REPTILE MEDICINE – HOW TO GET STARTED

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INTRODUCTION

Incorporating reptile patients into your practice can be a rewarding experience if your supportive staff is willing to work with these unusual species. Since reptile husbandry and nutrition play such an important role in keeping pet reptiles healthy, veterinarians and their support staff should have a basic understanding of the husbandry and correct diet of common pet reptile species, such as bearded dragons, veiled chameleons, leopard geckos, crested geckos, ball pythons, and corn snakes.
The reptile-specific equipment needs are minimal if the clinic already sees birds or small mammal patients. Suitable temperature-controlled housing is necessary for hospitalizing reptile patients. Otherwise, equipment used for other exotic patients is suitable for reptiles as well.

REPTILE HUSBANDRY

Incorrect husbandry accounts for the majority of diseases encountered in captive reptiles. Knowledge about the natural history and unique environmental and nutritional requirements is important for veterinarians to diagnose and treat husbandry-related disorders. This lecture will discuss common husbandry-related disorders and provide information on their treatment and prevention. Reptile patients have specific environmental and nutritional requirements to remain healthy. Due to the variety of reptile species maintained in captivity, veterinarians treating reptiles should be familiar with the basic concepts of reptile husbandry, as well as the specific needs of commonly kept reptile species.

Environmental temperature

Reptiles are ectothermic and therefore the body temperature is directly affected by the environmental temperature. In their natural environment reptiles regulate their body temperature, by behaviors such as basking (increasing body temperature) or hiding under cover, in order to maintain their body temperature within their preferred optimal temperature zone (POTZ). Most physiological processes, such as immune function, growth, and digestion are directly affected by body temperature. In captivity, the lack of an appropriate temperature gradient within an enclosure often prevents reptiles from regulating their body temperature. For most species, a focal basking light should be positioned at one end of the enclosure, resulting in an area with the highest environmental temperature. If sufficient ventilation is provided, the opposite end of the enclosure will remain cooler. Hence a temperature gradient is created, allowing the reptile to choose

the correct temperature zone, to modify its body temperature as needed for various physiological processes (e.g. digestion, etc.). In addition, a day-night temperature change is important. Night-time temperatures should be lower than day-time temperatures in most species. The author prefers to use bright light-emitting bulbs as a heat source for the basking spot since in the wild radiant heat is associated with visible sunlight. The use of ceramic heaters or red infrared bulbs as the primary heat source for basking spots is therefore discouraged. Other heat elements (e.g. under tank heat mats, tape, or cables) can be used to modify the environmental temperature accordingly, but in most cases are not necessary. Species-specific shelter should be provided at various temperature areas within the enclosure. In their natural environment, hiding spots are usually cooler, since they are not exposed to sunlight), and therefore care should be taken to provide shelter at the cool end of the enclosure.
Chronic exposure to high environmental temperatures without the availability of a temperature gradient will lead to various health problems, including chronic dehydration, kidney disease, bladder stones in certain lizards and tortoises, and problems shedding.

UVB light exposure
Insufficient exposure to UV-B radiation (280-315nm) is well known to lead to secondary nutritional hyperparathyroidism and metabolic bone disease in many reptile species, in particular herbivorous ones. The biologically active form of vitamin D_3 is 1,25 dihydroxycholecalciferol (syn. calcitriol), which regulates calcium metabolism by increasing calcium and phosphorus absorption from the intestine, mobilizing calcium resorption from bone. UV-B is necessary to activate the cholecalciferol pathway in species, which rely not on dietary vitamin D_3 intake, which is the case in herbivorous reptiles. If vitamin D3 is predominately of dietary origin or endogenously synthesized differs between reptile species based on their nutritional (carnivorous, omnivorous, herbivorous) strategy and natural behavior (e.g. nocturnal, vs. diurnal) and natural habitat. In omnivorous and carnivorous reptiles, the need to provision of artificial UV-B radiation in captivity remains controversial. In most reptile species evaluated, exposure to UV-B radiation will lead to increased plasma vitamin D levels. It needs to be remembered that most forms of artificial UV-B radiation provided in captivity are only an inadequate supplement for natural sunlight most reptiles are exposed to in their natural habitat. Hermann's tortoises *(Testudo hermanni)* exposed for 35 days to either mercury or fluorescent UV-B radiation-emitting light bulbs, had significantly lower 25-hydroxycholecalciferol plasma levels compared to days 0. While tortoises exposed to natural sunlight maintained their plasma 25-hydroxycholecalciferol levels. In bearded dragons *(Pogona vitticeps)* dietary supplementation of vitamin D3, even at high doses, was insufficient to maintain plasma 25-hydroxycholecalciferol levels, compared to bearded dragons exposed to artificial UV-B radiation.
Direct unfiltered sunlight is preferred over artificial UV-B radiation sources, whenever possible, but challenging to accomplish in most captive housing situations. A variety of UV-B emitting light bulbs are available, which vary in intensity of the emitted UV-B rays as well as heat emission (i.e. mercury vapor vs fluorescent bulbs). It is important to note that UV-B rays are completely blocked by most glass and Plexiglas products and can be significantly reduced by fine metal mesh. It is important to follow manufacturer guidelines

in regard to the optimal distance between the light bulb and the animal, since with increasing distance the amount of UV-B reaching the animal is progressively reduced.
Insufficient exposure to UV-B radiation leads to well-reported clinical signs associated with Nutritional secondary hyperparathyroidism (NSHP). Lethargy, reduced appetite, constipation, dystocia, or preovulatory stasis can be seen in animals with calcium deficiencies. However, these clinical signs are non-specific and other disease processes or husbandry problems should be ruled out. Skeletal deformities or fractures due to demineralization of the bones are common in reptiles suffering from calcium deficiencies. Fractures of the limbs and ribs are most commonly seen in lizards. Once total body calcium stores are depleted enough, so that blood calcium levels cannot be maintained at adequate levels, muscle twitching, tremors, paresis, and neurological signs can be seen. This hypocalcemic crisis, and is considered as an acute decompensation of chronic NSPH.

Humidity

Reptiles originate from a variety of natural environments with highly different degrees of relative humidity. In addition, within each natural environment humidity can vary greatly, and is usually higher in hiding spots, not exposed to sunlight as well as in areas with organic materials (e.g. soil, moss, etc.) In captivity, the humidity in reptile enclosures is affected by several factors, including heat, ventilation, and the presence of organic material. Regular misting or fogging can aid in keeping humidity at the desired higher levels of tropical and subtropical species.
Insufficient humidity can lead to a variety of health problems in reptiles, in particular to problems shedding (dysecdysis). If humidity cannot be maintained at sufficient levels in the entire enclosure, then hiding boxes filled with damp newspaper, coconut fiber, or other absorbent materials should be offered. Snakes and lizards will frequently use these “shedding boxes” during the shedding period and the risk of dysecdysis is reduced.

Substrate

A variety of substrates can be used in reptile enclosures. Newspaper or paper sheets offer the most hygienic option for substrate, as it allows for easy cleaning and monitoring. However, in species that require higher environmental humidity or like to dig in their substrate paper is not suitable for long-term use. Potting soil, mulch, and coconut fiber can be used as substrates but often will retrain a lot of moisture, and the risk for molt overgrowth is increased. Sand is sometimes used for desert species and usually does not cause problems. However, accidental ingestion of sand (or any other substrate) can lead to GI impaction and obstruction. Therefore, food items should never be offered directly on the substrate, but in a flat bowl or stone, which reduces the risk of accidental substrate ingestion. Some reptiles will purposely ingest substrate.
(pica), which is frequently seen in lizards and chelonians. In such cases, the substrate should be replaced with a material, which cannot be ingested. In addition, underlying causes for pica should be investigated.

REPTILE DRUG THERAPY

Reptiles provide clinicians with unique challenges due to their varied and unique anatomy and physiology. Drug therapy is therefore challenging in reptiles due to a variety of adaptions, which do not exist in mammalian or avian patients. To optimize the outcome of reptile patients undergoing drug therapy for treatment or prevention of diseases or for induction of anesthesia or analgesia, it is important to consider these unique adaptions.

Effect of body temperature

Reptiles are ectothermic and therefore the body temperature is directly affected by the environmental temperature. In their natural environment reptiles regulate their body temperature, through various behaviors, but in captivity, reptiles may be maintained outside of their preferred optimal temperature zone (POTZ). Since body temperature in reptiles is not kept constant but will vary based on the environmental temperature, clinicians have to expect varied responses to drug therapy in reptiles and should ensure that reptile patients are maintained at their POTZ before and during drug therapy. Drug absorption, distribution, metabolism, and excretion are all affected by body temperature. An increase in body temperature will lead to an acceleration of these processes, while lower temperatures will result in a delay in drug absorption, distribution, metabolism, and excretion. If sedation or anesthesia is induced with injectable drugs, reptiles may show a delayed or no onset of sedation, if they are below their POTZ, and the duration of drug effects will be prolonged, delaying complete recovery due to the delayed metabolism and excretion of the administered drugs. In contrast, reptiles that are maintained at the high end of their POTZ or above will show a more rapid onset of sedation or anesthesia, but the duration of effect (plateau phase) will be shortened, due to the acceleration in drug metabolism and excretion.

Temperature is also of particular concern if reptiles receive antimicrobials for the treatment of infections since their immune system will only function optimally within the POTZ.

Routes of drug administration

The oral route for drug administration is rarely indicated in reptiles, and a large variation in drug bioavailability has been reported. In any systemically sick reptile, oral drug administration should be avoided and instead, parenteral administration (i.e. subcutaneous or intramuscular injections) considered. Reptile owners and keepers can be trained to administer drugs by injection, which will result in more reliable and consistent drug delivery than oral drug administration. However, certain drugs, such as antifungals (e.g. terbinafine, itraconazole) can only be administered by oral route and often require long-term administration. Placement of esophageal feeding tubes in chelonians and lizards is therefore recommended if long-term oral drug administration is necessary.

Historically intramuscular (IM) drug administration has been considered superior to the subcutaneous route. However, for most drugs administered the subcutaneous route is the preferred method of administration by the author, since it is less painful, allows for delivery for larger volumes, and can be performed with less restraint than IM injections.

Intravenous (IV) drug administration is rarely indicated in reptiles, except for the administration of certain anesthetic induction agents (e.g. propofol, alfaxalone, ketamine). In most cases, placement of an intravenous catheter before IV drug administration cannot be easily accomplished, and therefore IV injections are performed using hypodermic needles or butterfly catheters. Intraosseous catheters are a suitable alternative to IV catheters in lizards, but are considered painful, and are therefore only recommended in cases of emergency or if intravascular access is required during anesthesia.

The intracoelomic administration of drugs and fluids has been reported but is not recommended by the author due to the risk of internal organ damage, in particular in female reptiles with developed ovarian follicles. Other routes of administration include nebulization of antimicrobials for skin and respiratory tract infections, intranasal administration of anesthetics and their reversal agents, and the topical administration of antiparasitics.

Renal portal system

Historically the administration of drugs in the caudal body half in reptiles has been controversial. Blood draining from the hindlimbs and tail in reptiles can directly reach the kidneys, due to the presence of a renal-portal system and therefore it has been assumed that renal tissue damage may occur if nephrotoxic drugs are administered. An additional concern is that only insufficient drug levels are reached, if drugs are excreted by the renal tubules are administered. Several studies have been performed to investigate the effects of hindlimb vs. forelimb injection on plasma levels of a variety of antibiotics, which undergo excretion by either glomerular filtration (e.g. gentamicin) or tubular excretion (e.g. carbenicillin). It was concluded from these studies that generally the effects of hindlimb administration of drugs are unlikely to be clinically significant and that the caudal body half is a suitable parenteral drug administration site in reptiles.[1] Therefore injection site is considered irrelevant in regard to drug kinetics by some authors, which recommend administering drugs anywhere in the reptile body. However other authors recommend that drug administration in the caudal body half should only be considered for specific drugs and if the administration of drugs in the cranial body half is not feasible. It has been recommended to adjust the drug dose if drugs are administered in the caudal body half, to account for the renal and hepatic first-pass effects on drug plasma levels. In contrast to the great amount of attention paid to the effects of the renal portal system on drug kinetic in reptiles, the hepatic-portal system and how the venous vasculature differs in reptiles compared to birds and mammals has not received much attention in the literature but has a much greater clinical impact than the effects of the renal portal system.

Hepatic portal system

The venous blood flow from the hindlimbs and tail in reptiles differs substantially from other higher vertebrates. In mammals and birds, the blood from the hindlimbs and tail drains into the caudal vena cava, which enters the right atrium of the heart. In contrast, the venous blood flow from the hindlimbs and tail region in reptiles drains into the ventral abdominal vein(s), which connect to the hepatic portal vein to enter the liver. Hence, any drug administered in the hindlimb or tail (caudal body half), enters the liver first, before reaching the systemic circulation, resulting in a hepatic first-pass effect, if the drug undergoes hepatic metabolism or excretion. The hepatic first-pass effect is one of the reasons why oral administration of many drugs is ineffective. The same effect has to be considered in reptiles when drugs are administered in the caudal body half, but not in mammals or birds because of the difference in how blood drains from the caudal body half. In red-eared sliders, the administration of ketamine and dexmedetomidine failed to induce anesthesia if the drugs were administered by intramuscular injection in the hindlimbs, while anesthesia was reliably induced in all animals following forelimb injection. A study on alfaxalone in turtles demonstrated the lack of anesthetic efficacy of this drug following intramuscular hindlimb injection, while administered intravenously in the jugular vein, anesthesia could be reliably induced. A pharmacokinetic study on buprenorphine in red-eared sliders showed 80% lower plasma levels following hindlimb administration compared to forelimb administration. Hindlimb injection of tramadol in turtles resulted in 20% higher metabolite levels, compared to forelimb injections, which is clinically desirable, since the metabolite has analgesic properties.

It cannot be assumed that hindlimb injection is a generally acceptable or unacceptable drug administration method in reptiles. Drugs that are metabolized or excreted predominately by the liver will undergo a hepatic first-pass effect (e.g. opioids, most anesthetics, oxytocin, etc.) and should therefore not be administered in the caudal body half. In contrast, drugs that do not undergo a significant hepatic first-pass effect (e.g. fluoroquinolones, many cephalosporins, aminoglycosides, etc.) can be administered in the caudal body half in reptiles, without concerns about altered drug kinetics. However, as a general rule drug administration in the cranial body half is preferred over administration in the caudal body half, because of the reduced risk of injection site-dependent effects on drug kinetics.