CATTLE FLUID THERAPY IN FOCUS

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Tim Potter and Gayle Hallowell detail two fluid administration techniques, and explain the considerations needed for their use

A HEALTHY, non-lactating, 650kg Holstein cow has a minimum water requirement of approximately 40L per day.

This requirement is more than doubled in an animal at peak lactation. In diseased animals, the water demands for milk production will frequently be reduced. However, there are other demands for water.

A cow whose body temperature rises above the normal range of 38.5°C to 39°C will require an additional 6L to 8L of water above the 24-hour baseline requirement for each degree increase in its temperature. Many disease conditions (such as diarrhoea) can cause an abnormal amount of body water loss. Abnormal losses, coupled with the fact that a sick cow often does not feel well enough to drink, will rapidly result in the animal becoming hypovolaemic and/or dehydrated.

Fluid therapy in ruminants is often viewed as difficult and time consuming, due to the volumes required and the time involved for administration and monitoring. For this reason, fluid therapy is often neglected in cattle, despite appropriate therapy greatly improving outcomes in a number of commonly encountered clinical situations.

This article will cover the two most common methods of fluid administration (oral and intravenous), and the main clinical decisions when implementing them.

Hydration and hypovolaemia

Hypovolaemia is defined as loss of fluid volume from the intravascular space, whereas dehydration is loss of fluid from the interstitial space. It is important that the clinician is able to differentiate between these two states via thorough clinical examination. The markers for dehydration identification are fairly crude; as vets, the minimum degree of dehydration we can detect is five per cent, and animals are usually nearly dead by the time they are 15 per cent dehydrated (see Table 1).

The skin tent test is performed by pinching an area of skin – usually over the eyelids or neck – and estimating the time it takes to return to its normal position (in a well-hydrated animal, this should be instantaneous).

Clinical signs indicative of hypovolaemia are vague, but include increased heart rate, cold extremities, increased capillary refill time, decreased urine output due to decreased renal perfusion, increased packed cell volume and total protein due to haemoconcentration, increased creatinine (in the absence of renal disease) and increased blood lactate concentrations.

Oral fluid therapy

Oral fluids are a cost-effective means to rehydrate cattle with mild or moderate hypovolaemia or dehydration.

Oral fluid therapy should be reserved for cows and calves that can stand, have no abdominal distension and still show some evidence of gastrointestinal function.

Animals unable to stand or suckle, or showing signs of ileus, should be treated with intravenous fluid therapy instead.

• Calves

The most frequently encountered indication for fluid therapy in bovine neonates is diarrhoea. Diarrhoea results in excessive faecal secretion of electrolytes and fluid. In calves, most diarrhoea is either secretory, malabsorptive or a combination of both. The average faecal losses are about 2L per day, but can be as high as 6L per day.

The losses result in systemic hypovolaemia and then dehydration. In addition, a secondary acidosis develops; this is due to increased L-lactate concentrations due to anaerobic metabolism resulting from poor perfusion, faecal bicarbonate loss and the bacterial fermentation of nutrients in the gastrointestinal tract to produce D-lactic acid.

The primary objective of oral electrolyte therapy is to replenish fluid and electrolyte losses, and then to maintain the calf in a positive balance. This is accomplished by the three following mechanisms.

– Provide a source of additional water and electrolytes. Even if fractional absorption of a given electrolyte is reduced, the total amount absorbed by the calf can be increased by increasing the quantities offered.

– Improve absorption by providing the agents, such as glucose and amino acids, to facilitate sodium absorption through co-transport mechanisms.

– Provide a more digestible solution, by replacing milk or milk replacer that may contain nutrients that are poorly absorbed and thus contribute to the diarrhoea.

Less important oral electrolyte therapy objectives include the support of immune and enteric function; the reduction of the potential negative impact on growth rates and a reduction in the severity of the diarrhoea.

The total daily oral fluid intake for a diarrhoeic calf should be in the region of 8L. The total replacement of milk or milk replacer with electrolyte solution in the first stages of diarrhoea treatment is adequate in most cases. However, even products containing 120mmol/L glucose can only provide 20 per cent of maintenance energy requirements, and animals in poor body condition may require additional energy support.

Oral electrolyte therapy can be administered either by a bottle fitted with a teat or by orogastric intubation. Absorption is slightly more rapid following suckling. However, orogastric intubation is frequently used because it is less time consuming.

• **Adult cattle**

Adult cattle that are not drinking, are hypovolaemic and/or dehydrated, or have ruminal acidosis, will have an increase in their ruminal osmolarity. Oral fluid therapy in adult cattle should be isotonic or hypotonic, and nonalkalinising or slightly acidifying (except in cases where acidosis or carbohydrate overload is the established cause of dehydration). The majority of commercially available rehydration therapies for calves are unsuitable for use in adults.

It is possible to prepare a slightly acidifying oral rehydration solution using readily available components. For example, per 20L of water, add:

• 200g of dextrose;

• 170g (approximately 5oz) of sodium chloride (NaCl);

• 15g (approximately 1oz) of potassium chloride (KCl);

• 7.4g (approximately 0.4oz) of calcium chloride ($CaCl_2$); and

• 3.8g of magnesium sulphate ($MgSO_4$).

The salts may be weighed out and stored in a plastic zip-locktype bag labelled with the type of salts, the amount and the date. These salts will keep indefinitely, and can be added to clean tap water as and when required. The addition of further products, such as direct-fed microbial preparations and rumen stimulants, is possible and, in recently calved animals, calcium supplements or propylene glycol may be used.

For oral fluid therapy to be effective in adult cattle, a minimum of 40L to 45L of fluid should be administered. Previously, the use of stomach tubes and funnels meant administration of 40L to 45L of fluid was time consuming and required an assistant. Commercially available stirrup pumps connected to stomach tubes now make the process quicker and easier, without the need for an assistant.

Intravenous fluid therapy

There are two main types of intravenous fluids – colloids and crystalloids. Colloids include blood and plasma (of which the main constituent is albumin) and the hydroxyethyl starches (such as pentastarch). The latter products may be used in individual valuable animals, but economics often prohibits their use.

Hypertonic (7.2 per cent) saline is widely used in practice and also has properties that mean it acts like a colloid, but it should always be followed with intravenous or oral isotonic fluids or water. Crystalloids include Hartmann's solution or Lactated Ringer's, 0.9 per cent NaCl and five per cent dextrose. The most practical fluids to use in cattle are plasma, hypertonic (7.2 per cent) saline and crystalloid solutions.

Fluids can be administered via a needle and flutter valve, but these can often only be used for short periods of time before a haematoma forms. Catheters are easy to place in the jugular veins of calves and cattle. If this is not possible, the cephalic vein can be used, although this is dependent on the patient's temperament. To allow appropriate fluid rates to be delivered, 14G catheters should be used in calves, with 10G to 12G catheters used in adults. If a catheter is to be left unattended it should be wrapped, as both calves and adults can "remove" them with their hindfeet, or rub them out.

• **Calves**

It has been reported that a high proportion of calves have failure of passive transfer[1]. However, only a very small percentage of these calves show clinical signs of disease, unless they are raised in particularly unhygienic conditions. They are, therefore, prone to developing septicaemia and diarrhoea, which may be concurrent. Total protein is thought to correlate quite well with immunoglobulin concentration. However, in hypovolaemic, and – sometimes – dehydrated calves, this can be artificially increased due to haemoconcentration. Primary causes of secretory diarrhoea can also lead to hypovolaemia, as can any disease that leads to pyrexia and reduced water intake or simply the inability to stand.

Fluid rates commonly reported for administration to large animals are very conservative. If one estimates the fluid deficits for a 10 per cent "dehydrated" 50kg calf, it is 5L plus maintenance requirements, which is somewhere between 3ml/kg/hr to 5ml/kg/hr or 72ml/kg/day to 120ml/kg/day (150ml/hr to 250ml/hr or 3.6L to 6L per day).

Using the 50kg calf as an example, we have established its fluid requirements are the 5L fluid deficit and 4L/day maintenance. The first step would be to place a catheter, provide a 1.0L fluid bolus of lactated Ringer's solution and observe changes in clinical parameters. It is most likely this animal will need another 1.0L bolus of lactated Ringer's solution.

Once the second bolus has been administered, the clinical parameters should again be reassessed. The animal still has a 3L fluid deficit and has a daily requirement of 4L, so the deficit should be replaced over the next six to eight hours (3L deficit = 375ml/hr (more than twice maintenance).The maintenance requirements that have not yet been provided are 4L over the next 16 hours – which works out at 250ml/hr (less than twice maintenance).

Sick calves benefit from receiving plasma, usually administered as blood, which is taken from either their mother or other animals on the farm. Bovine blood will not spontaneously separate, and it is frequently not practical to spin it when required in the field.

A normal-sized calf needs 2L of plasma, which means a minimum of 4L of blood should be administered over several hours. It has long been believed that plasma is only useful in animals that have low total protein – however, it not only contains protein (in the form of albumin), but also immunoglobulins, clotting factors, including antithrombin-three and other products very important for fighting localised and systemic infections, such as fibronectin.

• **Adult cattle**

Intravenous fluid therapy for adult cattle is also practical and affordable, but may require home-made isotonic crystalloids. There are many different ways of producing these, and they are not going to be as optimal as commercially produced ones. A formula for producing fluids can be seen in Table 2. Intravenous fluid therapy may be required for the sick endotoxaemic cow, secondary to severe mastitis, endometritis, peritonitis, pyelonephritis, pleuropneumonia or right displaced abomasums.

Hypertonic (7.2 per cent) saline can be life-saving in severely hypovolaemic/endotoxaemic animals.

It should be administered at 4ml/kg – in effect, 2L to 2.5L for a 500kg to 600kg cow respectively as a bolus. This can then be followed by either oral or intravenous fluids.

Although oral fluids are obviously easier to administer and do not require catheter placement, it should be taken into account that if the animal is severely hypovolaemic or endotoxaemic, blood flow will be directed away from the gastrointestinal tract to maintain perfusion to the brain, heart and kidney, and so absorption will be reduced. Endotoxins can also inhibit gastrointestinal motility, as can intrinsic gastrointestinal problems (such as corrected recommended daily allowances).

This may result in ruminal or overall gastrointestinal stasis, which means fluid will simply stay in the gastrointestinal system and not be beneficial to the cow. Each case must, therefore, be judged individually, based on a careful clinical examination.

Intravenous fluid therapy is not without potential adverse effects, such as haematomas around the vein being used and thrombophlebitis. The use of homemade solutions intravenously can increase the risk of systemic infections if they are not prepared in an optimal manner. Rapid fluid administration, particularly in endotoxaemic or septic patients, can lead to signs of fluid overload.

The clinical signs of fluid overload are primarily due to pulmonary oedema, and include increased respiratory rate and deeper individual breaths, flared nostrils and "wet lung sounds" and/or a wet cough.

Critical care of humans and small animals is a long way ahead of that commonly practised in cattle. The clear message that has come out of a lot of large human trials[2] is that if you want to be successful treating very sick animals, you need to be aggressive in the first eight to 24 hours. This applies both to fluid therapy and other treatments. If fluid deficits are corrected fully and aggressively, and combined with appropriate therapy, survival rates for critically ill bovine patients would increase.

References

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