TRIAGE OF SICK BOIDS (BOAS AND PYTHONS)

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Boas and pythons, members of the family Boidae (about 65 species in 16 genera), are commonly kept as pets and are frequently some of the most valuable reptiles presented in private practice. For example, the 'fire' and 'pie-bald' ball pythons (*Python regius*) currently sell for $4,000 to $10,000, while the so-called 'super jungle coral albino boa' (*Boa constrictor*) has a price tag of $20,000. Even if you don't particularly fancy the color mutants, the normal phenotypes that sell for under $100 are long-lived and many dedicated owners become attached to them, seeking veterinary care when their animal is sick.

Prevention is the key and owners of boids should be encouraged to seek professional preventative veterinary care, including quarantine protocols, routine blood work, fecal evaluations, etc. It is always easier dealing with an emergency for a snake that you already have baseline clinicopathologic data on.

More complete reviews of reptile critical care, emergency presentations and therapy is available from the references.

IT WAS FINE YESTERDAY…HONEST!

There are few true reptile emergencies. Many crises are really the terminal or near-terminal presentation of an unappreciated chronic process. Although the 'sudden' appearance of a mass, acute anorexia or vomiting and diarrhea can probably wait until the next scheduled appointment, acute/severe traumas (eg, injuries and burns) and severe changes in attitude or activity (eg, moribund) should be evaluated as emergencies. Having a reptile-friendly receptionist or technician can be helpful to filter calls from clients. During the initial phone call it is important that the owner is instructed how to properly transport a potentially large snake (eg, a large ice chest), while preventing sudden temperature changes. Husbandry and medical records (especially if a referral from another veterinarian), along with any vomitus, diarrhea, or unknown objects that may have appeared in the vivarium (eg, unfertilized ova, parasites) should also be brought with the animal to the clinic. An estimation of size and accurate identification of species is also essential, so that species-specific information can be perused and preparations made for the snake's arrival. Boids can exceed 600 cm (20 feet) and 150 kg, and therefore some advance preparation for hospitalization may be required.

INITIAL TRIAGE & PHYSICAL EXAMINATION

Upon arrival, the animal should be briefly examined to determine cardiovascular and respiratory stability, mentation, and evidence of trauma or hemorrhage. If cardiopulmonary-cerebral resuscitation, hemostasis or oxygen therapy are unnecessary, the snake can remain in the transportation carrier or moved to a hospital enclosure while a detailed review of husbandry, nutrition, and past medical history (including quarantine, preventative measures, home remedies, and treatments given by other veterinarians) is undertaken.

A detailed physical examination should follow established guidelines, with particular care given to resting respiratory and heart rates; neurologic evaluation; physical examination and palpation; oral examination including glottis; cloacal examination including temperature; and accurate weight. The tendency to rush through anamnesis and the physical, and move on to immediate diagnostic testing or therapy should be resisted. Differential diagnoses will often present themselves to the diligent clinician who is thorough in both historical review and physical examination.

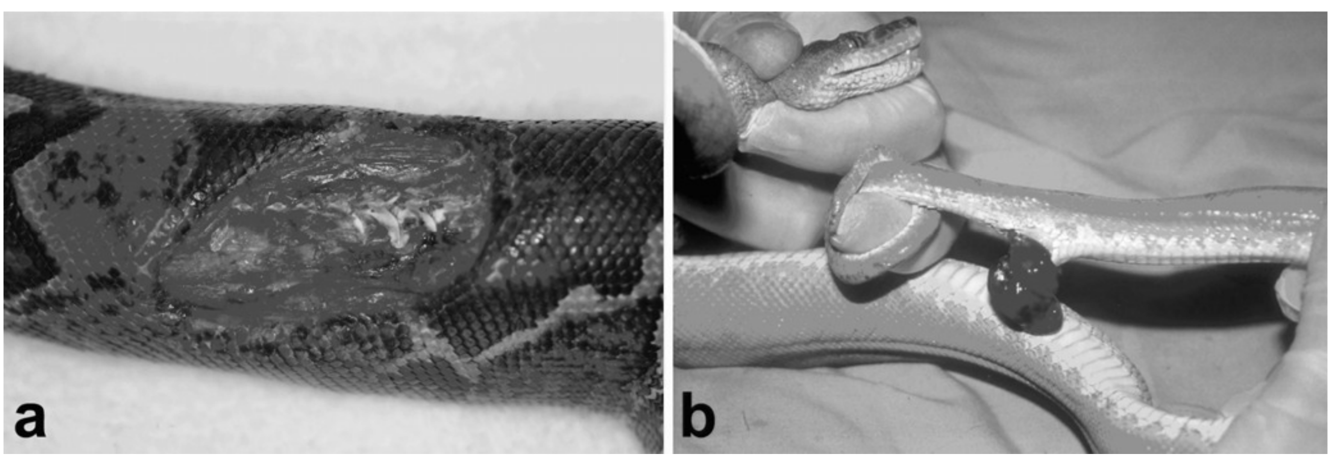

Figure 1. (a) One of several severe traumas caused by a live rat being left in the vivarium with this boa constrictor – note damage extends to and involves the spine. (b) Cloacocolonic prolapse in a green tree python.

CARDIOPULMONARY-CEREBRAL RESUSCITATION

The reptile should be examined for breathing and when no respiratory excursions are noted, cardiopulmonary-cerebral resuscitation (CPCR) should be initiated. The clinician should follow basic life support with the ABC (airway, breathing, circulation) approach of CPCR. Secure a patent airway by endotracheal intubation, and 100% oxygen should be initiated using an Ambubag (Ridge Medical) or ventilator (Small Animal Ventilator, Vetronics) connected to an oxygen outlet. Positive pressure ventilation is commenced at a rate of 4 to 6 breaths per minute, while peak positive pressure ventilation should not exceed 8 cm water. The heart is not easily auscultated using a standard stethoscope; however electronic stethoscopes and ultrasonic Dopplers are more rewarding. Electrocardiography (ECG) can be utilized to identify electrical activity. Dead reptiles may continue to exhibit cardiac electrical activity for many hours after CNS collapse. If no heart beat is detected, epinephrine can be administered endotracheally or intravenously; however, the author is unaware of any cases of recovery following true cardiac arrest in reptiles.

Pulmonary gas exchange and blood gases are difficult to interpret because of heterogeneous gas distribution within the lungs, arrhythmic breathing pattern, extrapulmonary gas exchange, cardiac and pulmonary vascular shunts. End tidal capnography during intermittent pressure ventilation may underestimate the true situation; however, the author has found pediatric mainstream capnography to be extremely valuable in monitoring ventilation. Pulse oximetry measures the hemoglobin absorbance and uses the ratio of oxyhemoglobin to deoxyhemoglobin to determine hemoglobin the saturation. Unfortunately, it is often difficult to obtain a reliable pulse wave, and the information provided for the hemoglobin saturation (SO_2) is based on the mammalian oxyhemoglobin dissociation curve. It remains unclear at this time whether pulse oximetry are accurate monitoring devices for use in snakes.

Doxapram can be given in cases of severe respiratory depression or arrest, and profound and immediate effects have been noted following IV administration. Boids typically have slow heart rates (30–70/min); however in cases of true bradycardia atropine is likely to be effective. If hypovolemia is suspected due to hemorrhage or severe dehydration, intravenous access (catheter or butterfly) should be placed (see catheter placement below) and fluids administered (see fluid therapy). The effectiveness of resuscitation can be assessed with the use of a Doppler probe placed at the base of the heart or peripherally (head or tail) to detect blood flow. The Doppler probe can sometimes be placed over a tail artery to assess pulse quality or determine systolic blood pressure (see shock resuscitation section). Trends in blood lactate and pH may be useful to assess improvement in circulatory status.

SHOCK, BLOOD PRESSURE, AND FLUID RESUSCITATION

Blood volume in healthy boids varies from 4% to 6%, and approximately 75% of body weight is water. Reptiles have an equal distribution of intracellular and extracellular fluid compartments (compared with mammals and birds; intracellular space contains 60% of fluid and the extracellular contains 40% of the total fluid volume). Approximately 30% of the extracellular fluid exists in the intravascular space and 70% within the interstitial space. The principles of water movement and fluid therapy are similar to that in other species.

The osmolarity of reptile plasma is typically lower than that of mammals, and consequently solutions osmotically balanced for mammals (eg, 0.9% normal saline) are likely to be mildly hypertonic for reptiles and may therefore further deplete the intracellular compartment. In addition, many arid species of snakes physiologically cope with dehydration by permitting major elevations of plasma osmolarity.

Blood pressure in reptiles is controlled by mechanisms similar to those described in mammals. Being ectotherms, normal blood pressure in snakes may be more profoundly affected by environmental parameters. The reptile’s ability to mount an appropriate sympathetic response to hypovolemia requires a warm environment.

Monitoring blood pressure in reptiles during fluid resuscitation may be valuable. Indirect systolic Doppler blood pressure techniques have been tried but with no correlation to direct measurements. In snakes, the cuff is placed just distal to the cloaca and the probe detects blood flow from the caudal tail artery. Indirect systolic blood pressures have been reported between 40 and 90 mmHg. Some snakes withstand 4% graded hemorrhage until the cumulative deficit is 32% of total blood volume, and are able to maintain their initial blood volume throughout hemorrhage. Typically, 50% to 60% of the hemorrhaged deficit is transferred from the interstitium to the circulation throughout hemorrhage. Thus, fluid shifts between the intravascular and interstitial compartments significantly compensate for acute hypovolemia, but in some species do not result in a well regulated arterial blood pressure. Therefore, intravenous fluid therapy using crystalloids and colloids may be important for the treatment of hypovolemia.

Perfusion deficits are assessed using mucus membrane color, capillary refill time, blood pressure and heart rate. Bolus doses of warmed crystalloids (5–10 mL/kg) with colloids (3–5 mL/kg) can be given intravenously until improvements are detected. Some colloids such as oxyglobin (hemoglobin-based oxygen carrier) have also the added advantage of carrying oxygen to the tissue. The use of blood transfusions in reptiles has been anecdotally reported.

INITIAL DIAGNOSTICS

Having resolved any immediate cardiorespiratory emergency, initial diagnostic tests should be prioritized to those that can be undertaken in the conscious animal and that will have an immediate impact on directing initial therapy.

Blood

Blood should be collected as a priority for both a complete blood count and full biochemistry profile. Unless dealing with a small individual or a severe hemorrhagic episode, blood volume is usually not a limiting factor when dealing with these larger snakes. Blood is most often collected from the caudal (ventral tail) vein or the heart. The caudal vein is accessed caudal to the cloaca, between 25% and 50% down the tail. It is wise to avoid the paired hemipenes of males and the paired cloacal musk glands. The needle is angled at 45 to 60 degrees and positioned in the ventral mid line. The needle is advanced in a craniodorsal direction, while maintaining slight negative pressure. If the needle touches a vertebral body it is withdrawn slightly and redirected more cranially or caudally. This vessel is most easily entered in larger snakes and lymphatic contamination is possible but generally uncommon. If circulation is poor, it may be necessary to sample directly from the heart. With the snake restrained in dorsal recumbency, the heart is located approximately 25% to 33% from snout to vent. The heart is palpated and immobilized. The needle is advanced at 45 degrees in a craniodorsal direction into the apex of the beating ventricle. Blood often enters the syringe with each heartbeat. It is wise to maintain digital pressure for 30 to 60 seconds following this technique. Good physical restraint is essential to avoid significant cardiac trauma.

Full laboratory analysis, especially hematology, can take hours or even days if using an external laboratory and therefore quick assessment tests are often necessary:

- Packed cell volume (PCV), total protein (TP), and glucose can be quickly determined from 2 heparinized hematocrit tubes of blood using a microhematocrit centrifuge and glucometer. Serial evaluations are cheap and inexpensive.
- Blood smears can be stained with a Diff-Quik stain (Dade Behring), and an estimated total and differential leukocyte count can be performed within minutes. The total leukocyte count is determined by multiplying the mean number of leukocytes of ten fields (x40 objective) by 2000. Be aware that inaccuracy of up to 25% is not uncommon.
- Point-of-care analyzers (eg, I-stat, Abbot) can provide valuable data on blood pH, gases, electrolytes, lactate, and glucose, etc. However, these machines are calibrated for mammals, and not validated for reptiles.
- VetScan (Abaxis) can produce a reptile biochemistry panel (total protein, albumin, globulin, AST, bile acids, total calcium, phosphorus, uric acid, glucose, CPK, K^+, Cl^-, and Na^+) from 0.2 mL of whole blood in less than 15 min.

In-house laboratory results are used to direct therapy, and other supportive measures.

Diagnostic Imaging

Initial imaging should be obtained before giving bolus fluids because subcutaneous or intracoelomic fluids will make interpretation more difficult. In addition, studies should only focus on techniques that can be accomplished without the need for sedatives or anesthesia, and that will help stabilize the animal and direct emergency treatment. Dorsoventral and lateral (horizontal beam) radiographs and ultrasonograms can often be obtained to help assess gross abnormalities, eg, open versus closed fractures of the skull and spine, pulmonary versus gastrointestinal rupture, cardiomyopathy versus cardiac tamponade, tracheal chrondromas versus pulmonary consolidation, renal mineralization, etc. Emergency radiographs are often imperfect regarding positioning and subtle lesions may not be appreciated. It may therefore be advisable to repeat radiographs at a later date, when anesthesia can be safely undertaken.

Sample Collection

Sample collection should focus on those items that will be corrupted or altered by emergency therapy. Therefore, just as blood should be collected prior to fluid therapy, so exudates, fluids, and aspirates are collected prior to antimicrobial and anti-inflammatory use. Sample collection should again be restricted to procedures that can be performed with physical restraint alone, although, gastrointestinal, cloacocolonic, and lung lavage can usually be performed in sick lethargic snakes with minimal resistance. In the case of lung lavage, aspiration should precede saline infusion, because copious volumes of exudates may be aspirated directly from the lungs.

Samples for microbiologic and cytologic evaluation should be divided into those to be sent to a main laboratory and those for immediate in-house assessment. Gram stains can help direct initial antimicrobial choice, while cytology can confirm inflammatory and infectious host responses.

INITIAL TREATMENT

Temperature & Humidity

Moribund snakes cannot move or thermoregulate, and unless presented in a severely hypo- or hyperthermic state, should be immediately housed at the upper end of the species-specific preferred optimum temperature zone, commonly 29-30 ^{o}C (88-90^{o}F). Unless species-specifc requirements dictate otherwise, 80% humidity should be provided.

Fluid Therapy

The parameters used for assessing hydration include mucous membrane moisture, skin elasticity, position of the ocular globe, PCV and TP. Many arid snakes have a high tolerance for dehydration and increases in plasma sodium and osmolarity. They are able to restore plasma

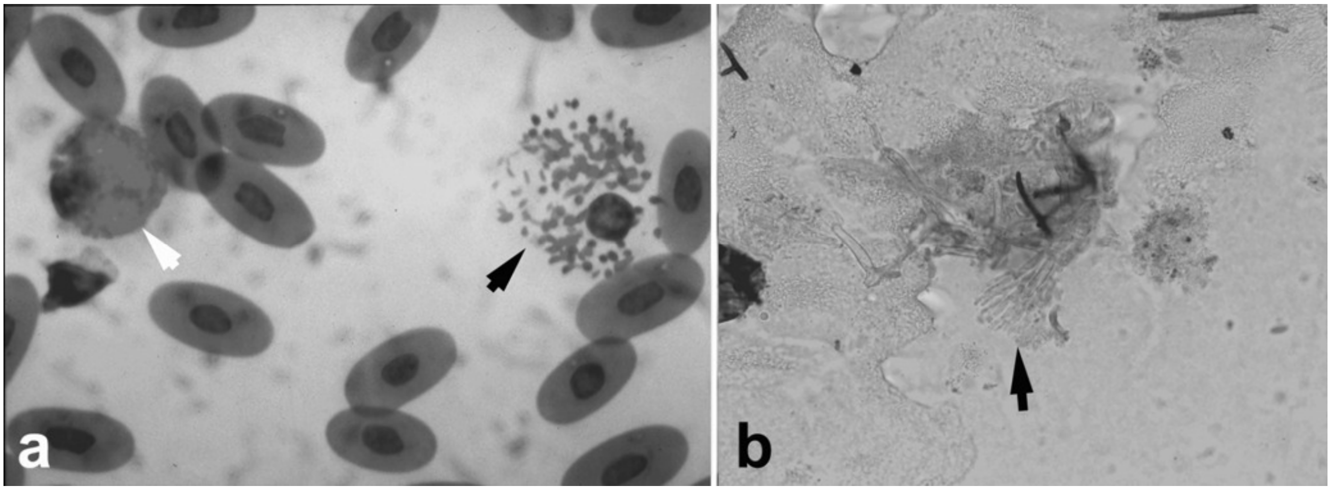

Figure 2. (a) Stained blood smear from a ball python demonstrating a reactive monocyte (*white arrow*) and toxic degranulating heterophil (*white arrow*), suggestive of severe inflammatory or infectious response. (b) Impression smear from an ulcerated wound indicating fungal elements (*arrow*) and the primary need for topical antifungal rather than antibiotic medication.

sodium through increased thirst and excretion of sodium from salt glands. Dehydration deficits should be restored using a crystalloid with an osmolarity comparable with normal reptile plasma (varies between 250 and 290 mOsm/L). The normal plasma sodium concentration varies with different species, but is generally between 142 and 165 mmol/L. Use of common mammalian isotonic crystalloids (Normal saline, 308 mOsm/L; Plasmalyte-A [Baxter], 294 mOsm/L; Normosol-R [Abbott], 294 mOsm/L) cannot be recommended because undiluted these fluids are relatively hypertonic for reptiles. Jarchow's modification (two parts of 2.5% dextrose in 0.45% saline and one part LRS, 278 mOsm/L) has been specifically recommended for reptiles in the past. The additional dextrose appears to be beneficial and once metabolized provides a net water gain which is particularly useful given that most reptiles present with water deficiencies. However, there may be little or no benefit of this self-made fluid when commercially available 2.5% dextrose in half-strength LRS (264 mOsm/L) is used as a replacement fluid. For meeting maintenance requirements, 2.5% dextrose in 0.45% saline (280 mOsm/L) also appears acceptable. Additional dextrose is given intravenously if the blood glucose is especially low. Reptiles produce lactate and use anaerobic metabolism during anoxia. Blood lactate levels also increase during shock with inadequate tissue perfusion. Lactate is rapidly metabolized to bicarbonate in the liver when tissue oxygen delivery is restored. Concerns over the use of lactate-containing fluids aggravating acidosis are largely unfounded in any snake with appropriate liver function. Fluid deficits can be replaced over 12 to 36 hours when lost acutely or more commonly over 48 to 96 hours for the chronically dehydrated snake. Maintenance fluid requirements are 5 to 15 mL/kg/day. Maintenance fluids are given orally when the reptile is able to assimilate oral nutrition and by soaking the in warm fluids. Water absorption may take place through the cloaca during freshwater soaks. Intravascular catheter placement is difficult in snakes and largely restricted to the heart (critical and temporary only) or jugular veins (cut-down procedure but can be maintained for days to weeks).

Wounds

Acute and severe wounds can be caused by burns, exposed nails or screws, and rodent bites. Burns result in proteinaceous fluid loss and can quickly become severely infected and cause septicemia. While rodents can cause extensive trauma, down to the level of the spine. Emergency measures involve copious wound flushing and wet-dry dressings, fluid therapy, and antibiotic cover. Debridement and reconstruction occur later under anesthesia when the snake is stable.

Cloacal Prolapse

Unlike mammals and birds, dystocia is seldom an emergency presentation; however, straining can lead to cloacal prolapse. Prolapse can also be associated with environmental problems, parasites and intestinal disease, or extramural pressure associated with masses. Identification of tissue origin and viability are important. If the cloaca is viable, then copious flushing should be followed by lubrication and replacement. If impossible, the tissue can be lubricated with an antibiotic ointment and covered with plastic wrap (Cling Wrap®) until the snake can be stabilized for surgical cloacopexy or resection and anastamosis.

Neurologic Dysfunction

Most cases of severe neurologic disease are due to inclusion body disease, septicemia, or CNS trauma. If the cause is obviously traumatic, then intravenous methyl-prednisolone at 1 mg/kg IV may be tried; however, steroids are best avoided in reptiles.

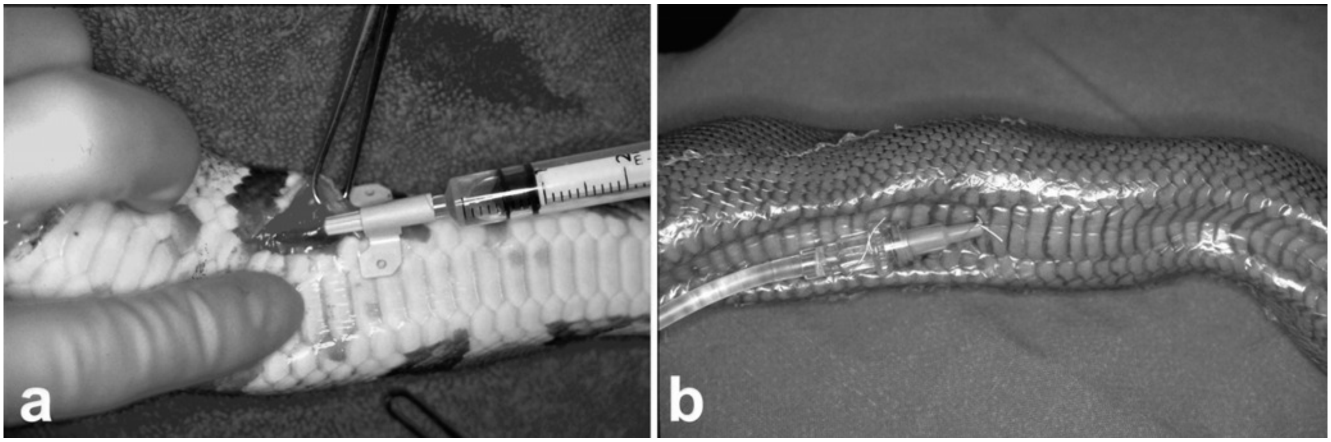

Figure 3. (a) Jugular catheter being placed into a moribund ball python under local anesthesia. (b) Cardiac catheter placed into the ventricle and sutured in place – the entire area is bandaged but the catheter is removed within 24 hours.

Drug Therapy

A complete listing of drugs is available elsewhere. However, the author's initial drug choices may include ceftazidime (gram-negative bacteria), penicillin (gram-positive bacteria and anaerobes), fluconazole or amphoteracin B (fungal), and meloxicam (NSAID) and/or morphine for analgesia.

FURTHER DIAGNOSTICS AND TREATMENT

Following initial stabilization over the initial 1 to 7 days, further case investigation and a definitive diagnosis should be pursued along established lines.[2, 3] Anesthesia, diagnostic imaging, endoscopy and surgery can be undertaken in an attempt to effect a cure.

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