶ This will aid in determining potential risk to employees and how extensive a personnel rabies prophylaxis program should be.

Based on current recommendations of the CDC's Advisory Committee for Immunization Practices (ACIP)⁸, rabies pre-exposure prophylaxis with human diploid cell culture vaccine (HDCV) should be provided to the following employees (especially in endemic areas):

- a. Those working directly with the rabies virus.
- b. Those having large animal (hoofstock and carnivore) contact or contact with susceptible animals (mammals) housed primarily outdoors.
- c. Those having direct contact with animals in quarantine.
- d. Those having exposure to potentially infected animal tissues or performing post-mortem examinations on animals with a history of poorly defined neurological disorder,
- e. Those having responsibility for capturing or destroying wild animals on grounds.

Intramuscular and intradermal forms of the Human Diploid cell vaccine (HDCV) for rabies are currently available and render active immunity via production of neutralizing antibodies. Note that the intradermal form of the vaccine is supposedly less painful upon injection, renders strong protection immunity, and is generally less expensive than intramuscular form. It is used for pre-exposure prophylaxis only. Human rabies immunoglobulins (HRIG) provide rapid passive immunity, lasting about 6 months. These are used primarily in a post-exposure situation in conjunction with the intramuscular HDCV vaccines.

The initial rabies prophylaxis series consists of 3 vaccinations given at 0, 7, and 21 or 28 days. Further employee categorization based on potential frequency of exposure will help determine the interval between the primary series and follow-up boosters and serologic monitoring. It is generally recommended that those individuals defined as having frequent exposure (see risk categories, Table 3 of ACIP recommendations, Attachment III) have serologic monitoring every 2 years after the first year of completion of the primary series. Booster doses are then administered to those with inadequate titers at that time. Inadequate antibody titers are defined as serum dilutions of less than 1:5 not causing complete neutralization of challenge virus.⁸ State or local health departments may provide names and addresses of laboratories performing rabies serologic testing if not available through the institution's hospital lab.

Hypersensitivity reactions to rabies vaccination, especially "serum sickness", are rare with the newer HDCV

products, but can occur. All employees receiving booster doses should be questioned and/or observed for type I (immediate) and type III (delayed - usually 2 to 21 days post-vaccination) hypersensitivity reactions. If either of these types of allergic reactions occur the attending physician should be consulted before giving further vaccinations in the series.

Rabies prophylaxis doesn't completely eliminate the need for follow up treatment in the event of rabies exposure, but does greatly reduce the number of injections, convalescent period, and expense incurred. The reader is referred to the ACIP's most recent recommendations for further information on rabies prophylaxis, hypersensitivity reactions, and treatment in the event of exposure.^{8,26,38} Any potential exposure situations should be reported.

3. Measles Prophylaxis

Measles (rubeola) is caused by a paramyxovirus and man is the primary reservoir. It is also one of the most frequently reported viral diseases of captive nonhuman primates and can be lethal. Protection is therefore recommended for all employees working with them, especially women of childbearing years. (Infection in the first 3 months of pregnancy may cause birth defects.)^{6,35}

Vaccination is usually acquired in childhood after 15 months of age as part of an attenuated live combination vaccine providing lifelong measles, mumps and rubella ("German measles") protection (MMR vaccine). All employees working with nonhuman primates and great apes should have documented proof of immunity, including either:

- (a) Those who have written documentation of immunization on or after their first birthday.
- (b) Those with documented laboratory evidence of measles immunity (protective titers).

Serum analysis for protective measles titers is recommended at the pre-employment exam for individuals who will be working with nonhuman primates and great apes. Vaccinations should be initiated if titers are low or if no previous vaccination has been given except under the following conditions:

- (a) Those with a history of anaphylactic reaction to the ingestion of eggs or to topical or systemic administration of neomycin (components of the MMR vaccine).
- (b) Those with significantly altered immunity as the result of various diseases or medical therapy.
- (c) Those with severe febrile illness.
- (d) Those having received immune globulin within the preceding 3 months .
- (e) Those who are pregnant or plan to become pregnant within 3 months of vaccination.^{6,35}

Those in the last 3 categories are eligible for vaccination at a later time or as directed by the consulting physician.

4. Viral Hepatitides: Information and Prophylaxis

There are several clinically similar diseases termed "viral hepatitis" which are etiologically and epidemiologically distinct. They are distributed worldwide and can constitute primarily public health concerns. Hepatitis A (infectious hepatitis), hepatitis B (serum hepatitis), and hepatitis C agents, however, have all been found to also occur in or be experimentally transmitted to some wild and captive nonhuman primates - primarily chimpanzees. Transmission is usually via direct contact (percutaneous or permucosal routes with infected blood, body fluids, etc.) or fecal-oral routes.^{5,7}

Because of the zoonotic potential, those employees who will be working with human medical emergencies or nonhuman primates - especially great apes (chimps), in a zoo, research, or import situation should have specific serologic screening for various hepatitis (A, B, or C) antibodies and/or antigens to assess degree of exposure/protection already present (baseline levels). Serum liver enzyme levels may also be measured in acute or chronic cases of disease to monitor severity.

A recombinant Hepatitis B vaccine should be offered to those individuals not vaccinated before or given immune globulins within the past 3-6 months. This vaccine is a noninfectious subunit viral vaccine produced by yeast cells.²¹ Hepatitis B immunization consists of a series of 3 intramuscular injections given at 0, 1, and 6 months. Immunity against hepatitis B is usually strong and long term following vaccination. Booster doses are not routinely recommended after vaccination unless inadequate titers are documented and protection is known to be required, nor is routine serologic testing to assess antibody levels. Post-vaccination testing for immunity should be considered, however, in the face of an outbreak or for persons at occupational risk who may have needle-stick exposures, etc., which may necessitate post-exposure prophylaxis.^{20,21,35}

A Hepatitis A vaccine is also available. It is an inactivated viral vaccine that imparts lifelong immunity once given. Preexposure immunization consists of 2 doses given 6-12 months apart. It is recommended for nonhuman primate handlers, emergency medical personnel, custodial personnel, and travelers to areas of high endemicity (various Third World countries). This is an important consideration for field researchers as well. The consulting physician can advise on specific endemic areas. Post vaccination testing for Hepatitis A titers is, again, optional unless exposure is suspected. Protective titer levels should be assessed at that time as deemed necessary.

Immune globulins for hepatitis A and hepatitis B (IG, HBIG) are available for short term passive immunity of 3-6 months. These are usually reserved for post-exposure prophylaxis and for international travelers going to endemic areas. The reader is referred to ACIP recommendations for further information regarding viral hepatitis prophylaxis.^{20,21,35}

5. Poliomyelitis Prophylaxis

"Polio" is caused by an enterovirus (Picornaviridae) and affects the neurologic system causing eventual paralysis in most human cases. It has also occurred in both wild and captive chimpanzee groups.^{5,7} All primates appear to be susceptible. See IDC animal quarantine guidelines for primate vaccination information.^{22,31}

All primate keepers should have documented polio protection. Vaccines are usually given in infancy or childhood. It consists of a series of 3 oral vaccines (trivalent oral Sabin vaccine) given at intervals of 0, 2, 4, and 16 months. The adult series is usually given at 0, 6-8 weeks, then 8-12 months later.³⁵

6. Other Vaccines

There are other vaccines available which are not generally recommended for routine prophylaxis, but which may be indicated under certain specific conditions. Some of the vaccines include yellow fever vaccine, hepatitis immune globulins, BCG vaccine, etc. The specific conditions usually involve international travel to endemic areas, exposure to imported animals from endemic areas, or specific research projects which deal directly with disease organisms in question. The CDC should be consulted for information regarding these situations and can advise accordingly as to which vaccinations, treatments, etc. may be appropriate. The institution's consulting physician may also have access to this information and should advise accordingly.

G. Herpes B-virus

Due to the extreme morbidity and mortality of Herpes B-virus infection in humans and its known prevalence in captive macaque populations, mention of special precautions and protocols for handling these animals and any

injuries incurred from them is warranted here. Complete information and guidelines are provided in the Herpes B Report of the AAZV Infectious Diseases Review.³⁷

Herpesvirus simiae (B-virus) is endemic in all rhesus, cynomolgus and other Asiatic monkeys of the genus *Macaca*; but has not been found to be harbored in other Old World or any of the New World monkeys. Humans who work with or care for these animals may be exposed to B-virus through bites, scratches, contaminated needle sticks and other routes. Infection in macaque species ranges from asymptomatic to characteristic buccal or mucosal lesions, while infections in man may vary in severity from mild to potentially fatal. For this reason any facilities handling or housing macaque species are advised to have strict management protocols in place with protective as well as post-exposure procedures well defined. These guidelines should be made available to the consulting physician and emergency room staff so they can become familiar with them. The latest draft of "Guidelines for Preventing and Treating B-virus Infections in Exposed Persons"⁹ is provided in the Herpes B Report noted above.³⁷

It is extremely important that macaque handlers have full knowledge of the potential risks of herpes B-virus and use proper protective measures regardless of how inconvenient and time consuming they may be. This may require an orientation and training program which covers the various aspects of the guideline's risk and safety information and allows time for questions. An attendance roster may even be recommended to document keeper participation.

H. Q Fever Testing and Information

Q fever is distributed worldwide and is caused by a rickettsial organism, *Coxiella burnetti*, found primarily in products of parturition (placenta, amniotic fluid, blood, soiled bedding) of infected hoofstock - namely sheep, goats and cattle. The most common mode of transmission is via inhalation of aerosols from infected placental products and amniotic fluids. This is true for transmission between ruminants, and ruminants and man. The agent can also be transported for some distance by dust particles is fairly resistant in the environment.^{5,7,27} *C. burnetti* has also been found to naturally infect many wild animals, including marsupials, rodents and lagomorphs and appears to be transmitted by tick vectors in these cases rather than aerosolization. No documented transmission to humans has occurred in these instances.⁷

Infection in ruminants and other wild animals is usually subclinical, but may occasionally cause abortions. Infection in man is variable. Incubation averages 20 days, and disease is characterized by rapid onset of high fever, chills, malaise, weakness, severe retrobulbar headache and pneumonitis in some cases. The major concerns with infection, however, are chronic sequelae which can result including endocarditis, pericarditis and chronic hepatitis.^{5,6,7,27} Morbidity and mortality are higher in these cases and proper precautions should be taken to protect those workers at risk.

All employees, researchers, veterinarians and veterinary staff working closely with exotic or domestic ruminants, or who will be exposed to their postpartum products, fetal tissues or their animal products (feces, hides, milk) are considered at risk, especially in endemic areas where nearby domestic cattle and ruminant populations are infected with or carry *Coxiella burnetti* organisms. These individuals should be assessed at the pre-employment or subsequent routine exams for likelihood of developing chronic sequelae should they acquire Q fever. Those with valvular or congenital heart defects, liver disease, or those immunosuppressed or receiving immunosuppressant drugs should be advised of the potential risks and receive medical clearance if necessary. This should be determined on a case-by-case basis and with consideration to incidence of disease in the area.

Serum samples should be saved for baseline Q fever titers. Employees should be instructed to report any clinical signs or symptoms resembling those of the disease mentioned above. Acute and convalescent serum samples are recommended if infection occurs to aid in diagnosis and to follow the clinical course of the disease. Complement fixation tests are most commonly used for diagnosis, but other tests are available. Routine serologic testing may be advised every 1-2 years in highly endemic or high exposure situations. The consulting physician can contact the CDC for further information on treatment and testing centers if none is available locally.

A human vaccine for Q fever is not currently available commercially in the United States. There are several vaccines being studied, however, and some have been shown to give good protection in experimental and occupational settings.^{5,7} They can be obtained under investigational new drug protocols where indicated.⁷ Contact the CDC for further information.

I. Toxoplasmosis Information and Testing

Toxoplasmosis is caused by the obligate protozoan parasite Toxoplasma gondii, an intestinal coccidium of the cat family. It is distributed worldwide. It has a complex developmental cycle in which domestic cats and wild felids serve as the only complete host, usually causing asymptomatic infection and shedding the potentially infective oocysts in their feces.

The T. gondii organism can also infect an unusually wide range of intermediate hosts including man. It has been found in over 200 species of mammals including domestic and exotic species and many types of birds.^{5,7,27} The parasite can only undergo extra-intestinal (incomplete) cycles in these hosts, eventually resulting in resistant cyst (bradyzoites) forms, if the host is susceptible. These cysts can localize in various organ tissues including skeletal or heart muscle, brain, CNS, retinal tissue or fetal tissues in pregnant individuals. Once encysted, they can persist for years or for the entire lifetime of the host. Most infections are transient and subclinical, but myocarditis, splenomegaly, encephalitis, or congenital disease may be observed in severely affected patients.

More specific information on disease occurrence, epidemiology and transmission is provided in several excellent references.^{5,7,27} The important points to bring out regarding personnel health in a zoo or wildlife setting include:

1. Identifying those individuals at risk:

Transmission to humans occurs primarily through contact with or ingestion of sporulated oocysts in infected soil and cat feces, contact with or ingestion of infected animal tissues, or by congenital transplacental transmission. In a zoo setting those at risk would therefore include any individuals exposed routinely to exotic cats or their tissues or wastes, and possibly grounds/horticulture crews who are exposed to highly contaminated soil (from feral or exotic cats).

2. Monitoring exposure and disease via serologic testing:

Demonstration of exposure/infection in cats and other mammals via serum titers is discussed elsewhere.^{22,32} There are also several serologic tests available to aid in diagnosis of human toxoplasmosis exposure and disease.

It is recommended that any female employee of childbearing years who will be exposed to felids or their feces regularly have toxoplasmosis titers determined at the pre-placement exam. Those who lack immunity and plan to work with cats should be informed of their susceptibility and be provided additional information on toxoplasmosis. Serum titers are also recommended in the event the employee becomes pregnant (first trimester). Job reassignment should also be strongly considered during the pregnancy due to potential risks to the unborn fetus if toxoplasmosis titers in the employee are at pre-exposure levels.^{6,29}

Immunocompromised individuals or those on immunosuppressive drugs are also at greater risk of infection and should inform their supervisor of their condition. Serum titers are recommended in these cases as well to monitor exposure. Further monitoring and testing are done on an individual basis at the discretion of the employee's personal physician or if recommended by the institution's consulting physician.

IV. WORK - RELATED INJURIES AND ILLNESS

Employees should be strongly encouraged to promptly report all suspected work-related injuries and illnesses to their supervisors. A logbook for recording these incidences should be kept by the supervisor or personnel department and include such basic information as name of individual, type of animal involved, time, date, circumstances, severity of injury, medical treatment, follow-up care, etc.

Injuries resulting from direct animal contact (bites, scratches) are of particular interest due to potential concomitant infections, several of which have already been mentioned (tetanus, B-virus, etc.). Wounds should be evaluated and treated under supervision of the consulting occupational health physician. Blood samples for serum evaluation as well as other specific tests may be indicated at the time of the injury to monitor disease depending on type of animal exposure.

Employees should also be counseled to report any gastrointestinal, respiratory or dermal illness which may resemble signs or symptoms of infections in the animals under their care. The consulting physician can then determine whether follow-up testing or treatment is required.

Work related allergies are also known to occur and employees should report these as well. They should again be advised to seek medical evaluation and treatment when needed.⁶

As mentioned previously, immunocompromised individuals or those on immunosuppressive medication can be at increased risk of contracting infectious diseases if exposed. For this reason these employees should also be advised to inform their supervisors of their current condition so that appropriate precautions and/or temporary job reassignment can be considered if deemed necessary.

V. VETERINARY DEPARTMENT SAFETY

In addition to zoonotic diseases and M-99 or carfentanil exposure, there are a variety of other safety hazards to be aware of in most veterinary hospitals. These hazards include exposure to vaccines and biologic agents, drugs and dangerous chemicals (for example, ethylene oxide), anesthetic gases, radiation, pesticides, physical hazards and infectious laboratory specimens and wastes. References are available for further information.^{27,28} Safety protocols should be in place (eg:M-99, carfentanil) where applicable and should be provided to the emergency room staff and consulting physician for review as well.

VI. CONCLUSION

It is beyond the scope and purpose of this text to elaborate further on the multitude of zoonotic diseases not yet mentioned which may be a potential threat to zoo employees under certain circumstances. There are numerous excellent resources available which give much more detailed information, especially regarding viral zoonoses in primates. (For further reading refer to references: 5, 7, 10, 12, 13, 14, 15, 16, 17, 18, 23, 30, 31, 33, 34.) The CDC can also be consulted for further information on specific diseases in question.

Prevention of disease and injury is the key to maintaining healthy animals and minimizing risks to humans in any zoo or laboratory setting. An active personnel health program is an integral part of that prevention. When used in conjunction with sound husbandry and management practices, including strict quarantine, personal hygiene, record keeping, and keeper education practices, protection of man and animal from disease will be maximized.

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Toledo Zoo

Guidelines for Handling Etorphine/Carfentanil

1. Only the veterinarian/trained animal health technician will handle the agents. Only the veterinarian will administer the agent.
2. Review and adhere to all legal restrictions regarding ordering, storage, inventory, record keeping, and disposal.
3. Review accidental exposure protocol (keep in immobilization bag) with appropriate personnel before handling the agents. The accidental exposure emergency kit should be readily available & stocked with in date Naloxone (NARCAN).
4. All personnel involved in the immobilization should be made aware of the potential dangers. All unnecessary personnel should be directed away from the immediate vicinity.
5. **NOTIFY THE EMT ON DUTY** before beginning the immobilization. He will be on standby with your trained staff for the entire procedure. If no EMT available, contact WALKER AMBULANCE, phone# 244-9511 for standby (contact Al Fink).
6. **ALWAYS WEAR GOGGLES or FACE SHIELD and ALWAYS WEAR ONE OR TWO PAIRS OF GLOVES** while handling the agents, firing, retrieving, & cleaning the darts. Have running water available.
7. Dart loading, firing, retrieval & clean-up should be done slowly & methodically. Minimize interruptions. Keep necessary staff out of projectile & potential spray paths.
8. Treat all guns, darts, syringes as loaded firearms.
9. Used darts should be immediately retrieved by the veterinarian in protective gear, and should be properly disposed of, or stored in a labeled container.
10. Clean up should be done immediately after the immobilization, with trained standby personnel. Depressurize all darts before cleaning them. Use pliers to remove needles. Wear protective gear. Triple rinse all empty drug bottles before disposing of in sharps container.
11. EMT/AMBULANCE standby should be informed when procedure & clean up are completed.

Toledo Zoo
**Accidental Etorphine/Carfentanil
Human Exposure Protocol**

1. If exposure occurs, do not leave patient unattended. EMT or ambulance personnel on standby should be notified.
2. If medical personnel are unavailable call for help. Radio Z-1, inform them that a medical emergency has occurred & have them arrange for medical transportation. Continue to monitor radio to give further information.
3. While waiting for medical backup, observe patient for clinical signs of drug exposure (loses consciousness, unable to walk or talk, etc.) Monitor pulse and respiration rates.
4. Lay victim down on ground on his side. Loosen collar and belt.
5. Have the accidental exposure emergency kit & oxygen tank ready.
6. Get cool water. Flush narcotic-exposed areas (oral, ocular, dermal) with large amounts of water.
7. If victim is awake & talking, observe only.
8. If victim becomes symptomatic (loses consciousness, unable to walk, talk, etc.)
ADMINISTER NARCAN:
 - a) Establish IV access, using IV catheter from emergency kit if possible. If IV access not immediately available give NARCAN dose (see below) IM into shoulder or thigh.
 - b) Give 10 mg NARCAN immediately IV or IM is victim if unconscious.
 - c) Continue giving 2 mg IV every 3 to 5 minutes until regains consciousness. Multiple doses may be required.
9. Check & clear airway of obstructions if unconscious. Administer CPR if indicated.
10. Transport to the hospital via hospital.
11. This Emergency Protocol, narcotic drug information, information on amount & route of drug exposure, doses/routes of NARCAN given, all unopened NARCAN vials should accompany the victim.

APPENDIX 7: AMERICAN ZOO AND AQUARIUM ASSOCIATION (AZA) GUIDELINES FOR ANIMAL CONTACT WITH THE GENERAL PUBLIC

**Submitted by the Animal Health Committee
Approved by the AZA Board, 1997
R. Eric Miler, DVM, Dipl. ACZM
Chair, 1992-1996**

Nearly every contact with other living organisms, whether it be with human or other animals, carries some risk of disease transmission. Diseases that are spread from animals to humans are called zoonoses (adj. = zoonotic disease). Responsible zoos should and do make reasonable attempts to limit the risk of the spread of disease from the animals in their care to their employees and to the general public.^{4,9} For the general public, the risk of contracting disease from most zoo animals is minimal to nonexistent due to their distance and isolation from the animals. However, contact areas for the general public can present increased risks that can be controlled with reasonable precautions. For this paper, contact areas refers to those areas in which there is direct physical contact between animals and people. These precautions are most effective when they are part of an overall preventive medicine program for the zoological park.^{5,8}

Risks of zoonotic disease can be markedly reduced by avoiding direct animal contact. However, this forgoes many valuable educational experiences and the establishment of a direct relationship between animals and the public. A reasonable alternative is adequate hand washing for those in whose direct contact with the animals is touching. Hand washing is perhaps the single most effective personal hygiene procedure for reducing the risk of infection.⁴ Given that fact, all areas in which the public has direct contact with animals should have access to hand washing facilities that are in the immediate vicinity of the contact (or an equivalent, e.g., bactericidal hand-wipes).

As outlined by the AZA and the USDA 's Animal Welfare Act, animal contact areas should always be supervised by a trained zoo representative. Obviously, animals that are ill, should not be used. Human food consumption should not occur in the immediate area of contact. Additionally, zoological institutions should be aware that the Centers for Disease Control (CDC) standards advise additional precautions may be necessary for humans that they classify as at increased risk of disease, including those that are immunocompromised. When a reportable disease is identified, all appropriate local, state and federal regulatory officials should be contacted.

More detailed information on zoonotic diseases may be obtained from a variety of veterinary and medical textbooks and journals,^{1,6} and from public health officials. Additionally, the AZA 's Quarantine Protocol provides further testing recommendations.⁷ Also referenced at the end of this report is a review of some of the risks associated with animals and immunocompromised humans.³ Following is a list of disease considerations and control programs recommended for animals commonly used in contact programs. Depending on the disease and history of the animals, testing protocols may vary from an initial or incoming quarantine test, to yearly repetitions. This protocol should be at the discretion of the institutional veterinarian.

Reptiles and Amphibians

Most notable among the disease risks presented by reptiles is the transmission of *Salmonella* sp. Salmonellosis is a common and often nonpathogenic infection of reptiles (in one survey, according to species, the infection rate ranged from 3% to 55%).² Diagnosis may be difficult. A cloacal swab or other sample positive on culture for *Salmonella* sp. is diagnostic for infection. However, due to intermittent fecal shedding of these organisms, false negative cultures frequently occur. So it is difficult, if not impossible to ascertain with certainty that an animal is *Salmonella* "negative." Therefore, all reptiles should be treated as salmonella carriers. Attempts to eliminate *Salmonella* carriers with antibiotic therapy have been unsuccessful and may be contraindicated as they can lead to chronic carrier states and increased resistance of these bacteria to antibiotics. Risks of transmission can be reduced

in two ways: 1) avoid all direct contact with reptiles or surfaces with which they have come in contact, or, 2) allow only supervised contact followed by hand washing as previously described.

Reptiles can also transmit a variety of other organisms, mostly gastrointestinal in origin, and the same procedures described above should be effective in reducing the risks of transmission to those in contact. These other risks include other gram negative bacterial infections. Reptiles used in contact areas should be free of snake mites and pentastomids (e.g., *Armillifer* sp.).

Amphibians may present several of the same zoonotic risks as reptiles, so again, contact should be followed by hand washing.

Birds

Birds used in contact areas should be free of chlamydiosis and zoonotic parasites (e.g., giardia). Chlamydiosis testing is appropriate for members of the orders *Psittaciformes*, *Galliformes*, and *Columbiformes*. As in reptiles, salmonellosis can be present and difficult to diagnose and so, birds should be treated as suspects. In the general human population, avian tuberculosis is generally considered to have very low zoonotic potential, however, it can present significant risks for immunocompromised individuals. Care should be taken to avoid public contact with known infected flocks.

Mammals - General

All mammals are considered at risk for infection with rabies. Current rabies vaccines are licensed for use in only 6 domestic species: dogs, cats, ferrets, sheep, horses and cows. For wild-caught individuals of most species, a prolonged (3-6 month) quarantine is necessary to reduce the risk that they are infected with the virus. Even then, some species, such as skunks, foxes, raccoons and bats may still represent a greater risk.

Any skin lesions compatible with dermatomycosis (“ringworm”) should be carefully evaluated in order to prevent transmission to those in direct contact with them.

Mammals - Primates

Unless extensive testing has been performed for a variety of viral, parasitic and bacterial diseases, all direct public contact with primates should be avoided. Public contact also places the primates at considerable risk of contracting diseases from humans.

Mammals - Small Ruminants/Neonatal Ruminants

All small ruminants, e.g., pygmy goats, sheep, dwarf cattle, llamas, etc., that are greater than 6 months of age and used in contact areas should be tested for tuberculosis, brucellosis and leptospirosis. Obviously any animals with lesions compatible with sarcoptic mange (mange mite = *Sarcoptes scabiei*) should be removed from contact. Any animals with lesions compatible with contagious erythema (“orf” in man) should be tested and removed from contact until proven negative. Calves should be checked and found free of *Cryptosporidium* sp. and other infections with protozoa. Other diseases of a potential zoonotic nature include infection with *Coxiella burnetii* (Q-fever) in endemic areas. Additionally, recent reports indicate that infection with Johnes disease (*Mycobacterium paratuberculosis*) may present zoonotic concerns, primarily in goats.

Mammals - Swine

These animals should be checked for gastrointestinal infection with *Balantidium* sp. efforts made to control this

infection. Additionally, consideration should be given to regular vaccination for the bacterial disease, *Erysipelothrix rhusiopathae* (“diamond skin disease”).

Mammals - Small Carnivores

In general, due to the potential for bites, small carnivores should be used in contact areas only with extreme caution. Due to the risk of bites, small felids are generally not used in direct contact. If they are, care must be taken that such animals are negative for infection with *Toxoplasma gondii*. All carnivores should be tested for and be free of zoonotic species of roundworms such as *Baylascaris* sp. Small carnivores (e.g., raccoons and skunks) obtained from the wild may present a greater risk of rabies and their use should be avoided in contact areas.

Mammals - Rodents and Lagomorphs

When using rodents and lagomorphs in contact areas, consideration should be given to the risk of bites, past history and exposure to hantavirus, salmonella and tularemia.

Mammals - Chiropters

At the present time, CDC regulations effectively prohibit the use of bats in direct contact areas.

Fish/Aquatic Tanks

Due to the potential for infection with atypical mycobacteria, *Vibrio* sp., *Erysipelothrix rhusiopathae* and variety of gram negative bacteria, contact with fish or touch tanks should also be followed by hand washing.

Summary

It is important to evaluate the risks of zoonotic diseases in a rational context. Contact animals can provide a valuable educational experience for visitors and participants in public programs to zoological parks and aquariums. Most zoonotic diseases of concern in public areas can be prevented with reasonable testing and quarantine programs and proper hand-washing techniques.

These are intended to be general guidelines and the risk of diseases can vary by area, so each zoological institution should develop its own zoonoses control program. Two excellent resources for reviewing testing and preventive procedures for many of these diseases are the American Association of Zoo Veterinarians' *Infectious Disease Notebook*,¹ and the American Veterinary Medical Association's *Zoonoses Updates*.⁶ In summary, the most effective method for disease prevention is a complete and thorough veterinary program and common sense sanitary measures.

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APPENDIX 8: AMERICAN ASSOCIATION OF ZOO VETERINARIANS (AAZV) GUIDELINES FOR POST-GRADUATE TRAINING PROGRAMS IN ZOOLOGICAL MEDICINE

Approved by the American Association of Zoo Veterinarians Board, 1996

Post-graduate training programs are an integral part of the education of specialists in zoological medicine. Given the importance of these programs, the following are the recommendations that the American Association of Zoo Veterinarians has made regarding various features that should be available in such training programs. For the purposes of this document, internships are defined as one year programs that are available to either new or experienced veterinary graduates. Residences are 2-3 year programs available to those that have had additional clinical experience since graduation from veterinary college.

The primary focus of a post-graduate training program should be education. This aspect of the program should be broad-based and include the following components. The trainee is participating in order to gain clinical experience, so at the minimum, the training institution should have at least one full-time veterinarian with a minimum of 5 years experience (100% time) in the practice of zoological medicine. Although part of a clinical training program is gaining experience, the trainee should always have access to a staff veterinarian for advice and consultation. The veterinarian should be assisted in aspects of the program by other experienced zoo professionals (curators, and when available, behaviorists, nutritionists, pathologists and researchers). To provide broad-based experience, the institution should have or have access to a variety of taxa, orders and species of animals.

It is highly recommended that a post-graduate training residency program be affiliated with an academic institution. Obviously, veterinary colleges are the most appropriate choice, but medical colleges and local biology faculties may also offer opportunities for academic input. Additional educational opportunities in the areas of formal classroom work, regularly scheduled journal clubs and seminars should be strongly considered.

A veterinary facility should exist that meets the minimal standards of the AAZV Guidelines (published earlier in this report).

Salaries of post-graduate positions should minimally be commensurate with those offered to interns or residents at the veterinary college(s) in the state or region.

Additional guidelines that allow post-graduate training programs to meet the standards of the American College of Zoological Medicine can be obtained from the Secretary of that organization (name and address available in the American Veterinary Medical Association [AVMA] Directory).

APPENDIX 9: PEST CONTROL IN THE ZOOLOGICAL GARDEN

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INTRODUCTION

Pests in the form of insects, rodents, nuisance birds and certain mammals are common in zoos due to the ready availability of shelter, food and water. Despite the prevalence of pests in a zoological garden, the ways in which a zoo chooses to confront the problems are as variable as the types of pests. Some zoos would seem to give very little attention to the matter of pest control, while others direct a great deal of effort to the problem but may have little apparent success. It is interesting to note that the *Zoological Park and Aquarium Fundamentals*, published in 1982 by the American Association of Zoological Parks and Aquariums (AAZPA), does not really address the topic of pest control in any organized fashion, nor is pest control a frequent topic at regional or national zoo conferences. Ignoring the presence of unwanted pests detracts from the visitor experience, increases operating costs due to physical damage and food waste, and presents a real threat to the health and welfare of the animal (and plant) collection as well as those of the employee and visitor.

Attention to sanitation and proper storage and removal of refuse and solid waste are important first steps when tackling pest control. Using the basic principles of pest control, one must appreciate the uniqueness of implementing these control procedures in a zoological garden. A successful control program must combine a thorough knowledge of both the biology of the pests in question and the effects of any proposed control methods on not only the pests, but also on the zoo's animal collection, the employees and visitors.

This article is provided in hope that it will stimulate the reader to review his/her institution's pest control program and assist in implementing or improving such a program.

AN ASSESSMENT - HOW TO APPROACH A COMPREHENSIVE PEST CONTROL PROGRAM

Identifying the Problems

The easiest way to identify pest problems at a facility is to ask the employees. Employees represent the eyes and ears of an organization, and can easily identify the location and severity of infestations. As noted above, pests are not only a public relations, but also represent waste of financial resources and create potential health hazards for the visitor, employee and zoological specimens. Once the problems have been identified, plot them on a map of the facility. In this way, pest problems common to many of the areas and buildings can be identified as well as those problems unique to certain areas or buildings. The pest control program can then be designed to provide a regular service that will keep the common problems under control, as well as devise specific approaches to combating the unique pest problems.

Identifying Outside Expertise

Some pest control companies have the expertise to evaluate problems and make specific recommendations for controlling and preventing pest problems at a zoological facility. However, because of time constraints and economics, rarely can these companies devote the kind of time required to fully develop such a program. A few consultants are available in private industry who have had experience specifically with zoological parks. Most are

members of the National Pest Control Association located in Vienna, Virginia. Personnel of some of the large zoological gardens might also be available to lend assistance in developing a comprehensive zoo pest control program.

Who Will Do The Work

The most cost effective, secure and controlled way of implementing a pest control program is by utilizing in-house staff to perform the work. Pest control firms often find themselves at a disadvantage when it comes to performing pest control and prevention procedures in a zoological garden. Some areas to consider are:

- 1) In-house staff know every nook and crevice of the facility. They generally are long-term employees who consider the safety of the animals and their habitats first. The person or persons chosen to carry out the applications of chemicals, because of their involvement with the health of the animals, would tend to be conservative in their approach to pest control and not use materials or devices with which they might be unfamiliar, thus putting the collection at risk.
- 2) Outside pest control firms generally experience turn-over problems and, as a consequence, lack personnel adequately trained for the type of problems commonly encountered in a zoological garden.
- 3) Having an inside pest control operator(s) on staff perform chemical applications enables the facility to have direct supervision over this individual(s) and participate more fully in the program.
- 4) Knowing the zoo employees will assist the in-house applicator in maximizing his control effort.

Some further considerations to be aware of when using in-house staff to provide an effective pest control programs are as follows:

- 1) The individual must be certified by the state in order to purchase and use certain Restricted Use Pesticides for the control program. The testing to gain certification requires technical expertise with respect to the handling and use of chemicals. A person may have to be hired away from a pest control firm for the position of pest control operator for the facility.
- 2) Specific insurance to cover the application of Restricted Use Pesticides must be obtained by the facility in many states in order to fulfill the requirements of certification.

A Safe and Effective Plan

Implementation of a pest control program in a zoological garden poses many unique problems. One must attempt to control pest populations in and around exhibits without harming any of the exhibit specimens. One must consider primary toxicity of the materials used as well as the secondary effects. Not only can the exhibit specimens be poisoned directly by coming in contact with residual deposits, but they may eat insects that have ingested chemical or experienced external contamination. One must consider cumulative dosages arising from the ingesting of carcasses. For instance, there are studies, both in-house and in the field, which indicate that Talon (brodifacoum) extremely toxic to birds, particularly birds of prey. For example, in Malaysia on oil palm plantations, where owls are encouraged through provision of nest boxes, sharp declines in owl numbers were observed on estates where rodenticides such as Talon were used to counter warfarin resistance. The decline of barn owls in the British Isles over the last ten years is also being blamed on secondary poisoning from the newer, single dose anticoagulant rodenticides.

Developing the Plan

The goal of a pest control program in a zoological garden is to bring current populations of pests down to acceptable levels and then maintain those levels through a plan which incorporates a weekly, regular routine for servicing the various buildings and areas of the establishment. In the initial phase of the program, some buildings, because of their heavy pest problems, will require a concerted effort in “cleaning-out” the populations. Such a clean-out could entail setting up a mechanical trapping or toxic baiting program for mice coupled with a heavy treatment for both small and large cockroaches. A repeat treatment may be required 2-3 weeks after the initial treatment. After the initial phase, which may require up to 6 months to complete, each building and area will be put on a schedule to enable the keepers and curators at each site to prepare for a regular pest control visit. For instance, the reptile house could be treated every other Thursday morning, the rare mammal house every Thursday afternoon, the bird house on Monday, Wednesday and Friday afternoons, etc. Where the public might interfere with a certain pest control operation, this application could be scheduled at a time when the public is not allowed into the zoological garden proper. Once the schedule has been devised and printed, it should be disseminated to all concerned.

Developing a pest control program for a zoological garden requires the input of management, curatorial staff, the exhibit design personnel, keepers and the sanitation department. Each pest problem must be fully documented for the entire establishment. Concerns of each group and situation unique to particular buildings or exhibits must be discussed fully and everyone made aware of what is being proposed. It must be agreed that the pest control department will implement the entire program, and that individuals in various departments cannot be allowed to alter or supplement the program with do-it-yourself pest control measures. If a conflict of opinion arises, this must be discussed openly and candidly before implementation of any chemical control measures.

As previously stated, the responsibility for the pest control program must lie in the hands of very few people. Management should have direct supervision over the pest control program and personnel. Each facet of the program must be fully discussed before implementation. Chemical storage, inventories, safety procedures, and application technique must be reviewed before the pest control department can be charged with the responsibility of these areas of the program. Every conceivable contingency should be discussed with knowledgeable individuals prior to implementation of the plan. Each department must have confidence in the pest control personnel and plan before actual implementation. By reviewing all aspects with every department, zoo personnel will have many opportunities to question the propriety of the plan and address specific concerns.

Personnel directly responsible for the implementation of the pest control program must be knowledgeable in all phases of pest control operations. In order to maintain efficiency, management must recognize that these individuals must regularly attend workshops pertaining to professional pest control. As previously discussed, these individuals must be certified and maintain their certification requirements by attending updates and technical workshops. In addition, management might wish to provide subscriptions to professional pest control trade journals and have a number of references available in the library pertaining to pest control operations. A list of references and journals can be found in Table 1.

PHILADELPHIA ZOO ' S PEST CONTROL PROGRAM

Influence of the Surroundings and Physical Plant on Our Program

Our pest problems are to some extent a consequence of our setting - in a park in a large urban area - and a consequence of our heavy visitation - over one million people each year. For example, cockroach egg cases can be inadvertently carried in by the public. The large number of deliveries bring in not only cockroaches but also mice. The lake and stream within the Zoo itself create ideal environments for rodents to live and breed. Our locations near some major rivers makes us a frequent stop-over for several species of waterfowl as well as gulls. As in any urban area, pigeons abound if not controlled. Being bounded on one side by a major railroad thoroughfare creates occasional problems from cats and dogs. And the park-like setting of the Zoo creates pressure from raccoons and opossums.

The physical plant itself may have a serious effect on the prevalence of unwanted pests as well as act to impede immediate and efficient control of pest problems. Older facilities, especially those being poorly maintained, are more challenging. It is important to note that whether designing new exhibits, whole buildings, food facilities, etc., some attention should be given to the question of pest control and build it into the design rather than deal with what often proves to be a more difficult problem after the fact.

The pests of the Philadelphia Zoo are not unlike those found in any large metropolitan zoo. When the pest control program was first put into effect, rats could be found in the waterfowl outdoor exhibit areas. Mice were rampant in many buildings, particularly the bird house and the commissary. The pigeon population numbered approximately 1,800 birds. Cockroaches found in the buildings represented six different species. Ants were a problem in some of the houses, particularly in the reptile and bird houses. Today these problems and others of similar nature are well under control or have been virtually eliminated.

Rodents

Rat control consists primarily of gassing rodent burrows with hydrogen phosphide pellets and baiting perimeters of buildings and strategic locations with anti-coagulants. Maki or Contrac (bromadiolone) loose bait in a weatherproof, tamper proof bait station seems to be working well for the exterior rodent baiting program.

Mice are a bit more difficult to control in a zoological setting. In non-bird areas, the use of small bait stations and bromadiolone pelletized bait has proved extremely effective. Because of non-target poisoning, particularly of birds, Talon (brodifacoum) should not be used in indoor or outdoor zoo environments. In fact, it cannot be used anywhere in a building where birds are housed. It is simply too toxic a material, both primarily and secondarily, to be used around birds. Alternatives such as protected glueboards, expanded trigger snap traps, and multiple Ketch-all traps are used for mouse control in areas where baiting is unacceptable.

For feral cats, opossum and raccoons, Hav-A-Hart live traps are used as well as other homemade designs. Fish-flavored cat food is an excellent bait in these traps. They are strategically placed around the Zoo at common entry points for wild animals.

Cockroaches

The control of the six species of cockroaches is complex and never ending. Large species, such as the Surinam, American, Australian, Oriental and Smokey Brown are controlled with 2% Baygon Bait and by spraying with residual insecticides. In crawl areas, tunnels, and unused basements, a periodic power spraying with encapsulated insecticides is quite effective. In kitchens and walkways, Ficam W is used as a non-volatile, odorless, long-lasting residual spray. Neither pyrethrum nor synthetic pyrethroids either as a fog, an aerosol bomb, or a coarse spray, should be used indiscriminately within a zoo. This material is extremely toxic to cold blooded animals and must be used only in appropriate locations. No insecticidal fogging for cockroaches should be allowed. Only coarse, residual sprays should be used in addition to baiting programs for cockroach control.

With German cockroach control, special attention is paid to the food preparation areas and cracks and crevices around cages, food areas and service areas. Careful use of a finished spray of Safrotin (proprymphos) to cracks and crevices and, where possible, to surfaces has been extremely effective in controlling these populations. For German cockroach control where pesticide contamination might be a problem, Max-Force bait traps have been used with some degree of success. In addition, insect growth regulators (IGRs), such as Torus (fenoxycarb) are excellent for cockroach control.

Free-Flying Birds

With the control techniques available and the possibility of problems with non-target species, very little can be done about starling and sparrow populations at a zoo. Elimination of nesting and roosting sites may help to some degree, but will not control the populations encountered at a zoo. Trapping may also help to reduce populations to some degree.

Feral pigeon control, however, can be quite effective. The use of an Avitrol (4-aminopyridine) baiting program, especially in mid-winter, can be very successful in reducing the population of unwanted pigeons. This reduction of pigeons will notably decrease the amount of food that must be provided to outdoor exhibit birds as well as reduce the fecal contamination on buildings, sidewalks, picnic tables, etc.

Stinging Insects and Flies

The yearly plague of yellowjackets and honeybees foraging in trash cans can virtually be eliminated by proper pesticide applications and timing. Knox-Out, an encapsulated form of diazinon, sprayed on trash receptacles and the trash itself on a weekly basis, will eliminate most of the stinging insects and many of the flies. Beginning early in the spring (mid-March in the Philadelphia area), this weekly spraying knocks out the first brood of foraging yellowjacket workers. Not only are the first workers killed, but much of the encapsulated diazinon is transferred back to the nesting site. In this way the colony is virtually wiped out. Instead of being inundated by yellowjackets in August and September, particularly around picnic areas, visitors to the Zoo will be surprised at the absence of yellowjackets because of this early season and continued weekly spraying program of the foraging sites.

Flies will also be greatly reduced by the yellowjacket program. In addition, Flytek (methomyl with muscamone) can be used quite effectively and safely at a zoological garden. The careful use of this bait has been successful in reducing housefly populations, particularly in walkways, outdoor exhibits, and manure piles.

Ant control is important in bird and reptile areas because the ants can attack, kill, and eat small reptiles, amphibians, and birds. Various bait compounds have been used successfully, including Magi-Kit Jelly, Silica Gel Duck and Ficam W spray. Glueboards are also fairly effective in containing certain ant infestations. For ant infestations, Maxforce (hydamethylnon) bait is quite effective.

SUMMARY

In summary, a build-up of pests in a zoological garden that goes unnoted will undoubtedly rob the facility of certain aesthetic qualities as well as be responsible for increased operating expenses and possible health threats to the collection, employees and visitors. Through careful evaluation of the problem(s) and development of a comprehensive program, the zoological garden can effect a major impact on troublesome, unwanted pests.

Table 1. Suggested Reference Material for Use In Pest Control Programs

TEXTS

Mallis, Arnold, 1990. Handbook of Pest Control: The Behavior, Life History, and Control of Household Pests, 7th Edition, Franzak and Foster Company, Cleveland, OH, 44143. 1152pp. This thick book is considered the "Bible" of the pest control industry. It has detailed chapters on wood destroying organisms, cockroaches, flies, ants, and rodents among many others pertinent to implementing an Integrated Pest Management Program.

Truman Lee C., Gary W. Bennett, William L. Butts, 1988. Scientific Guide to Pest Control Operations, 4th Edition. Harcourt Brace and Jovanovich, 276pp. This book is helpful to people implementing an Integrated Pest Management program and is used as the textbook for a Purdue University sponsored correspondence course aimed at pest control professionals.

Timm, Robert M., editor. 1993. Prevention and Control of Wildlife Damage, Great Plains Agricultural Council Wildlife Resources Committee and Nebraska Cooperative Extension Service Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, Nebraska, Chapters A-H, loose-leaf. This loose-leaf notebook is considered one of the finest for managing vertebrate pests that might gain access to your facility. It is particularly helpful for controlling and preventing problems with rodents, squirrels, raccoons, opossums, feral cats and dogs, etc.

Anon. 1992. Data Trio: Volume 1, Reference Directory for Pests, Sites, and Formulations, Volume II, Specimen Label Reference Book; Volume III, MSDS Reference Book, G.I.E. Publishing, Cleveland, OH. Vol 1 hardbound, Vols II & III loose-leaf with periodic updates. To comply with government regulations including the EPA, every in-house IPM program should have this excellent reference set readily available. Outside pest control contractors should also have this set in their library.

Hayes, Waylan J., Jr., 1982. Pesticides Studied In Man, Williams and Wilkins, 428 E. Preston Street, Baltimore, MD 21202. 672pp.

Cornwell, P.B. 1968. The Cockroach Volume 1. Hutchinson of London, 178-202 Great Portland Street, London, W-1. 391pp.

Cornwell, P.B. 1973. Pest Control In Buildings. Hutchinson of London, 178-202 Great Portland Street, London, W-1. 186pp.

Hickin, Norman E. 1974. Household Insect Pests. Associated Business Programmes London, 17 Buckingham Gate, London, SW-1. 176pp

Sweetman, Norman L. 1965. Recognition of Structural Pests and Their Damage. William C. Brown Company Publishers, 135 Locust Street, Dubuque, Iowa, 52003. 371pp.

Committee on Urban Pest Management, 1980. Urban Pest Management. National Academy Press, 2101 Constitutional Ave. N.W., Washington, DC, 20418. 273pp.

Herns, William B., Maurice T. James, 1961. Medical Entomology. The MacMillan Co. New York. 616pp.

Weber, Walter J., 1979. Health Hazards From Pigeons, Starlings, and English Sparrows. Thomson Publication, P.O. Box 9335, Fresno, CA 93791. 138pp.

MAGAZINES

Pest Control Magazine. \$25/year, 12 issues. Advanstar Communications, 7500 Old Oak Blvd, Cleveland, OH 44130. Monthly Trade Journal.

Pest Management. \$35/year to non-members. This trade publication is sent to all members of the National pest Control Association, 8100 Oak Street, Dunn Loring, VA 22027.

Pest Control Technology. \$30/year, 12 issues. G.I.E., Inc. Publishers, 4012 Bridge Avenue, Cleveland, OH, 44113. Monthly Trade Journal.

APPENDIX 10: VETERINARY HOSPITALS - AVERAGE ROOM SIZE FOR RECENTLY PLANNED OR CONSTRUCTED NEW ZOO ANIMAL HOSPITALS

ROOMS	SIZE (SQUARE FEET)
Treatment	500
Surgery	580
Radiology	370
Recovery	190
Pharmacy	240
Clinical Laboratory	470
Necropsy	<u>460</u>
Total Clinic Area:	2810
Wards	
Inside Rooms	1970
Inside Stalls	570
Outside Cages and Flights	1010
Outside Pens	1840
Food Prep	170
Quarantine	<u>1800</u>
Total Animal Area:	7360
Office (average square feet per office)	150
Medical Records	210
Conference Room	370
Total Non-Clinical Non-Animal Area:	<u>730</u>
Grand Total:	10,900

The following are the new zoo hospital facilities from which the above data was calculated:

San Diego Wild Animal Park (planned), San Diego Zoo, Baltimore Zoo, Calgary Zoo, Columbus Zoo, National Zoo, Front Royal Conservation and Research Center, North Carolina Zoo, Philadelphia Zoo, St. Louis Zoo, Woodland Park Zoo

FIGURE 1: AMERICAN ASSOCIATION OF ZOO KEEPERS (AAZK)

ANIMAL DATA TRANSFER FORM



- 1. Keeper receiving the animal**
- 2. Zoo file/Veterinarian**
- 3. Keeper sending animal**

Date: _____

Common Name _____ Scientific Name _____

Individual Name	Sex	Birth Date*	Weight*	Vendor Specimen# (ISIS #)	Zoo ID	Studbook#
1)						
2)						
3)						

*note if it is actual or estimated

Diet: Present diet and supplements, favored items, problem foods, feeding procedures.

Brief Reproduction Record: Relative data, introduction techniques, behavior toward young, specific concerns.

General Medical History and Physical Conditions: Usual response to medicine, including immobilizing agents and their successful mode of administration, recurring physical problems and symptoms.

Enclosure, Maintenance Data: General exhibit description, cage mates, considerations to avoid abnormal behavior, cleaning and disinfecting procedures.

Personal comments

Present institution _____

Previous institution _____

Future institution _____

Form completed by _____ Title _____

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