General Anesthesia in Horses on Fluid and Electrolyte Therapy

Lindsey B.C. Snyder, DVM, MS*, Erin Wendt-Hornickle, DVM

KEYWORDS

• Crystalloids • Colloids • Hypertonic • Saline • Calcium • Potassium

KEY POINTS

- Hypotension is linked to myopathies in horses, with prolonged hypotension (defined as mean arterial pressure of 55–65 mm Hg) resulting in a significantly increased risk of postanesthetic myopathy.
- Maintaining a colloid oncotic pressure (COP) above 20 mm Hg has been suggested to prevent tissue and intestinal edema. Reducing the COP below 20 mm Hg with fluid therapy in humans is associated with an increase in the interstitial fluid volume in relation to the plasma volume.
- The Starling-Landis equation dictates the body's fluid dynamics.
- Balanced electrolyte solutions are most commonly used for fluid therapy during anesthesia; however, colloid solutions will maintain the vascular volume.
- The colloid osmotic pressure is the primary force opposing the leakage of fluid from blood vessels.
- Electrolyte imbalances can play an important role in fluid therapy, and can be greatly influenced by the fluids administered.

RATIONALE FOR FLUID THERAPY

General anesthesia of horses is not without complications, with morbidity and mortality rates higher than those for other species (0.12%–0.90%).[1] Morbidity, even in horses that are systemically healthy, can include hypotension and subsequent neuropathies, as well as postoperative tissue and pulmonary edema. Horses, because of their large body mass, are especially prone to anesthesia-related myopathies.[2] One of the most common complications in equine inhalant anesthesia is hypotension. Hypotension is linked to myopathies in horses, with prolonged hypotension (defined as mean arterial pressure of 55–65 mm Hg), resulting in a significantly increased risk of postanesthetic myopathy.[3] Hypotension can be treated various ways. One

Anesthesia & Pain Management, Department of Surgical Sciences, University of Wisconsin-Madison School of Veterinary Medicine, 2015 Linden Drive, Madison, WI 53706, USA
* Corresponding author.
E-mail address: culpl@svm.vetmed.wisc.edu

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recognized therapy to limit hypotension is to administer intravenous (IV) fluids in an effort to maintain or even increase intravascular volume.[1] The type of IV fluids chosen can affect fluid shifts between the vascular and interstitial spaces, therefore contributing to or limiting the development of tissue and pulmonary edema.

Further evidence for fluid therapy includes the fact that general anesthesia with inhalant anesthetics has been shown to decrease myocardial contractility and mean arterial pressure in horses.[2] Inhalant anesthetics decrease myocardial functioning.[4] One way to limit anesthetic-induced myopathies in horses is to prevent myocardial depression and maintain tissue blood flow.[2] Fluid loading, the administration of high volumes of IV fluids over a short duration, is one way to accomplish this goal. Fluid loading counteracts the hypovolemia induced by preoperative fasting and ongoing losses from urinary output.[5] The need for intraoperative fluid therapy is all the more important in cases with existing comorbidities. In horses with strangulating-type colic, the morbidity rate is high because of the pathologic changes, including hypotension, that endotoxemia causes secondary to translocation of toxins across the gut.[6]

BACKGROUND

A horse's adult body weight is approximately 60% water, located in various compartments throughout the body.[7,8] Body fluids are divided into the intracellular and extracellular fluid (ECF) compartments. The extracellular compartment is further divided into the interstitial, intravascular, and transcellular compartments. Dehydration causes a decrease in the ECF secondary to a decrease in total body water and is characterized by an increase in packed cell volume (PCV) and total protein (TP). Hypovolemia, on the other hand, is a decrease in fluid in the intravascular compartment. Physical examination and clinical pathology laboratory results (PCV, TP) can aid in determining the degree of dehydration or hypovolemia. In extreme losses, heart rate may also become elevated and the pulse quality will be decreased. A blood pressure measurement can assist in quantitating the degree of hypovolemia or dehydration. In either case, dehydration or hypovolemia, fluid therapy is critical in the face of inhalant anesthetics. In the case of dehydration, fluid deficits should ideally be replaced slowly to allow for fluid equilibriums to be reestablished between intravascular, interstitial, and intracellular compartments. Under anesthesia, however, the need for fluid support outweighs the slow equilibration process. Hypovolemia can be treated much more rapidly by filling the vascular compartment to improve tissue perfusion. The standard intraoperative fluid rate of 10 mL/kg/h in anesthetized patients may need to be increased in a dehydrated or hypovolemic horse to fill the vascular and interstitial spaces and prevent ischemia of the tissues.[7] In any case, the goal in anesthetic fluid therapy should be to optimize cardiac preload.[5]

FLUID DYNAMICS

The colloid oncotic pressure (COP), is the osmotic pressure exerted by proteins in plasma that draw water into the vascular system. Proteins are the only substances that do not readily diffuse through the capillary membrane.[9] Numerous studies have evaluated the effects of fluid administration on the COP. In healthy awake horses, COP and TP decrease in a linear fashion when 40 mL/kg/h of IV crystalloids are administered[10] and 11 mL/kg/h when anesthetized.[11] The linear relationship has also been demonstrated in horses given 15 to 25 mL/kg/h IV crystalloids during colic surgery.[12] Additionally, healthy anesthetized dogs had a decrease in COP of 5 mm Hg when administered 9.4 $\pm$ 4.6 mL/kg/h of crystalloids. The administration of fluids did not