AMPHIBIAN MEDICINE

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A veterinarian should have a thorough understanding of the biology and captive husbandry of amphibians before practicing medicine on the amphibian patient. Several excellent sources concerning the anatomy and husbandry of amphibians are readily available, and there are a few texts which focus on aspects of their veterinary care. Amphibians are a unique class of vertebrates that have existed for over 300 million years. Amphibians were the first vertebrates that could utilize terrestrial habitats, but most modern species still rely upon aquatic environments for breeding and the development of young. There are three extant orders of amphibians --Gymnophiona, the caecilians, Urodela, the newts and salamanders, and Anura, the frogs and toads.

Several anatomic features have important consequences to the veterinary clinician:

a) extremely thin epidermis and dermis. Minor abrasions will remove the epidermis, and can become the point source for a more serious infection.

b) toxin producing glands. The clinician should wear (washed) latex gloves to avoid contact with these potentially irritating substances.

c) the lung or skin are usually the primary site of respiration for terrestrial amphibians, while the gills and skin are important for aquatic amphibians.

d) the hepatic portal veins receive blood from the caudal portion of an amphibian with possible consequences on the pharmacokinetics of hepatic excreted drugs.

e) an amphibian can not concentrate its urine beyond the solute level found in its plasma. Aquatic amphibians excrete ammonia, terrestrial amphibians excrete urea and uric acid.

f) amphibians are carnivorous as adults. Some amphibians have teeth that can inflict severe bite wounds.

Amphibians tend to prefer cooler and moister environments than the sympatric reptiles. Tropical amphibians are best maintained at temperatures between 21-26°C (70-80°F), and temperate amphibians will do best at temperatures between 15-21°C (64-72°F). The relative humidity should range from 75-95% for most species of amphibians, and daily misting with aged water is recommended. A thermal and humidity gradient should exist within the enclosure so that an
amphibian can seek its preferred microenvironment. A temperate (10 hr on, 14 off) or tropical (12 hr on, 12 hr off) photoperiod is suggested. Full spectrum illumination is suggested given the unknowns of a particular species' spectral requirements. Amphibians may be categorized by husbandry requirement - fossorial, terrestrial, and aquatic. Fossorial and terrestrial amphibians should be provided with 2.5-10 cm of sterile topsoil. A covering of leaves and/or sphagnum moss should be placed on top of the soil, and cork bark or other flat pieces of bark can be added for hiding spots. A wet bog-like area should be provided in one corner of the cage. A shallow source of potable water is needed. Deep water dishes should be avoided as terrestrial amphibians can become trapped and drown. Terrestrial amphibians that are arboreal require a vertically oriented enclosure. Broad-leaved plants and tall hollow logs should be used to provide hide spots. Aquatic amphibians require a typical aquarium setup with an under gravel filter and an outside canister filter. The substrate may be a bare tank bottom, sand, river mud, or pea gravel. Retreats should be provided, but use only items with smooth edges. A dense mat of floating aquatic plants is desirable. A haul out area of damp sphagnum moss will be utilized by many specimens, and should be provided.

The amphibian examination should be performed in a routine manner. The exam should include a husbandry review. A water sample from the enclosure should be analyzed. The amphibian should be observed prior to handling. Posture, attitude, and respiratory rate should be noted. Material around the nares, skin lesions, and corneal lesions should be noted. The animal should blink if the ocular globe is approached. Abdominal palpation should be attempted. Oral examination is facilitated by the use of a speculum. Withdrawal reflex of the limbs and righting reflex should be tested and noted.

Parasitologic diagnostics should include direct, flotation, and acid fast stain. Skin lesions should be scraped and examined by wet mount. Medium sized amphibians (50-100 g) will yield blood samples adequate for white blood cell count (WBC), packed cell volume (PCV), total solids (TS), leukocyte differential, chemistries, and/or blood culture. Complete blood counts (CBC) and full serum or plasma chemistry panels can be expected of larger amphibians. Lithium heparin does not affect the values of plasma calcium, sodium, or ammonia. Ammonium heparin and sodium heparin may be used if the ammonia or sodium level of the plasma is not important. Venipuncture sites include the lingual venous plexus, the midline abdominal vein, the ventral caudal vein, and cardiocentesis. Complete blood counts may be performed in the same manner as described for avian and reptilian species. The granulocytes of amphibians have not had staining characteristics correlated with cellular capabilities and immune functions as yet. It is important to note that basophilic leukocytes appear to be the predominant leukocyte type in many amphibians. Serum or plasma chemistries of the amphibian patient may be processed on standard dry film analyzers. Abdominocentesis sites are the paralumbar fossa or lateral to the ventral midline. Data obtained may include protein content (generally < 2.0 g/dl), cytology, and microbial specimens.

Amphibian bacteria should be cultured at room temperature and a second set at 35°C (98°F). Specialized techniques may be needed for proper identification of the isolates. Clinical signs suggestive of bacterial septicemia in an amphibian include, but are not necessarily limited to the
following: hypopyon, hyphema, petechiation of the ventrum, ecchymotic hemorrhages of the ventrum, bloating (e.g., ascites, gastrointestinal gas), subcutaneous edema, anorexia, lethargy, convulsions, and sudden death. Ventral hemorrhages (hence the descriptive term red leg disease) are similar to lesions of disseminated intravascular coagulation, and may be present from hours to days prior to death. In classic outbreaks of red leg disease, more than one animal in an enclosure is affected as a rule.

Gram negative bacteria such as *Aeromonas* spp., *Pseudomonas* spp., *Proteus* spp., and *E. coli*, are part of the bacterial flora that may be routinely cultured from otherwise healthy captive amphibians. Poor husbandry increases the likelihood that these organisms may become pathogenic. Clinical signs may be brief. Postmortem lesions are consistent with disseminated septic thrombi. Culture of the blood and internal organs of the dead amphibian is warranted to determine the underlying pathogen, while a blood culture of living patients and apparently healthy amphibians within the same enclosure is suggested. Aeromonads are the most common isolates from cases of clinical bacterial disease in amphibians, and has historically been associated with the syndrome known as red leg disease. Some bacteria, such as *Flavobacterium* spp., have as high an epizootic potential as the classic *Aeromonas* spp.

Appropriate antibacterial therapy varies depending on the sensitivity pattern of the isolate from the clinical case. Initial treatment should include tetracycline (50 mg/kg p. o. b.i.d.), and simultaneous treatment with aminoglycosides (e.g., amikacin 5 mg/kg i.m. q 48 hr). Husbandry review for contributing factors is warranted. The affected and suspect amphibians should be isolated, individually monitored, and treated on a case-by-case basis. Broad spectrum antibiotics with anaerobic activity (e.g., metronidazole 100-150 mg/kg p. o. q 2-3 wk, 50 mg/kg p. o. s.i.d. x 3 days, 50 mg/l as a bath for up to 24 hr; piperacillin 100 mg/kg s.c. or i.m. s.i.d.) may be warranted as anaerobic bacteria may be isolated from ill amphibians. Morbidity and mortality in an outbreak is high despite treatment.

*Chlamydia psittaci* infections of the African clawed frog (*Xenopus laevis*) mimic red leg disease in that species. Its occurrence in other species of amphibians is undocumented. Doxycycline (10-50 mg/kg p. o. s.i.d.) is the drug of choice for chlamydial infections.

Cutaneous ulcers, nodules, abscesses, prolonged lethargy, and poor feeding response are suggestive of chronic bacterial infections, as well as fungal and mycobacterial infections. Skins scrapings of lesions should be obtained to rule out mycobacterial or fungal involvement. Cutaneous ulcers and abscesses of bacterial etiology respond quite well to debridement and appropriate antibiotic therapy, both topical and parenteral. Internal granulomatous infections, as may result in wasting and lethargy, carry a grave prognosis. The mycobacteria associated with amphibians are generally water-borne or saprophytic. Amphibians with systemic mycobacterial infections generally display weight loss despite a good appetite. Euthanasia is recommended if mycobacterial infection is confirmed.

Saprolegniasis is primarily an infection of aquatic amphibians. Cotton-like material on the surface of the amphibian's skin is the hallmark of this disease. Skin scrapings are diagnostic. The incidence
of saprolegniasis is lessened in warm water. Saprolegniasis will be eliminated by appropriate use of salt (10-25 g sea salt/L water s.i.d. x 10-30 min) or formalin baths (0.4 ml 37% formaldehyde/L water s.i.d. x 10-60 min). Isolated lesions respond to topical applications of dilute benzalkonium chloride or malachite green. Chromomycosis is a disease of anurans that is caused by pigmented fungi. Cutaneous lesions are usually dark raised nodules, and the anuran may show signs of debilitation and weight loss. Diagnosis may be achieved by wet mounts of the scrapings and fungal culture. Chromomycosis has a tendency to become pansystemic, unlike saprolegniasis which is normally a cutaneous infection, and chromomycotic granulomatous lesions may spread throughout the viscera. The course of this disease may be quite slow, and therapy is usually unrewarding.

*Entamoeba ranarum* has been reported as a cause of disease in anurans, and suspected as a cause of disease in other amphibians. Pathogenic amoebas are most likely to directly attack the colonic mucosa. Clinical signs are limited in the early stages of amoebiasis and include anorexia, dehydration, wasting, diarrhea, and hematochezia. Failure to pass any stool and regurgitation may be noted at this point. Anasarca, ascites, and dehydration may accompany renal or hepatic amoebiasis in amphibians. Metronidazole (100 mg/kg p.o. q 14 days) is useful in eliminating amoebic cysts. Ciliated protozoa are reported from most orders of amphibians, but gastrointestinal forms are not clearly shown to be pathogenic. Cloudy patches of skin, ulcers, and reddened gills may be related to ciliated protozoal infections in aquatic amphibians. Skin scraping will usually reveal ciliated protozoa causing cutaneous lesions. Salt baths, formalin baths, acriflavine baths (500 mg/l x 30 min s.i.d.), and benzalkonium chloride (2 mg/l x 60 min s.i.d.) may be used to treat ectoparasitic protozoa.

*Rhabdias* spp. are the best known lungworms in anurans. Heavy infections can result in damage to the pulmonary tissue with associated inflammation and secondary infections. Diagnosis is through fecal parasite examination, and the characteristic rhabditiform larvae may be seen. Levamisole (8-10 mg/kg i.c.), fenbendazole (50-100 mg/kg p.o.), and ivermectin (0.2 mg/kg i.m.) may be tried. Nebulization or intratracheal levamisole may be effective.

*Pseudocapillaroides xenopi* has caused desquamation and cutaneous hemorrhage in the African clawed frog. The nematodes and ova can be demonstrated in both the mucous and skin scrapings from the lesions. Thiabendazole (50-100 mg/kg p.o.) was an effective treatment. Fenbendazole, ivermectin, and levamisole may be efficacious too. A levamisole bath may be more effective than parenteral routes.

Signs of gastrointestinal distress may accompany intestinal nematodiasis. Demonstration of parasite ova in the affected amphibian warrants anthelmintic treatment. Fenbendazole, ivermectin, and levamisole are recommended choices for intestinal nematodiasis.

Commonly encountered noninfectious diseases of amphibians include metabolic bone disease. Adult frogs may develop spastic tetany following exercise. Abdominal bloating may be noted. Spinal deformities, angulation limb deformities, and "rubber jaw" may be noted in advanced cases. Parenteral calcium and vitamin D is recommended. Oral supplementation with a slurry of flaked
tropical fish food (generally high in both calcium and vitamin D) may be beneficial. Calcium glubionate at a dose of 1 ml/kg may be given daily to effect, generally a minimum of 6 wk. Daily baths in 5% calcium gluconate may allow uptake of the calcium ion.

Gastric overload and/or impaction (GOI) often results from eating a single overly large prey or consuming too many prey items. Horned frogs (*Ceratophrys* spp.), African bullfrogs (*Pyxicephalus* spp.), and tiger salamanders (*Ambystoma* spp.) are commonly affected. Overly zealous feeding attempts may result in foreign body ingestion. Broad spectrum antibiotics and appropriate parenteral fluid therapy is recommended for an amphibian presented with GOI. Hypotonic saline may be used for gastric lavage. Medical therapy (e.g., mineral oil) may be beneficial, but surgery is recommended.

Various compounds have been documented as dangerously toxic to amphibians. Clinical signs associated with toxicity vary depending on the agent. Treatment requires removing the toxin and providing support (e.g., clean water rinse, parenteral fluids, nutritional support, specific antidotes).

The dehydrated amphibian is best treated by a shallow bath of clean, dechlorinized, well-oxygenated water. Parenteral fluids may be necessary, and should be slightly hypotonic (e.g., 1 part saline to two parts 5% dextrose or nine parts saline to one part sterile water). Do not exceed 25 ml/kg for an initial dose. Avoid use of potassium-containing fluids in the initial therapy.

Abrasions warrant a husbandry review including methods of restraint. Abrasions may require treatment with topical antibiotics (e.g., benzalkonium chloride) if the wounds appear to be spreading, becomes erythematous, or has any opaque discharge noted.

Some anurans develop white corneal opacities. Histopathological analysis of the corneal tissue suggests the presence of cholesterol clefts, and this condition is referred to as lipid keratopathy. Etiology of these lesions is unknown, but may be nutritionally related. Treatment of lipid keratopathy is generally unrewarding. Gout has been reported in anurans.

Cloacal/rectal prolapse is a potentially fatal condition of amphibians. If detected early, the prolapse can be gently replaced. Glycerine gel may be applied to the rectal mucosa to moisten and shrink the tissue prior to placement. A nylon pursestring suture should be used to close the cloaca for 2-3 days, and the amphibian not fed until after the suture has been removed. A red rubber catheter may be left in place to allow voiding of liquid wastes. Prognosis is guarded.

Amphibian medicine is still in its infancy despite the long history of amphibians in biomedical research. This article is a touchstone to the field, and is intended only to acquaint the clinician with this field of veterinary medicine.
REFERENCES


