

## **SECTION III**

# **THERAPEUTIC DECISION SUPPORT FOR LABORATORY, WILDLIFE, AND ZOOLOGICAL ANIMALS**

## SOURCES AND APPLICATION OF THERAPEUTIC INFORMATION TO LABORATORY SPECIES

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As a veterinary student in the early 1970's, most of my knowledge of therapeutics in pet and domestic animals was obtained from lecture notes and species or discipline specific texts, like Kirk's Current Veterinary Therapy, Veterinary Dermatology, Veterinary Ophthalmology, and others. Admittedly, in those days I spent little time reading journal articles, and much less on those dealing with pharmacology or pharmacokinetics. To be honest, what I really wanted to know was: what drug? what dose? what route? During my short time in private small animal practice, we got a lot of information from the drug company route men who were in the business of marketing their various products. As long as one was dealing with the common species, whether they were dogs and cats, or domestic livestock, there were ample sources of information regarding the use of drugs for anesthetic and therapeutic purposes. Difficulty arose, however, when the animal presented was ferret, hamster, rat or mouse. The response of many practitioners in those instances was to tell clients that they knew nothing about those animals, and if the client was fortunate enough, perhaps they knew someone to refer the animal to, or knew someone in the laboratory animal medicine field, that they could refer their clients questions to.

I left private practice in 1974, and began a three year post-doctoral fellowship in Laboratory Animal Medicine at the Johns Hopkins University School of Medicine. I've been there for now for 22 years. My "practice" deals with many species--ranging from mice to baboons, used for a large variety of research projects. I deal with naturally occurring and iatrogenic disease; and serve as a resource to investigators in a wide number of areas particularly regarding appropriate anesthetic and analgesic drugs.

In the early days of my laboratory animal career I dealt with many naturally occurring diseases in most of the species. Most of our dogs were random source, genetically variable animals, many came from the local or state animal shelters and commercial Class B dealers. Wild caught rhesus and cynomolgus monkeys were obtained in large numbers. Most of our rabbits came from commercial suppliers who were bunchers--they obtained their animals from a number of small breeders. Rodents were purchased from commercial breeders and ranged in quality from fair to excellent. With rodents we had the problem of bringing in healthy, clean animals and housing them in the same room with animals infected with a variety of viral and mycoplasmal diseases.

Finding information about diseases, drug efficacy, dosage and route of administration in these various non-traditional pet species was sometimes difficult because of limited sources. As in veterinary school, much was learned by word of mouth from others in the field and from lecture notes and handouts from other institutions and from short courses, like those given at the Armed Forces Institute of Pathology. There were two journals that could be consulted for a wide breadth of information in the field. One of them, Laboratory Animal Science, had its beginning in 1950. In that year a group of veterinarians from a number of research institutions formed the Animal Care Panel, the progenitor of the American Association for Laboratory Animal Science. Those same veterinarians were also the founders of the American College of Laboratory Animal Medicine. The Animal Care Panel published a yearly proceedings of the Annual Meeting, which, in 1957, evolved to a monthly publication called the Proceedings of the Laboratory Care Panel. In 1971 this journal was renamed Laboratory Animal Science (1). The other journal, Laboratory Animals, (from England), began publication in 1967 (2). There were a number of short monographs called the Aeromedical Reviews that were written by the Air Force veterinarians at Brooks Air Force Base. Over the years there has been a steadily increasing number of books published that deal specifically with the common animal species used in biomedical research. In 1974 the first in a series of species or subject specific books in Laboratory Animal Medicine, "The Biology of the Laboratory Rabbit", was published by

Academic Press for the American College of Laboratory Animal Medicine. The Rabbit text was followed in 1976 by "The Biology of the Guinea Pig"; in 1979 by "Spontaneous Animal Models of Human Disease" and "The Laboratory Rat" and in 1980 by the four volume "The Mouse in Biomedical Research". In 1984 a more general text, Laboratory Animal Medicine was published; followed in 1987 by "Laboratory Hamsters;" by a second edition of the Rabbit text in 1994, and in 1995 the first volume of "Nonhuman Primates in Biomedical Research" (3-11).

Using these and other sources of information, many institutions, like ours, prepared drug formularies for their investigators to provide information about antibiotic, anesthetic, analgesic and tranquilizing drugs for the variety of species that were used. Some of the dosages and administration schedules were referenced; many were not. Recently a well referenced drug formulary for laboratory animals was authored by Drs. Hawk and Leary and is available from Iowa State University Press (12).

I also learned a lot by trial and error. When I first starting dealing with ill rhesus monkeys or baboons, I quickly learned three rules about them: (1) nonhuman primates do not usually take oral medications more than once; (2) all IV lines are fair game once the animal feels better and (3) working with them while awake was a dangerous task. It was not easy to physically restrain a monkey and shove a pill in its mouth three to four times a day. Fortunately, ketamine had recently come on the market for use in cats and nonhuman primates, and was superior to the previously used product phencyclidine (Sernylan). Ketamine made the handling of monkeys much easier and safer, and simplified some of the medical treatments that we used. However, I did not like the idea of "knocking down" a monkey three times a day to pass a stomach tube for the administration of a drug. At that frequency the animal spent most of its time either chemically restrained or waking up from the drug. In so far as choice of drugs was concerned, other than ketamine, I am not aware of any drugs that specifically are marketed for use in nonhuman primates. I based my choice of drug on my previous experience in dogs. If I was using a "dog drug", I used the dog dose. If I used a "human drug", I used the pediatric dose. Whenever possible I tried to choose drugs that could be administered by intramuscular injection, ideally no more than 3 times a day. Fortunately, laboratory animal veterinarians do not have to worry about withdrawal times, or extra-label usage problems in any of our patients.

When it came to treating rodents and rabbits there were lots of other problems. For ease of administration, rabbits and rodents were usually treated for a variety of diseases with tetracycline or sulfa antibiotics that were water soluble and could be given in the drinking water. Mycoplasma pneumonia in rats used to be a common problem, particularly in long term animals. Tetracycline was recommended for treatment because in vitro data showed effectiveness. However there was a wide disparity in the recommended dosages (400 mg/liter to 4 grams/liter plus 50 grams sucrose) and no efficacy data for rats was available from the manufacturer. In 1985, Bill Porter, one of the postdoctoral fellows in our Division, did studies to determine what dosage administered in drinking water would produce detectable blood levels. To our surprise he found that only 3 of 18 animals given the highest dosage developed minimally effective blood levels of 0.3 mcg/ml. A number of animals also drank very little medicated water and lost weight during the study (13). While discussing this presentation with John Strandberg, my Division Director and a co-author on the paper, I learned that they had difficulty getting this paper published because some of the reviewers felt that the data was too challenging to the accepted norm.

In addition to the problem just described, there are also well documented drug toxicities in some of the common laboratory animals that preclude the use of a number of antibiotics. Administration of antibiotics effective against gram positive bacteria (like lincomycin and clindamycin) can result in fatal enteritis in hamsters, guinea pigs and rabbits. Procaine penicillin is fatal to mice because of the toxic effects of procaine (12). These toxicities greatly limit the spectrum of antibiotics that can be used to treat these animals.

It is interesting and ironic to note that although rats and mice are the species that are commonly used to determine drug efficacy and pharmacokinetic data during drug development, that information is proprietary and not available to laboratory animal veterinarians who deal with these species in large numbers.

When it comes to the application of therapeutic information, there are a number of devices and delivery systems that are commonly used in the research laboratory that can also be used for therapeutic purposes. There are various implantable vascular access ports (14) and indwelling catheters that can be used in most species, but these catheters also require some type of protective device, like a vest and tether to prevent damage by the animal (15). For effective use these vests and tethers require an acclimation period, something that is usually impossible for animals that become acutely ill. When in use, these systems also provide an easy conduit for antibiotic and therapeutic drug administration. Osmotic pumps (16) with a delivery time ranging from 7 to 28 days (depending on the size) can be implanted subcutaneously or intraperitoneally to deliver a specific volume of drug per hour. These pumps can also be attached to intravascular or intrathecal catheters to deliver drugs via those routes. Implantable pellets (17) containing a variety of drugs can be inserted subcutaneously, and will deliver a specific amount of drug for 21 days. For nonhuman primates, some antibiotics as well as aspirin can be given by use of a chewable flavored tablet (18).

Fortunately for laboratory animal practitioners, many of the difficulties we faced regarding therapeutic decisions have been minimized, because the incidence of many of these naturally occurring diseases has decreased markedly. The overall use of large animals has decreased, and the availability of dogs from pounds has been stopped in many localities and states. There is pressure now to prevent the acquisition of any random source animals from Class B dealers. More purpose bred, well vaccinated dogs are used; all of the cats that we currently use are high quality purpose bred animals. Few wild caught nonhuman primates are available--many now come from commercial breeding facilities in the country of origin, and are in excellent health when they arrive. Pasteurella-free rabbits are readily available from commercial breeders. Almost all of our rodents come from virus antibody-free, barrier facilities, and can be maintained in sterilized caging systems that minimize disease transmission from cage to cage.

Most of our clinical work now involves iatrogenic situations and some of these provide therapeutic challenges. If antibiotics need to be used, will the drug of choice interfere with the results of the study? If so, are alternatives available, or will the study have to be stopped? As an example, many of my investigators use rhesus macaques for long term studies that involve the central nervous system. One in particular has been studying the interaction of the cerebellum, the vestibular system and the eye. His standard paradigm is to train an animal over along period of time to follow a moving light. Then the animal is surgically implanted with a sire coil around the eye so that eye movement can be followed by putting the animal inside a magnetic field. As the eye moves, the computer can follow the movements. A small head restraint device is surgically implanted on the skull to keep the head from moving during the recording sessions. These restrainers are aseptically screwed to the calvarium and surrounded with dental acrylic. With time there is always some degree of infection at the skin:acrylic interface. When the amount of infection gets excessive systemic antibiotics may be indicated, but aminoglycosides cannot be used because of possible vestibular toxicity--even though they might appear to be the drug of choice by in vitro sensitivity testing.

In my opinion the biggest challenge that laboratory animal veterinarians face today is the issue of adequate anesthesia and pain relief in animals used for biomedical research. For many of these species we still do not know the answers to the questions that I posed earlier: what drug, what dose, what route? Often the question is not what drug, what dose, what route, but what effect will it have on the particular receptor that they are studying? Or how can the animal be kept anesthetized and physiologically normal during a study that is going to last 48 hr? If I use post operative analgesics will there be any effect on free-radical formation or the complement cascade pathway? Quite frankly, I do not know the answer to many of these questions, and I usually recommend that the investigator consult with their physician colleagues in anesthesia or pharmacology.

The most exciting source of information and advice from colleagues in the field is the Internet. The mailing list that I find of most value is COMPMED (19), a mailing list for discussion of comparative medicine, laboratory animals and related topics. The individuals who regularly monitor the list span a wide range of disciplines and institutions, including veterinary anesthesia, laboratory animal medicine. It is rare that a question will not be answered or discussed, sometimes exhaustively. As an example of the variety, on April 2 of this year questions raised and discussed included the use of intraperitoneal Innovar-vet as a post

surgical analgesic in mice (not available and not very good); a source of alligator bile (there is one); and the relationship between brain and body size in the mouse (a number of references were given). The future of electronic information distribution is unlimited. Knowing how the internet has exploded in the past few years, there is no reason to suspect that this method of information dispersal will not further proliferate in the future. We in the laboratory animal medicine and comparative medicine field would welcome all of you to the list, to help us with our questions and to provide guidance for our investigators.

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14. Norfolk Medical Products, Inc. 7307 Ridgeway, Skokie, Illinois, 60076
15. Lomir Biomedical Inc., 99 East Main Street, Malone, New York, 12953
16. Alza Corporation, 950 Page Mill Road, Palo Alto, California, 94304
17. Innovative Research of America, 2 N. Tamiami Trail, Suite 404, Sarasota, Florida, 34236. Phone: 941-365-1406 or 800-421-8171
18. BioServ. P.O. Box 450, Frenchtown, New Jersey, 08825
19. COMPMED. Comparative Medicine Mailing List.  
List Owner: Ken Boschert, DVM (ken@wudcm.wustl.edu)  
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## THERAPEUTIC CONSIDERATIONS WHEN TREATING FISH

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Once the decision to medicate a fish or group of fishes has been made, the practitioner must determine the most effective mode of administration. The selection of drug should be based upon clinical tests, species and number of animals being treated, specificity of the chemical, the environment into which the drug is placed, and experience. If food fish are to be treated, options become severely limited as only a few drugs are approved for use.

The majority of drug doses used in marine and freshwater tropical fish are empirical. A table of medications and the doses used at the National Aquarium in Baltimore is published in the 1991 Eastern States proceedings (Whitaker, 1991). Proper water temperature, and therefore body temperature, must be maintained to assure assimilation and metabolism of the drug.

Water quality parameters, such as ammonia, nitrite, nitrate, dissolved oxygen, temperature, salinity, alkalinity, and pH, should be monitored frequently during treatment. Certain chemicals, especially antibacterial agents, have deleterious effects upon the bacteria responsible for biological filtration resulting in ammonia and/or nitrite toxicity. Neomycin sulfate, cupric sulfate, chloramphenicol, methylene blue and formalin are examples of such chemicals. Formalin also removes oxygen from the water requiring increased aeration of the system during treatment.

Chemicals used to treat fish should be of excellent quality. For instance, formalin over time may develop a white precipitate called paraformaldehyde which is deadly to fish. When adding vitamins and/or drugs to the diet, care must be taken to avoid their inactivation. Common causes of this include contact with chlorinated tap water or hot gelatin during food preparation. Medicated foods must be kept frozen or cool prior to feeding.

Drug selection and mode of administration are evaluated simultaneously when devising a therapeutic plan. Some fish such as goldfish will continue to eat during a severe illness enabling the use of medicated foods. In others, the drug of choice may require parental therapy which due to stress or the inability to restrain the fish becomes impractical. The environment as a whole is also considered prior to drug administration. For example, the use of copper sulfate, a commonly employed anti-parasiticide in marine fish, is toxic to invertebrates and can not be used in living reefs. Malachite green, an anti-parasiticide used commonly in fresh water fishes, is toxic to scaleless and young fish. Lastly, human exposure to these drugs must also be evaluated. Chemicals used as baths are of greatest concern. Without proper precautions for instance, organophosphates such as trichlorfon used to treat trematodes and crustaceans may become toxic to both people and fish. Similarly, formalin and malachite green present hazards as potential carcinogens.

Therapeutics may be administered topically, orally, parenterally or via short or long term baths. Each route has advantages and disadvantages. A good example of topical therapy involves the use of ophthalmic cyanoacrylate to treat corneal ulcers which are occasionally observed following transport or an infection with external parasites. Cyanoacrylate provides a water-tight patch allowing re-epithelialization of the cornea. Without such treatment many superficial corneal ulcers progress to melting ulcers culminating in rupture of the eye.

If fish are eating, incorporating medications into their food provides a direct and stress-free method of administration. Fish that have been previously conditioned to accept a non-medicated gel food often readily accept a medicated preparation. The concentration of drug added to the basic gel diet is based upon the assumption that an ill fish may consume 1% of its body weight daily. The gel, which binds the drug and prevents it from leeching into the water, may be frozen in small cubes for 6 months to a year. Fish that eat live food may be medicated by injecting the drug into the prey item just prior to feeding.

Parental administration may be indicated in a septic animal. Clinical signs such as large dermal ulcers and multifocal areas of erythema support the use of intravascular, intramuscular or intraperitoneal injections. Intramuscular injections have been criticized for two reasons. First, the muscle of fish is poorly vascularized and therefore the uptake of drug may be inadequate. Second, when the fish swims away, the contraction of the muscles may force the drug out of the fish. Despite these concerns, our experience using injectable drugs has been good. Intraperitoneal injections provide an alternative form of parental therapy. Care must be taken not to introduce bacteria from the skin and mucus into the coelomic cavity of the fish. This may be done by gently wiping mucus away from the site using sterile saline, and minimizing the number of injections given by this route. Proper restraint is also crucial to the safe delivery of medications using this method. Intravascular injections are often not feasible for small fish but may work well in larger animals.

Dips and baths are commonly used to medicate fish. This method is extremely useful when working with large numbers of fish or those easily stressed by handling. Certain parasitic infections may require weeks of treatment. Activated carbon must be removed from the system during the treatment period to prevent it from binding and removing medications. Copper, for instance, is effective only against newly emerged adults and immature free-swimming stages. It must therefore be maintained at therapeutic levels for approximately 3 weeks to eliminate the infection. Disadvantages of long term copper therapy include possible toxicity, immune suppression, and inhibition of the biological filter. When practical, it may be advantageous to expose fish to a high level of drug for a short period of time. Care must be taken to protect the biological filter from these "short term" dips. Concentrated formalin dips of up to 250 ppm for 15 minutes to an hour are often used in this manner to treat parasitized marine fish. Freshwater dips for marine fish, and saltwater dips for freshwater fish are effective in controlling many external parasites.

The osmotic gradient that a fish copes with is also considered when providing therapy. Marine fish live in an environment which contains a higher concentration of osmotically active ions than does its own body fluids. Subsequently, the osmotic gradient favors the movement of water from the fish to the environment. The scales, intact epithelium, mucus, gills, and kidney all play a role in maintaining osmotic homeostasis within the fish. When any of these mechanisms are compromised by disease, dehydration occurs in the marine fish. Lowering the salinity diminishes this gradient and may effectively provide "fluid therapy" or minimize the further loss of body water. Freshwater fish face the opposite challenge, and therefore will benefit from salt added to the water.

#### **Reference:**

Whitaker, BR: Basic concepts concerning the diagnosis, management, and treatment of fish disease. Eastern States Veterinary Proceedings, 1991, pp 548-551.

## SOURCES AND APPLICATION OF THERAPEUTIC INFORMATION TO ZOOLOGICAL SPECIES

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Veterinarians dealing with zoological collections in a modern zoo or aquarium deal with a wide range of species and correspondingly large gaps in knowledge of physiology and drug therapies. In a typical zoo and aquarium setting, the medical department deals with mammals, birds, reptiles, amphibians, fish, and insects. The amount of knowledge on both disease and treatment regimes decreases as one goes down the phylogenetic ladder. The greatest amount of knowledge is known about mammals, mainly due to extrapolation from domestic species where research is economically driven and concentrated zoo research efforts dealing with this group. Knowledge of the other groups is expanding; however, it is a low and tedious process, and again, the amount of research often varies with the economic importance of the animal groups.

With very few exceptions, therapeutic agents for zoo animals are all used off-label. This is legal if the animal is not destined for food production.

A veterinarian's role in the zoo community is three-fold: 1) to set up extensive, preventative programs, which include quarantine, vaccinations, parasitology, pathology, nutrition, disease surveillance, keeper health, sanitation; 2) to treat animals on a daily basis; 3) to perform research which will add to the foundation of knowledge for zoo medicine. In preventative medicine, we mainly deal with vaccines and dewormers. In day-to-day clinical cases we often deal with anesthetics, antibiotics, and analgesics. In the area of research, we are often trying to elucidate the pharmacokinetics of these drugs in controlled situations.

One of the greatest advances in zoo medicine over the last 20 years has been the development of relatively safe anesthetics for the handling of these species. Previously, managers often hesitated to call veterinarians because when veterinarians immobilized the animals, they often used primitive drugs such as nicotine sulfate, barbiturates, or phencyclidine, with disastrous results. It got to be a "Catch 22" where managers thought they were going to lose the animal due to handling during veterinary care, so they would wait until the animal was on death's door, dooming the veterinary care. This cycle continued for many years. However, with the advent of xylazine (Rompun®), ketamine, and etorphine, veterinarians have managed to disband this image and actually become pro-active at treating problems. There were several pioneering studies to delineate which drugs were safe in what species and good dosage rates. Since that time, azaperone, detomidine, and Telazol® (tiletamine + zolazepam) have also been added to the list of useful drugs. At the present time, etorphine is off the U.S. market and is being replaced by carfentanil, which is noted to cause problems with hyperthermia in certain species. Renarcotization and subsequent complications can also occur.

Zoos, through good pathology programs, have delineated what diseases certain animals are susceptible to and veterinarians have vaccinated zoo animals using domestic animal vaccines for these diseases. The use of commercial modified live vaccines derived from cell cultures of closely related species has been discouraged since clinical distemper has been caused in a variety of exotic canids from these products, particularly in lesser pandas. Rabies has been seen in skunks vaccinated with MLV. Zoos, therefore, use either killed vaccines in these animals or modified live vaccines that are grown on tissue cultures of foreign species such as Fromm-D distemper grown from chicken cell origin. Vaccine use is off-label because there have been no challenges made on zoo animals. Both the economics of the individual animals is too high and the after market is too low to support vaccine challenges. There have been several studies in zoos, however, showing that animals do respond to these vaccines and produce reasonable titers comparable to their domestic species counterparts.

There is a strong community of veterinarians dedicated to publishing their trial and error results whether they are positive or negative and a wealth of information is now available on most drugs. One must assume the responsibility that not all outcomes are going to be positive, as is the case of utilizing ivermectin in tortoises. There are relatively few studies on pharmacokinetics of analgesics and antibiotics in this diverse array of species. Over the last 20 years, there are a lot of "in my experience" type accounts of antibiotic dosages which have not been detrimental to the animal and appear to improve its clinical situation.

A very general thumb rule with which one approaches a clinical case needing antibiotics and dewormers is that the mammal dose should be figured out on a weight basis from a basic domestic animal dose of a related species and modified by metabolic scaling if the animal is extreme in its size, either small or large. For dosing birds with a drug that has no known research done on it, we generally go with three times the mammal dose taking in mind metabolic scaling. Correspondingly, for reptiles, the mammal dose is divided by three. Fish and amphibians have been dealt with in the aquarium lecture. This is a vague thumb rule, and not without peril. If followed for aminoglycosides in reptiles, deaths would occur due to kidney failure. Recently, a number of reliable books and formularies have been developed and are listed in Table 1. Veterinarians are encouraged to utilize these and join the American Association of Zoo Veterinarians, the American Association of Avian Veterinarians, and the American Association of Reptilian and Amphibian Veterinarians for sources of information and updated treatment regimens for the particular species they are working with.

When approaching a new species or a species for which a drug has not been utilized, especially in an elective situation, then one must assess the risk/benefit, not only of the pharmacokinetics but of the delivery of the drug and possible complications to the situation. If there are multiple animals to be treated in an elective situation, it behooves the veterinarian to try the new drug on one animal and wait 24 hours to see if there is a detrimental response before going on to treat other animals. Most zoo veterinarians have seen adverse reactions in one species or another, and by not waiting have killed multiple animals instead of just one. This has resulted in the loss of such animals as killer whales and wombats. Once a risk assessment has been performed, it is deemed necessary to use a drug and a dose has been formulated by utilizing existing formularies, personal communications, or your own thumb rules taking to mind metabolic scaling then one must look at the practicality of delivering that drug.

Often in zoo medicine, the drug of choice, as determined by culture and sensitivities or by experience in domestic animals, cannot be utilized for practical reasons. For example, the dose may have to be administered too frequently to get the blood levels necessary for the case. Often the route of choice for zoo animals, which is the least invasive, is orally. However, it does have its drawbacks. Frequently, a sick animal is off food and water and, therefore, will not take such medication. If they are eating, appetite may be marginal and they may go into an inappetent situation and then reject the food that contains the medication. In the case of primates, the animal may be able to hide medication in their pouches and then expel it at a later time, so you're never sure of your dosages. Many oral drugs are contraindicated in ruminants as they may affect the flora of the rumen. The frequency at which a drug is given may be deemed impossible because the animal eats once a day or perhaps even once a week as in the case of snakes. Injectable drugs can be given by restraining the animal or given remotely by pole syringes or darts. The advent of the plastic dart has increased our ability to treat animals safely and with minimal stress. However, the nature of these animals makes handling or treating them multiple times a day detrimental. They often will become stressed and go off food and/or get secondary stress-related diseases such as aspergillosis or malaria in birds. Veterinarians are often stuck with the dilemma of not utilizing the drug of choice but a drug that may be adequate and practical to deliver, such as long-acting antibiotics. Hormones, antibiotics, and analgesics research is being done to see if they can be delivered by subcutaneous implants over a long period of time, which would cut back on the amount of handling. This is being done at the present time with selastic and ceramic implants. This area is in its infancy, and there is a tremendous amount of research to be done.

In summary, there has been relatively little pharmacokinetic research that has resulted in hard core data relative to the number of drugs and species that are in a zoological park. One should start with a thorough literature search and use of the internet as well as the personal communications with the zoo veterinarian,

avian, and reptile and amphibian veterinarian organizations. If these are unrewarding, one must use the vague thumb rule of the known dose for a domestic species adjusted for metabolic scaling and a three times dose for birds with increased metabolism and one-third the mammal dose for reptiles, keeping accurate records of the results. When approaching a new situation, on an elective basis, only one animal out of a group should be treated before medicating the other animals. One must pick a drug with a practical delivery mechanism because the best drugs do not always guarantee successful management of a case. One must take a very holistic approach, including management, stress levels, food intake, and the pharmacokinetics of the drug to be used. The knowledge of zoological species and pharmacokinetics is growing at a rapid rate due to the efforts of practitioners working on a shoestring budget doing good controlled studies with different drugs. These studies need to be published, particularly if they are successful but even if they are not, so that other people will not repeat disastrous results.

#### **TABLE 1. SOURCES OF INFORMATION**

##### **Books**

Zoo and Wild Animal Medicine. (M.E. Fowler); Saunders Publishing Co., Editions 1, 2, 3  
 Exotic Animals. (E.R. Jacobson, G.V. Kollias); Churchill Livingstone Publishers  
 Clinical Immobilization of North American Wildlife. (Nielsen, Haigh, Fowler); Wisconsin Humane Society  
 Capture and Care of Wild Animals. (E. Young); Cape Town, Human and Rosseau Publishing Co.  
 Avian Medicine. (B.W. Ritchie, G.J. Harrison, L.R. Harrison); Wings Publishers, Lake Worth, FL  
 Diseases of Reptiles. (Cooper, Jackson); Academic Press  
 Reptile Care. (F.L. Frye); TFH Publication, Neptune City, NJ  
 Laboratory Animal Medicine. (J.G. Fox, B.J. Cohen, F.M. Loew); Academic Press  
 Handbook of Veterinary Drugs. (D.G. Allen, J.K. Pringle, D. Smith, P. Conlon); Lippincott Publishing Co.

##### **Journals**

Journal of Zoo and Wildlife Medicine  
 Journal of Wildlife Diseases  
 Zoo Biology  
 Seminars Avian/Exotic Pet Medicine  
 Journal of Avian Medicine and Surgery  
 Bulletin of the Association of Reptilian and Amphibian Veterinarians

##### **Association/Proceedings**

American Association of Zoo Veterinarian  
 American Association of Avian Practitioners  
 American Association of Reptile and Amphibian Veterinarians  
 American Zoological Association SSP Medical Advisors