Review of the Use of Hypertonic Saline in Equine Practice

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The potential uses for hypertonic saline in equine practice include shock syndromes, dehydration, controlled hemorrhage, and acute traumatic central nervous system injuries. This product is ideal for mobile equine practitioners because of its low cost, rapid administration, and minimal storage-space requirements. Authors’ addresses: Loomis Basin Equine Medical Center, 3901 Sierra College Boulevard, Loomis, California 95650 (Fielding); and Department of Medicine and Epidemiology, School of Veterinary Medicine, University of California, Davis, California (Magdesian); e-mail: langdonfielding@yahoo.com. © 2010 AAEP.

1. Introduction
Hypertonic saline solutiona (7.2%) has been used to treat hypovolemia in horses for a number of years; however, its potential uses in veterinary practice recently have been expanded.1–7 Although once primarily considered a treatment for shock, it has a number of new indications for a variety of medical conditions.8 The potential benefits of hypertonic saline continue to be elucidated through research and include modification of the immune, cardiovascular, and gastrointestinal systems. The purpose of this review is to outline the new and old uses of hypertonic saline as they apply to equine practitioners.

2. Physiology
The physiology behind the effects of hypertonic saline (HS) relates to its high osmolarity (7.2% NaCl, approximately 2,400 mOsm/l) compared with other body fluids (approximately 300 mOsm/l).9 When HS is administered intravenously, fluids with a lower osmolarity, such as those within the intracel-
nal edema and therefore, reduce the incidence of ileus.\textsuperscript{12}

In addition to the fluid-shifting effects of HS, it has a number of additional potential benefits. Recently, it has been shown that the increased concentration of plasma sodium induced by HS results in the release of vasopressin; this causes an increase in blood pressure, because vasopressin is a potent vasocostrictor.\textsuperscript{13} Other effects of HS include a decrease in endothelial swelling as well as improved immune function.\textsuperscript{14}

3. Specific Advantages of HS in Equine Practice

Although HS may provide advantages to a number of species, equine practitioners in particular should pay close attention to the new advances in the use of this product. Two of the major limitations faced by equine veterinarians involve cost of product as well as time required to administer a large volume of fluids. HS is ideal for use in horses because of its low cost (approximately $20 per 2-l dose) and rapid rate of administration. Whereas large volumes of isotonic fluids may take hours to administer, the beneficial effects of HS can begin immediately. An additional advantage of HS is that it requires only a small amount of storage space in an equine veterinarian’s pack.

4. When to Administer HS

The indications for HS can be divided into two categories (Table 1). The first encompasses conditions associated with hypovolemia that require an acute expansion of blood volume, and these include sepsis, endotoxemia, and acute controlled hemorrhage. The second category includes conditions that are associated with tissue edema, especially traumatic brain injury.

5. Hypovolemia

Briefly, hypovolemia in horses can be recognized by seven clinical criteria:

1. Increased heart rate
2. Poor pulse quality
3. Cold extremities
4. Decreased mentation
5. Decreased jugular refill
6. Pale mucous membranes
7. Slow capillary refill time

Table 1. Indications and Dosages for the Use of IV Hypertonic Saline in Equine Practice

<table>
<thead>
<tr>
<th>Condition</th>
<th>Indications for Hypertonic Saline Administration</th>
<th>Dose of Hypertonic Saline (7.2%)</th>
<th>Additional Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolemia</td>
<td>A: Clinical signs</td>
<td>2–4 ml/kg</td>
<td>Follow with additional IV isotonic crystalloids and make sure that oral fluids are available if appropriate.</td>
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<tr>
<td></td>
<td>B: Laboratory values</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1) Increased heart rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2) Poor pulse quality</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>3) Cold extremities</td>
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<td></td>
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<td></td>
<td>6) Pale mucous membranes</td>
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<td></td>
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<td></td>
<td>7) Slow capillary refill time</td>
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<td></td>
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<tr>
<td></td>
<td>8) Decreased urine output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traumatic Brain Injury</td>
<td>A: History and/or external signs of head trauma</td>
<td>1 ml/kg</td>
<td>Additional supportive therapies are important and may include IV isotonic fluids and electrolyte monitoring.</td>
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<tr>
<td></td>
<td>B: Neurologic deficits localized to the brain</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>1) Seizures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2) Behavioral changes</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>3) Circling</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>4) Cranial nerve deficits</td>
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<td></td>
<td>5) Head tilt</td>
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<td></td>
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<tr>
<td></td>
<td>6) Nystagmus</td>
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</tbody>
</table>
Other indications of hypovolemia may include decreased urine output or abnormal laboratory indicators of hypovolemia, such as increased packed cell volume and total protein, lactate, and creatinine concentrations.

If more than one of these criteria is present, hypovolemia should be suspected, and HS is often indicated. A dose of 4 ml/kg of 7.2% HS can be rapidly administered through a 14-gauge IV jugular catheter. Peripheral catheters in smaller veins are less ideal, because the HS may cause irritation to the vascular endothelium. Caution should be used if administering HS through a needle placed into the vein, because extravasation of fluid into the tissues may be irritating. After HS has been administered, it should be followed by the administration of a standard isotonic fluid such as lactated Ringer's solution (LRS), Plasma-Lyte 148 (or Normosol-R), or 0.9% saline. Ideally, fluids that are lower in chloride (Plasmalyte 148 or Normosol-R) may mitigate some of the hyperchloremia that can result from 7.2% hypertonic saline compared with 0.9% saline, which is associated with hyperchloremic metabolic acidosis. Many horses that receive HS will become thirsty and begin drinking water because of the high plasma concentration of sodium. The allowance of oral hydration will depend on the horse’s specific disease process; horses with acute abdominal disease, such as those with gastrointestinal reflux, will require IV fluids instead.

6. Traumatic Brain Injury

Diagnosis of traumatic brain injury (TBI) is based on history (usually owner observation), external signs of trauma (swelling and wounds to the sides or back of the head), neurologic deficits localized to the brain (i.e., seizures, behavioral changes, circling, cranial nerve deficits, head tilt, or nystagmus), or specific clinical signs of trauma such as the presence of blood or cerebrospinal fluid in the ear canals or nares. If TBI is suspected, a dose of 1 ml/kg of 7.2% HS can be administered rapidly. Additional doses may be warranted throughout medical treatment, but sodium or osmolarity monitoring is optimal before repeat administration of HS. Although specific research has not been performed in horses, serum sodium concentrations should likely not exceed 155 mmol/l, and serum osmolarity should not exceed 320 mmol/l. The presence of ongoing hemorrhage (e.g., from ear canals or nares) is a contraindication to HS administration. New research suggests that traumatic spinal-cord injury may also benefit from HS. Although it is too early to make specific recommendations for treatment of acute spinal-cord injury, it is likely that a similar dosing regimen would be beneficial.

7. Specific Considerations

1. Uncontrolled Hemorrhage

Although controlled (blood loss that has been stopped through ligation or direct pressure) hemorrhage is one of the main indications for the use of HS, uncontrolled hemorrhage is more controversial. If active bleeding is continuing (either internally or externally), the use of HS should be carefully considered. Increases in blood pressure are common after HS administration, and this has the potential to increase bleeding from an actively hemorrhaging site or to restart bleeding from a poorly controlled site.

2. Severe Dehydration

In an animal that is severely dehydrated, it is possible that there will be insufficient fluid for HS to pull out of cells or interstitial tissues. Some references consider severe dehydration a contraindication for HS administration. Preliminary results from a recent study in dehydrated endurance horses showed benefit to fluid balance with administration of HS. As more research becomes available, this issue may be further clarified. As a general guideline, it is very important that access to oral water and/or additional isotonic IV fluids is available when using HS in dehydrated horses (and probably under all situations).

3. Unresponsive Hypotension

New research suggests that HS can directly raise blood pressure independent of its blood-volume expansion effects. Equine anesthesia may be a setting for HS to be used for this purpose, especially for cases with refractory hypotension. More research is needed before a strict recommendation can be made.

4. Ileus

HS may play a role in decreasing intestinal edema and thereby, treating associated ileus. This is another area of ongoing research. It is unlikely that HS will be a specific treatment for ileus, but rather, it may represent an added benefit to resuscitating horses with gastrointestinal emergencies.

5. Electrolyte Disorders

One of the biggest drawbacks of HS is its effects on electrolytes and acid-base balance. Specifically, it causes significant increases in both plasma sodium and especially, chloride concentrations. The result is the creation of a hyperchloremic metabolic acido-sis, which has been associated with renal and other organ dysfunction. HS should be used judiciously in patients with renal dysfunction or pre-existing electrolyte disturbances. Its benefits still outweigh the risks under some circumstances, but practitioners should be aware of these secondary effects.
8. Conclusion

The uses of HS in equine practice have become substantially more diverse within the past few years. It is particularly well-suited for the equine practitioner. Its low cost, long shelf life, and rapid administration make it particularly attractive for use in the field. HS can replace more expensive and problematic solutions, such as mannitol, which are often impractical to stock on veterinary practice vehicles.

References and Footnotes


*Fielding CL, Magdesian KG. Unpublished data.*