Fluid Therapy for Veterinary Technicians

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OVERVIEW

Development of the fluid therapy plan falls under the responsibility of the veterinarian. However, the veterinary technician should be familiar with the process of developing the fluid therapy plan. Being knowledgeable about this process will allow the technician to anticipate the needs of the patient and be better able to monitor the progress of the patient. This discussion will focus on distribution of body water, patient assessment, fluid administration routes, development of the fluid therapy plan, and the administration of the fluid therapy plan.

DISTRIBUTION OF BODY WATER

On average 60% of the body weight is due to water in the normal healthy animal. However, age, sex, and nutritional status may cause this to vary. In young animals water content may be as much as 70 - 80%, while older animals may have water content that is 50 - 55% of their body weight. Almost 2/3 of the total body water is intracellular fluid (ICF, water located in cells) and the remaining 1/3 is extracellular fluid (ECF, water that is outside of the cells). Extracellular fluids can be further divided into intravascular or plasma water (water in the vascular space) (1/4 of the ECF volume) and interstitial fluid (fluid that is present in the spaces between cells) (3/4 of the ECF volume). Transcellular fluid is found in very small amounts and is also considered an ECF fluid. Examples of transcellular fluids include cerebral spinal fluid, synovial fluid, plural fluid, peritoneal fluid, aqueous humor, and gastrointestinal secretions.

COMPOSITION OF BODY FLUIDS

The concentration of solutes in the ECF and ICF fluid compartments are strikingly different. ECF contains large quantities of sodium, calcium, chloride and bicarbonate with small amounts of potassium, phosphate, magnesium, and protein. In ICF the distribution is reversed. The principle electrolytes in ICF are potassium, phosphate, and magnesium.

DETERMINING FLUID REQUIREMENTS

A good history along with a complete physical examination is the foundation for the development of a fluid therapy plan. It is important to determine the degree of dehydration and the perfusion status of the patient prior to beginning fluid therapy. There are several clinical and laboratory methods which may be used to determine the hydration status of the patient.

History

The owner should be asked questions about food and water intake. Is the animal eating? If not, when did it last eat? Is the animal drinking water, if so, increased or decreased amounts? Is the animal suffering any abnormal losses such as vomiting, diarrhea, or polyuria? What is the duration of theses abnormal losses?

Physical Findings

Skin turgor or skin elasticity is a crude way of determining the interstitial compartment volume status. When assessing skin turgor its best to use the same location for consistency in technique. The lateral thorax or between the shoulder blades are good locations to assess skin turgor. With 5% dehydration the skin, when lifted, will return to it's normal position fairly quickly but slightly slower than normal. With 8% dehydration the skin returns to its normal position slower than 5% dehydration but faster than 12% dehydration. When the patient is 12% dehydrated the skin will remain tented and not return to it's normal position. Elasticity of the skin is affected by cachexia and obesity. It is possible to have a normally hydrated patient that has reduced skin elasticity due to cachexia; or a dehydrated patient that has normal skin elasticity as a result of being fat. Other signs consistent with dehydration include dry skin and mucus membranes, oliguria, and signs of compensatory peripheral vasoconstriction.

Laboratory Analysis

Packed cell volume (PCV) and total protein (T.P.) are simple tests that can be used to evaluate hydration. PVC and T.P. are often elevated with dehydration. In the case of anemia, the PCV may appear to be normal but this is due only to hemoconcentration. A urine specific gravity greater than 1.030 usually indicates that the kidneys are responding to the dehydration in an appropriate manner**.** Electrolyte and acid base status should be determined. Depending on the disease process, It is not uncommon to find electrolyte abnormalities with sodium and / or potassium. Like the electrolytes, the acid base status of a patient may be altered due to a variety of disease processes. The normal pH (hydrogen ion concentration) is maintained in a narrow range of 7.35 - 7.45. If the pH is less than 7.35 or greater than 7.45 the patient is academic or alkalemic respectively.

FLUID ADMINISTRATION ROUTES

Oral

The oral route is the most physiologic. Fluids can be administered rapidly with minimal side effects. This route should not be used in the presence of vomiting. This route is also inadequate for animals that have had acute or extensive fluid losses. Fluid absorption is not sufficiently rapid via the oral route, in those cases where the fluid loss has been extensive and blood flow inadequate.

Subcutaneous

Fluids are usually administered in the subcutaneous tissues over the dorsal neck and cranial trunk. In the absences of vasoconstriction and hypovolemia the rate of absorption is approximately six to eight hours. Fluids should be administered at body temperature to decrease the discomfort to the patient and improve absorption. Only isotonic fluids should be administered by this route. Potassium supplementation up to 40 mEq/L may be added to the fluids. The rate and volume of administration will vary from patient to patient. Skin necrosis and infection are complications associated with this route of fluid administration.

Intravenous

This is the route of choice when vascular volume restoration is desired. This route is superior to all others with perhaps the exception of intraosseous. Fluid absorption is rapid. In addition to isotonic solutions, hyper and hypotonic solutions may be administered via this route. The rate and volume administered will vary from patient to patient based upon the desired endpoint.

Intraosseous

Fluids are administered via the bone marrow. Like intravenous administration, fluid absorption is rapid. This route is indicated when it is difficult to gain venous access using standard techniques. This route is best used for the short-term administration of fluids and or drugs. Fluid rates of 11 ml/min with gravity and 24 ml/min under 300 mm Hg pressure have been used to deliver the fluids.

Intraperitoneal

Intraperitoneal administration is the administration of fluids into the peritoneal cavity. The rate of absorption from this route is roughly equivalent to the subcutaneous route. Peritonitis and intra-abdominal abscess are potential complications associated with this route. Intraperitoneal administration does not offer any advantages over other routes; therefore it is reserved as a last resort.

DEVELOPMENT OF A FLUID THERAPY PLAN

The basic components of a fluid therapy plan include the determination, calculation, and replacement of the volume deficit (percent dehydration); abnormal on going losses; and maintenance needs. The veterinarian will determine the types of fluids used and the rates. In addition to the previously mentioned components, potassium supplementation must be taken into consideration.

Volume Deficit Repair

To determine the volume replacement, multiply the percent dehydration by the patient's body weight, this will equal the amount of fluids in liters estimated to correct dehydration (Figure 1). When the nature of fluid losses are not known, are due to trauma, and or electrolyte measurements are not available an excellent replacement solution is Lactated Ringer's or it's equivalent. The electrolyte concentration of Lactated Ringer's is similar to that of the ECF.

Calculation of volume deficit 20 kg patient is 10% dehydrated.

20 kg x.10 = 2.0 liters (2000 ml)

Figure 1 The calculation for determining the volume of fluids to correct the dehydration.

Abnormal Ongoing Losses

Losses through vomiting, diarrhea, excessive urination, burns and transudation into body cavities are considered to be abnormal ongoing losses. These losses should be calculated into the fluid therapy plan. Typically, abnormal losses should be replaced mL for mL. In the event that the volume of abnormal losses is unknown, initially, administer a volume of fluids that is equal to maintenance and adjust the volume up or down as needed. Lactated Ringer's with supplemented potassium added to a final concentration of 10 mEq/L is the fluid of choice for abnormal ongoing losses. This type of fluid will approximate the composition of most abnormal losses.

Maintenance

Normal losses occur through breathing, salivation, urination and defecation. It is important to include these losses in your fluid therapy plan. A rough rule of thumb for the administration of maintenance fluids is to give 50-75 ml/kg per day, slightly higher for the febrile patient. Predictive charts are also available for the calculation of maintenance fluid needs (Table 1 and 2).

Table 1 Daily water requirements for cats

Body Weight (kg)	Total Water mL/day	mL/Hr
1.0	80	3
1.5	108	5
2.0	134	6
2.5	159	7
3.0	182	8
3.5	204	9
4.0	226	9
4.5	247	10
5.0	267	11

The composition of a maintenance fluid is one that is low in sodium (40 - 60 mEq/L) and high in potassium (13 - 20 mEq/L). Under normal conditions the body tends to retain sodium and excrete potassium. Hence the need for a maintenance type solution. Maintenance fluids should not be given as replacement fluids for correction of dehydration this may lead to hyponatremia and hyperkalemia when large volumes of fluids are given.
A patient may develop hypernatremia or hypokalemia if Lactated Ringer's is used solely for maintenance needs and no other source of free water is available. Maintenance fluids may be obtained commercially (Plasmalyte 56 ™ or Normosol M™) or can be "homemade". This is done by mixing 1-2 parts D_5W and 1 part Lactated Ringer's and adding potassium chloride to bring the concentration up to 13-20 mEq/L; or using ½ strength Lactated Ringer’s or saline with potassium supplementation.

Potassium Supplementation

Potassium chloride (KCl) might be added to fluids when serum potassium levels are known to be low (hypokalemia). If potassium levels are not known, hypokalemia may be expected in cases of fluid loss due to gastrointestinal loss, diuresis and anorexia. Based on the magnitude of these losses the body potassium depletion is thought to be mild, moderate, or severe, the fluids should be supplemented with potassium to 20, 30, or 40 mEq/L respectively. Potassium should not be administered at a rate faster than 0.5 mEq/kg/hr (Figure 2). When high

Table 2 Daily water requirements for dogs

Body Weight (KG)	Total Water mL/day	mL/Hr
1	132	6
2	222	9
3	301	13
4	373	16
5	441	18
10	742	31
20	1248	52
30	1692	71
40	2100	87
50	2481	103

concentrations of potassium are administered the heart rate should be monitored closely. Severe hypokalemia can occur when bicarbonate, insulin, or glucose is given without the concomitant administration of KCl. This is due to the shift of potassium from extracellular fluid into the cells.

FLUID ADMINISTRATION

Once the volume deficit replacement needs, abnormal ongoing losses and maintenance needs are calculated, the three are totaled. The fluid infusion rate may be determined by totaling up the volume of fluids to be given and dividing that by the total number of hours in a day available to safely administer the fluids.   If there aren't enough hours available to safely administer the fluids the patient may be sent to an emergency clinic for continued care or given some of the required fluids subcutaneously. Generally we like to correct the fluid deficit (volume needed to correct dehydration) over four to eight hours.

Figure 2. Calculation of maximum K^+ administration rate20 kg patient receiving LRS + KCL q.s. to 40 mE/L @ 150 ml/hr (0.15 L/hr).

Maximum K^+ administration rate is:

20 kg x 0.5 mEq/kg/hr = 10 mEq/hr

The patient is receiving 4.5 mEq/hr, this does not exceed the max K^+.

40 mEq/L x 0.15 L/hr = 4.5 mEq/hr

It is usually the responsibility of the veterinary technician to administer the plan. The veterinary technician should be able to correctly add fluid additives and label the fluids. The technician may be required to calculate and set the fluid drip rate. The responsibility of monitoring and trouble-shooting the fluid delivery system is the technicians. The patient will need to be reassessed at frequent intervals to ensure that the fluid therapy plan is meeting its desired effect.

Fluid delivery systems

Labels should be placed on the fluid bags when hung. The date, time, initials of the person mixing the fluids and concentration of additives are included on the label. Labels allow all nursing personnel to know the contents of the fluid bags and when and who hung the fluids.

Adhesive tape or commercially available timing labels are placed on the fluid bag and marked to monitor the volume administered over time. This enables the technician to quickly estimate the volume of fluid received.

A large selection of fluid delivery supplies are available on the market. There are the standard IV fluid administration sets. These administration sets have an in-line drip chamber used to estimate flow rates. Depending on the manufacture, administration sets are designed to deliver 10, 15, 20, or 60 drops per milliliter. Buretrols allow you to accurately determine the volume of fluids administered. Depending on the manufacture, buretrols can hold from 100 - 150 mls of fluids. The use of buretrols will decrease the risk of fluid overload to smaller patient.

To calculate drip rates it will be necessary to know the drop size for the administration set being used. Drops per minute can be calculated from the following formulas figures three:

Fluid delivery

Fluids may be delivered via gravity flow or with the use of syringe pumps and fluid infusion pumps. When setting up a system using gravity flow the infusion pressure is dependent on the height of the fluids above the patient. Fluid flow is also limited by the ambulatory patient and catheter position. When setting the drip rate on a gravity flow system, make sure the limb or neck is fully extended. This prevents the fluid rate from exceeding the pre-set rate should the patient's positioning change.

Drop Size	**Formula**
10 drop/ml	(mL/hr) ÷ 6 = drop/min
15 drop/ml	(mL/hr) ÷ 4 = drop/min
20drop/ml	(mL/hr) ÷ 3 = drop/min
60 drop/ml	(mL/hr) ÷ 1 = drop/min

Syringe pumps are used to administer medication or fluids to small patients at a constant rate. A syringe is placed in the pump and the plunger is automatically pushed at a constant rate.

Fluid infusion pumps are being used more frequently in veterinary medicine. The Baxter 6200 and 6300 are two types of fluid infusion pumps commonly used. They are non-volumetric pumps that deliveries fluids by intermittently squeezing the IV tubing (peristaltic action).

Monitoring

Because the calculation of fluid volume is based on subjective data, potential inaccuracies occur. Therefore, it is necessary to reassess the patient often. Your patient may require more or less of the original calculated fluid volume. You are looking for a resolution in the signs that indicated that the patient was in need of fluids. Patients should be weighed at the beginning of therapy and several times a day thereafter to determine fluid gains and loses. Acute change in body weight is a result of fluid gains or losses rather than change in body mass. A 0.5 kg weight gain is equivalent to a 0.5 liter fluid gain.