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1. Introduction
There are many intravenous (IV) fluid choices available to equine practitioners. Deciding which of these fluids to carry in inventory and in the truck will depend in part on the types of emergency cases most commonly seen in practice that require IV fluid intervention. Having information on hand regarding IV fluids most commonly chosen in different emergency settings will aid practitioners in making economical and practical decisions regarding which IV fluids to stock and carry. “First bag” choices for IV fluids may need to be made with limited clinical pathology data available but are generally aimed at restoring various fluid compartments within the body (Fig. 1). Follow-up, longer-term IV therapy is generally more directed and is based, at least in part, on recognized electrolyte and acid-base abnormalities. This presentation is aimed at aiding the practitioner in deciding what to administer initially, the first bag.

2. Materials and Methods
A brief e-mail survey was sent to veterinarians with specialty board certification in Large Animal Internal Medicine (via the ACVIM-LA list) and/or Emergency and Critical Care (by direct e-mail request). The survey presented nine distinct clinical situations in which intravenous fluid administration might rationally be part of the initial therapy:

- Ten-minute-old foal delivered from a prolonged dystocia (~120 minutes) with an APGAR score of 6
- Obtunded, hypothermic minimally responsive 24-hour-old foal
- Six-day-old foal with diarrhea
- Three-day postpartum mare presenting as mild to moderate colic with foal at side and in shock, heart rate 72; mucous membranes (mm) pale; CRT, 3 seconds; slow jugular fill; extremities cold
- Two-year-old Thoroughbred filly with a head injury from falling backward on its poll, no epistaxis
- Four-year-old Quarter Horse with frequent pipistream diarrhea, depressed, approximately 8% dehydration, has been on antibiotics, mucous membranes injected, heart rate 80
- Ten-year-old Arabian mare, badly tied up after an apparently energetic trail ride, not making urine
- Twenty-two-year-old Morgan horse with mild colic and palpable pelvic flexure impaction
- Eight-year-old Thoroughbred broodmare

How to Choose Your ‘First Bag’ of Intravenous Fluids

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days in foal, presenting with severe colic and abdominal distention.

The survey purposefully did not provide information regarding clinical pathology or clinical chemistry results, nor were blood gas results included to more accurately represent an ambulatory situation in which such testing and results might not be immediately available. Detailed physical examination findings were also not included because this information is not initially available when choosing which fluids to carry to any call. The survey asked a single question: “What do you use and/or add to your ‘first bag’?”

3. Results
Veterinarians from the United States, England, Europe, and Australia, representing both specialties, replied. Approximately 20 equine-oriented veterinary specialists responded. The following is a summary of responses by case situation supplied:

Ten-Minute-Old Foal Delivered From a Prolonged Dystocia (~120 Minutes) With an APGAR Score of 6
Two veterinarians would not necessarily administer IV fluids at that point in the described case but would continue to observe. Most responding veterinarians described the use of some type of isotonic polyionic crystalloid replacement fluid with a normal strong ion difference, although one veterinarian listed 0.18% saline with 4% dextrose as the first choice. One veterinarian would use either 0.9% saline or polyionic crystalloid replacement fluid. Fluids specifically mentioned included lactated Ringer’s solution, Hartmann solution, Plasmalyte, Plasmalyte 148, and Vetivex 18 (0.18% saline with 4% dextrose, a maintenance rather than replacement fluid) (Table 1). If the amount of fluid to be administered was mentioned, it was between 500 mL and 1 L. Supplements added included (in order of frequency mentioned): dextrose (1% to 5%), thiamine (1 g/L), vitamin C, dimethylsulfoxide (DMSO) (1% to 2%), and 50% MgSO4 (25 mL).

Obtunded, Hypothermic, Minimally Responsive 24-Hour-Old Foal
All veterinarians chose to administer isotonic polyionic crystalloid replacement fluids at bolus rates. One chose to administer 200 mL of hypertonic saline before other fluids. Dextrose/glucose supplementation was suggested in 60% of responses and was supplied as a piggyback constant rate infusion (CRI) 5% dextrose solutions or as a 1% additive to the first crystalloid bag followed by a CRI at 4 mg/kg per minute. One veterinarian suggested hetastarch administration and another suggested calcium, if ionized calcium was low on blood gas. Thiamine was supplemented in the first bag by several veterinarians.

Table 1. Composition of Commonly Used Intravenous Fluids

<table>
<thead>
<tr>
<th></th>
<th>Na (mEq/L)</th>
<th>Cl (mEq/L)</th>
<th>K (mEq/L)</th>
<th>Ca (mEq/L)</th>
<th>Mg (mEq/L)</th>
<th>Lactate (mmol/L)</th>
<th>Acetone (mmol/L)</th>
<th>Gluconate (mmol/L)</th>
<th>Dextrose (%)</th>
<th>Osm (mOsm)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% Dextrose in water</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>252</td>
<td>4.0</td>
</tr>
<tr>
<td>10% Dextrose in water</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>505</td>
<td>4.0</td>
</tr>
<tr>
<td>0.9% NaCl</td>
<td>154</td>
<td>154</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>308</td>
<td>5.0</td>
<td>-</td>
</tr>
<tr>
<td>Lactated Ringer’s solution†</td>
<td>130</td>
<td>109</td>
<td>4</td>
<td>3</td>
<td>-</td>
<td>28</td>
<td>-</td>
<td>-</td>
<td>308</td>
<td>5.0</td>
<td>6.5</td>
</tr>
<tr>
<td>PlasmaLyte A†</td>
<td>140</td>
<td>98</td>
<td>5</td>
<td>-</td>
<td>3</td>
<td>27</td>
<td>23</td>
<td>-</td>
<td>294</td>
<td>7.4</td>
<td>-</td>
</tr>
<tr>
<td>PlasmaLyte 148†</td>
<td>140</td>
<td>98</td>
<td>5</td>
<td>-</td>
<td>3</td>
<td>27</td>
<td>23</td>
<td>-</td>
<td>294</td>
<td>5.5</td>
<td>-</td>
</tr>
<tr>
<td>Hartmann solution†</td>
<td>131</td>
<td>111</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>28</td>
<td>-</td>
<td>-</td>
<td>279</td>
<td>6.5</td>
<td>-</td>
</tr>
<tr>
<td>Vetivex 18†</td>
<td>31</td>
<td>31</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>264</td>
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<td>-</td>
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<tr>
<td>7.5% Hypertonic NaCl</td>
<td>1283</td>
<td>1283</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2587</td>
<td>5.0–5.7</td>
<td>-</td>
</tr>
<tr>
<td>Hetastarch: COP 31 mm Hg (6% in 0.9% NaCl)</td>
<td>154</td>
<td>154</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>310</td>
<td>5.5</td>
<td>-</td>
</tr>
</tbody>
</table>

*Maintenance solution for use after volume replacement complete.
†Isotonic polyionic fluid with a relatively normal strong ion difference.
Six-Day-Old Foal With Diarrhea
Saline, either hypertonic (500 mL) or isotonic, was more frequently chosen (30% of respondents) for use in this case than for the first case. Hetastarch was also mentioned by one respondent, whereas the majority chose isotonic polyionic crystalloid replacement fluids. Many suggested KCl addition to fluids at 20 mEq/L. Overall, this case prompted the most requests for blood gas or electrolyte results before making fluid choices. Calcium gluconate was suggested if low, whereas one respondent suggested bicarbonate if low on blood gas.

Three-Day Postpartum Mare Presenting With Mild to Moderate Colic With Foal at Side and in Shock
(Heart Rate, 72; mm Pale; CRT, 3 Seconds; Slow Jugular Fill; Extremities Cold)
Seventy percent of responding veterinarians would initially administer 2 L of hypertonic saline to this horse, followed by isotonic polyionic crystalloid replacement fluids at two times maintenance. Additives were uncommon in responses to this question but when mentioned included aminocaproic acid (70 mg/kg over 20-minute loading dose, then 15 mg/kg per hour in 0.9% saline as a CRI), oxytocin (50 mg), calcium (120 mL 23% calcium borogluconate in 5 L), and hetastarch.

Two-Year-Old Thoroughbred Filly With a Head Injury From Falling Backward on Its Poll, No Epistaxis
One veterinarian would not administer fluids until neurologic status fully assessed, whereas 60% of respondents chose to administer 1 to 2 L of hypertonic saline as their first bag. Saline (0.9%) was administered by 20%, whereas isotonic polyionic crystalloid replacement fluids were mentioned either as first-line treatment or as follow-up to hypertonic saline. Additives included thiamine and MgSO4 added to follow-up fluids at 20 mL 50% MgSO4/L for a maximum of 50 mg/kg.

Four-Year-Old Quarter Horse With Frequent Pipestream Diarrhea, Depressed, Approximately 8% Dehydration, Has Been on Antibiotics, Mucous Membranes Injected
(Heart Rate, 80)
Forty percent of respondents would initially treat this case with hypertonic saline (1 to 2 L) followed by isotonic polyionic crystalloid replacement fluids. The remainder would administer only isotonic polyionic crystalloid replacement fluids at bolus rates, whereas a small percentage would use 0.9% saline. Additive or additional infusions during initial treatment included polymyxin B (1.5–3 million units), calcium (as 23% calcium gluconate), and hetastarch; follow-up fluid additives were potassium chloride (20 mEq/L) and calcium gluconate.

Ten-Year-Old Arabian Mare, Badly Tied Up After an Apparently Energetic Trail Ride, Not Making Urine
Initial fluid choices in order of frequency chosen included isotonic polyionic crystalloid replacement fluids as a bolus (generally 20 L), 0.9% saline, and hypertonic saline followed by isotonic polyionic crystalloid replacement fluids. Enteral water administration was mentioned. Calcium gluconate was the only mentioned additive.

Twenty-Two-Year-Old Morgan Horse With Mild Colic and Palpable Pelvic Flexure Impaction
Respondents overwhelmingly chose enteral water with or without electrolytes and MgSO4 as their first bag. Mineral oil administration by nasogastric tube was mentioned. Many stated that if the impaction was severe, they would add isotonic polyionic crystalloid replacement fluids at twice maintenance with KCl (20 mEq/L) as the most commonly mentioned additive.

Eight-Year-Old Thoroughbred Broodmare 338 Days in Foal Presenting With Severe Colic and Abdominal Distension
Both hypertonic saline and isotonic polyionic crystalloid replacement fluids were commonly the first fluids administered, with isotonic polyionic crystalloid replacement fluids also required as follow-up to hypertonic saline. Hetastarch was chosen to be given simultaneously with isotonic polyionic crystalloid replacement fluids in one instance. One respondent chose 0.9% saline. Calcium was mentioned once as an additive. Many respondents were very busy trocharizing the colon/cecum and preparing for surgery while the fluids were being administered.

4. Discussion
Intravenous fluids are administered to veterinary patients for several purposes, including replacement of lost vascular volume (bleeding, sensible and insensitive fluid losses, etc); replacement of total body water deficits (dehydration); replacement of electrolyte losses or correction of electrolyte aberrations (ie, hypernatremia or hyponatremia); correction of metabolic acid-base abnormalities (hyperlactemia, metabolic acidosis); provision of parenteral nutrition (glucose, proteins as amino acids, lipids, vitamins, trace minerals); correction of low oncotic states (hypoproteinemia); and treatment for specific medical conditions. Determining which IV fluids to administer for which purposes and which medical conditions has been the subject of many reviews and discussions, but, ultimately, any equine practice must choose IV fluids to keep readily available for administration in cases requiring immediate intervention. This brief survey was conducted to provide information to equine veterinary practices regarding which fluids might be suggested for initial use by specialists in both internal medicine and emergency and critical care on the basis of their experience in treating emergent cases. From the responses submitted, it was clearly frustrating for many specialists not having hematology results, physical examination findings, and history; however, this created more realistic ambulatory situa-
tions requiring the specialists to use their best guess of the underlying problem(s).

The next sections grouped each clinical situation assessed by the specialists into four groups: gastrointestinal disturbances, critically ill neonatal foals, central nervous system (CNS) trauma, and renal injury. The physiology will be reviewed and the choices of the specialists discussed in each of the categories.

Gastrointestinal Disturbances

Four of the nine clinical situations were designed as examples of gastrointestinal disturbances ranging from mild to severe, with one additional case presenting as either a gastrointestinal disturbance or blood loss case. In the most mild example, the 22-year-old Morgan horse with mild colic and palpable pelvic flexure impaction, most veterinarians did not immediately administer intravenous fluid support but rather preferred to administer enteral fluids (frequently with mineral oil) with or without electrolytes. Intravenous fluids, administered as isotonic polyionic crystalloids, were only suggested if the impaction was severe and then only as two times maintenance in addition to enteral fluids.

The 6-day-old foal with diarrhea prompted many requests for additional information because the severity and potential importance of fluid loss associated with diarrhea in these cases can be quite variable. Whereas the majority of respondents chose isotonic polyionic crystalloids, many chose to administer saline, either as 0.9% (normal saline) or as 7.5% (hypertonic saline). It is not unusual for foals of this age to have unpredictable but severe electrolyte imbalances—hyponatremia and hypochloremia, for example—with severe diarrhea and dehydration, prompting some to reach for saline as their first bag.1–4 For others, the advantage of isotonic polyionic crystalloid fluids being closer to normal plasma values in their makeup (Table 1) may have been of greater benefit, allowing for more gradual correction of any unrecognized electrolyte imbalances. Too-rapid correction of either hypotension or hypernatremia has been reported as deleterious in many species.5 In these cases, fluid resuscitation is aimed first at volume replacement and then at electrolyte correction, once data become available; this approach is reflected in the majority choice of isotonic polyionic crystalloid fluids.

The 4-year-old Quarter horse with frequent pipes-tream diarrhea, depression, approximately 8% dehydration, injected mucous membranes, and a heart rate of 80 beats/minute that had been on antibiotics represents a severely dehydrated horse with (probable and somewhat predictable) electrolyte abnormalities (again, hypotension and hypochloremia) and endotoxemia (implied).6,7 Respondents were somewhat equally divided between administration of hypertonic saline (1 to 2 L) followed immediately by isotonic polyionic crystalloid fluids or immediate bolus administration of isotonic polyionic crystalloid fluids. The goal of immediate therapy in these cases is adequate restoration of vascular volume to ensure tissue perfusion and either approach is probably acceptable. Correction of electrolyte imbalance can take place later in the clinical course, and the relatively small volume of hypertonic saline administered should not correct hypernatremia too quickly.5 In this case, a large fluid deficit is present. Correction of estimated dehydration, assuming a 500-kg horse, is 40 L; additional fluids would be required to address continued losses and maintenance. A reasonable approach would be 20 L of isotonic polyionic crystalloid fluids as a bolus over 2 to 4 hours followed by 3 to 4 L per hour. Polymyxin B (1.5–3 million units) was suggested as an additive to the first bag as an anti-endotoxemia treatment. Calcium (as 23% calcium gluconate) and KCL (20 mEq/L) were suggested as additives to follow-up fluids. Hetastarch was listed by some as an initial fluid to be administered along with the initial crystalloid fluids, because of presumed (and probable) hypoproteinemia.

The 8-year-old Thoroughbred broodmare, 338 days in foal presenting with severe colic and abdominal distention, was presumed by many to be a surgical candidate, prompting one respondent to reply: “Oh dear! Trocharize and bolus on the way to the surgical suite!” In this case, restoration of vascular volume and tissue perfusion was considered paramount, and both hypertonic saline (1 to 2 L) followed by high-rate isotonic polyionic crystalloid fluids and bolus administration of isotonic polyionic crystalloid fluids were suggested approximately equally. Respondents were concerned with improving perfusion before definitive treatment. Depending on the time needed before definitive diagnosis and treatment, administration of 20 to 40 L of isotonic polyionic crystalloid fluids might be required.

Finally, a 3-day postpartum mare presenting with mild to moderate colic with a foal at her side and in shock, had heart rate of 72; mm pale; CRT, 3 seconds; slow jugular fill; extremities cold. The assumption made by most in this case was postpartum bleeding. However, gastrointestinal accident, peritonitis, uterine tear, or other periparturient problems might be the primary concern. Respondents overwhelmingly chose to administer hypertonic saline (2 L) followed by bolus administration of isotonic polyionic crystalloid fluids in an effort to combat shock. Additives mentioned included amnioacproic acid (70 mg/kg over 20-minute loading dose, then 15 mg/kg per hour in 0.9% saline as a CRI), oxytocin (50 mg), calcium (120 mL 23% calcium borogluconate in 5 L crystalloid). Hetastarch was used by some, presumably to counteract soon-to-be-recognized hypoproteinemia caused by whole blood loss.

Critically Ill Neonatal Foals

Two cases representing critical illness in a neonatal foal were included. The first, a 10-minute-old foal...
delivered from a prolonged dystocia (~120 minutes) with an APGAR score of 6 received a wide variety of fluid approaches ranging from none (with further close observation) to 500 mL to 1 L of isotonic polyionic crystalloid fluids. In this situation—unless blood loss occurred or there was severe in utero sepsis—vascular volume resuscitation is not necessarily required initially. The APGAR score suggests a mildly to moderately asphyxiated foal, and additives suggested by respondents were aimed at early intervention for this. Supplements suggested to be added to the first bag included (in order of frequency mentioned): dextrose (1% to 5%), thiamine (1 g/L), vitamin C, DMSO (1% to 2%), and 50% MgSO4 (25 mL). Dextrose is aimed at providing energy support, thiamine supports normal intracellular energy metabolism, vitamin C and DMSO are provided as anti-oxidant treatment, and magnesium is thought to be neuroprotective.

The second foal case, an obtunded, hypothermic minimally responsive 24-hour-old foal, represents a variety of conditions of the critically ill neonate ranging from severe sepsis to hypoxic ischemic disease. Initial treatment of these foals is fairly uniform and aimed at stabilization and intravascular volume resuscitation in addition to providing an energy source. All respondents chose to administer isotonic polyionic crystalloid replacement fluids at bolus rates (20 mL/kg over 20 minutes, repeated as necessary), but the majority also recognized the need for almost immediate energy support. Energy support was supplied either as a piggyback CRI (4 mg/kg per minute, ~250 mL/h 5% dextrose solution to a 50-kg foal) or as a 1% additive to the first crystalloid bag followed by a CRI as described. I personally tend to include the first dose of any IV antimicrobial treatment in the first bag in addition to 1% dextrose while I begin preparing for dextrose CRI (5% dextrose at 250 mL/h initially will work for most foals) in these cases.

**CNS Trauma**

The 2-year-old Thoroughbred filly with a head injury from falling backward on its poll, with no epistaxis, represented a case of CNS trauma. This type of injury is not uncommon in practice and is probably seen most commonly in foals being halter-broken. The concern in these cases is the severity of injury, if there is basisphenoid injury, and if there is rectus capitis rupture or avulsion from the skull base. In this example, it was suggested that rectus capitis avulsion did not occur as a result of the absence of epistaxis. Coup–contra coup injuries also occur with these injuries, and fluid therapy is aimed at minimizing edema and further injury to the brain. Hypertonic saline is commonly recommended in the treatment of CNS injuries, particularly those involving the brain, and the respondents were apparently aware of this as hypertonic saline was the fluid of choice for the majority. A few chose not to administer fluids immediately, whereas others opted for isotonic polyionic crystalloids or 0.9% saline. Additives included thiamine. MgSO4 was also added to follow-up fluids at 20 mL 50% MgSO4/L for a maximum of 50 mg/kg.

**Renal Injury**

The anuric 10-year-old Arabian mare, badly tied up after an apparently energetic trail ride, represented a case of acute kidney injury associated with pigment (myoglobin) released from the body and deposited in the renal tubules. Initiation of diuresis is the first-order treatment in these cases. Respondents chose to treat this mare with isotonic polyionic crystalloid replacement fluids as a bolus (generally 20 L), 0.9% saline, or hypertonic saline followed by isotonic polyionic crystalloid replacement fluids. Caution is required because continued administration of fluids to cases such as this without inducing urine production can be harmful and result in fluid overload with pulmonary edema. If an initial bolus does not result in urine production, other methods of inducing diuresis should be attempted, such as furosemide, and fluid administration must be slowed down or stopped.

**5. Conclusions**

Hypertonic saline (1-L bags), isotonic polyionic crystalloid fluids with a normal strong ion difference (1 L and 3- to 5-L bags) and 5% dextrose in water (1-L bags) appear to be the most commonly chosen IV fluids in this survey. Volumes that might be useful to have on hand for an initial IV fluid resuscitation in an ambulatory situation might include the following:

- **Foals:** 1 to 4 L isotonic polyionic crystalloid; 2 L 5% dextrose
- **Adults:** 2 L 7.5% hypertonic saline; 20 to 30 L isotonic polyionic crystalloid; hetastarch

Commonly mentioned additives included thiamine, calcium (23% calcium gluconate), magnesium (50% MgSO4), and polymyxin B, and all are easily carried in an ambulatory practice. If practical and within the client’s budget, hetastarch or a similar colloid may prove useful in some situations.

The reader is cautioned that additional fluids would be required for continued treatment of all cases listed above. Some specific fluid brands are listed in Table 1.

**References and Footnotes**

5. Pfennig CL, Slovis CM. Sodium disorders in the emergency
department: a review of hyponatremia and hypernatremia. 


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