Introduction to Fluid Therapy

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Fluid therapy is supportive. The underlying disease process that caused the fluid, electrolyte, and acid-base disturbances must be diagnosed and treated appropriately. In formulating a fluid therapy plan, 6 questions should be considered:

1. Is fluid therapy indicated?
2. What type of fluid should be given?
3. By what route should the fluid be given?
4. How rapidly should the fluid be given?
5. How much fluid should be given?
6. When should fluid therapy be discontinued?

Is fluid therapy indicated?

The hydration status of the animal is estimated by careful evaluation of the history, physical examination findings, and the results of a few simple laboratory tests. Normally, fluid input consists of water consumed in food, water that is drunk, and water produced metabolically in the body. Maintenance water and electrolyte needs parallel caloric expenditure, and normal daily losses of water and electrolytes include respiratory, fecal, and urinary losses.

In disease states, decreased fluid intake results from anorexia, and increased fluid loss may occur by urinary (e.g., polyuria) and gastrointestinal (e.g., vomiting, diarrhea) routes. Third-space loss of fluid occurs when effective circulating volume is decreased, but the fluid lost remains in the body.

The time period over which fluid losses have occurred and an estimate of their magnitude should be determined. Physical findings associated with fluid losses of 5% to 15% of body weight vary from no clinically detectable changes (5%) to signs of hypovolemic shock and impending death (15%). The hydration deficit is estimated by evaluating skin turgor, moistness of the mucous membranes, position of the eyes in their orbits, heart rate, character of peripheral pulses, capillary refill time, and extent of peripheral venous distention (i.e., inspection of jugular veins). A decrease in the interstitial compartment volume leads to decreased skin turgor and dryness of the mucous membranes. A decrease in plasma volume leads to tachycardia, alterations in peripheral pulses, and collapse of peripheral veins. When these cardiovascular signs are present, the patient is in shock and should be resuscitated promptly before correction of the hydration deficit. Thus, a crude clinical estimate of hydration status and the patient's response to fluid administration become important tools in evaluating the extent of dehydration and planning fluid therapy. The urinary bladder should be small in a dehydrated animal with normal renal function. In the absence of urinary obstruction, a large bladder in a severely dehydrated patient indicates failure of the normal renal concentrating mechanism. Body weight recorded on a serial basis traditionally has been considered a good indicator of hydration status, especially when fluid loss has been acute and previous body weight has been recorded (i.e., 1 kg loss of body weight equals a 1 L fluid deficit). In one study, however, clinician estimates of hydration in dogs and cats admitted to a veterinary teaching hospital intensive care unit did not reliably predict changes in weight after 24 to 48 hours of fluid therapy. In chronically ill animals, loss of weight also includes loss of muscle mass. Anorexic animals have been estimated to lose 0.1 to 0.3 kg of body weight per day per 1000 kcal energy requirement. Another factor that must be considered in evaluating body weight is the possibility of third-space loss. Fluid lost into a third space does not decrease body weight. Packed cell volume (PCV), total plasma protein concentration (TPP), and urine specific gravity (USG) are simple laboratory tests that aid in the evaluation of hydration. These results should be obtained before initiating fluid therapy.

What type of fluid should be given?

The composition of a *balanced* fluid (e.g., lactated Ringer's solution) resembles that of extracellular fluid (ECF) whereas that of an *unbalanced* solution (e.g., normal saline) does not. Fluid preparations may be further classified as *crystalloids* or *colloids*. Crystalloids (e.g., 5% dextrose, 0.9% saline, lactated Ringer's solution) are solutions containing electrolyte and non-electrolyte solutes capable of entering all body fluid compartments. Colloids are large-molecular-weight substances that normally are restricted to the plasma compartment and include plasma, dextrans, and hydroxyethyl starch (hetastarch). Crystalloid solutions expand the plasma compartment with equal effectiveness, but 2.5 to 3.0 times as much crystalloid solution must be given (compared with a colloid solution) because the crystalloid is distributed to other sites (e.g., interstitial compartment, intracellular compartment).

Crystalloid solutions also can be classified as *replacement* or *maintenance* solutions. The composition of replacement solutions resembles that of ECF whereas maintenance solutions contain less sodium (40 to 60 mEq/L) and more potassium (15 to 30 mEq/L) than do replacement fluids. Most animals that require fluid therapy can be managed with a limited number of crystalloid and additive solutions. The most useful crystalloid solutions for routine use are a balanced replacement solution (e.g., lactated Ringer's solution,

Normosol-R, Plasma-Lyte 148), 0.9% saline, and 5% dextrose in water. Supplementation of crystalloid solutions with KCl may be necessary when body fluid losses have included large amounts of potassium.

The choice of fluid to administer is dependent on the nature of the disease process and the composition of the fluid lost. The patient's acid-base and electrolyte disturbances should be considered when choosing a fluid, and losses should be replaced with a fluid similar in volume and electrolyte composition to the fluid that has been lost. If clinical assessment of the patient suggests a fluid-responsive type of shock, the resuscitation phase of fluid therapy should be instituted. If clinical signs of hypovolemia are not present, the hydration deficit and maintenance needs may be combined and administered during the next 24 hours.

By what route should fluids be given?

The route of fluid therapy depends on the nature of the clinical disorder, its severity, and its duration. The *intravenous* route is preferred when the patient is very ill, when fluid loss is severe, or when fluid loss is acute.

The *subcutaneous* route is convenient for maintenance fluid therapy in small dogs and cats. The subcutaneous space in dogs and cats can accommodate relatively large volumes of fluid, and potassium can be used in concentrations up to 30 mEq/L without irritation. Approximately 10 mL/kg or 50 to 200 mL of fluid may be administered per site.

How rapidly may fluids be given?

The rate of fluid administration is dictated by the magnitude and rapidity of the fluid loss. The patient with fluid-responsive shock syndrome requires aggressive fluid administration. Fluid administration rates may vary, depending on the type of fluid that has been chosen. One approach is to calculate a "shock fluid dose" and administer it as rapidly as possible in divided aliquots until a stable and sustainable cardiovascular endpoint has been achieved. Clinical evaluation of the patient should occur after administration of each aliquot using a "titrate to effect" approach. The shock dosage of isotonic crystalloids is 80 to 90 mL/kg for dogs and 40 to 60 mL/kg for cats.

Contemporary losses also must be considered when adjusting the rate of fluid administration. Severe ongoing losses (e.g., vomiting and diarrhea in a patient with acute gastroenteritis) may necessitate rapid administration to keep pace with contemporary fluid loss. When fluids are given rapidly, cardiovascular and renal function should be monitored. It usually is not necessary or desirable to replace the hydration deficit rapidly in chronic disease states. Instead, the hydration deficit may be calculated, the daily maintenance requirement of fluid added to this amount, and the total volume administered over 24 hours. Ongoing or contemporary losses also must be taken into consideration when estimating the patient's fluid requirements for a 24-hour period.

How much fluid should be given?

The purpose of fluid therapy is to increase tissue perfusion, repair fluid deficits, supply daily fluid needs, and replace ongoing losses. The initial assessment of hydration determines the volume of fluid needed to correct the hydration deficit (*replacement requirement*). The hydration deficit is calculated as the percentage dehydration (estimated by physical examination) times the patient's body weight in kilograms. The resultant value is the fluid deficit in liters. During the rehydration phase of therapy, this volume is administered over 24 hours in conjunction with maintenance fluid requirements and replacement of ongoing or contemporary losses.

Coincident with or after replacement of the animal's hydration deficit, the *maintenance requirement* must be administered. The maintenance fluid requirement is the volume needed each day to keep the animal in balance (i.e., no net change in body water). The maintenance fluid requirement for dogs and cats can be determined from reference charts that use formulas based on energy expenditure to calculate accurate daily fluid requirements. Although estimates of 40 to 60 mL/kg/day frequently are used to calculate maintenance fluid requirements, such estimates are only accurate for some animals. Cats, very small dogs, and very large dogs are not well served by the use of such estimates, and these patients may benefit from more accurate assessment of their fluid requirements. Approximately two-thirds of the maintenance requirement represents sensible (i.e., easy to measure) losses of fluid (i.e., urine output), and one-third represents insensible (i.e., difficult to measure) losses (i.e., primarily fecal and respiratory water loss).

In addition to the hydration deficit (replacement requirement) and maintenance requirement, *contemporary (ongoing) losses* must be considered. These are not always easily determined but can be very important. Ongoing losses (including those caused by vomiting, diarrhea, polyuria, large wounds, drains, peritoneal or pleural losses, panting, fever, and blood loss) should be estimated and carefully replaced along with the maintenance volume of fluid.

When should fluid therapy be discontinued?

Repeated assessment of the patient by observation of clinical signs and determinations of body weight, urine output, PCV, TPP, and USG is necessary to make appropriate adjustments in fluid therapy. The animal's urine output should be observed carefully after fluid therapy has begun. Measurement of central venous pressure (CVP; normal, 0-3 cm H_2O) with a jugular catheter positioned at the level of the right atrium allows the cardiovascular response to fluid administration to be monitored. CVP increases from below normal into the normal range when fluids are administered to a dehydrated animal. A progressive increase in CVP above normal during fluid

therapy is an indication to decrease the rate of fluid administration or to stop fluid therapy temporarily. Ideally, fluid therapy is discontinued when hydration is restored and the animal can maintain fluid balance on its own by eating and drinking. As the animal recovers, fluid therapy usually is tapered by decreasing the volume of fluid administered by 25% to 50% per day.

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