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Practical Fluid Therapy and Treatment Modalities for Field Conditions for Horses and Foals with Gastrointestinal Problems



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KEYWORDS

- Intravenous fluids • Pain management • Antimicrobials • Oral fluids • Hypovolemia • Colic

KEY POINTS

- Fluid therapy should use both the oral and the intravenous route when possible, but a functioning gastrointestinal system is required to effectively use oral fluids.
- Fluid therapy (oral or intravenous) can be administered by bolus or continuous infusion, and each method has specific advantages and disadvantages.
- Pain management is an essential aspect of field treatment and should be initiated early and allow for additional diagnostic testing and treatments to be completed.
- In neonatal foals, antimicrobial coverage may be appropriate in most, if not all, cases of gastrointestinal disease.
- In older animals, greater than 2 to 3 months of age, routine antimicrobial use for gastrointestinal disease should be avoided unless a specific bacterial focus exists that is likely to respond to antimicrobial administration.

INTRODUCTION

In many equine practices, there is increasing demand for higher levels of diagnostic testing and treatment services in the field. Point-of-care laboratory testing, ultrasound machines, and endoscopy and radiography systems all have portable options. In many instances, a diagnosis can be made without ever leaving the farm. Similar expectations for treatment also exist, and ambulatory practitioners should be familiar with the options and controversies surrounding the field management of the horse or foal with gastrointestinal (GI) disease.

The author has nothing to disclose nor any conflicts of interest.
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Vet Clin Equine 34 (2018) 155–168
<https://doi.org/10.1016/j.cveq.2017.11.013>
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There are many practical considerations for the field treatment of GI disease, but this article focuses on 3 areas whereby the field practitioner will often be required to make decisions:

1. Fluid therapy
2. Pain management
3. Antimicrobials

Although these same concepts apply to the management of horses in both hospital and field conditions, there are some unique considerations in the field that must be addressed. The major limitation in the field is often the availability of facilities and personnel. Rapid fluid administration can be challenging without appropriate height for hanging fluids, and catheters can easily be damaged or dislodged in stalls that are not appropriate for horses receiving intensive care. Safety of the personnel handling the horse is important and affected by adequate pain control in horses that are rolling or repeatedly getting up and down. The decision for antimicrobial use is often made without the benefit of complete laboratory testing results. Despite these limitations, field treatment has benefits, including familiar surroundings for the horse and more rapid initiation of treatment. The remainder of this article examines these 3 main areas of consideration when initiating field treatment of GI diseases in horses and foals.

SECTION 1: FLUID THERAPY

The need for fluid therapy in the field will often be determined using a combination of the following:

1. Physical examination findings
2. Historical information
3. Owner preferences

Physical Examination Findings

Some of the simplest physical examination findings of dehydration can be easily evaluated:

1. Prolonged skin tenting
2. Dry/tacky mucous membranes
3. Urine concentration

However, recognition of dehydration using clinical examination findings is unreliable.^{1,2} Even with increased experience and training, clinicians are often unable to accurately quantify the degree of dehydration. The clinical signs of hypovolemia/hypoperfusion may be easier to detect as compared with those of dehydration. Although these are rarely used to determine an exact amount of fluid loss (or volume needed for replacement), they are excellent markers to suggest that fluid therapy is warranted:

1. Heart rate
2. Pulse quality
3. Mucous membrane color
4. Capillary refill time
5. Mentation
6. Extremity temperature
7. Jugular refill time
8. Urine output

When multiple perfusion parameters are abnormal, fluid therapy is likely to be warranted. However, similar to dehydration parameters, fluid therapy should not be based on these examination findings alone. In many cases, even when referral to a hospital is planned, some degree of stabilization with fluids before transport is indicated.

Historical Information

Historical factors that may influence the decision to begin fluid therapy include the duration of illness, decreased water intake (if noted by owner), or excessive fluid losses (sweating, diarrhea, and so forth). A history of chronic nonsteroidal anti-inflammatory drug (NSAID) use or previous episode of renal failure may also influence decisions about fluid therapy. Given the limitations of the physical examination to accurately detect dehydration, these historical factors are often important in decision making.

Owner Preferences

Finally, owner preferences may play a large role in the decision to initiate fluid therapy in the field. An owner may have had a previous sick animal that they perceived was saved by fluid treatment in the field or conversely an animal that was lost in transport because they thought treatment was delayed. There may be financial reasons for postponing treatment or refusing hospital or referral care.

Ultimately, the recommendation to initiate fluid therapy in the field should first be made based on the clinical examination and historical factors on an individual case basis. However, consideration of the facilities and personnel available as well as the owner preferences must also be taken into account. A treatment plan that considers all of these factors will be most likely to lead to success and owner satisfaction, as opposed to forcing a plan that is not practical or not desired by the client. When owners elect field treatment instead of hospital referral, equine practitioners should carefully note this decision in the medical record.

Once the decision has been made to begin fluid therapy, there are 2 main choices that must be made:

1. Enteral and/or intravenous (IV) administration of fluids
2. Bolus or continuous administration of fluids

Enteral Versus Intravenous Fluid Administration

There have been several excellent research studies evaluating the benefits of enteral fluids to treat many forms of equine GI disease.³⁻⁶ However, a near universal requirement for this mode of treatment is a functioning GI system that can manage and use enteral fluid administration. Although this concept seems incredibly simple, the importance of a functional GI tract cannot be emphasized enough.

The presence of significant net gastric reflux (>4 mL/kg) would be an indication that enteral fluid therapy may not be effective or even detrimental. However, the lack of net reflux when a nasogastric tube is placed does not guarantee that the horse will tolerate significant volumes of enteral fluids. It is not uncommon to administer enteral fluids to a horse without net reflux, only to return hours later and find a similar volume of fluid waiting in the stomach when a nasogastric tube is placed again. Such fluids would have had limited beneficial effect for the horse.

Indications that enteral fluid therapy may not be appropriate:

- a. Net gastric reflux >4 mL/kg
- b. Disease process likely to be associated with ileus
- c. Ultrasound examination consistent with ileus or gastric distention (**Fig. 1**)

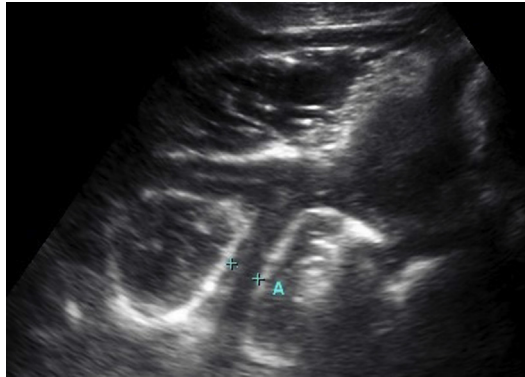


Fig. 1. Ultrasound image of small intestine in a horse with signs of colic. This small intestine may be unable to effectively absorb water from the oral administration of fluids.

IV fluids effectively bypass the GI system, and this attribute can be both an advantage and a disadvantage. In a horse with a poor ability to absorb enteral fluid, IV fluids can be life saving. However, conditions in which high fluid volumes are desired within the GI system (ie, impactions), IV fluids may be less effective than enterally administered fluids.³⁻⁵ IV fluids typically take a longer time to administer than enteral fluids (particularly in bolus administration), and this is another important factor to consider for treatment in the field.

Most equine practitioners carry only one type of IV fluid on their truck in the larger 3- to 5-L bags that are appropriate for horses. Ideally, this fluid would be appropriate for as many different types of equine emergencies as possible. For equine GI disease, an isotonic crystalloid is usually appropriate, and the author prefers one of the commercially available acetated fluids (**Table 1**). These fluids typically have a lower chloride concentration than lactated Ringer solutions or 0.9% saline solution, which may be advantageous.⁷ Hypertonic saline (7.2%) is also used in critical cases of equine GI disease, but should be followed with an isotonic IV fluid.

An important point to note, a combination of IV and enteral fluid administration is appropriate in horses with a functioning GI system. Conversely, in horses with enteritis and/or reflux, IV fluids should be used alone.

Enteral Versus Intravenous Fluid Administration in Foals

The author's practice frequently manages foals with GI disease in the field with IV fluid therapy. Enteral fluid therapy in foals is common in patients that are not able to nurse; however, this is used less frequently as a primary means for hydrating neonatal

Table 1
Common crystalloid fluids used in the field

Fluid	Na ⁺ (meq/L)	K ⁺ (meq/L)	Cl ⁻ (meq/L)	Ca ⁺⁺ (meq/L)	Mg ⁺⁺ (meq/L)
Normosol R	140	5	98	0	3
Lactated Ringer solution	130	4	109	3	0
0.9% Saline	154	0	154	0	0
7.2% Saline (hypertonic)	1232	—	1232	—	—

patients with GI disease. In neonatal foals, the GI system is often not functioning, the cost of IV fluids is minimal, and the time for administration of IV fluids is short. For all of these reasons, the IV route may be preferred over the oral route.

Bolus Versus Continuous Infusion of Fluids

After deciding whether to use the oral or IV route for fluid administration, the practitioner must next decide the rate of administration. Bolus administration has 2 distinct advantages:

1. Hypovolemia/dehydration is corrected more rapidly.
2. Less time is required for administering fluids.

Continuous fluid infusion (or smaller intermittent bolus administration over a prolonged period of time) could be less likely to cause fluid overload and may be more effective in rehydrating the animal. However, it will be slower to correct hypovolemia and will require more of the practitioner's time.

- A. Practical recommendations for the *bolus* administration of IV fluids to a moderately dehydrated/hypovolemic horse include the following:
 1. Use a 12- to 14-gauge IV catheter (larger catheters may have a higher rate of complications)⁸
 2. Use large-bore IV sets⁹
 3. Raise the fluids as high as possible if trying to achieve rapid rates
 4. Use a volume of 20 to 40 mL/kg bolus of an isotonic crystalloid over 1 to 2 hours
- B. Practical recommendations for the *bolus* administration of enteral fluids to a moderately dehydrated/hypovolemic horse would include the following:
 1. 10 to 15 mL/kg bolus of water through a nasogastric tube
 2. Electrolytes may be added to the administered fluids
 3. Larger volumes are possible, but more conservative amounts may prevent associated signs of colic
 4. An additional 10 to 15 mL/kg bolus can be administered every 30 to 60 minutes if the horse is tolerating the enteral fluids well

There are many options for the electrolyte composition of enterally administered fluids. The following combination has been recommended to create an enteral fluid that is similar to the electrolyte concentrations in equine plasma and has been safe to administer to horses in large volumes¹⁰:

1. 5.27 g/L of NaCl
2. 0.37 g/L of KCl
3. 3.78 g/L of NaHCO₃

As a practical approximation, a practitioner could start with a 10-L bucket of drinking water, add 50 g of NaCl (regular table salt), 4 g of KCl (a sodium-free salt alternative), and 40 g of NaHCO₃ (baking soda) and create an appropriate fluid for administration.

Many variations of this combination are possible. Fluids with a very low sodium concentration should not be repeatedly administered in large volumes because hyponatremia may develop.

- C. Practical recommendations for the *continuous* infusion of IV fluids to a moderately dehydrated/hypovolemic horse include the following:
 1. 2 to 4 mL/kg/h of an isotonic crystalloid is typically appropriate for patients without significant ongoing losses.

2. Patients with significant volumes of diarrhea or reflux can require as much as 10 mL/kg/h of an isotonic crystalloid.
 3. Fluid rate should be set at: $\text{Ongoing losses/h (L/h)} + 2 \text{ mL/kg/h} = \text{Administered rate (L/h)}$
- D. Practical recommendations for the *continuous* infusion of oral fluids to a moderately dehydrated/hypovolemic horse include the following:
1. 2 to 4 mL/kg/h of oral electrolyte solution
 2. Fluids can be dosed intermittently every 1 to 2 hours

Bolus Versus Continuous Intravenous Fluids in the Field Treatment of Foals

Foals with GI disease are often treated with initial bolus fluid administration (20 mL/kg) of an acetated, isotonic IV crystalloid because this can be a very practical and effective means to stabilize these hypovolemic patients. The author finds continuous administration of IV fluids to foals in the field to be quite challenging particularly with inexperienced clients. Smaller volume (eg, 10 mL/kg) fluid boluses can be repeated every 3 to 6 hours, depending on the amount of fluids being lost (ie, diarrhea or reflux) and the volume of milk that the foal is ingesting. Fluid balance is critically important in foals, and clients and practitioners should carefully monitor for signs of fluid overload with repeated fluid bolus administration.

SECTION 2: PAIN MANAGEMENT IN THE FIELD FOR HORSES WITH GASTROINTESTINAL DISEASE

Pain control is essential for effective field management of GI disease. Without adequate pain management, fluid therapy and diagnostic testing can be extremely difficult to carry out in a horse that is trying to roll or lay down. Many cases of equine GI disease are referred to hospital facilities because of an inability to adequately control the patient's discomfort as opposed to a specific requirement for surgery. In the author's opinion, the immediate cessation of pain is one of the single most important contributions that a veterinarian can make on arrival to evaluate and treat a horse with GI disease. With analgesia, the horse is more easily handled and the owners quickly feel that the situation is under control.

Numerous treatments for pain management are available to the equine practitioner in the field setting, and some of the more common options are discussed later. Similar to fluid therapy, pain management options can be separated into both intermittent and continuous dosing. Some practical notes about the use of continuous infusions in the field should be considered:

1. Pain medications can be added to the bags of IV fluids, but it is important that dosing is calculated carefully and the rate of administration is tightly controlled. Changes in fluid rate will also affect changes in medication administration rate!
2. If owners are assisting with fluid administration wherein medications are included, very detailed instructions are required and the risks need to be explained.
3. Owners should have clear instructions to stop all fluids if the horse's behavior changes or if they have concerns.
4. Infusions can also be given through infusion pumps, but the costs and training to use these devices may make them impractical in many field situations.

If adding continuous pain medications to the IV fluids, the following should be followed:

1. Divide the size of the IV fluid bag (ie, 5 L) by the number of liters per hour (ie, 1 L/h) to get the number of hours per bag.

2. Take the dose of pain medications (ie, 7 mg/h) and multiply by the number of hours per bag to get the number of mg of medication per bag.
3. Example:
 - a. Fluid rate of 2.5 L/h
 - b. 5-L IV fluid bags
 - c. Detomidine rate of 0.01 mg/kg/h (5 mg/h to 500-kg horse)
 - d. Add 10 mg detomidine per 5-L bag of fluids
 - e. **IMPORTANT TO REMEMBER:** If the fluid rate changes, so will the rate of medication administration

Nonsteroidal Anti-Inflammatory Drugs

Nonsteroidal anti-inflammatory medications (NSAIDs) are used very commonly in cases of equine GI disease. In some instances, before the arrival of the veterinarian, the owner may have administered these medications. These medications have many reported advantages and disadvantages^{11–13} (**Table 2**).

Each case of GI disease should be considered individually when considering whether to administer an NSAID at the start of treatment. Unless there is specific knowledge of renal disease or severe dehydration, a half to full-labeled dose of an NSAID administered to horses exhibiting pain associated with GI disease is a reasonable treatment protocol. IV administration will provide more immediate relief, but oral administration is an option as well. Two frequently used NSAIDs for horses with GI disease include the following:

1. Flunixin meglumine (0.5–1.0 mg/kg)
2. Firocoxib (0.1–0.2 mg/kg)

Firocoxib may be preferred in cases with small intestinal ischemic injury.¹⁴ The use of NSAIDs in neonatal foals with GI disease should be carefully considered. Renal function may already be compromised in these patients, and the chronic administration of flunixin meglumine has been associated with gastric ulceration in foals.¹⁵ However, pain management in foals with enteritis can often be achieved with low doses of flunixin meglumine (0.25 mg/kg IV). In the author's opinion, there are selected cases wherein this class of medications can be appropriate to resolve discomfort while other treatments are initiated.

Alpha-2 Agonists

Alpha-2 agonists are commonly used to provide both pain relief and sedation for horses with GI disease. They are often considered for use when rectal examinations and nasogastric intubation will be performed, because they can help to prevent injury to the horse, handler, and veterinarian. However, the analgesic effects of these medications are significant and should not be underestimated¹⁶ (**Table 3**).

Table 2
Selected advantages and disadvantages of nonsteroidal anti-inflammatory medications in horses

Advantages	Disadvantages
Rapid administration	Nephrotoxic
Moderate time to onset of pain relief	Association with gastric ulcers
Long duration of action	Association with right dorsal colitis
Anti-inflammatory effects	Long duration of action
Reasonable cost	

Three alpha-2 agonists that are available to most equine practitioners are often at the following doses for a single dose administration:

1. Xylazine (0.2–1 mg/kg IV)
2. Romifidine (0.04 mg/kg IV)
3. Detomidine (0.01 mg/kg IV)

The negative effects of alpha-2 agonists in horses with GI disease are frequently emphasized, including inhibition of GI motility and gastric emptying.^{17,18} Some practitioners also feel that these medications may mask the animal's true degree of pain, thereby potentially delaying surgery. However, the ability to immediately halt signs of discomfort and provide safety for those handling the horse makes these drugs invaluable.

The alpha-2 agonists can be used as intermittent bolus medications or as continuous infusions. Intermittent bolus administration is a safe way to administer this class of drugs because it allows the veterinarian to observe the horse as each dose wears off. Improvement or deterioration in clinical signs can be evaluated and additional doses considered at each time point.

Continuous infusions are appealing because they smooth out the “ups and downs” associated with intermittent bolus administrations. Client satisfaction is often higher with continuous infusions, but it can be difficult to assess changes in the horse's condition. In the author's experience, intermittent bolus injections are best used at the beginning of treatment and during the evaluation period. Once a treatment plan has been decided (ie, management at the farm instead of referral), continuous infusions can be used to provide relief to the horse and owner while treatment continues. It is extremely important that the veterinarian takes the time to educate the owner on the clinical signs indicating that the infusion dose is too high or low.

Detomidine can be a particularly effective drug to use as a continuous infusion to manage painful horses that do not require surgery or do not have a surgical option. The author has used continuous infusions over a 12-hour period to provide relief to horses with GI pain while waiting for the beneficial effects of rehydration and time. In cases where there is not a definitive need for euthanasia and surgery is not indicated, an infusion of this medication can be invaluable to relieve suffering and provide comfort to the owner. Infusion doses of 2 alpha-2 agonists for use in horses are the following:

1. Detomidine: 0.01 to 0.02 mg/kg/h
2. Xylazine: 0.5 to 1.5 mg/kg/h

An initial bolus dose of the medication can be given before starting the infusion (see dosages above).

In addition to IV bolus administration and continuous infusions, alpha-2 agonists can also be given intramuscularly (IM). Detomidine can be used IM for longer-term pain

Table 3

Selected advantages and disadvantages of alpha-2 agonist medications in horses

Advantages	Disadvantages
Rapid administration	Inhibit GI motility
Rapid onset of pain relief	Short duration of action
Short duration of action	Induction of diuresis
Reasonable cost	

management but the effects will be less pronounced than IV administration.¹⁹ Dose titration will be easier with IV administration or infusion, however.

The author has not used continuous infusions of alpha-2 agonists in neonatal foals. These medications can provide profound analgesia and sedation in foals, but cardiovascular and respiratory depression can also be significant.

Opioids

Opioids represent an additional class of analgesic medication that can be used for field management of pain in equine GI disease. There continues to be debate about the visceral analgesia provided by opioids in horses.^{20,21} Butorphanol is an agonist-antagonist opioid analgesic that is often used in combination with alpha-2 agonists. Similar to the alpha-2 agonists, its primary use can be sedation for completion of procedures or for pain control (**Table 4**).

Butorphanol can be administered as intermittent bolus doses or as a continuous infusion.²² Butorphanol is often given as an initial IV bolus dose (0.01–0.02 mg/kg) for procedures in the field combined with alpha-2 agonists. If continuous pain control is needed, an infusion (0.013 mg/kg/h) can be started and has several benefits over intermittent bolus dosing, including smoother pain control and decreased negative effects of the medication.²² Intermittent bolus administration of butorphanol can be given IV or IM.

Butorphanol (0.05 mg/kg IV) has been shown to have analgesic effects in healthy foals.²³ The author typically uses a dose of 0.01 to 0.02 mg/kg of butorphanol IV often combined with midazolam (0.1–0.2 mg/kg IV) in foals. There is less information available regarding its use in sick foals. The author has not used continuous infusions of butorphanol in neonatal foals.

Lidocaine

Lidocaine is a class 1B sodium channel blocker. Lidocaine has several potential benefits that directly relate to the management of GI disease in horses (**Table 5**).^{24,25}

Lidocaine is typically administered with a loading dose of 1.3 mg/kg, followed by a continuous infusion of 0.05 mg/kg/min (3 mg/kg/h). Some practices do not use the loading dose and simply begin the infusion recognizing that there will be a longer time to reach steady state and the full effect of the infusion. Lidocaine has some additional benefits in that it may diminish some of the negative effects of NSAIDs on the GI system.²⁶ For this reason, the author incorporates lidocaine in pain management for GI disease whenever it is practical. The author does not use lidocaine as commonly for field management, because it requires continuous infusion and the analgesic effects may be inadequate for horses with more severe discomfort. In addition, side effects are not uncommon and may be difficult for owners to recognize.

To the author's knowledge, lidocaine infusions have not been evaluated in neonatal foals. However, the author has used these infusions (2–3 mg/kg/h) in foals

Table 4
Selected advantages and disadvantages of opioid medications in horses

Advantages	Disadvantages
Rapid administration	Inhibit GI motility
Rapid onset of pain relief	May cause excitation at high doses
Moderate duration of action	Analgesia and sedation may be milder compared with other medications
Reasonable cost	

Table 5
Selected advantages and disadvantages of lidocaine use in horses

Advantages	Disadvantages
Minimal inhibition of GI motility	Used primarily as a continuous infusion
Reasonable cost	Can cause ataxia or recumbency if given too quickly
Anti-inflammatory	
Analgesic	

with enteritis in a hospital setting. Close supervision is required to use these infusions with foals in the field, because an accidental bolus administration could be life threatening.

SECTION 3: ANTIMICROBIAL USE IN THE FIELD FOR HORSES AND FOALS WITH GASTROINTESTINAL DISEASE

The third major category of therapeutics for consideration in field management of GI cases is the use of antimicrobials for horses with GI disease. For the purposes of this article, foals (less than 2–3 months of age) will be considered separately because the disease conditions and negative effects of antimicrobial administration are different between these age groups.

Antimicrobial Use in Horses with Gastrointestinal Disease that Are greater than 2 to 3 months of Age

The decision to initiate antimicrobial therapy in horses over 2 to 3 months of age with suspected GI disease is complex. Abdominal sepsis is one of the major indications for antimicrobial use. This can be due to septic peritonitis, which can often be associated with an internal abscess or GI perforation. Infectious enteritis caused by specific bacteria such as *Neorickettsia risticii*, *Rhodococcus equi*, *Lawsonia intracellularis*, *Clostridium difficile*, or *Clostridium perfringens* are additional indications for early initiation of antimicrobial therapy.²⁷ However, there are other causes of enteritis such as equine coronavirus, salmonellosis, and other undiagnosed causes that are less likely to benefit from antimicrobial therapy. Antimicrobial therapy itself can cause GI disease through changes in the GI microbiome.²⁸

In cases of enteritis, concerns over bacterial translocation are often considered an additional reason for antimicrobial treatment whereby there may be intestinal inflammation and compromise of the mucosal barrier. A low white cell count (specifically a low neutrophil count) may also be considered an indication for antimicrobial use in this patient population.

When evaluating the evidence for the use of antimicrobials in adult horses with GI disease (other than septic peritonitis), it is difficult to find strong support for this practice.²⁹ Studies have shown the presence of bacteremia in some horses with colitis; however, a similar investigation into horses with colic is warranted.³⁰ Previous treatment with antimicrobials does not affect the incidence of bacteremia.³⁰ Likewise, the presence of bacteremia does not necessarily mean that antimicrobials will reduce later complications associated with infections.

Even more importantly, there is evidence that antimicrobial use is associated with the development of colitis due to *C difficile*.²⁸ Given the potentially negative effects of antimicrobial administration and the lack of proven beneficial effects, the author thinks that these medications should be restricted to cases in which a suspected and/or proven infection is likely to respond to antimicrobials. Diagnosis of a specific

pathogen is unlikely to take place on the first visit to the farm, and therefore, antimicrobial use at initial treatment of adult horses is not routinely indicated unless there is a high suspicion for a specific bacterial focus. As further research is completed, these recommendations may change for specific diseases. Likewise, if septic complications (ie, septic thrombophlebitis) develop, then appropriate antimicrobial use would be warranted.

Foals

Antimicrobial use in neonatal foals with GI disease has many similar considerations as in adult horses. However, there is less evidence of negative effects of antimicrobial use on the GI system of newborn foals. In addition, bacteremia and subsequent septic foci are more frequently identified in newborn foals (joints, lungs, umbilical structures) than in adult horses.

A clinical trial evaluating routine antimicrobial coverage for foals with a variety of GI disease (meconium impaction, enteritis, and so forth) is greatly needed. Until such time, it is prudent to continue to cover these patients with broad-spectrum antimicrobials to minimize the chances for sepsis secondary to GI disease. However, continued consideration of responsible antimicrobial stewardship is important.

OTHER MEDICATIONS FOR FIELD MANAGEMENT OF GASTROINTESTINAL DISEASE IN HORSES

Numerous medications can be considered for the management of a wide variety of GI diseases in horses. This article focuses on 3 key areas of decision making for the equine field practitioner. Treatments for gastric ulceration are considered in Pilar Camacho-Luna and colleagues' article, "[Advances in Diagnostics and Treatments in Horses and Foals with Gastric and Duodenal Ulcers](#)," in this issue. Although not specifically fitting into the 3 categories of this article, N-butylscopolammonium bromide (0.3 mg/kg IV or IM) can be an effective addition to field management of the horse with GI disease. This medication can decrease the signs of colic in many horses, but may not be effective for horses with more severe clinical signs.

CLINICAL PROTOCOLS FOR FIELD MANAGEMENT OF EQUINE GASTROINTESTINAL DISEASE

Example 1: Prolonged and Significant Gastric Reflux (>4 mL/kg/h)

Horses can develop intestinal ileus with infectious enteritis, peritonitis, exercise-associated exhaustion, or for unknown reasons. Regardless of the cause, horses with ileus often have extensive and ongoing fluid losses, abdominal discomfort, and a GI system that is unlikely to handle oral fluid administration.

Practical plan for field management:

1. IV fluid administration of an isotonic crystalloid
 - a. Fluid rate = Rate of gastric reflux (L/h) + 2 to 4 mL/kg/h
2. Additional supplementation of dextrose (1 mg/kg/min) in the IV fluids if prolonged anorexia is present (over 24–48 hours in adult horses; immediately in neonatal foals)
3. Placement of nasogastric tube to remove and quantify reflux
4. Administration of NSAID initially if well hydrated
5. Administration of an initial bolus dose of alpha-2 agonist to facilitate nasogastric intubation and to control pain
6. Continuous infusion of lidocaine to manage pain

Example 2: Prolonged and Significant Diarrhea

Horses can develop diarrhea for a variety of causes, and many do not require extensive management if the horse is eating and drinking normally. However, in cases with dehydration or anorexia, field treatment can be very effective. Causes of infectious diarrhea include *Salmonella*, *Clostridia* sp, and *Neorecketsia risticii*. Sand ingestion and other noninfectious causes of diarrhea may also require field treatment.

Practical plan for field management:

1. IV fluid administration of an isotonic crystalloid
 - a. Fluid rate = Approximate estimate of diarrhea (L/h) + 2 to 4 mL/kg/h
2. Administration of NSAID initially if well hydrated
3. Administration of an initial bolus dose of alpha-2 agonist and butorphanol to facilitate diagnostic procedures and to control pain
4. Continuous infusion of lidocaine to manage pain (if needed)
5. Continuous infusion of butorphanol to manage pain (if needed)
6. Continuous infusion of alpha-2 agonist to manage pain (if needed)

Example 3: Impaction Colic with Mild Abdominal Discomfort

Feed impactions of the large colon are commonly described in horses and can frequently be treated in the field. More severe cases that have surgical treatment options should be referred to a facility where abdominal surgery can be performed if required. Impactions of the small colon and other intestinal segments can also develop, and many may be managed in the field as well depending on the specifics of the case.

Practical plan for field management:

1. Oral fluid administration through a nasogastric tube only if net reflux is not present: Initial bolus of 15 mL/kg followed by repeat administration of 8 mL/kg every 30 to 60 minutes
2. IV fluid administration of an isotonic crystalloid
 - a. Fluid rate = 2 to 4 mL/kg/h
3. Administration of NSAID initially if well hydrated
4. Administration of an initial bolus dose of alpha-2 agonist and butorphanol to facilitate diagnostic procedures and to control pain
5. Continuous infusion of lidocaine to manage pain (if needed)
6. Continuous infusion of alpha-2 agonist to manage pain (if needed)

Example 4: Gas Distended and Severely Painful Colic

Severe gas distention can develop with many different types of colic, including ileus, feed obstructions, and strangulating lesions. Initial pain control is important, but field management should be considered after evaluation of the owner's willingness to pursue surgery or more intensive care at a hospital facility.

Practical plan for field management:

1. Oral fluid administration through a nasogastric tube only if net reflux is not present: Initial bolus of 16 mL/kg followed by repeat administration of 8 mL/kg every 30 to 60 minutes
2. IV fluid administration of an isotonic crystalloid
 - a. Initial fluid bolus 20 to 40 mL/kg
 - b. Continuous fluid rate = 2 to 4 mL/kg/h
3. Administration of NSAID initially if well hydrated

4. Administration of an initial bolus dose of an alpha-2 agonist and butorphanol to facilitate diagnostic procedures and to control pain
5. Continuous infusion of alpha-2 agonist to manage pain (if needed and referral/surgery is not an option)

REFERENCES

1. Vega RM, Avner JR. A prospective study of the usefulness of clinical and laboratory parameters for predicting percentage of dehydration in children. *Pediatr Emerg Care* 1997;13:179–82.
2. Pritchard JC, Burn CC, Barr AR, et al. Validity of indicators of dehydration in working horses: a longitudinal study of changes in skin tent duration, mucous membrane dryness and drinking behaviour. *Equine Vet J* 2008;40:558–64.
3. Lopes MA, White NA 2nd, Donaldson L, et al. Effects of enteral and intravenous fluid therapy, magnesium sulfate, and sodium sulfate on colonic contents and feces in horses. *Am J Vet Res* 2004;65:695–704.
4. Lopes MA, Walker BL, White NA 2nd, et al. Treatments to promote colonic hydration: enteral fluid therapy versus intravenous fluid therapy and magnesium sulphate. *Equine Vet J* 2002;34:505–9.
5. Hallowell GD. Retrospective study assessing efficacy of treatment of large colonic impactions. *Equine Vet J* 2008;40:411–3.
6. Lester GD, Merritt AM, Kuck HV, et al. Systemic, renal, and colonic effects of intravenous and enteral rehydration in horses. *J Vet Intern Med* 2013;27:554–66.
7. Fielding L. Crystalloid and colloid therapy. *Vet Clin North Am Equine Pract* 2014;30:415–25.
8. Higgins J. Preparation supplies and catheterization. In: Fielding CL, Magdesian KG, editors. *Equine fluid therapy*. 1st edition. Hoboken (NJ): Wiley-Blackwell; 2015. p. 129–41.
9. Nolen-Walston RD. Flow rates of large animal fluid delivery systems used for high-volume crystalloid resuscitation. *J Vet Emerg Crit Care (San Antonio)* 2012;22:661–5.
10. Lopes MA. Enteral fluid therapy. In: Fielding CL, Magdesian KG, editors. *Equine fluid therapy*. 1st edition. Hoboken (NJ): Wiley-Blackwell; 2015. p. 261–78.
11. Marshall JF, Blikslager AT. The effect of nonsteroidal anti-inflammatory drugs on the equine intestine. *Equine Vet J Suppl* 2011;39:140–4.
12. McConnico RS, Morgan TW, Williams CC, et al. Pathophysiologic effects of phenylbutazone on the right dorsal colon in horses. *Am J Vet Res* 2008;69:1496–505.
13. Holland B, Fogle C, Blikslager AT, et al. Pharmacokinetics and pharmacodynamics of three formulations of firocoxib in healthy horses. *J Vet Pharmacol Ther* 2015;38:249–56.
14. Cook VL, Meyer CT, Campbell NB, et al. Effect of firocoxib or flunixin meglumine on recovery of ischemic-injured equine jejunum. *Am J Vet Res* 2009;70:992–1000.
15. Traub-Dargatz JL, Bertone JJ, Gould DH, et al. Chronic flunixin meglumine therapy in foals. *Am J Vet Res* 1988;49:7–12.
16. Roger T, Ruckebusch Y. Colonic alpha 2-adrenoceptor-mediated responses in the pony. *J Vet Pharmacol Ther* 1987;10:310–8.
17. Sutton DG, Preston T, Christley RM, et al. The effects of xylazine, detomidine, acepromazine and butorphanol on equine solid phase gastric emptying rate. *Equine Vet J* 2002;34:486–92.

18. Zullian C, Menozzi A, Pozzoli C, et al. Effects of α 2-adrenergic drugs on small intestinal motility in the horse: an in vitro study. *Vet J* 2011;187:342–6.
19. Mama KR, Grimsrud K, Snell T, et al. Plasma concentrations, behavioural and physiological effects following intravenous and intramuscular detomidine in horses. *Equine Vet J* 2009;41:772–7.
20. Sanchez LC, Robertson SA, Maxwell LK, et al. Effect of fentanyl on visceral and somatic nociception in conscious horses. *J Vet Intern Med* 2007;21:1067–75.
21. Muir WW, Robertson JT. Visceral analgesia: effects of xylazine, butorphanol, meperidine, and pentazocine in horses. *Am J Vet Res* 1985;46:2081–4.
22. Sellon DC, Roberts MC, Blikslager AT, et al. Effects of continuous rate intravenous infusion of butorphanol on physiologic and outcome variables in horses after celiotomy. *J Vet Intern Med* 2004;18:555–63.
23. McGowan KT, Eifenbein JR, Robertson SA, et al. Effect of butorphanol on thermal nociceptive threshold in healthy pony foals. *Equine Vet J* 2013;45:503–6.
24. Peiró JR, Barnabé PA, Cadioli FA, et al. Effects of lidocaine infusion during experimental endotoxemia in horses. *J Vet Intern Med* 2010;24:940–8.
25. Robertson SA, Sanchez LC, Merritt AM, et al. Effect of systemic lidocaine on visceral and somatic nociception in conscious horses. *Equine Vet J* 2005;37:122–7.
26. Cook VL, Jones Shults J, McDowell MR, et al. Anti-inflammatory effects of intravenously administered lidocaine hydrochloride on ischemia-injured jejunum in horses. *Am J Vet Res* 2009;70:1259–68.
27. Uzal FA, Diab SS. Gastritis, enteritis, and colitis in horses. *Vet Clin North Am Equine Pract* 2015;31:337–58.
28. Båverud V, Gustafsson A, Franklin A, et al. *Clostridium difficile*: prevalence in horses and environment, and antimicrobial susceptibility. *Equine Vet J* 2003;35:465–71.
29. Dunkel B, Johns IC. Antimicrobial use in critically ill horses. *J Vet Emerg Crit Care (San Antonio)* 2015;25:89–100.
30. Johns I, Tennent-Brown B, Schaer BD, et al. Blood culture status in mature horses with diarrhoea: a possible association with survival. *Equine Vet J* 2009;41:160–4.