
DIAGNOSING AND MANAGING RENAL DISEASE IN REPTILES

K. Wright, DVM, Dipl ABVP (Reptile & Amphibian)

Wright Bird & Exotic Pet House Calls, Mesa, AZ 85203 USA

ABSTRACT

This article focuses on how I diagnose renal disease in reptiles. Initially many reptilian patients with underlying renal disease are not diagnosed since the signs are non-specific, such as anorexia, dehydration, lethargy, and weight loss.

Comparing Reptiles to Mammals

Kidneys eliminate nitrogenous wastes resulting from protein metabolism. This process provides a good overview of how reptiles' kidneys differ from those of domestic mammals. Protein metabolism results in ammonia, a highly toxic water soluble compound. Ammonia either must be quickly filtered from the blood into the urine, a process that requires copious amounts of water to keep the blood ammonia concentration diluted to levels tolerated by the brain, or converted to a less toxic compound that can be tolerated in the bloodstream, which requires more energy. A reptile that lives in fresh water, such as a Florida softshell turtle (*Apalone ferox*), may excrete a large proportion of its nitrogenous wastes as ammonia since it is in no danger of becoming dehydrated. There is nothing to be gained by expending the energy to convert more of the ammonia into urea. For a reptile that has intermittent access to fresh water, such as a Florida box turtle (*Terrapene carolina bauri*), water conservation often is more important than energy conservation and so the mitochondria and cytosol of hepatocytes expend the energy via the ornithine cycle to convert ammonia to urea. Urea is water soluble, less toxic than ammonia, and does not cross the blood-brain barrier. It may be present in the blood stream at higher concentrations than ammonia without ill effects. Urea is freely filtered by glomeruli and the filtrate stored as the urine in a bladder. A reptile that rarely has access to fresh water, such as a Florida gopher tortoise (*Gopherus polyphemus*), has a physiology that places a premium on water conservation. Glutamine synthetase and glutamine dehydrogenase within the hepatocytes convert urea to uric acid, a water insoluble compound with low toxicity. Uric acid is filtered by the glomeruli and actively secreted by the kidney tubules; it requires much less water than urea to be safely transported to and stored within the bladder. Uric acid is typically stored and excreted as potassium salts. A Florida gopher tortoise requires much less water to process a gram of protein than a dog of the same body mass, even adjusting for the two species different metabolic rates. Uric acid as a nitrogenous waste is not without hazard. During dehydration, water flow through the kidneys may be slowed or almost completely shut down causing uric acid to precipitate and crystallize in the tubule or glomerulus. If uric acid precipitates in tissues, the reptile is suffering from gout.

Most reptiles can shift their protein metabolism in response to the availability of water, producing larger amounts of ammonia in their urine when water access is unrestricted and

increasing the proportion of urea and uric acid as water is restricted. There are limits to how much they can shift one way or the other.

The reptile kidney has far fewer nephrons than an equal-sized mammalian kidney, something on the order of a thousand times less. Thus a kidney infection or other disease may more rapidly become irreversible in a reptile compared to a mammal. Another significant difference from the mammalian renal system is that the reptile kidney cannot concentrate urine. A healthy reptile's urine specific gravity reflects the plasma osmolality at the time of formation.

Urine flows from the kidney through the ureters to the bladder which may be vestigial or lacking in many reptile species. Unlike mammals, the bladder is not sterile as it opens into the cloaca. Since the gastrointestinal tract also empties into the cloaca, the bladder may be contaminated with microbes from feces.

The water in the bladder acts as a fluid reserve for the reptile and may be absorbed back into the body in times of water stress. There are cilia lining the bladder that likely keep solid material in the bladder, like microcrystals of urates, in suspension. Even when the urate levels are high, the suspension remains fluid and easier to void through the urethra than if it is allowed to form into larger crystals. It is similar to what a Slushee™ machine does with ice, or an ice cream machine with frozen milk. If the cilia are damaged, large crystals begin to form. Crystals may also form as the dissolved solutes become very concentrated in the urine of a reptile that is not drinking and consequently not completely emptying its bladder on a regular basis. Theoretically, mineral crystallization results from urine retention leading to urine supersaturation with mineral constituents until an ionic balance appropriate for crystal aggregation occurs, or a matrix (such as protein) is formed that serves to start crystal growth.

In reptiles without a bladder, the urine may retrograde into the colon which serves as a “pseudo-bladder”. In times of dehydration these reptiles may appear constipated.

Contributing Factors

Chronic subclinical dehydration is suspected as an underlying cause of degenerative renal disease in many pet reptiles. The water bowl may be too small for full immersion; swimming may be beneficial for reptiles such as green water dragons (*Physignathus cocincinus*). Water may not be presented in the appropriate manner; an anole (*Anolis carolinensis*) drinks droplets and may not drink water from a bowl. Arboreal reptiles such as panther chameleons (*Furcifer pardalis*) and emerald tree boas (*Corallus caninus*) may become dehydrated if one relies entirely on automatic drip systems or foggers rather than taking the time to watch that they drink. People often misjudge how much water desert reptiles need, or do not recognize the impact on their local conditions on their reptiles. For example, pet bearded dragons (*Pogona vitticeps*) and leopard geckos (*Eublepharis macularius*) do well in humid Central Florida without “moisture retreats” or weekly soaks in shallow water baths. If that same approach is used in arid Central Arizona these lizards will become dehydrated.

A poor thermal environment is often implicated in the development of renal disease. If the reptile cannot reach its preferred optimal temperature zone (POTZ), its renal metabolism may be slower than needed to move uric acid out of the tubules and into the ureters and bladder.

Malnutrition is implicated in degenerative renal disease. Vitamin A deficiency leads to squamous metaplasia of the renal epithelium, restricting the lumen of tubules and decreasing the functional capacity of the nephrons. A diet that has inappropriately high levels of protein, for example feeding animal protein to an herbivorous tortoise, will predispose the reptile to prolonged hyperuricemia. If the circulating plasma has inordinately high level of uric acid, this may cause the uric acid to precipitate out into tissues causing gout.

Green iguanas (*Iguana iguana*) are often kept in a “perfect storm” of pitfalls leading to dehydration and renal disease: cage humidity under 80% relative humidity; a water bowl too small and/or not cleaned often enough; temperatures are often too low; and a diet that is high in dried materials like pellets or biscuits and/or includes animal protein like dog food and cat food. (While green iguanas do eat some animal matter as neonates, adult green iguanas are almost entirely folivorous (eating leaves).)

If the water bowl is not cleaned and disinfected frequently, a reptile may be forced to drink and bathe in feces-contaminated water. This is likely a major factor in hexamitiasis outbreaks and bacterial pyelonephritis.

Clinical Signs

Clinical signs of renal disease are nonspecific until the disease is advanced. Inappetance or anorexia, sunken eyes, and lethargy are early signs. A foul or unusual odor to the oropharynx may be noticed at more advanced stages. A white sheen may be visible in the oral mucosa. The iridial and scleral blood vessels may become prominent and tortuous. In end stages, the tail tip and digits may show dry or wet necrosis from ischemia related to mineralization of the small blood vessels. If a reptile with advanced renal disease is force fed, it often vomits or regurgitates.

Unfortunately, most reptiles are not presented until they are in advanced renal failure. Renomegaly may be detected in lizards by palpating just anterior to the pelvis in the paralumbar fossa. In snakes it may be felt in the caudal 1/3 of the body. Large chelonians and lizards may have renomegaly detected with a digital cloacal exam. Most reptiles with renomegaly are often constipated as the enlarged kidneys obstruct the pelvic canal and preclude passage of feces and urates. This enlarged colon can be palpated. The reptile is often weak, lying on the table rather than sitting in an alert and erect posture. The breath may have a foul odor. The reptile may be obviously dehydrated with sunken eyes and thick ropy mucus in the oropharynx. A bladder stone may be palpable in those reptiles that have bladders (e.g., green iguana, tortoises) or as a urolith in the colon (e.g., chameleons, bearded dragons).

The Sonoran desert tortoise (*Gopherus agassizii*) and African spurred tortoise (*Geochelone sulcata*) account for the majority of bladder stone cases. Since these are the most common species kept as pets in Arizona, it is not too surprising they account for the majority of my

patients. Any species of tortoise may develop bladder stones. Nevertheless, when all of the commonly seen species of tortoises at my practice are included (e.g., leopard tortoise *Geochelone pardalis*, European tortoises *Testudo* spp., redfoot tortoises *Geochelone carbonaria*, Indian star tortoises *Geochelone elegans*, and Aldabra tortoises *Geochelone gigantea*), the vast majority of bladder stone cases are desert tortoises and African spurred tortoises with leopard tortoises a distant third. Bladder stones have been found in juvenile tortoises fewer than 2 inches (5 cm) in length and adult tortoises weighing over 70 pounds (35 kg). Bladder stones are also seen in green iguanas and chuckwallas (*Sauromalus* spp.) and rarely in other lizards in my practice. Bladder stones may be hard and firm or hard and friable.

There is no single sign that indicates a tortoise or lizard has a bladder stone. Some tortoises may lose their appetites; others may simply be less active. More serious signs are straining or failure to defecate. Gravid females may repeatedly dig nests and strain to lay eggs without success. Some tortoises and lizards appear paralyzed or paretic in their hind limbs or may walk with an exaggerated limp on one or both sides, a sign sometimes described as a wheelbarrow gait. It is common that a tortoise or lizard is presented with another problem, such as an upper respiratory infection, and the bladder stone is detected in the course of the examination and diagnostics. Because this condition is so prevalent in my clinical practice, it is always on the differential diagnosis list for any sick tortoises and is a compelling reason I recommend regular radiographic screening as part of the diagnostic work-up as well as part of the annual preventive medicine program for tortoises.

Diagnosis

Remember, offer good medicine and let clients decide the paths for their pets' veterinary care. Veterinarians often omit bloodwork from the initial reptile database due to a perception that clients won't pay for diagnostic tests on reptiles. Other veterinarians rely largely or exclusively on outside labs for blood chemistries and reserve the in-house labwork only for gravely ill patients. If you've got the diagnostic machine, use the machine and your quality of care will improve! Except where a reptile's body size precludes obtaining an adequate volume of blood safely, I recommend in-house screening bloodwork (Abaxis Avian/Reptilian Profile Plus) along with a PCV for rapid assessment of an ill reptile. This rapid screening includes chemistries valuable for detecting kidney disease. I consider Ca, P, K⁺, uric acid, and albumin as the main indicators of kidney function available on the Abaxis Avian Reptilian Profile Plus. Depending on initial results, outside labwork such as BUN, complete blood count, protein electrophoresis, and other tests may be offered.

Diagnosing renal disease is an interpretive art that must consider many factors. The calcium, phosphorus, and potassium levels are more indicative of the reptile's renal function. If the Ca:P ratio is inverse, particularly if the phosphorus is twice normal value, the kidneys are likely not filtering effectively. If the solubility index of the blood exceeds 55 (SI = Ca in mg/dl x P in mg/dl), mineralization of the body tissues often occurs and may be detected as a white sheen in the oral mucosa similar to gout. Hyperkalemia increases the likelihood of kidney disease since 90% of potassium excretion is via the kidney and anything that decreases its function may

decrease potassium excretion. Reptiles have a wider range of potassium compared to the tightly regulated system of mammals, but values over 7 mmol/L are often abnormal

Hypoalbuminemia may occur with excess loss such as a protein-losing nephropathy. Low albumin is also associated with low production (such as cirrhosis, hepatic lipidosis, and hepatic amyloidosis) or excess loss such as protein-losing enteropathies. Unfortunately albumin is quantitatively inaccurate using dry film analyzers but is precise and will reflect overall trends from sample date to sample date thereby letting you know that albumin is rising, falling, or remaining approximately the same. Protein electrophoresis through an outside lab provides a more accurate albumin level and may help distinguish albumin loss from lack of production.

One misconception is that a reptile has healthy kidneys if its uric acid is within normal limits and that it has kidney failure if the uric acid is high. Uric acid fluctuates with eating and may double or triple its baseline levels in a snake or other carnivorous reptile that recently fed. Uric acid is a relatively insensitive test for kidney disease except if the level is high and remains high. Chronic elevation of uric acid will result in gout. Sometimes this is detected as a white sheen in the oral mucosa.

It may be helpful to have BUN for some reptiles. Many reptiles show a normal elevation of BUN before and during hibernation which appears to protect against freezing but may show elevations of BUN with dehydration and renal disease. BUN may fluctuate with feeding and suffers the same interpretive limitations as uric acid.

Reptile kidneys contain moderate levels of AST, ALT, CK, and LD (lactate dehydrogenase). However these enzymes are found in other tissues and therefore elevations of these enzymes are not specific for kidney disease. Also, enzymes may not be elevated depending on the nature of the renal insult and the timing of the blood sample. I strongly suspect that the delay between the first mild signs of a reptile's illness, such as missing a meal, and its presentation to a veterinarian may miss elevated enzymes unless the insult is ongoing (such as active inflammation, infection, or toxicosis).

Anemia is commonly associated with renal failure likely due to reduced erythropoietin levels. Reptile erythrocytes may live 90 to more than 300 days depending on the species, so anemias generally indicate chronic disease processes of several months' duration. If a reptile has a PCV at or below 10% it has a grave prognosis. Leukocytosis or profound leukopenia, toxic heterophils, and elevated globulins suggest pyelonephritis.

Urinalysis may be helpful. Reptile urine is not sterile so bacteria are to be expected. Signs of a kidney infection are increased WBCs and RBCs and casts. The finding of even a single *Hexamita* should be considered significant since this flagellated protozoa may infect the kidneys. Tortoises and herbivorous lizards produce alkaline pH when they are eating and in an anabolic state; neutral to acidic urine is produced when they have not been eating for a few days and are starting to become catabolic.

Radiographs and ultrasonograms may reveal renomegaly, bladder stones, or impaction of the colon. Mineralization of the tissues may be detected on radiographs. Unfortunately, all of these diagnostic tests are only useful in detected late stage renal disease. Confirmation of the type and stage of renal disease is best achieved with biopsy. Endoscopy is helpful in obtaining a biopsy, but the kidneys may also be biopsied in some lizards using a needle punch biopsy inserted through a caudolateral incision between the upper leg and tail. Renal biopsy is the gold standard to characterize renal disease. Unfortunately, the cost, patient risks, turnaround time for results, and often inconclusive histopathology may not alter your treatment plan unless it confirms another disease process beyond your presumptive (operating) diagnosis of “kidney disease”. The histopathology often yields a prognosis (which is often poor) but may not answer the question, “Why did my pet get sick?”

Treatment

In pet reptiles the common diseases of the kidneys include acute and chronic failure, pyelonephritis, and renal neoplasia, with gout a common sequela of renal disease. Renal disease is a common problem of adult to geriatric reptiles.

As a general rule, pyelonephritis has a fair prognosis if caught early and treated appropriately. However, once the kidney has been irreparably damaged, amelioration of the disease is possible but a full recovery is not.

Management of the reptile in renal failure is aimed at improving the thermal environment, adequate hydration (20 ml water/kg orally (PO) once daily (SID) minimum), and a diet that provide a small amount of high quality protein with low levels of potassium and phosphorus. Kidney infections are often treatable so antibiotics should be considered even if the urine was nondiagnostic. Diuresis with dilute saline may be helpful (20 ml/kg SID, often by intraosseous (IO) catheter hooked to a syringe pump or by subcutaneous or intracoelomic route). Soaking in shallow lukewarm water will help with diuresis. Gavaging with water may also help provided you are not inducing fluid overload. Allopurinol (10 mg/kg PO SID) has ameliorated effects of hyperuricemia in some animals. Red palm oil and other omega fatty acid mixes may help reduce inflammation, and supplemental B-vitamins and elemental liquid diets may help provide appropriate nutrition. Typically a reptile will show improvement within 5-7 days of fluid therapy although sometimes it may take 2-3 wk. Reptiles that continue to appear depressed following a few days of fluids therapy carry a poor prognosis. Even with aggressive management, it is unlikely for the reptile to live longer than 6 mo once diagnosed with advanced renal failure. There is no data available on mild renal failure patients as too few reptiles have been diagnosed early enough for long-term retrospective studies.

A client should be informed that a pet reptile with elevated phosphorus, elevated potassium, and an inverse calcium to phosphorus ratio carries a guarded prognosis, and will require significant care to be given a chance to recover. It usually takes at least 5 days to know if any improvement is a true measure of the recovery from underlying disease. In my experience, about one in four reptiles with advanced renal disease are able to recover and live a good quality of life afterward. About one in four need life-long special care, and two in four die or are euthanatized.