Tech Tip

ADVANCED FLUID THERAPY
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The first consideration of fluid therapy is based on patient status as each patient is an individual with specific needs. What is the patient's current physical condition based on physical exam and evaluation of lab work? What is the scheduled procedure? What is the speed of your surgeon?

The goal of fluid administration should be the support of oxygen delivery, systemic blood pressure whether due to hypotension or hypovolemia, prevention of, or correction of electrolyte imbalances, metabolic or acid-base disorders.

As we all know, total body fluid composition is divided into extracellular fluid and intracellular fluid. Approximately 1/3 of the body's fluid is distributed into the extracellular space and the remaining 2/3 considered to be intracellular fluid. Of the extracellular fluid this is further divided between the interstitial fluid which contains 3/4 of the extracellular fluid and plasma containing the remaining 1/4 of the extracellular fluid. To put this in a different perspective, approximately 605 of the patient's body weight consists of fluid with 20% of the body weight being extracellular fluid and the remaining 40% of the body weight being intracellular fluid.

Going back to our patient status, evaluate hydration, electrolyte balance, renal and hepatic function. What are we working with and what do we have in our armory to effect correction? Fluid therapy is critically important during the perioperative period. The most important goal is to maintain hemodynamic stability and protect vital organs from hypoperfusion (heart, liver, brain, kidneys). All sources of fluid losses must be accounted for. Good fluid management goes a long way toward preventing problems.

- Conventional Crystalloids
- Colloids
- Hypertonic Solutions
- Blood/blood products and blood substitutes

Conventional crystalloid is combinations of water and electrolytes. Combination of water and electrolytes. These are balanced salt solution with electrolyte composition and osmolality similar to plasma. The most commonly used crystalloids are lactated Ringers, Plasmalyte, and Normosol. They have a short intravascular retention as the fluids equilibrate with intracellular and interstitial compartments. They contain a base source ($Na^{++}CO_3^-$): lactate: liver metabolism acetate: muscle metabolism and gluconate: metabolism in most body tissue. Crystalloids are comprised of small molecules. These fluids are good for volume expansion. However, both water and electrolytes will cross a semi-permeable membrane into the interstitial space and achieve equilibrium in 2-3 hours. It is important to remember: 3mL of isotonic crystalloid solution are needed to replace 1mL of patient blood. This is because approximately 2/3rds of the solution will leave the vascular space in approximately 1 hour or less. A major disadvantage is that it takes approximately 2-3 times the volume of a crystalloid to cause the same intravascular expansion as a single volume of colloid. Commonly calculated crystalloid rate of administration for surgical patients are 5 ml/kg for the first hour for anticipated procedures without significant blood loss and decreasing by ½ for each subsequent hour. If significant blood loss or extension surgical time is anticipated, this may be raised to 10/kg for the first hour and decreasing to ½ after the first hour.

Colloids are large molecular weight solutions (nominally MW > 30,000 Daltons)> these solutes are macromolecular substances made of gelatinous solutions which have particles suspended in solution and do NOT readily cross semi-permeable membranes or form sediments. Because of their high osmolarities, these are important in capillary fluid dynamics because they are the only constituents which are effective at exerting an osmotic force

across the wall of the capillaries. These work well in reducing edema because they draw fluid from the interstitial and intracellular compartments into the vascular compartments. Initially these fluids stay almost entirely in the intravascular space for a prolonged period of time compared to crystalloids. These will leak out of the intravascular space when the capillary permeability is deranged or leaky. Albumin solutions are available for use as colloids for volume expansion in the setting of CHF however albumin is in short supply right now. There are other solutions containing artificial colloids available. The general problems with colloid solutions are:

- Much higher cost than crystalloid solutions
- Small but significant incidence of adverse reactions
- Because of gelatinous properties, these can cause platelet dysfunction and interfere with fibrinolysis and coagulation factors thus possibly causing coagulopathies in large volumes.
- These fluids can cause dramatic fluid shifts which can be dangerous if they are not administered in a controlled setting.

Common rates of administration for the canine patient are 3-5 ml/kg/hr with a daily total volume to remain within a 20-30ml/kg range. The feline rates are lower and may be calculated at 1-3 ml/kg/hr with a daily total volume of 20 ml/day. Should colloids be used in conjunction with IV crystalloid therapy, the rate of administration of the crystalloid may be reduced by up to 50%.

Hypertonic solutions are those containing sodium concentrations greater than normal saline. They are available in 1.8%, 3%, 5%, 7.5%, 10% solutions. Hyperosmolarity creates a gradient that draws water out of cells; therefore, cellular dehydration is a potential problem. These solutions are often used in veterinary medicine as a quick "band aid" for refractory hypotension until other interventions are made available. The most common calculated dose is 3-7 ml/kg IV bolus given over time up to 15 minutes. With the elevated sodium content, the patient must first be euvolemic prior to administration. It is recommended that only a single dose of hypertonic saline be administered due to the potential for cellular dehydration.

The decision to administer blood products preoperatively is often based on the packed cell volume and hemoglobin concentration. In veterinary medicine a packed cell volume of 20% is often considered the transfusion trigger. Whole blood may need to be administered in volumes of 10 to 30 ml/kg, depending on the magnitude of anemia and hypovolemia (cats: 5 to 15 ml/kg). These volumes should be halved if packed red blood cell products are used. The rate of administration depends upon the magnitude of the hypovolemia. The amount of blood to administer can also be calculated: (desired PCV - current PCV) x body weight (kg) x 2 ml whole blood (assumes a PCV of about 40%) (Or 1 ml packed red blood cells [assumes a PCV of about 80%]). Intraoperatively, the decision is based on the amount of acute blood loss with the initial packed cell volume being taken into consideration. Typically at TAMU, if there is significant observed blood loss and the packed cell volume has decreased by at least 25%, blood products are prepared for delivery. Bearing in mind that the entire patient status should be considered regarding the ability to deliver oxygen to the cells. Having said that, what is the blood pressure, what is the heart rate, has it raised as a compensatory response to a change in volume status, and has the end tidal CO2 decreased as a result of volume loss? Remember that the oxygen saturation estimated by the pulse Oximeter only tells you the percent of hemoglobin saturation which is not helpful in blood loss situation. Bottom line - if the hemoglobin has dropped to an unreadable level due to blood loss, the pulse Oximeter can still give you excellent % saturation readings. Look globally at the patient!