

FLUID THERAPY: UNDERSTANDING TYPES AND USES

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INTRODUCTION

Fluid therapy must be tailored to the patient's conditions. A patient should be given enough fluids to support its daily maintenance needs which should account for all fluid losses that may occur throughout the day. There are two types of fluids, crystalloids and colloids and it's important to understand the differences between the two.

Crystalloids: There are three categories of crystalloid fluids: isotonic, hypotonic, and hypertonic. Isotonic crystalloids are similar to extracellular fluid because they contain similar electrolyte concentrations (sodium, chloride, potassium, magnesium, calcium and bicarbonate-like anions). Within 30 minutes 75-98% of the fluids shift into the extravascular space, so therefore the infusion must be continuous and you need large volumes in order to make a difference. Examples of isotonic fluids include: Lactated Ringers, Normosol-R, and Plasmalyte-A. Isotonic fluids are used to restore fluid deficits and to provide maintenance fluid requirements. They are the most common fluid used.

Hypotonic fluids (5% Dextrose in Water, 0.45% NaCl) have a lower osmotic pressure. They should not be used to treat shock because they contain too much water and will redistribute too quickly. Hypotonic fluids should be considered when a patient has a free water deficit, hyponatremia, or for a patient in congestive heart failure or liver failure. Congestive heart failure and hepatic failure are associated with increased sodium retention which is why an infusion of a hypotonic fluid is ideal.

Hypertonic fluids (7%-7.5% NaCl) have a higher osmotic pressure. They are very useful when large volumes cannot be given fast enough. Hypertonic fluids cause fluids to shift from the interstitial space into the intravascular space in order to improve venous return and cardiac output. It is a fluid of choice when dealing with head trauma. One dose equals 4xs the volume of isotonic saline so a much smaller volume is needed. If interstitial dehydration or hyponatremia secondary to a free water deficit are present, the use of hypertonic solutions is contraindicated. The overall effect of hypertonic saline lasts for about 20 minutes. An infusion along with a crystalloid and/or colloid can be used for the effect to be sustained. Minimally crystalloids must be given after the hypertonic saline.

Because of the vast amount of crystalloid choices it may get confusing as to what to use when. A good rule of thumb is to first look at serum sodium levels. If the pet has normal sodium you can consider using Lactated Ringer's, Normosol-R or Plasmalyte-A. If the pet has a low sodium then you may want to consider 0.9% NaCl because it contains more sodium. If the patient has had a persistent decrease in sodium then you may want to consider LRS or Normosol (LRS has a lower concentration of sodium than Normosol). During chronic hyponatremia, the brain adapts to prevent cerebral edema. With rapid correction of serum sodium concentration, osmotic shifts and cerebral dehydration can occur.

The second item that should be looked at when deciding what crystalloid to use is the patient's potassium level. Patients that have a normal or low potassium should likely be put on Lactated Ringer's, Normosol-R or Plasmalyte-A. If the patient has a high potassium then 0.9% NaCl, which contains no potassium, should be considered. It is important to remember that the choice of what crystalloids to use is not an exact science.

Colloids: Colloids are high molecular weight fluids that do not pass readily through the capillary membranes. They help to increase oncotic pressure because they keep fluids in the intravascular space. The particles draw sodium and water around to their core structure within the vascular space, thus contributing to the water holding property of a colloid. About 50-80% of the infused volume stays in the intravascular space. Colloids should ideally always be administered with a crystalloid fluid, to replenish both intravascular and interstitial fluid deficits.

There are two types of colloids: synthetic and natural. Synthetic colloids include substances such as hydroxyethyl starch and Dextrans (40 and 70). Natural colloids include blood products, plasma products and albumin products. Because colloid molecules are much larger and play a role in colloid osmotic pressure, it is important to ensure that patients are not given colloids too quickly or are given too much as they can easily cause fluid overload in a patient. Whenever a colloid is administered with a crystalloid, calculated crystalloid doses should be decreased by 25-50%, in order to avoid fluid/volume overload. Since synthetic colloids are large molecular products it seems prudent to avoid use of these products in renal compromised patients. While the veterinary studies do suggest patients that are already renal

compromised may develop worsening renal injury there are few veterinary related studies showing that the use of synthetic colloids in healthy patients cause renal injury. With the increase number of human related studies showing the numerous side effects of HES it seems only logical that more veterinary studies may surface. At this time we do not have any evidence based literature supporting whether or not to use colloids in veterinary medicine.

Most natural colloids are delivered only one or two times to help alleviate a specific condition the patient is suffering from (anemia, hypoalbuminemia). Most of the times while these products are being given, other fluids (crystalloids) are discontinued because of the threat of incompatibility and/or fluid overload. Veterinary medicine now advocates component therapy when using a blood product as opposed to using whole blood. Packed red blood cells (PRBCs) are considered the treatment of choice when dealing with anemic patients.

Packed red blood cells (PRBCs) are harvested from whole blood and are stored refrigerated for approximately one month. While PRBCs do not carry any coagulation factors, most patients that are suffering from anemia due to acute bleeding only require a PRBC transfusion. Since PRBCs are more concentrated than whole blood a dosage of only 6-10ml/kg is needed. Most veterinarians will start at a rate of about 0.25ml/kg for the first 30 minutes to watch for any reaction for either whole blood or PRBCs. In the case of heart disease, rates should not exceed 4ml/kg/hr.

Serum albumin is important because it maintains oncotic pressure. When a decrease in albumin occurs, the COP decreases causing an increase permeability to the vascular system which, in turn, causes fluids to shift out of the vascular space resulting in edema. Human serum albumin (HSA) has been used successfully in both dogs and cats. Because both dogs and cats do not have antibodies that recognize HSA, the initial transfusion usually goes well with little to no side effects. Most veterinary studies have focused on 25% HSA. The rates for HSA vary, but most clinicians recommend administration at a rate of 0.25ml/kg/hr for the first 15 minutes to watch for any signs of a reaction and then increase to 1ml/kg/hr if it is tolerated. The dose of both HSA and canine albumin should not exceed more than 2g/kg/day.

Besides PRBCs, the most common blood component product used in veterinary medicine is fresh frozen plasma (FFP). Fresh frozen plasma contains water, electrolytes, albumin, globulin and coagulation factors. Fresh frozen plasma does not contain platelets, but does contain all coagulation factors. Fresh frozen plasma is a common natural colloid used to treat coagulation disorders as well as certain other diseases such as pancreatitis and peritonitis. Fresh frozen plasma is generally administered at a dose of 6-10 ml/kg, however multiple doses may be needed because of the short half-life of clotting factors.

Cryoprecipitate is a plasma component that contains a high concentration of clotting factors von Willebrand's factor, factor VIII, XIII and fibrinogen. It is typically used in patients with von Willebrand's disease, hemophilia A or a fibrinogen deficiency.

Platelet rich plasma (PRP) contains concentrated platelets and all clotting factors which are harvested from whole blood that is less than 8 hours old. Platelet rich plasma is indicated in patients that have a decreased platelet count that require surgery or have clinical bleeding. It is not indicated in cases of immune-mediated thrombocytopenia because the patient's body will destroy any new platelets within minutes.

Fluid Rates: There are three phases of fluid therapy, emergency, replacement and maintenance, and each of these has their own set of rates to use. It is important to remember that much like choosing what type of fluid to put a patient on, calculating out fluid rates is not an exact science. While there are plenty of suggested rates, there is nothing that can determine how a patient will handle the fluids until administration begins. This is why constant monitoring must occur to ensure under or over hydration is kept as minimal as possible.

Emergency Stage: Emergency rates of fluids are generally reserved for diseases or injuries that cause the pet to be in a life-threatening situation. Some examples including being hit by a car, septic shock, gastric dilatation and volvulus and hyperthermia. Emergency fluid therapy is aimed at restoring vital parameters until a patient is no longer in shock. Most veterinarians usually treat shock with isotonic crystalloids first. Canine shock doses for isotonic crystalloids are 20-40ml/kg given over 15 minutes and a feline dose is 10-20ml/kg over 15 minutes. After the initial bolus is given the patient should be reassessed. Shock doses can be continued at 70-90 ml/kg over one hour in the canine and 35-50 ml/kg over one hour in the feline.

Hypertonic crystalloids (7.5% NaCl) can be given at a rate of 4ml/kg over two minutes, and treatment with hypertonic crystalloids should not exceed 1-2 hours (many veterinarians suggest a 1-2 time initial use only).

Colloids (dextran or hetastarch) can also be given and are the fluid of choice in many emergency clinics for the treatment of shock. Colloids are particularly useful in patients with poor perfusion. Shock doses for synthetic colloids are 10-20 ml/kg in the dog given either rapidly or over 15 minutes and 10-15 ml/kg in the cat given over 15 minutes. If necessary, colloids can be rapidly given to cats, but it is not advisable since rapid administration has been shown to cause vomiting, hypotension, prolonged bleeding or collapse in cats.

Replacement Phase: The volume of fluid given during the replacement phase is based on the level of dehydration as well as ongoing losses. The goal is to return the patient's fluid status back to normal. Deficit volumes are estimates based on physical findings. To calculate volume deficits you must estimate the percent of dehydration multiplied by the body weight in kilograms will equal the amount of fluids in liters. (Ex: A 35kg patient is 10% dehydrated. $35 \times 10\% = 3.5$ liters). It is generally recommended to correct about 75% of the dehydration over the first 24 hours and the other 25% on the second day. Some veterinarians recommend a front-end loading technique where dehydration is corrected in the first 4-8 hours. For febrile animals an additional 10% of fluids should be added to the calculation to every degree over normal. It is important to remember that the replacement phase must be combined with the maintenance phase.

Surgery rates are considered part of the replacement phase. The anesthetic procedure rate at 3 mL/kg/hr in cats and 5 mL/kg/hr in dogs is the current recommendation.

Maintenance Phase: Maintenance volumes account for normal ongoing losses like urinations and feces. Maintenance fluids rates are approximately 50-75 ml/kg/day for both the dog and cat. Colloids can also be given at a constant rate. The most common colloids are hetastarch and dextran which can be given at rates of 20 ml/kg/day for dogs and 10-15 ml/kg/day for cats. There is also a tetrastarch now available called Vetstarch. Remember that whenever a colloid is administered with a crystalloid, calculated crystalloid doses should be decreased by 25-50%, in order to avoid fluid/volume overload.

Conclusion: As a technician you are the person who administers fluid therapy to your patient after the veterinarian creates an order to do so. It is important to understand why you are administering a certain type of fluid to your patient so you can provide better care.