Liberty Wildlife Medical Services

Medical Services
Training Program

• Section Six •

Fluid Therapy

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Avian Respiratory System

The manual in this section is from the:
Manual of Ornithology
Avian Structure and Function
By Noble S. Proctor and Patrick J. Lynch

The Respiratory System

The avian respiratory system is the most efficient in the animal kingdom, and in both its large and small details it is surprisingly unlike that of most other land vertebrates. In spite of their importance, lungs comprise just 2 percent of a birds' body volume (Welty and Baptista 1988). Unlike mammals, birds do not have a muscular diaphragm to power inspiration and expiration; they rely instead on the musculature of the intercostals muscles (Fedde 1975). When a bird *inhales*, air enters the lungs as a bird *exhales*. Almost every major part of a bird's body is in direct communication with its respiratory system of air sacs, a complex anatomic feature unique among modern vertebrates (Schmidt-Nielsen 1971, 1983). The anatomy and air pathways of the avian respiratory system are described by Powell and Scheid (1989) and Scheid and Pliper (1989).

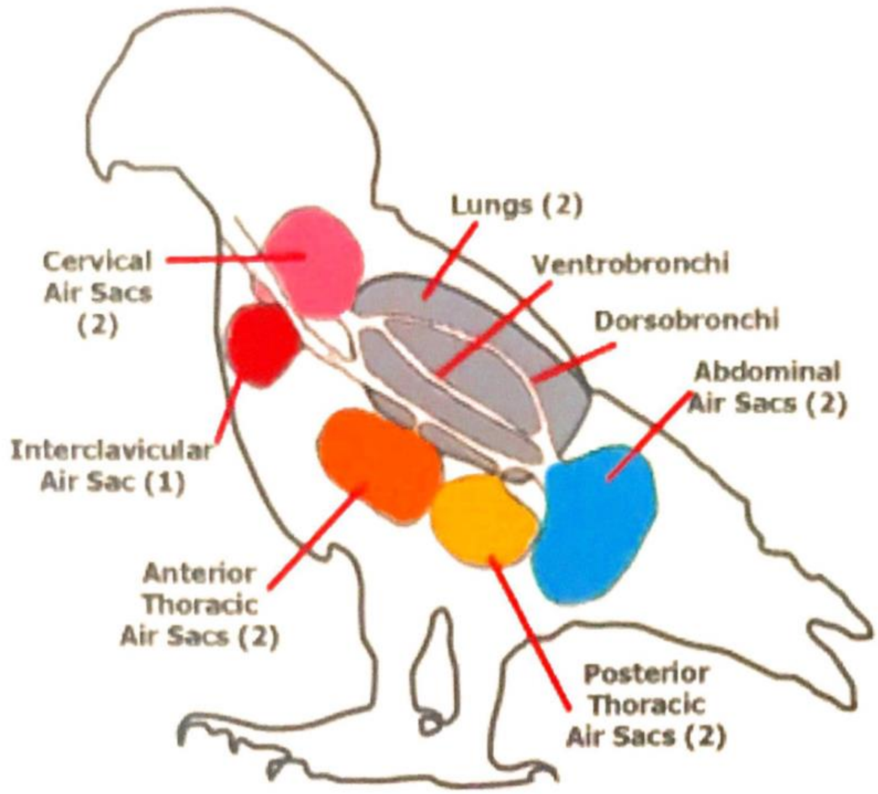
The primary function of the respiratory system is to supply oxygen to the body tissues and to carry away the carbon dioxide produced by metabolic activity. In birds this process of gas exchange is crucial, because the demand for oxygen produced by active flight is enormous. The flight muscles must receive a large and constant supply of oxygen to maintain flight, and such metabolic wastes as carbon dioxide must be removed quickly. In birds both heat and muscular energy are produced at the cellular level through the oxidation of foods stored primarily as fat within the body tissues. This cellular level of respiration, called internal respiration, actually produces metabolic heat and muscular energy. The gross structures of the respiratory system (pharynx, trachea, lungs, and air sacs) comprise the external respiratory system. The external respiratory system brings air into the body, exchanges oxygen from the air with carbon dioxide from the blood and expels waste-laden air from the body (Lasiewski 1972, Salt and Zeuthen 1960).

Reptiles and mammals move air through their lungs in a tidal-flow pattern in which the lungs are blind sacs and air moves in and out of the lungs through the same pathway. Birds, in contrast, have evolved a complex respiratory system of lungs and auxiliary air sacs that allow a continuous stream of air to pass through the lungs in an efficient one-way flow. At rest, both birds and small mammals of equal body size need about the same amount of oxygen to sustain body temperature and moderate activity. But small mammals cannot match birds in producing the huge extra energy demands needed to sustain flight for long periods. The relative efficiency of the avian respiratory system has been demonstrated by exposing sparrows and mice to a simulated altitude of about nineteen thousand feet. At this height mice become comatose, while sparrows are still able to fly and are apparently unaffected by the low levels of oxygen (Schmidt-Nielsen 1971).

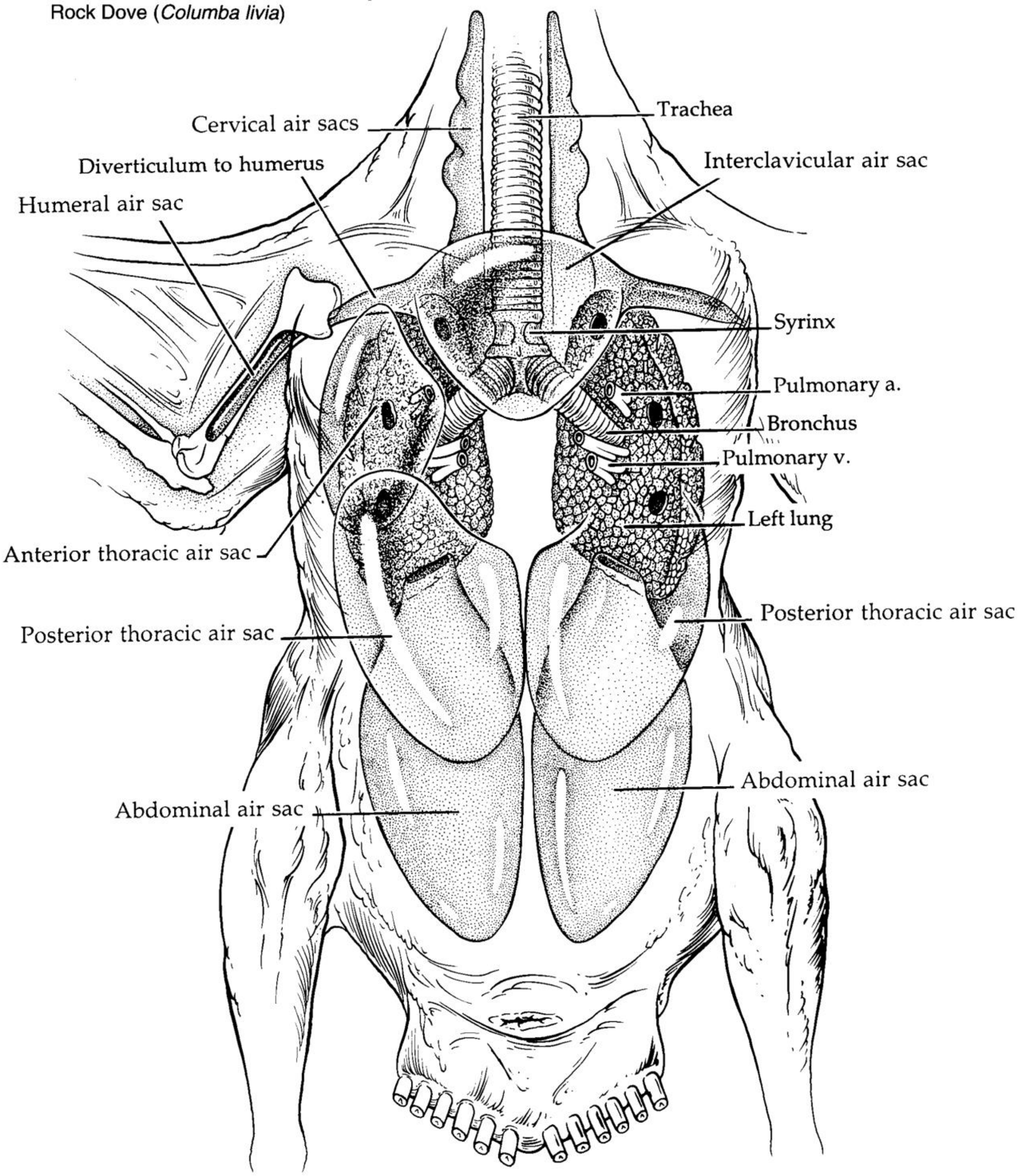
Most flying birds are relatively small, weighing well under a pound. This is a great advantage in flight, but it imposes a difficult physiologic dilemma: small animals have a much higher ratio of body surface area to volume than do larger animals, so they radiate proportionately more heat and must expend relatively more effort to maintain homoiothermy. Most small flying birds face a double respiratory burden – to supply great quantities of oxygen to the flight muscles when in active flight and to feed the metabolic "furnace" that keeps their body temperature from falling dangerously low when they are inactive in colder environments.

The avian respiratory system also cools the body. Birds lack sweat glands and are covered with an insulating blanket of feathers that effectively prevents them from radiating excess heat produced by muscular activity or from shedding heat absorbed from the environment. In hot environments the air sacs of the respiratory system are thought to aid birds in shedding excess heat as they breathe. Cooling apparently takes place as air passes over the walls of the air sacs and absorbs heat from the body, and this lowers the bird's internal temperature. A *few* of the more ardent advocates of homoiothermy in dinosaurs have theorized that the extensive system of pneumatized bones and body cavities found in birds probably evolved first in dinosaurs. Many theropods, including such well-known genera as *Deinonychus* and *Tyrannosaurus*, had extensively pneumatized skulls and the same type of rigid rib cage found in birds (Bakker 1986; Paul 1988). This suggests (but by no means proves) that some dinosaurs may have had a elaborate birdlike system of air sacs and pneumatized bones, but there is little direct fossil evidence for such a claim (Ostrom 1987).

Respiratory System of Birds

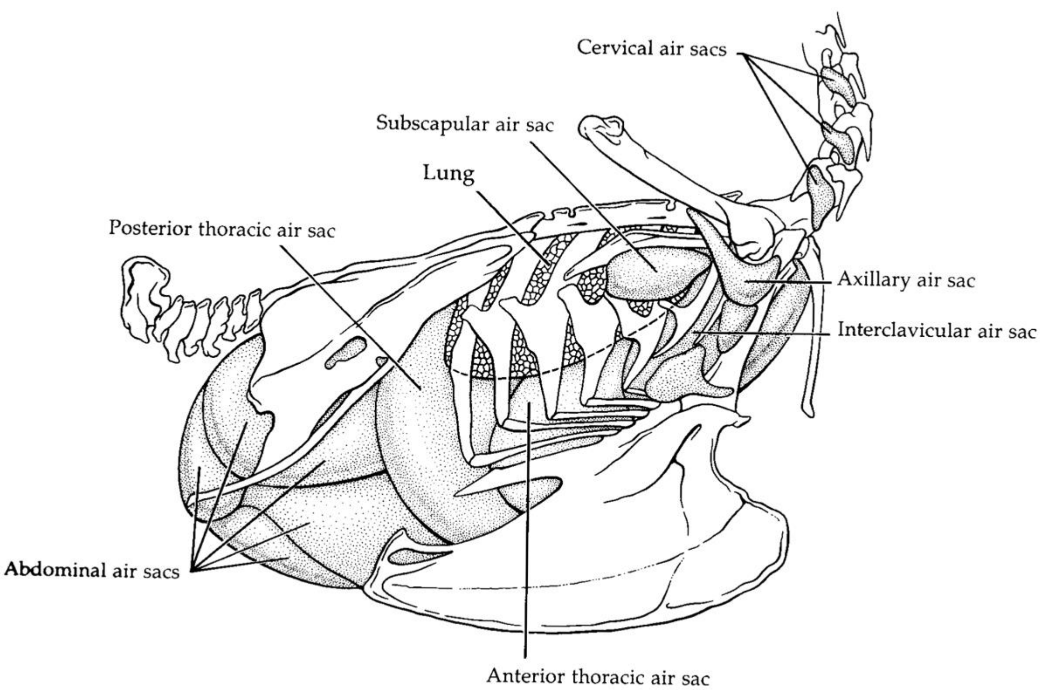


Diagrammatic View of the Air Sac System
Rock Dove (*Columba livia*)



In most species of birds the air sacs occupy about 15 percent of the volume of the thorax and abdomen (Welty and Baptista 1988). In the lateral view of the air sac system depicted below, the air sacs have been inflated to show their positions in the body. Note the smaller air sacs surrounding the pectoral girdle and extending up both sides of the cervical spine. In most of the larger flying species, virtually every major bone is pneumatic to some degree, either perforated with connections to the air sacs or filled with hollow cavities. The remarkable complexity and extent of the air sac system strongly suggests that the sacs have a much greater function beyond external respiration. The air sacs are particularly well placed to aid the bird in shedding excess heat from its body as it breathes, and this thermoregulatory function explains why so much of the bird's body is penetrated with diverticulae from the air sac system. As air flows over the moist surfaces of the air sacs it causes evaporation. Evaporation absorbs heat and cools the tissues that are in contact with the walls of the air sacs.

Lateral View of the Air Sac System
Rock Dove (*Columba livia*)

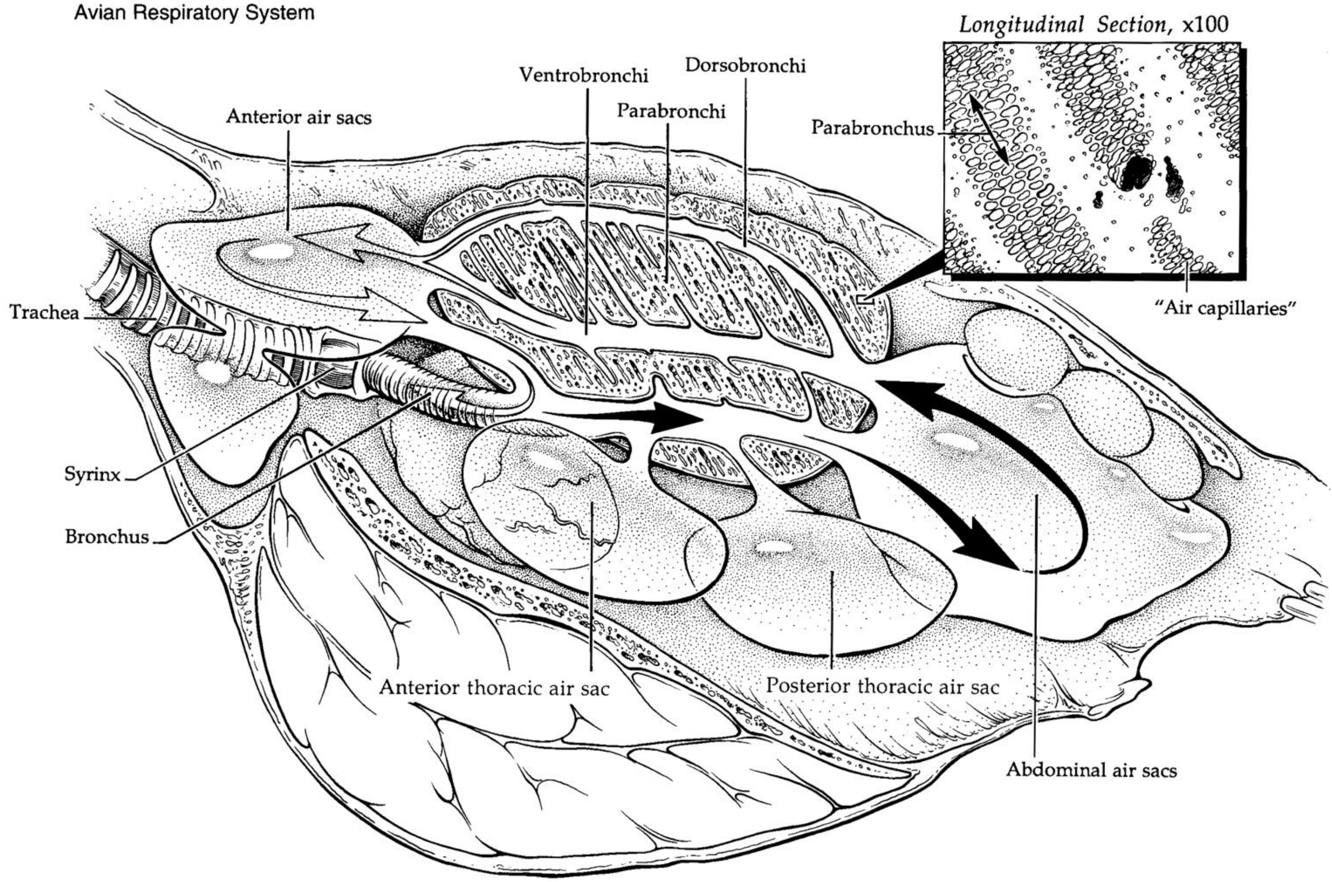


Functional View of the Respiratory System

A diagrammatic view of the avian respiratory system opposite illustrates the path of a single breath of air as it flows through the air sacs and lung. Note that the exchange of carbon dioxide from the blood with oxygen from the air takes place only within the lung. The air sacs are poorly supplied with blood vessels and do not directly aid in gaseous exchange. The total respiratory cycle in birds actually takes two cycles in inhaling and exhaling to complete. The path of a break through the system can be summarized in four steps:

1. First inhalation (black arrows)
   As a breath of air flows down the trachea, it passes through the syrinx and into the left or right bronchus. The bronchus brings the air to the lung. Once inside the lung the bronchial tube is called the mesobronchus, and it passes most of the air completely through the lung and into the posterior air sacs in the abdomen. The abdominal air sacs expand on inhalation as the abdomen expands, and this pulls the inhaled breath into the abdominal sacs.
2. First exhalation (black arrows)
   As the bird exhales, the abdomen contracts, and this forces the air in the abdominal sacs into the lungs. Within the lungs, the air passes through a progressively finer sleeve of tiny air passages, called the parabronchl. The smallest air passages within the lung are called the air capillaries that the exchange of oxygen for carbon dioxide takes place. The blood capillaries channel blood in through the lung tissue along with walls of the air capillaries, and this countercurrent flow of blood produces the maximum efficiency in gaseous exchange.
3. Second inhalation (white arrows)
   As the bird inhales again the air in the lungs is driven out, and the stale air full of carbon dioxide now passes into the anterior air sacs, principally the interclavicular and anterior thoracic sacs.
4. Second exhalation (white arrows)
   The anterior sacs contract, and this drives the air out into the trachea, where it passes up and out of the nostrils, completing the respiratory cycle.

Diagrammatic View of the
Avian Respiratory System



For the purposes of this diagram the air sacs are drawn much smaller than they appear in a live bird so that the major sacs will be easier to identify individually. In life the air sacs almost completely surround the abdominal viscera, and the sacs overlap each other extensively. If your dissection specimen was preserved in formalin, it may be difficult to appreciate the complexity and extent of the air sac system. If a fresh specimen is available, carefully open the abdominal wall and examine the air sacs that lie between the viscera and the wall. They will appear as thin, transparent sheets of tissue adhering to both the abdominal contents and the abdominal wall.

Introduction to Fluid Therapy

Fluid therapy is treatment that attempts to replace lost fluids in an animal. The type of fluid, amount needed, and route of administration vary with the animal's needs and condition.

In this section you will review the reasons for fluid therapy, become familiar with the equipment you will need, learn aseptic techniques for preparation, discuss the routes, methods, and administration of different types of fluids, and guidelines for determining quantities.

This section will end with a hands-on workshop which will provide the opportunity to put this material into practice.

Indications for Fluid Therapy

There are many conditions which may indicate the need for fluid therapy. The most common are dehydration, injury or trauma, blood loss, shock, starvation, vomiting or diarrhea, and toxicity. These conditions and causes do overlap in some ways.

Dehydration

Dehydration is the state that occurs when the body loses more fluid than it takes in. This negative fluid balance decreases the circulating blood volume and the amount of fluid in the tissues. There are several clinical signs of dehydration. You may find one or more in an animal you are examining.

- **Mouth**: Dehydration can be indicated during a normal assessment during the examination of a bird's mouth. When first opening the bird's mouth you may see "thready" mucus or ropes of saliva. This is a sign of dehydration. Touch the inside of the mouth. Tacky mucus membranes is another sign.
- **Skin**: Dehydration can be observed in the skin, too. Carefully look at the surface of the skin in one of the bird's apteriums. If the skin appears loose or unusually wrinkled, the animal is very likely dehydrated. Another way to identify dehydration is by "tenting" the skin. Simply pinch an area of the skin and note the manner in which it returns to normal. If an animal's skin does not readily return to its normal position, the animal is probably dehydrated.
- **Evidence of a cause**: There are several conditions which cause dehydration. Vomiting or diarrhea can quickly deplete the fluids in an animal's system. It is important to monitor these conditions carefully as fluids can be lost in large quantities and dehydration can occur quickly. Excessive bleeding or large open areas without skin are other indicators.

Injury or trauma
Injury or trauma can often be a cause of dehydration.

- Large areas of exposed tissue (degloving wounds) may have allowed fluids to escape through evaporation.
- Head injuries can result in an animal being unable to drink.
  - Heads can be inverted
  - Impairing mental problems
- Too depressed (down) to drink.
- Blindness
- Hole in crop or other part of the digestive tract

Blood loss
Blood loss can result deplete fluids and needs to be replaced.

- Internal or external trauma
- Compound FXs
- Gunshot wounds
- Surgical procedures (some blood loss may be unavoidable)

Shock
Shock is the body's response to some type of insult. The body seeks to protect the heart and brain at all costs. Fluids help to raise the blood pressure and keeps the blood flowing. Signs of shock can be pale mucous membranes, non- responsiveness, low body temperature, or low blood pressure.

Starvation
In a starving animal, the digestive system is not fully functioning. Hydration aids in stabilization.

- Some animals get liquid from food
- Some are too weak to get to food or water
- When the body is stabilized they may begin to feed

Dehydration often masks itself as starvation. Depleted breast tissues "collapse" causing the bird's keel to feel pronounced. Fluid therapy can restore fluid to tissues and return "thickness" to muscle.

Vomiting or diarrhea
Vomiting or diarrhea can quickly cause dehydration. Replace fluids as needed.

Toxicity

When toxins are present in the system, fluid therapy is beneficial. It improves the function of the kidneys and liver by clearing the toxins from the bloodstream.

- Nephritic drugs (toxic to kidneys)
- Poisonings/toxic exposure

Principles of Fluid Therapy

Sallie C. Welie, VMD

Introduction

Fluids play a vital role in the health and survival of all living creatures and are an important constituent of all cells. Fluid and cellular components in the circulatory system transport nutrients and oxygen to, and remove waste materials and carbon dioxide from organ systems throughout the body. Adequate circulatory pressure must be maintained so that each tissue received the perfusion that it needs to maintain normal function. When fluid imbalances occur due to starvation, disease or injury, life-threatening dehydration and shock may result.
Normal fluid loss through respiration, evaporation and elimination occurs at a daily rate of fifty milliliters (mls) per kilogram of body weight or approximately 5% of the animal's weight each day. Animals were decreased intake (dueto injury or starvation) or increased loss (resulting from bleeding, vomiting, diarrhea, polyuria or infection) will experience some degree of dehydration. Additionally, oil contaminated animals may lose the ability to absorb fluids from their gastrointestinal tract because of petroleum induced enteritis. Oiled animals often experience increased fluid loss because of toxic injury to their kidneys. It is safe to assume that all oiled animals need some degree of fluid support and many will require intensive fluid therapy.

Signs of Dehydration

<5%	no clinical signs skin turgor return time – 1 sec
5-7%	tacky mucous membranes decreased urine output skin turgor return time – 2-5 sec
8-9%	weak pulse sunken eyes skin turgor return time – 2-5 sec animal is depressed, lethargic
10-12%	general signs of chock no return of skin turgor

An estimation of the amount of dehydration can be made based on the physical characteristics described below. However, if the dehydration is less than 5%, it is usually not detectable, and if it is greater than 10-12%, it is usually fatal. Birds showing depression, weakness, skin tenting, and loss of roundness to the eye generally have fluid deficits between 5% and 10%. Mammals with 5-7% dehydration usually have tacky mucous membranes (feel the gums in the mouth), decreased urine output, and the skin will take two to five seconds to return to normal after it is pinched and lifted from the animal's back. A mammal's pulse will become weak and the animal will be depressed and lethargic as dehydration approaches 8-9%. It may enter shock and have no return of the lifted skin by the time it reaches 10-12% dehydration. Replacement fluids are calculated on an assumed 10% deficit.

Fluid therapy is used to correct existing deficits (replacement fluids), to provide for daily needs (maintenance fluids), and to provide for ongoing losses from bleeding, loss of kidney function, diarrhea, etc. Fluids may be administered orally (per os) or by injection (subcutaneous, intravenous or intraosseous injection). The route of administration is determined by the animal's condition, the volume of fluids to be given, and the training of the administrator. Multiple routes of administration can be used simultaneously. Intraperitoneal fluids are rarely administered to birds or mammals, but are often the best (and easiest) route to use with reptiles and amphibians.

Calculating Fluid Needs (after Redig)

1. Weigh the animal using a metric scale. Add 10% to this weight to compensate for probable dehydration. This gives the corrected body weight.
2. Compute maintenance and rehydration volumes; these are calculated separately, although they are given at the same time. Fluid therapy should be administered in three to four doses spread evenly through the working day.
3. To calculate maintenance fluids, find out 5% of the corrected body weight in grams. This corresponds to the total number of mls or con centimeters (cc) of fluid required by the animal in a twenty-four-hour period. This volume is administered via three equal injections and/or by gavage for as long as maintenance support is needed (usually three or four days). Once the animal is eating and drinking readily, maintenance fluid support is usually discontinued.
4. To calculate replacement fluids, determine 10% of the corrected body weight in grams. This corresponds to the total number of mls which is equal to ccs needed to correct the fluid deficit. Replacement fluids are given over a three-day period (50% on day 1, 25% each on days two and three) via three equal daily administrations.
5. For convenience, calculations can be entered into a table as shown in the example below. Note that all calculations rely on the equivalency factor that one cubic centimeter of water weighs one gram and that one milliliter equals one cubic centimeter.

EXAMPLE
A bird admitted weighing 50 grams (gm) is estimated to be 10% dehydrated. What are its fluid needs for the next four days?

1. Calculate corrected body weight: 50 x 10% = 5 gm, 50 + 5 = 55 g,
2. Maintenance fluids: 55 gm x 5% = 2.75 gm = 2.75 cc
3. Replacement fluids: 55 gm x 10% = 5.5 gm = 5.5 cc. This given over a three day period as follows:
   Day 1: 5.5 cc x 50% = 2.75 cc
   Day 2: 5.5 cc x 25% = 1.375 cc
   Day 3: 5.5 cc x 25% = 1.375 cc

Day	1	2	3	4
Maintenance	2.75	2.75	2.75	2.75
Replacement	2.75	1.375	1.375	0.0
TOTAL	5.5	4.13	4.13	2.75
Volume given TID* To nearest 0.1 cc	1.8cc	1.4cc	1.4cc	0.9cc

* Three times a day

Fluid Selections

A balanced electrolyte solution such as lactated Ringer's solution (LRS) can be used safely for all routes of administration. The addition of 2.5% dextrose to oral and subcutaneous (SQ) fluids, and 5% dextrose to intravenous (IV) and intraosseous (IO) fluids provides a much-needed energy source. If LRS is not available, Normosol R®, D5W, or half strength saline can be used. Hypertonic solutions, and solutions containing high sodium concentrations are not recommended for rehydration purposes.

Once fluids are opened, they should be used within twenty-four hours for IV or IO injections, and within five days (maximum) for SQ injections. Oral use may be continued unless the solutions become cloudy in appearance. Refrigerating opened fluids between uses will retard bacterial growth so that fluids can be used for five days for IV or IO injections, and for up to ten days for SQ injections.

Guidelines for Fluid Administration

Oral Fluids

"If the gut works, use it." Animals that are responsive, can maintain their head carriage, have functioning gastrointestinal (GI) tracts, and which are not seizing or in shock, are good candidates for oral fluids

Oral fluids can be used in conjunction with injectable (parentera) fluids if the above criteria are met. With the exception of toxin ingestion, adult mammals are not gavaged but are allowed free access to bowls of oral fluids.

1. Pedialyte – a sterile solution that should be used within 48 hours of opening. Pedialyte provides water, some electrolytes, and a small number of calories.
2. Balanced electrolyte solutions (Normosol R®, LRS) – these sterile solutions provide water and electrolytes.
3. Dilute Gatoraid (mix 50:50 with tap water) – provides water, electrolytes, and some calories.
4. Emergency formula – one teaspoon salt and three teaspoons sugar in one-quart boiled water (water should be boiled for five minutes and allowed to cool to room temperature; use solution within 48 hours).

The following solutions can be used to provide nutritional support and can be administered three to six hours after initial rehydration fluids are given.

1. Osmolite® or Ensure® (vanilla or fruit-flavored) – dilute 50:50 with water for the initial feeding. If the animal tolerates diluted Osmolite, it may be given full strength for the next feeding (keep open containers refrigerated and use within twenty-four hours).
2. Diluted Emeraid® (mix 50:50 with water) – this provides nutritional support in addition to fluids for birds, and is generally not given to severely dehydrated birds.

If the animals are stable, reasonably hydrated, and can tolerate full strength Osmolite but will not hand-fee or eat on their own, a diluted and strained gavage diet can be given. Follow fluid therapy guidelines for techniques and volumes.

Parental (injectable) fluids

These fluids are indicated in animals that are seriously ill, very depressed, or shocked, or which require very large volumes that cannot be given orally. Administrators should be trained in aseptic techniques and follow medical protocols. Consult section entitled "Calculating Fluid Needs" to figure out volumes required; sites for administration are discussed below.

1. Subcutaneous fluids – of all parenteral routes, subcutaneous fluids are the most easily administered. They are recommended for animals that cannot receive oral fluids but have adequate peripheral circulation and are not in shock. Subcutaneous fluids may be used alone or together with oral or intravenous fluid support. Consult "Calculating Fluid Needs" to determine relative volumes.
2. Intravenous fluids – recommended for animals that have poor peripheral circulation, are in imminent danger of shock, or are suffering from severe blood loss, emaciation, severe dehydration or acute trauma. They are useful when large volumes of fluids must be given, and can be used in conjunction with subcutaneous fluid support.

A bolus of up to 3% of the animal's body weight can be given if respiratory disease is not present and if kidney function is adequate. Care must be taken to avoid over hydration of head trauma patients and hematoma formation when administering IV preparations. In birds, IV catheters can be placed in the medial metatarsal vein. In mammals, IV catheters can be placed in the cephalic vein or the saphenous vein.

3. Intraosseous fluids – recommended for animals requiring long term fluid support such as those suffering from acute kidney failure. Repeated administration of large boluses is possible through a catheter placed in the distal ulna (Ritchie, 1990). NOTE: Because pelicans' ulnas are pneumonic bones they cannot be used for intraosseous fluids. Instead, the tibiotarsi must be used.

Administration of Oral Fluids

1. Materials: Prepared fluids, syringe (approximately 20-50 cc), adapter, appropriately sized catheter (feeding tube).
2. Determine volume needed for basis of species and eight. Draw up slightly more than is needed.
3. Heat the fluids by placing them in hot water until they are just warm to the touch (approximately 100 degrees F). If fluids are too hot, they can scald the lining of the esophagus and crop.
4. Measure the catheter to the animal's neck, by holding it along the side of the bill and neck. Determine how much catheter should still be exposed once the tip has reached the crop area (base of neck in birds, or to the last rib in mammals). FIRMLY attach the catheter to the adapter and the adapter to the syringe.
5. Expel excess fluid to empty catheter of air.
6. Hold the animal's head by placing your fingers behind the jaw. Extend the neck up and forward. Open the bill or mouth and slowly insert the catheter down the back of the throat; no resistance should be felt and the animal should not gag. Feel the outside of the animal's neck along the trachea; the catheter can often be seen or palpated as it is being inserted. Always check the glottis (the opening at the base of tongue in birds, not often visible in mammals) to make certain that the catheter was not inserted into the trachea by mistake.
7. It is safe to allow the bird's bill or the mammal's mouth to close slightly over the tube; this is often more comfortable than holding the mouth open. The edges of the bill or mouth are not as sharp as the commissures (corners of the mouth). Never allow mammal to completely close its mouth or in any way bit a gavage tube. ALWAYS leave enough tube exposed so that the hand holding the head can grasp the end of the tube; this insures that the animal will not pull its head away, tearing the tube from the syringe and leaving the tube in the throat.
8. Expel the fluids slowly, waiting briefly after administering each five ccs. If the animal beings to choke, regurgitate or if fluid begins to back up in the throat, pinch off the tube and remove it slowly. Allow the animal to shake its head and neck. Do not administer additional fluids at this time.
9. Once the fluid in the syringe is low, be careful to halt the feeding before any air is expelled into the gastrointestinal tract. Pinch the tube to prevent drips and possible aspiration, and slowly withdraw the tube.

10. Use a clean catheter for each animal.

Site for Injection

Subcutaneous fluids are given in the loose skin where the leg meets the body (inguinal area) in birds, or in the broad flat area where the neck joins the back in birds and mammals. The patagium is not recommended as an injection site. A 23- or 25-gauge needle is carefully inserted under the skin (needle should move freely under the skin); a blister or bubble will form as the warmed fluid is expelled, but administration should be discontinued before the skin becomes excessively taut.

IV fluids can be given to birds in the medial metatarsal vein (preferred) or the brachial vein using a 23- or 25-gauge butterfly catheter to administer a bolu of warmed LRS. IV fluids can be given to mammals in the cephalic vein in the forelimb, or the saphenous vein on the inside the hind leg. Fat mammals with short limbs (beavers, opossums, muskrats) may be inserted in the dorsal tail vein. The jugular vein is not recommended as an injection site. Once the needle is withdrawn, digital pressure should be applied to reduce the risk of hematoma formation.

Intraosseous fluids are given in a spinal needle positioned in the distal ulna of birds only. Intraperitoneal fluids are given near the junction of the hind leg and abdomen of turtles, lizards and amphibians, being careful not to insert the needle too deep.

Editor's Note: All injections should be done under the direction of a veterinarian.

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Ritchie, B.W. et al, 1990. A technique of introsseous cannulation for intravenous therapy in birds. *In* compendium of Continuing Education, vol. 12, no. 1, pp 55-58.

Fluid Therapy Chart (Maintenance and Replacement)

Animal Weights: 1 to 10 grams

Incoming weight (in grams)	1	2	3	4	5	6	7	8	9	10
Corrected body weight (in grams)	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11
Day 1 (cc per dose*)	0.04	0.07	0.11	0.14	0.18	0.21	0.25	0.28	0.32	0.35
Day 2 (cc per dose*)	0.03	0.05	0.08	0.11	0.13	0.16	0.19	0.21	0.24	0.27
Day 3 (cc per dose*)	0.03	0.05	0.08	0.11	0.13	0.16	0.19	0.21	0.24	0.27
Day 4 or maintenance only (cc per dose*)	0.01	0.04	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.18

Animal Weights: 10 to 100 grams

Incoming weight (in grams)	10	20	30	40	50	60	70	80	90	100
Corrected body weight (in grams)	11	22	33	44	55	66	77	88	99	110
Day 1 (cc per dose*)	0.36	0.7	1.1	1.4	1.8	2.1	2.5	2.8	3.2	3.5
Day 2 (cc per dose*)	0.27	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
Day 3 (cc per dose*)	0.27	0.5	0.8	1.1	1.3	1.6	1.9	2.1	2.4	2.7
Day 4 or maintenance only (cc per dose*)	0.18	0.4	0.6	0.7	0.9	1.1	1.3	1.5	2.4	1.8

Animal Weights: 100 to 1000 grams

Incoming weight (in grams)	100	200	300	400	500	600	700	800	900	1000
Corrected body weight (in grams)	110	220	330	440	550	660	770	880	990	1100
Day 1 (cc per dose*)	3.5	7.0	10.5	14.0	17.5	21.0	24.5	28.0	31.5	35.0
Day 2 (cc per dose*)	2.7	5.3	8.0	10.7	13.3	16.0	18.7	21.3	24.0	26.7
Day 3 (cc per dose*)	2.7	5.3	8.0	10.7	13.3	16.0	18.7	21.3	24.0	26.7
Day 4 or maintenance only (cc per dose*)	1.8	3.7	5.5	7.3	9.2	11.0	12.8	14.7	16.5	18.3

* Administer three doses per day

NOTE: When calculating the fluid needs for turtles and tortoises, weight use half their body weight as the Incoming

Equipment

Fluid therapy requires equipment that is not used in a simple assessment or well care exam. Syringes, needles, tubing or catheters, and your fluid of choice should all be on hand.

Syringes

Syringes come in a variety of sizes, based on the volume they contain. Syringe volume is usually measured in cc's or ml's. The small tuberculin syringes may indicate measurement in "units" but these figures should always be translated into cc's or ml's (100 units = 1 cc) for the purpose of our records. Some syringes come without a needle and one must be selected and attached. Others come with a needle, either permanently attached or with a removable needle already on the hub.

Needles

Needles come in a variety of sizes, too. There are usually two measurements for needles, the length and the gauge. Needle lengths are usually 1 inch, 1 1/2 inch, or 2 inches. A needle's gauge indicates its circumference. The larger the *number* of the gauge, the smaller the diameter the needle will have. Needle gauges commonly range from 18 to 27. An 18-gauge needle will be larger than a 27-gauge.

Tubing or catheters

Fluids can be given orally through tubing or catheters. Tubing is available in a variety of lengths and diameters. Long heavy tubing is needed to tube long- necked birds such as great blue herons. You will also need small thin soft tubes for hydrating hatchlings and other small birds. Small catheters are ideal for this purpose.

Types of Fluids

Fluid therapy can be accomplished with many types of liquids.

Water

Ordinary tap water can be used as fluid therapy. A bowl of water can often provide what an animal needs—in a very low stress manner! If an animal can drink on its own, offering it water and a low stress environment are good options for fluid therapy. Tap water can also be administered orally (PO) by tubing the animal.

LRS / Normosol

Normosol and LRS (lactated Ringer's solution) are commonly administered during fluid therapy. It can be administered by the Medical Services staff either orally (PO) or under the skin which is called subcutaneously (SQ).

Normal Saline

0.9% Sodium Chloride (normal saline) can also be administered during fluid therapy. Like LRS, normal saline can be given by the Medical Services staff either orally (PO) or subcutaneously (SQ).

D5W
5% dextrose (D5W) can be given if the animal is extremely weak and you need to get in additional calories. Similar to LRS and normal saline, D5W can be given by the Medical Services staff either orally (PO) or subcutaneously (SQ).

Higher calorie products
It is important to understand the difference between 5% dextrose (D5W) and LRS with 5%. LRS with 5% dextrose can *only* be given orally by Medical Services staff. The products look very similar so caution should be used when reading labels. 10% dextrose and 50% dextrose must also only be given orally by the Medical Services staff.

Emeraid
Fluid therapy can also be given with added nutritional ingredients. Emeraid has several different products that can be used. These should be diluted 50:50 with water and offered orally (PO).

Aseptic Techniques

It is important to use a sterile technique during any fluid therapy procedure. This is for the protection of the animal you are treating as well as for the protection of future animals that made need the same products. As the amounts of fluids used in birds are often very small, a 1000 ml. bag of fluid will last quite a long time! We must take precautions to ensure the bag's sterility.

Always follow the steps below.

- Always use a clean new needle and syringe each time you prepare fluids.
- Keep the bag of fluids sterile. Wipe the rubber end with alcohol before inserting your needle.
- Do not re-inject unused fluids back into the bag.
- Do not reinsert a needle into the fluid bag if it was already in an animal. If you need more fluids, get a new syringe and needle. Only sterile needles should be inserted into the bag.
- When you are filling your syringe, pull back on the syringe until you have reached the necessary amount and then withdraw the needle immediately.

Routes and Methods of Administration

This section will discuss the different routes of administration and methods that are used. Although there may other methods available, the ones discussed here are acceptable for use at Liberty Wildlife by trained Medical Services staff.

<u>Per Os (Oral - PO)</u>

Tap water, LRS, normal saline, D5W, LRS w/5% dextrose, 10% dextrose, 50% dextrose, and other products such as Emeraid can be administered orally (PO).

- <u>Offer water</u>. Often, the best way to hydrate is to have the animal drink on its own! White wing, mourning, and Inca doves can have their beaks "dipped" in water to encourage drinking.
    - Method: Place a bowl of water in enclosure.
- <u>Tubing</u> is the processing of providing warmed fluids directly into the crop or stomach through a tube or catheter. Great care must be taken when tubing animals to ensure they do not aspirate the fluid. Sometimes tubing an animal with a small amount of high-calorie liquid can help "jump-start" its system.
    - Method:
        - Measure tubing length to reach desired area.
        - Select the type and quantity of fluid
        - Draw up fluid into a syringe with the tubing attached
        - Carefully insert the tubing into the throat. (Care must be taken to avoid the trachea.)
        - Dispense the fluid (monitor the quantity carefully)
        - Remove the tube *slowly*
- <u>Hydration through food</u>. A mouse can be injected within a small amount of fluids to provide additional hydration. Worms can be drowned in water before offering. Standard feeding formulas can be diluted more than usual, providing more liquid. Food pieces that are being force-fed can be soaked in water, although care must be taken to make sure that liquid is not accidentally dripped into the trachea.
    - Method:
        - Inject into mouse. Don't make it too big!
        - Be cautious when hand-feeding soaked pieces.

Parenteral

Parenteral fluids are given by injection. Medical Services staff will be giving subcutaneous (SQ) injections only. Additional parenteral methods will be reviewed here, however they are administered only by the veterinarians or senior Medical Services staff.

- Subcutaneous (SQ): Subcutaneous (SQ) fluid therapy is the injection of fluids beneath the skin. LRS, normal saline, and D5W can be administered subcutaneously (SQ). The advantage of administering fluids subcutaneously is that the body will absorb the fluids as needed, without the risk of over hydrating or drowning your patient. There are several sites in birds that can be available for fluid therapy. The preferred site is the apterium on the side of the torso, lateral and proximal to the femur. This area contains loose skin to allow for the movement of the leg and can expand to hold a significant amount of liquid. Caution must be used to ensure fluids are not injected into the nearby air sacs. There are other sites, such as between the wings (scapulas) on the back and the area on the inside of the flap near the proximal humerus, however they do not have the expansion of the preferred site and therefore cannot hold the same amount of liquid.
    - Method
        - Select your fluids.
        - Select your syringe size and needle.
        - Draw up the fluids using aseptic technique.
        - Warm the fluids in a bath of hot water.
        - Restrain the animal.
        - Locate the proper site. If you have difficulty locating the site, you can wet down the feathers with a small amount of alcohol. (Do not saturate bird as this might cause pain or burning at the injection site. Also, the alcohol will make the bird cold.)
        - Insert the needle at an angle (almost parallel) just under the skin. It is helpful to have the bevel up.
        - Pull back slightly on the syringe to make sure you are not in an air sac. You are checking for air or for blood. Watch the hub carefully, this can happen! If air or blood enters the syringe, stop, remove the needle, and try another location.
        - If you did not see air or blood enter your syringe, begin to inject the fluids. A small bubble will appear on the skin, which will slowly grow. Monitor the bubble carefully to be certain that the site does not become too hard.
- Intravenous (IV): Intravenous (IV) fluid are injected directly into the vein. The advantage to this method is its quick entrance into the blood system.
    - Intravenous (IV) fluids are given by the veterinarians or senior medical staff only.
- Intraosseous (IO): Intraosseous (IO) fluids are injected directly into the bone.
    - Intraosseous (IO) fluids are given by the veterinarians or senior medical staff only.
- Intraperitoneal (IP): Intraperitoneal (IP) fluids are injected directly into the peritoneum
    - These are not usually given to birds.
    - Administered by the veterinarians or senior medical staff only.

Volumes for Fluid Therapy

It is critical to carefully determine the amount of fluids you are planning to administer, even if the method is subcutaneously. The volume will be influenced by the animal's species and condition, the type of fluid you are administering, and the method of administration. There is a specific method that calculates fluid therapy dosages and the timing of administration. A handout following this section details this procedure. The following procedures rely on a "rule of thumb" which will ensure safe administration based on the weight of the animal.

Determining volume for SQ injections:

- Weigh the bird
    - The weight of bird must in grams
- Take 10% of the bird's weight (divide weight by 10)
    - (10% of bird's body weight is blood volume and the blood volume is approximately 1cc/gram.)
- This number (10%) is the *maximum* volume in cc's that can be safely administered.
    - You will not be exceeding 10% of blood volume. (SQ volumes only! PO volumes are much less.)

MS6 Fluid Therapy Lab

SQ Fluids

1. Identify your specimen
2. Locate all injection sites on your specimen
3. Make a chart
4. Weigh your animal
5. Determine the amount of fluids
6. Select your equipment
7. Draw up using aseptic technique
8. Warm fluids
9. Position animal correctly for site
10. Administer the fluids SQ
11. Record your notes, add initials and date

Oral Fluids

1. Determine if animal has crop or stomach
2. Select your equipment
3. Draw up the fluids using aseptic technique
4. Warm fluids.
5. Position animal correctly.
6. Administer fluids.
7. Record in chart.

Fluid Therapy Worksheet
Section Six

1. Fluid therapy is
    a. A treatment.
    b. A way to replace lost fluids in an animal.
    c. Based on the animal's species.
    d. Varies with the animal's needs and condition.
2. Some conditions which may indicate the need for fluid therapy are
    a. Blood loss
    b. Vomiting
    c. Toxicity
    d. Dehydration
    e. Fractures
    f. Shock
3. When can dehydration occur?
4. *Describe in detail five clinical signs of dehydration. Use the back of this page.*
5. In a syringe with increments up to 50 units, how much fluid will it contain?
6. What is the best administration method for fluid therapy?
7. Describe the procedure for administering oral fluids. Include your comments on volume.
8. Name three products that can be used for fluid therapy and how they are administered.
    a.
    b.
    c.
9. Describe the aseptic technique for administering fluids.
10. What products can be administered per os?
11. What products cannot be administered SQ?
12. What is the meaning of parenteral?
13. Describe the "rule of thumb" method for calculating quantities for SQ fluids and the reasoning behind it.
14. Two great horned owl babies have been brought in with extreme dehydration. They weigh 256 grams and 356 grams. What would you do? (Be specific.) Why is one so much bigger?