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Role of Fluid Therapy in Veterinary Medicine

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Fluid therapy maintain fluids within the blood and body systems to help, balance and support normal body functions. The disease process that causes fluid, electrolyte, and acid-base disturbances must be diagnosed and treated appropriately. The role of fluid therapy in treatment is supportive. It is essential to know about the distribution of fluid and water in the body, to understand fluid therapy and its applications. Total body water (TBW) comprises approximately 60% of a patient's body weight. Approximately 67% of TBW is found inside the body's cells and is referred to as intracellular fluid (ICF). The remaining 33% of TBW is extracellular fluid (ECF). Interstitial fluid, which bathes cells and tissues (~24% of TBW). The Plasma, liquid portion of blood, which constitutes most of intravascular volume (~8%–10% of TBW). Transcellular fluid, which comprises synovial joint fluid, cerebrospinal fluid, bile, and the fluid in the linings of the peritoneal cavity, pericardium, and pleural space (~2% of TBW). A helpful rule of thumb to simplify the distribution of fluids in the body is the 60:40:20 rule: 60% of a patient's body weight is water, 40% of body weight is ICF, and 20% of body weight is ECF.

The major therapeutic objectives of fluid therapy are to correct existing abnormalities that already exist, provide maintenance therapy and monitoring until the animal has recovered. Correction of abnormalities may require 4 to 6 hours, and maintenance therapy may be necessary for 2 to 4 days, depending on the cause of the disease. Patients who cannot adequately perfuse their tissues require immediate intervention with fluid therapy to restore perfusion and correct shock. Shock is defined as the critical imbalance between the delivery of oxygen and nutrients (carried by blood) to tissues and the tissues demand for these components. If allowed to persist, this imbalance can lead to acute decompensation and death. Restoring perfusion and, subsequently, oxygen and nutrient delivery to tissues is crucial to survival in these patients. Patients may present with several clinical signs and owners may report a history of recent fluid loss, such as intractable vomiting, severe diarrhea, or hemorrhage. Once shock is recognized, access to the intravascular compartment must be achieved and fluid resuscitation initiated as soon as possible.

There are at least five possible free water, electrolyte, acid-base, and oncotic pressure abnormalities that could exist at the same time, that must be corrected:

- Fluid volume deficit (free water)
- Plasma osmolar deficits
- Specific electrolyte imbalances
- Acid-base imbalance
- Oncotic pressure imbalances

Types of Intravenous Fluid

Fluids are categorized on the basis of their -

A. Physical nature (crystalloid and colloid)

B. Osmolarity (hypotonic, isotonic and hypertonic).

Crystalloid Solutions: A crystalloid is a substance that forms a true solution and is capable of being crystallized. Examples of crystalloid solutions are Ringer's solution, lactated Ringer's solution, acetated Ringer's solution, 0.9% NaCl, 7.2% NaCl (hypertonic saline), 1.3% $NaHCO_3$, 8% $NaHCO_3$, calcium gluconate, and 50% dextrose. Sodium chloride is the classic example of a crystalloid solution.

Hypotonic Crystalloid Solutions: Lactated Ringer's solution is a balanced, polyionic, alkalinizing, and hypotonic (275 mOsm/L) crystalloid solution. Lactated Ringer's solution alkalinizes because lactate is predominantly metabolized to the bicarbonate ion.

Isotonic Crystalloid Solutions: Isotonic sodium bicarbonate (1.3% NaHCO3 solution) is an alkalinizing isotonic crystalloid solution that is used to treat severe acidemia (indicated whenever blood pH <7.20 as a result of metabolic acidosis). This solution is alkalinizing.

Hypertonic Crystalloid Solutions: Fifty percent dextrose is 2500 mOsm/L (approximately eight times normal osmolarity). Fifty percent dextrose solutions are commonly administered to ruminants with ketosis or hypoglycemia and produce a transient increase in cardiac contractility. If 1 g of dextrose given intravenously will provide 5 kcal (2.1 kJ) of energy, the approximate amounts of dextrose solution needed to meet the energy needs for maintenance in cattle.

Calcium gluconate 23% or calcium borogluconate- Calcium borogluconate is the standard treatment for milk fever (hypocalcemia) in cattle. Calcium gluconate should not be added to sodium bicarbonate solutions because a white precipitate ($CaCO_3$) forms immediately that interferes with normal fluid administration. Likewise, calcium gluconate should not be administered with tetracycline antibiotics because a yellow precipitate forms.

Colloid Solutions: A colloid is a substance that is too colloid large to pass through a semipermeable membrane. Examples of colloid solutions administered to ruminants are whole blood, stroma-free Hb, plasma, dextrans, hydroxyethyl starches, and gelatins. As a group, colloid solutions are excellent for sustained expansion of plasma volume, which is in marked contrast to the effect of crystalloid solutions. Colloid solutions are contraindicated in congestive heart failure, because these animals have increased plasma volume. Five different kinds of solutions are used in veterinary practice:

- Polyionic crystalloid solutions, such as lactated Ringer's solution and acetated Ringer's solution, are indicated for dehydration and moderate degrees of acid-base and electrolyte imbalance.
- Hypertonic saline solution and an oral water load represent a practical and inexpensive alternative to parenteral administration of large fluid volumes.
- Hypertonic or isotonic sodium bicarbonates, such as 8.4, 5.0 (hypertonic), or 1.3% (isotonic) solutions of sodium bicarbonate, are used for severe strong ion (metabolic) acidosis and hyponatremia, particularly in dehydrated depressed calves with diarrhea.
- Chloride-containing acidifying solutions, such as Ringer's solution, are used for treatment of strong ion (metabolic) alkalosis.
- Colloid solutions, such as plasma or blood, are administered more frequently than Dextran 70 or hydroxyethyl starch solutions.

Ways to Provide Fluid Therapy: - Depending on the species receiving fluid therapy and need, fluids given in several ways i.e. Oral, subcutaneous, intravenous, intraosseous, and intraperitoneal routes.

Oral Route: it is the simplest way of fluid therapy, providing water per os can correct some conditions, including mild salt toxicity and mild cases of dehydration. Providing water via the oral route is as simple as offering the patient a bowl with a premeasured volume of water on a set schedule and measuring the amount consumed. However, in patients that have gastrointestinal pathology (i.e., parvovirus infection) or are unable to consume adequate amounts of water to maintain normal urine production or to establish and maintain fluid homeostasis, other means of fluid resuscitation must be used.

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Subcutaneous Route: Subcutaneous fluids are common in veterinary therapy, used for many disease conditions, including cases of mild vomiting and diarrhea or mild dehydration, or to support kidney function in animals with chronic kidney disease. As with other therapies given subcutaneously, it takes time for subcutaneous fluids to be absorbed into the bloodstream; thus, the subcutaneous route is not appropriate to treat life-threatening conditions such as severe dehydration or shock.

Intravenous Route: IV fluid therapy is very common in veterinary practice, allows practitioners to restore intravascular volume, correct dehydration, and administer IV medications. In addition, access to the vascular space allows for other therapies, including transfusions, medications, and parenteral nutrition.

In emergency situations or when a large volume of fluid is needed over a short amount of time, selecting a catheter with a large bore and a short length is preferable to allow for rapid infusion of fluids. This is a function of Poiseuille's law, which governs the flow of fluid through a tube: essentially, the shorter the tube, the smoother the flow, and the larger the tube's diameter, the faster the flow, meaning that large-bore, short catheters are the best choice when a large volume of fluid must be delivered quickly, such as in cases of hypovolemic shock. T-ports and additional tubing (e.g., extension sets) may decrease both the amount of fluid and the speed of delivery. In an emergency situation, it is best to minimize any extra IV accessories that might impede flow.

In addition to peripheral access, IV fluid therapy can be delivered through central line catheters. These catheters are longer than typical peripheral IV catheters and reach the central circulation via the vena cava. Central lines are commonly placed in the jugular vein, with the tip of the catheter sitting just outside the entrance to the right atrium to facilitate measurement of central venous pressures, if desired. Jugular central line catheters can be placed with a guidewire (i.e., Seldinger technique) or a peel-away introducer. They are available with multiple lumens to enable sampling, concurrent administration of incompatible fluids, and administration of hypertonic solutions that may cause phlebitis if given peripherally (e.g., dextrose concentrations >7.5%). The central circulation can also be reached with a long, through-the-needle catheter (e.g., Intracath) placed in either the lateral saphenous vein or the medial femoral vein or a peripherally inserted central catheter (PICC) in the same vessels. Because of their long length, smaller bore, and longer time usually required for placement, central catheters are not recommended for emergency fluid therapy, but can be maintained for long periods, making them well-suited to longer-term fluid therapy.

Intravenous Intraosseous Route: Intraosseous (IO) catheters are an excellent choice for providing drugs and fluids to patients in which IV access is difficult, if not impossible to obtain in a timely

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fashion. Patients with severe hypotension or complete cardiovascular collapse (i.e., patients in cardiac arrest), that are severely dehydrated, or in which IV access is not obtainable (as in patients with edema, burns, thrombosis, or obesity) can benefit from placement of a catheter in the medullary cavity of a bone (IO). This route is also very useful in tiny patients, such as neonates and pocket pets (e.g., hamsters, gerbils). The materials are readily available in most, if not all, veterinary practices, and placement may mean the difference between life and death.

For all of the advantages of the IO route, there are several limitations. Fluid cannot be provided at a rate equivalent to that of IV access, and the needles are not designed for long-term use. Mostly, removal of IO access devices within 72 to 96 hours of placement is recommend to avoid the development of osteomyelitis or bone infections, as long as IV access can be obtained.

Fluid Therapy Formulas:

Calculation of Dehydration Deficit

Body weight (kg) × % dehydration as a decimal = liters of fluid required to correct dehydration

Calculation of Maintenance Fluid Requirements

Dogs: Body weight (kg)0.75 × 132 = 24-hour fluid requirement in milliliters

Cats: Body weight (kg)0.75 × 80 = 24-hour fluid requirement in milliliters

Ongoing losses (e.g., from diarrhea, vomiting, or polyuria) must be calculated and added to the total maintenance requirement obtained from these formulas.

Adverse Effect: - Adverse reactions to intravenous fluid administration include sudden muscle weakness (suggests hypokalemia) and sudden tachycardia and hyperventilation, which suggest overhydration. When these occur the fluids should be stopped and the clinical findings must be assessed.

Conclusion

Understanding the role of fluid therapy, methods of providing fluids, types of fluids available, are essential to provide patients safe treatment.

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