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Raptor Emergency and Critical Care: Therapy and Techniques*

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KEY FACTS

- The standard small animal emergency evaluation protocol (i.e., airway, breathing, circulation) is applicable to birds.
- Intraosseous catheters are the preferred route of vascular access for fluid and drug therapy in birds.
- While blood donation from the same species is preferred, transfusions from other avian species (heterologous) may also be acceptable.

ABSTRACT: Following initial assessment, cardiopulmonary resuscitation, placement of intraosseous and intravenous catheters and air sac tubes, and figure-of-eight bandaging may help clinicians stabilize critical raptor patients. Fluid therapy, including crystalloids, colloids, and blood products, is indicated in critical avian patients. Estimation of dehydration is challenging but necessary to calculate fluid need. Consideration of route, rate, and type of fluid as well as continued patient hydration status assessment are necessary for successful fluid therapy. In addition to fluid therapy, corticosteroids, analgesics, and antibiotics commonly found in veterinary practices are required for raptor critical care. Potential drug therapies and descriptions of emergency techniques in raptors are provided.

Most wild raptors presented to veterinarians have traumatic injuries. Rapid initial assessment and prioritization of problems of the major body systems are critical.

CARDIOPULMONARY RESUSCITATION

There are no studies of CPR in birds. However, the standard small animal emergency evaluation protocol (i.e., airway, breathing, circulation [ABC]) is applicable to birds. In these patients, establishing an airway involves tracheal intubation. To avoid tracheal damage, endotracheal tubes should be uncuffed or the cuff should not be inflated (an inflated cuff may cause necrosis of tracheal tissue due to the inexpansile nature of the avian trachea). In the case of upper-airway destruction or obstruction, air-sac cannulation should be performed (Box 1). Pediatric Ambu-bags or a standard anesthesia machine equipped with a nonrebreathing circuit (Bain) can be used to administer oxygen. Positive-pressure ventilation should occur every 4 or 5 seconds.[1] Keel movement or caudal air-sac inflation is used rather than airway system pressure to gauge appropriate insufflation. External cardiac massage can be at-

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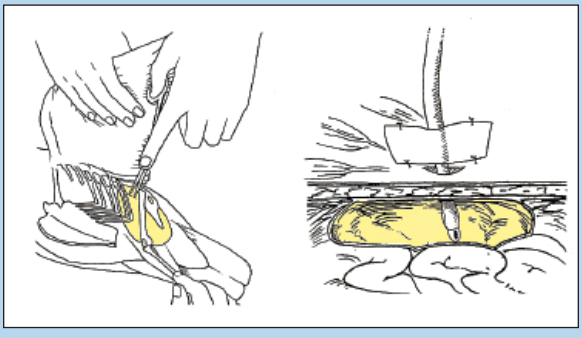
BOX 1
Emergency Air-Sac Cannulation

Materials: Sterilized hemostat, scalpel blade, scrub, nonabsorbable suture, sterile endotracheal tube or red rubber tube that has an internal diameter greater than that of the bird's trachea, cloth tape.

Procedure: The air-sac tube is placed into the left lateral abdominal air sac, which is preferred because of its relatively greater size; however, the right abdominal and cervical air sacs may also be used.[30]

1. The bird is placed in dorsal or right lateral recumbency, and the triangular area bounded by the cranial thigh, keel, and last two ribs is aseptically prepared.
2. A small skin incision is made cranial to the thigh. A hemostat is then driven caudal to the last rib and into the abdominal air sac. A loud popping sound may be heard.
3. The tube, which should be short in order to minimize dead space, is secured in place with a sutured tape flange. If an endotracheal tube is used, tube security may be improved by inflation of the cuff. The tube may be left in place for 3 to 5 days.

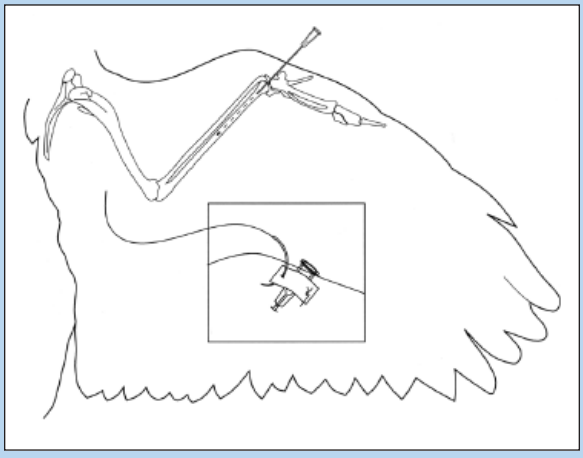


BOX 2
Intraosseous Catheter Placement in the Ulna

Materials (as needed): Tape, nonabsorbable suture, 18- to 25-gauge spinal needle (a needle with a stylet should be used to avoid plugging the catheter), scrub, Vetrap™ (3M, St. Paul, MN), povidone–iodine ointment, heparin–saline solution.

Procedure: With the wing flexed, the crest of the distal ulna is palpated at the dorsal aspect of the carpus. The area is aseptically prepared.

1. The lay of the ulna is palpated with one hand during insertion of the spinal needle.
2. In a manner similar to normograde pin placement, the needle is inserted using firm pressure up to the hub, if possible.
3. Correct catheter placement can be confirmed by blood on aspiration, ease of fluid injection, lack of subcutaneous fluid on injection, blanching of the ulnar vein, and trabecular grating on rotational movement of the catheter.
4. On placement verification, the catheter should be secured with a tape flange attached to the skin with nonabsorbable suture. The insertion site should be dressed with an antibiotic ointment and gauze, and the wing should be wrapped in a figure-of-eight bandage (Box 3).



tempted by pushing down and then pulling up on the keel, which may affect blood pressure and cardiac output via changes in intrapulmonic and abdominal pressure.[2] Access to the circulatory system via intravenous (IV) or intraosseous (IO) catheterization (Box 2) is established following respiratory stabilization. Drugs commonly used in avian CPR are found in Table 1. In collapsed or comatose avian patients, provision of heat by heat lamp, incubator, or thermal heating pad is extremely important.

FLUID THERAPY

Routes of Administration

The route of fluid therapy may be decisive in critical raptor patients. Subcutaneous (SQ) and oral routes of fluid therapy and nutritional support should be reserved for stable patients that are less than 5% dehydrated.

Subcutaneous Fluid Therapy

Areas for SQ fluid administration include the inguinal region, midback, intrascapular area, axillary region, and lateral flank.[3,4] Total volume of fluids administered per site should not exceed 10 ml/kg to avoid blood-flow disruption and poor absorption.[5] Hyaluronidase, a protein enzyme that modifies the permeability of connective tissue, has shown promise in aiding absorption of SQ fluids in avian patients.[6] Intracoelomic fluid therapy is avoided,

TABLE 1
Avian Cardiopulmonary Resuscitation Drugs[22]

Drug	*Dose*
Epinephrine 1:1000	0.5–1.0 ml/kg IM, IV, IO, IT
Doxapram (Dopram V®, Fort Dodge Animal Health, Fort Dodge, IA)	20 mg/kg IM, IV, IO, IT
Atropine	0.5 mg/kg IM, IV, IO, IT
Prednisolone sodium succinate	10–20 mg/kg IM, IV q15min as needed

IM = intramuscular; *IO* = intraosseous; *IT* = intratracheal; *IV* = intravenous.

and care should be taken when administering fluids SQ to avoid introducing fluid into the extensive air-sac system. Fluids containing dextrose or glucose should not be administered SQ as they may provide a medium for bacterial growth. In critical patients, IV or IO routes of fluid administration are preferred.

Intravenous Catheters

Intravenous catheter placement in birds has been described but is not recommended for the novice.[7,8] Maintenance of an indwelling catheter is hindered by fragile vessels, lack of dermal tissue for catheterization, and patient temperament.[9] Bolus IV therapy has also been described; however, due to the fragility of avian veins, it may lead to hematoma formation even when performed with the patient under anesthesia. Catheterization of the deep ulnar vein (see companion article, May 2001)—when properly secured with suture and tissue glue and accompanied by a figure-of-eight wing bandage—may be suitable for large raptors (Box 3).[10]

Intraosseous Catheters

Intraosseous catheter placement is preferred in birds because of ease of placement and maintenance as well as the ability of this type of catheter to provide ready venous access for fluids and drugs.[9,11] IO catheters should not be placed in pneumatic bones (i.e., humerus, femur) as these may act as a direct portal to

BOX 3
Figure-of-Eight Bandage Application for Wing Fractures and Coverage and Stabilization of Wing Catheters

Initial bandage placement ensures prevention of slippage from the anconeal joint, which would promote undue bandage stress at the carpus and leverage forces at the humerus. Start with the bandage placed under the wing as far in the axillary regions as possible *(A)*. The wing is then brought together as a single unit so that the bones of the humerus, radius and ulna, and metacarpus are roughly parallel in order to form functional splints for the broken bone. Successive layers of wrap are shown here as moving down the wing for the purpose of illustration. In reality, this wrap would probably be placed much higher, depending on the fracture *(B)*. Note that the finished wing position mirrors that of the normal wing at rest and that no flight feathers are bent out of place *(C)*. To give further stability to fractures at or proximal to the humerus, a wrap that stabilizes the wing to the body may be placed. Care should be taken that this body wrap, which should be placed under the unaffected wing instead of incorporating it, is not too tight or low. Improper placement could affect respiration by compromising keel movement *(D)*.

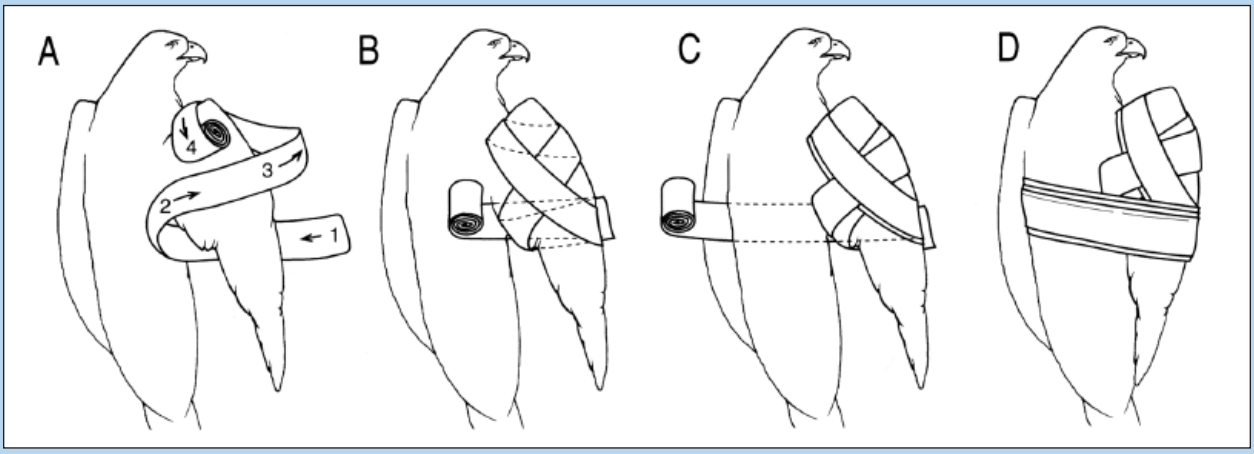


TABLE 2
Clinical Signs of Dehydration in Raptors[4,14,24,25]

Percent Dehydration	*Clinical Signs*
≤5%	Not detectable
≥6%	Minimal clinical change; mild decrease in skin turgor; subtle loss of skin elasticity, "tenting"; decreased turgor or increased wrinkling of cere; loss of brightness and roundness of eyes; increase glaze to the eyes; slightly dry oral mucous membranes; thick ropy saliva in the pharynx
≥7%	Ulnar vein refill time >1 second
8%–10%	Loss of skin elasticity more pronounced; skin tents over dorsal metatarsus when elevated; eyes lose brightness; oral mucous membranes are dry
>10%–12%	Substantial loss of skin turgor; skin ridging over medial and lateral aspects of toes; tented skin stands in place; muddy color to mucous membranes; dry membranes; cool extremities; enophthalmia; definite, severe depression; increased heart rate
>12%–15%	State of shock more profound, patient approaches death; moribund; coma

the air-sac system. The preferred sites for IO catheterization are the distal ulna in larger raptors (greater than 500 g) and the proximal tibiotarsus in smaller raptors (less than 500 g). Placement is similar to that used for normograde insertion of an intramedullary pin (Box 2). Strict aseptic technique (similar to that for IV catheters) should be adhered to in placement and continued care of IO catheters. They should be flushed with heparinized saline regularly as they may be more prone to blockage than are IV catheters, and, barring extenuating circumstances, their use should be discontinued after 3 to 5 days. IO catheters may be used to administer injections, slow boluses, and constant-rate infusions. Most drugs may be infused through IO catheters, although hypertonic or strongly alkaline drugs should be diluted before infusion.[12]

Indications

Information on fluid therapy in birds is sparse, with most references extrapolated from mammals.[4,7,13,14] In critically ill raptors, fluid therapy is almost always indicated. Although raptor dehydration is difficult to assess, clinical signs can be used for estimation (Table 2). Additional nonspecific signs of significant dehydration in birds include tenacious, viscous mucus in the oropharynx.[15] In young birds (which are more susceptible to dehydration), wrinkled, reddened skin or a sunken face with prominent eyes may be apparent.[16] Clinical signs of improved hydration include weight gain, improved pulse, return to normal skin plasticity, increased urine output, and improved mental attitude.[14] Acute signs of overhydration include apprehension, regurgitation, tachycardia, and dyspnea.[14] While necessary in many cases, aggressive fluid therapy should be monitored carefully in anemic or hypoproteinemic patients, which are more likely to succumb to cardiovascular collapse or pulmonary edema.[5]

TABLE 3
Fluid Doses for Common Sizes of Raptors Based on Route of Administration[22]

Raptor Weight (g)	*Intravenous/ Intraosseous Bolus (initial; ml)*	*Subcutaneous (ml)*
100–250	2–5	12–18
>250–500	5–8	18–24
>500–750	8–12	24–28
>750–1000	30–40	28–30

Fluid Volume

In an emergency, a quick reference for an initial bolus of crystalloids is useful (Table 3). A standard calculation is often employed for fluid therapy in raptors after shock therapy is initiated. Replacement of fluid deficit takes place over 48 hours (at most); the maintenance fluid rate for raptors is 50 ml/kg/day. However, pediatric raptors may require up to 50% more fluids than do adults.[5] A recent study of Amazon parrots also documented that avian fluid needs may be higher than thought, with water intake of approximately 100 ml/kg/day, depending on the food type offered.[17] Box 4 provides an example of a fluid therapy plan.[3,4]

Fluid Type

Ultimately, it is best to base fluid therapy on the patient's acid–base and electrolyte status. However, some general recommendations can be made based on clinical presentation. Most raptors present with maladies that result in metabolic acidosis and/or hyperkalemia, including trauma, extreme catabolic states, hypothermia, and renal dysfunction. Balanced electrolyte solutions (e.g., lactated Ringer's solution, Normosol-R® [Abbott Labs, North Chicago, IL]) are preferred in these cases.[5,7,13,14]

BOX 4
Example of a Fluid Therapy Plan for a 500-g Raptor

Chief complaint:	Traumatic injury, no apparent respiratory compromise
Minimum database:	Packed cell volume >20%, total solids >2.0, 7% dehydration
Fluid therapy type:	Balanced electrolyte (lactated Ringer's solution, Normosol-R® [Abbott Labs, North Chicago, IL])
Initial shock dose of fluid given at presentation:	8 ml, intravenous or IO (see Table 2; 500–750 g)
Replacement fluids (percentage of dehydration; g)**:**	(0.07)(500 g) = 35 ml
Maintenance fluids (50 ml/kg/day)**:**	(0.05)(500 g) = 25 ml
Daily fluid rate for 48 hours (½ dehydration + maintenance)**:**	35(0.5) + 25 = 42.5 ml/day divided q6h (42.5/4 = 10.6 ml IO slow bolus q6h)
Preferred route of administration:	IO catheter in ulna or tibiotarsus

IO = intraosseous.

Hypokalemia is a common sequela to vomiting and diarrhea in birds. If hypokalemia is documented, lactated Ringer's solution or Normosol-R® may be supplemented with KCl (3 mEq/kg, not to exceed 11 mEq/day).[5] Appropriate fluid therapy choices for common presentations of critically ill raptors are listed in Table 4.

Colloids

Iron dextran (a complex of ferric oxyhydroxide and low-molecular-weight, partially hydrolyzed dextran derivative) is indicated for use in birds suffering from severe blood loss or iron-deficiency anemia. Its use is contraindicated in the septic patient because of the potential for providing growth nutrients for bacteria.[18] Hetastarch is a synthetic polymer that acts as a plasma volume expander and is indicated for chronic hypoproteinemia in birds.[19] Oxyglobin® (Biopure, Cambridge, MA) is a purified polymerized hemoglobin of bovine origin indicated for use in anemic dogs, regardless of the anemic etiology. Although Oxyglobin® has not been studied in raptors, one author has seen positive results in several avian species.[5] Dextrans, hetastarch, and Oxyglobin® are all removed by the kidney and should be used with caution (if at all) in patients with cardiac or renal impairment.

BLOOD TRANSFUSIONS

While rarely indicated, blood transfusions should be considered in critically ill raptors when packed cell volume (PCV) falls below 20%.[18,20] Major ruleouts for anemia in wild raptors include traumatic blood loss, a hemolytic episode associated with hemoparasites, toxicities, or chronic disease.[18] The decision to administer a transfusion should be based on clinical signs, PCV, chronicity of the anemia, cause and severity of the anemia, possibility of further blood loss, and the patient's ability to tolerate the stress of the transfusion. Barring blood transfusion, iron dextran may be used to stimulate blood cell formation. Blood types are currently unknown in avian species, so crossmatching is seldom pursued.[20] Same-species transfusions have the longest erythrocyte survival time, but heterologous transfusions between members of the same genus may also be acceptable. A single transfusion between different species

TABLE 4
Fluid Therapy Choices for Critically Ill Raptors[7,13]

Clinical Abnormality	*Acid–Base Status*	*Suggested Fluid Therapy*
Trauma ± hemorrhage	Metabolic acidosis	Lactated Ringer's solution or Normosol-R®(Abbott Labs, North Chicago, IL), colloid, blood
Emaciation/starvation/extreme catabolic state	Metabolic acidosis	Lactated Ringer's solution or Normosol-R®, colloid, +KCl
Infectious disease (endotoxic shock)	Metabolic acidosis	Lactated Ringer's solution or Normosol-R®, 0.9% saline

TABLE 5
Drugs and Vitamins Indicated for Emergency Use in Raptors

Drug/Vitamin	*Indication*	*Route and Dosing Regimen*
Activated charcoal	Suspected toxin ingestion	2–8 mg/kg PO[5]
Aminophylline	Bronchodilation (mild diuretic)	10 mg/kg IM/IV q6–8h as needed[5]
Atropine	Organophosphate or carbamate toxicity	0.5 mg/kg ½ IV, ½ IM or ¼ IV, ¾ IM, then IM q4–6h until signs abate[22–26] Excessive use may lead to gastrointestinal stasis[5]
Butorphanol	Analgesic of choice	1–4 mg/kg IM[22,23] Ataxia may be seen at higher doses
Calcium EDTA	Preferred chelator in lead or zinc toxicosis	35 mg/kg IM q8h for 3–4 days, off 2 days, repeat until asymptomatic[22] May treat up to 30 days May lead to renal tubule necrosis Discontinue use if polyuria or polydipsia occurs[5]
Calcium gluconate	Hypocalcemia	50–100 mg/kg IM, dilute with sterile saline or water[22]
	Hyperkalemia	0.5 ml/kg IM[18]
Calcium lactate, calcium glycerophosphate	Hypocalcemia	75–100 mg/kg IM[22]
Dexamethasone sodium phosphate	Head trauma (until signs abate) Shock (single dose) Hyperthermia (until stable)	2–4 mg/kg IM or IV q12h[22]
Dexamethasone	Head trauma	2–4 mg/kg IM or IV q6–8h, taper dose[21,22] 0.5 mg/kg IM or IV sid q5–7days[22]
	Trauma	1 mg/kg IM once[22]
	Inflammation, trauma, shock, enterotoxemia	3 mg/kg IM or IV[22]
Dextrose 50%	Hypoglycemia	1–2 ml/kg IV, dilute IO[22]
Diazepam	Anticonvulsant	0.5–1.0 mg/kg IM or IV, as needed[22]
Diphenhydramine	Organophosphate or carbamate toxicity	4 mg/kg tid IM[26]
	Blood transfusion reactions	2 mg/kg IM, IV, or IO[22]
Furosemide	Cranial trauma, cerebral edema, pulmonary congestion	2–6 mg/kg IM, IV, or IO[5,21,22]
Hetastarch 6%	Hypovolemic shock, hypoproteinemia	10–15 ml/kg IV or IO for one to four treatments over 24 hr Reduce crystalloid volume by amount of hetastarch given[19]
Hetastarch	Sepsis and hypoproteinemia	5–40 ml/kg Recommend 5 ml/kg over 10–15 min to effect May be given IV or IO[27]
Hyaluronidase (Wydase™)[a]	Increases absorption of subcutaneously administered fluids	150 U/L SQ (United States Pharmacopeia)[6]
Hypertonic saline (7%)	Head trauma without hemorrhage, hydropericardium, pulmonary edema	4–5 ml/kg IV or IO, constant-rate infusion or slow bolus[18,21]
Iron dextran (6%)	Anemia (contraindicated in sepsis)	10–20 mg/kg IM, repeat in 7–10 days as needed[21,22]

(continues on next page)

TABLE 5 *(continued)*

Drug/Vitamin	*Indication*	*Route and Dosing Regimen*
Mannitol (25%)	Head trauma (contraindicated if intracranial hemorrhage is suspected)	0.25–2.0 mg/kg/day slow IV or IO[21,22]
Oxyglobin®[b]	Anemia	10 ml/kg IV or IO[5]
Phenobarbital	Anticonvulsant	1–4 mg/kg bid PO[28]
Prednisolone sodium succinate (SoluDelta Cortef®)[c]	Shock	10–20 mg/kg IV or IM q15min, as needed[5]
Vitamin B complex	Head trauma Supplementation	10 mg/kg IM once[21] 1–3 mg/kg IM or in feed q1–7d[22]
Vitamin A	Supplementation	10,000 IU/300 g weekly IM[18]
Vitamin D_3	Supplementation	1000 IU/300 g weekly IM[18]
Vitamin C	Antioxidant	20–50 mg/kg IM q1–7d[18]

PO = oral; *IM* = intramuscular; *IO* = intraosseous; *IV* = intravenous.
[a]Wyeth Labs, Philadelphia, PA.
[b]Biopure, Cambridge, MA.
[c]Pharmacia & Upjohn, Kalamazoo, MI.

can be safe and efficacious, although erythrocyte survival time is shorter.[20]

Donation

Blood can be collected from the donor bird's jugular, brachial (wing), or median metatarsal veins. Suitable anticoagulants include sodium citrate, acid citrate dextrose, or citrate phosphate dextrose with or without adenine (1 ml/10 ml blood) or heparin (0.25 ml/10 ml blood).[20] After collection, blood may be refrigerated for up to 24 hours.

Administration

The recipient should receive 10% to 12% (or 1 to 2 ml/100 g) of its blood volume.[20] While blood may be given by IV bolus, the IO method is preferred because it allows administration of either a constant-rate infusion (approximately 2 ml/minute) or multiple boluses of blood over 2 to 4 hours, which the transfusion should span. Blood should be administered through a filter or pediatric administration set to prevent introduction of microscopic clots. Birds with transfusion reactions may exhibit hemolysis, urticaria, anaphylaxis, or vomiting due to volume overload. Treatment is symptomatic and usually involves antihistamines, steroids, and epinephrine.

DRUG THERAPY

Corticosteroids

Corticosteroids have been recommended in cases of shock, toxicity, and nervous system compromise in raptors. Short-acting corticosteroids (e.g., prednisolone sodium succinate, dexamethasone sodium phosphate; Table 5) are preferred for use in raptors. Prolonged use of systemic or topical corticosteroids in birds has been associated with adrenal suppression and necrosis, secondary bacterial and fungal infection (aspergillosis), and interference with normal feather development.[5,21,22] Steroid administration can cause leukopenia due to lymphopenia and result in relative heterophilia of the avian leukogram within hours. Complete blood counts from samples obtained after steroid administration should be evaluated accordingly.[18]

Pain Control

Once the patient's major body systems are stable, analgesics may be administered. Signs of pain in birds include escape reactions, vocalization, excessive movement, increased respiratory rate, increased heart rate, retracted neck, wings held close to the body in a guarding manner, and abnormal behavior. While raptors may have a high tolerance for pain, their behavioral tendency to mask illness to avoid predation may hide signs of pain. Analgesics are indicated for procedures or conditions that cause pain in other animals. Butorphanol is the analgesic of choice in birds; however, carprofen has also been recommended for use in raptors by one author (Table 5).[5,23] As a respiratory depressant, butorphanol should not be administered before a procedure in which general anesthesia is required.

Antibiotic Administration

While ideally all antibiotic therapy should be based on

TABLE 6
Injectable Antibacterial Drugs for Use in Raptors[22]

Drug	*Dose and Route*[22]
Oxytetracycline	16 mg/kg/day IM[22]; 48 mg/kg IM q48h (IM injection may cause significant muscle necrosis)[5]
Enrofloxacin (Baytril®, Bayer Animal Health, Shawnee Mission, KS)	10 mg/kg PO or IM q12h[22]; 15 mg/kg/day PO 15 mg/kg IV (red-tailed hawks only)[29]
Trimethoprim–sulfamethoxazole	48 mg/kg PO or IM q12h
Ceftiofur	10 mg/kg IM q8–12h[22]
Cefazolin	50–100 mg/kg PO or IM q12h

culture and sensitivity results, if sepsis is suspected in the emergency setting, a parenterally administered, broad-spectrum antibiotic should be used. Antibiotic choice should also be based on ease of administration, possible toxic effects, necessary dosage regimen, and drug availability. Table 6 lists common antibiotics useful in raptors.

BANDAGING

Femoral fractures usually require surgical fixation and are managed with cage rest in the emergency setting. Short-term bandaging for injuries of the avian pelvic limb below the stifle but above the tarsus may be accomplished with a padded Robert-Jones splint or bandage. A ball bandage may be used to immobilize fractures distal to or involving the tarsometatarsus. To effectively stabilize the phalanges, cottonballs or cast padding is applied to the ventrum of the foot until the talons are extended. The entire foot is then covered with a nonadherent bandage material (e.g., Vetrap™, 3M, St. Paul, MN).

Figure-of-eight bandages stabilize and prevent complications of fractures and cover and stabilize catheters placed in the veins or bones of the wing (Box 3). Body wraps are added to figure-of-eight bandages to provide more stability to fractures at or proximal to the humerus, including those of the coracoid, clavicle, and scapula.[15] Any wrap that extends around the coelom must not constrict movement of the keel, or respiration will be compromised. Figure-of-eight bandages can be composed of any minimally adherent covering, including masking or paper tape, cast padding, or Vetrap™. The recommended material is Vetrap™ because of its self-adherent capabilities and feather nonadherence.

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ARTICLE #5 CE TEST

The article you have read qualifies for 1.5 contact hours of Continuing Education Credit from the Auburn University College of Veterinary Medicine. *Choose the best answer* to each of the following questions; then mark your answers on the postage-paid envelope inserted in *Compendium*.

1. Which of the following is not recommended for avian wound care?
   a. use of wet-to-dry bandages
   b. temporary fracture stabilization until patient stabilization has been achieved
   c. topical application of steroid-containing preparations
   d. priority given to fractures and wounds involving the coelom and air sacs
   e. use of masking tape, paper tape, cast padding, or Vetrap™

2. Which of the following is not recommended for use in avian patients?
   a. ball bandages
   b. figure-of-eight bandages
   c. Ehmer slings
   d. Velpeau bandages
   e. c and d

3. A sign of significant dehydration in birds is
   a. tenacious, viscous mucus in the pharynx.
   b. wrinkled, reddened skin.
   c. a sunken face with prominent eyes.
   d. an ulnar refill time greater than 1 second.
   e. all of the above

4. The _____ route is recommended for fluid therapy in critically ill raptors.
   a. intracoelomic
   b. oral
   c. rectal
   d. SQ
   e. IO

5. Which of the following statements regarding IO catheters is false?
   a. Strict aseptic technique should be used in their placement and care.
   b. They may be used to administer fluid therapy and some drug therapy.
   c. They should be flushed with heparinized saline.
   d. They should not be used in small (less than 500 g) raptors.
   e. They should not be placed in pneumatic bones (i.e., humerus, femur).

6. Which of the following statements regarding electrolyte status and fluid therapy of injured raptors is false?
   a. Acidosis is common.
   b. Hyperkalemia or hypokalemia may be present.
   c. Fluid therapy is best directed by appropriate electrolyte diagnostics.
   d. A balanced electrolyte solution is preferred.
   e. Colloids are inappropriate.

7. Which of the following statements regarding colloid use in emergency raptor patients is false?
   a. Iron dextran should not be used if septicemia is suspected.
   b. Dextrans, Oxyglobin®, and hetastarch are contraindicated with cardiac or renal impairment.
   c. Hetastarch is indicated for hypoproteinemia.
   d. Iron dextran is indicated for anemia or blood loss.
   e. Oxyglobin® has been thoroughly tested in birds.

8. Which of the following factors should be considered before blood transfusion in raptors?
   a. clinical signs
   b. PCV (hematocrit)
   c. cause of the anemia
   d. ability of the patient to tolerate the transfusion
   e. all of the above

9. Which of the following is not a suitable anticoagulant for avian blood?
   a. acid citrate dextrose
   b. sodium citrate
   c. citrate phosphate dextrose with or without adenine
   d. heparin
   e. calcium edetate

10. Signs of pain or distress in birds include
    a. vocalization.
    b. excessive movement.
    c. increased heart and respiratory rates.
    d. abnormal behavior.
    e. all of the above