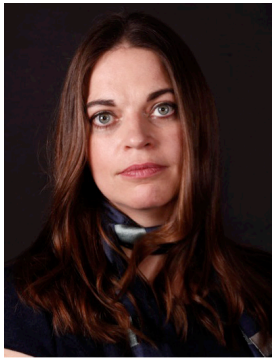

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21ST CENTURY FLUID THERAPY

Intravenous fluid therapy

In humans and animals, fluid therapy is a core element for the resuscitation of critically ill patients, since fluid therapy is essential to decrease mortality and accelerate recovery. In equids fluid therapy is a fundamental component of the treatment for diseases, such as SIRS, sepsis, colic, hypovolemia and shock. The purpose of fluid therapy is to restore effective blood volume, correct hypotension, improve cardiac output, normalize tissue oxygenation and correct electrolyte and acid base abnormalities. The ultimate aim is to prevent organ dysfunction[8]. Thus fluid therapy is the mainstay in the treatment of SIRS and sepsis induced hypovolaemia.

Sepsis is a complication of critical illness with high degree of mortality. In horses with gastrointestinal disease SIRS is a common complication, and as in man it carries a high mortality rate. In adult horses SIRS commonly originates secondary to gastrointestinal disease (i.e. colitis), due to bacterial and endotoxin translocation through the gut wall[10]. The most current Surviving Sepsis Campaign guidelines recommend crystalloids over hydroxyethyl starches (HES) as the preferred fluid for resuscitation. The most commonly used type of intravenous fluid therapy for resuscitation in humans and equids are the polyionic isotonic crystalloid fluids, Lactated Ringers and 0.9 % sodium chloride.

Intravenous fluid therapy effects and side effects

Intravenous fluids expand the intravascular space. However depending on the fluid type, leakage into the extravascular space varies in speed and degree. Crystalloids fluids counteract the movement into the extravascular space due to the osmotic pressure exerted by its solutes. Whilst colloids create oncotic pressure gradients to keep fluids within the intravascular space[7]. Thus in theory the blood volume expansion may be proportional to the solute tonicity or oncotic power. Colloid fluids remain in the intravascular space longer than crystalloids, thus less fluids are needed to achieve similar hemodynamic effects, as shown by the recent CHEST trial. Colloids have been used for rapid and long lasting circulatory stabilization, although data supporting this practice is lacking.

The major complications of fluid resuscitation are pulmonary and interstitial oedema. There are concerns with the use of colloids with regards to immune effects in critical illness, acute kidney injury, coagulopathy, increased risk of death and higher costs. However, the administration of large volumes of 0.9% sodium chloride has been associated with hyperchloraemic metabolic acidosis due to increased plasma chloride and decreased strong ion difference. Furthermore hyperchloraemia may cause renal vasoconstriction and decrease glomerular filtration rate, leading to acute kidney injury and higher mortality.

Enteral fluid therapy

Where enteral fluids can be used they have many advantages not least from a financial point of view, particularly in the management of impactions, oral supplementation of electrolytes, provision of nutrition and treatment of dehydration when present without hypovolemia. Interestingly NICE guidelines recommend that justification is required as to why intravenous fluids are chosen over enteral fluids and that if the former are used should be stopped as soon as practical.

Water absorption and blood flow

Water absorption from the gastro-intestinal tract in the normal horse primarily occurs in the large intestine, and more specifically the large colon. In an adult horse a volume of up to 100L of fluid and associated secretions is absorbed during the course of the day[27-29]. In the hypovolemic horse, in order to protect the vital organs, blood flow is diverted from the gastro-intestinal tract. Once blood flow is reduced, so too are gastro-intestinal motility and absorption. In addition, obtunded, hypovolemic horses have a reduced thirst drive. It is for this reason that using oral fluid therapy in hypovolemic animals is unsuccessful at best and detrimental in certain scenarios.

Enteral fluids can be delivered in the form of water from a bucket, via an indwelling narrow nasogastric tube (continuous administration of oral fluids), via a conventional nasogastric tube (intermittent fluid administration) and when data is extrapolated from other species instilled per rectum.

Proctoclysis

There are various descriptions in the literature of the use of fluids per rectum in a variety of veterinary species and in man. They appear to be an effective way of providing maintenance requirements or provision of enough fluids to allow other vascular access to be obtained. They have been reported to be used for over 100 years in man on the battlefield. They are commonly reported for use in elephants and have been partially used successfully in a small number of horses. In humans, the maximum amount of fluid that can be absorbed in a 70Kg adult is 150ml/hr with a maximum installation rate of 500ml/hr via a foley catheter. Similar fluid instillation rates proportionate to body size have been used in elephants and horses and significantly higher rates experimentally in rabbits. The suggestion from one study is that absorption of fluids per rectum will still occur in the face of hypovolemic shock.

Fluids used enterally

These include water, hypo or isotonic fluids supplemented with electrolytes (e.g. sodium chloride and potassium chloride) and also hypertonic magnesium sulphate. Hypotonic fluids given enterally are likely to be absorbed from the gastro-intestinal tract, whereas isotonic fluids are more likely to remain the gastro-intestinal lumen.

Magnesium sulphate is used enterally as a cathartic agent as an initial treatment for large colonic impactions. Initial use of 0.5g/kg is recommended diluted in water. Experimentally magnesium sulfate is not as effective in increasing colon water content when compared with a balanced electrolyte solution but does increase the water content of feces in the small colon. Balanced electrolyte solutions can be made from sodium chloride and combined sodium and potassium chloride (LoSalt®) with approximately 5g of each per 1L of water. If only using sodium chloride, add a maximum of 9g per 1L of water. In horses that have severe hypokalemia, potassium chloride can be used orally (0.1-0.2g/kg/day) in addition to intravenous fluid supplementation.

Products not recommended for use enterally

Mineral oil can be used as a marker of gastrointestinal transit (18 hours to anus if transit time is normal). For impactions, it works its way around without penetrating it as well as hindering water penetrating. Based on this observation, increased cost over water and the fatality if this product ends up in a horse's lungs it cannot be recommended for treatment of pelvic flexure impactions.

Dioctyl sodium sulphosuccinate is a detergent that should penetrate impacted fecal material by affecting surface tension, thus allowing water to enter the feces. Care should be taken as a 3-fold overdose is fatal[39] and also increases absorption of mineral oil so should not be administered with it. There is no benefit of this over water based on an experimental study.

Sodium sulphate is an even more potent cathartic than magnesium sulphate, but consistently causes hypernatremia and hypocalcemia, so is not recommended.

Oral glucose in fluids does not provide sufficient nutrition to be valuable in horses and glucose and glycine containing fluids in an experimental diarrhea model resulted in incomplete fluid absorption.