

**FLUID THERAPY IN THE EQUINE**  
**Joanne Hardy, DVM, PhD, Diplomate ACVS**

Fluid administration for maintenance or replacement purposes is one of the mainstays of equine critical care, and should be readily and easily available in any equine hospital. The availability of commercial materials and fluids for use in large animal makes fluid administration easy and cost effective in most situations. This paper reviews materials available and principles to follow when planning fluid administration.

**MATERIALS FOR FLUID ADMINISTRATION**

Intravenous catheters

Intravenous catheters are available in varying materials, construct, length and diameter (see following tables). In choosing a catheter, consider desired fluid rate, fluid viscosity, the length of time the catheter will remain in the vein, the severity of the systemic illness, and the size of the animal. The rate of fluid flow is proportional to the diameter of the catheter, and inversely proportional to the length of the catheter and the viscosity of the fluid. Teflon catheters should be changed every 3 days, whereas polyurethane catheters can remain in the vein for up to 2 weeks. Horses that are very ill (bacteriemic, septicemic, endotoxic) are more likely to encounter catheter problems and benefit from polyurethane or silicone catheters. Standard adult horse catheter sizes are usually 14g in diameter and 5.25 inches in length. For more rapid administration rates (shock) a 12g or 10g should be used. Plasma and blood products, because of their increased viscosity, will also flow slower, so if volume replacement is also needed, administration of these fluids can be combined with a balanced electrolyte solution.

The catheter construction needs also to be considered (see table). Through-the-needle catheters are most common for standard size adult horses. An over-the-wire catheter is best used in foals, and miniature horses, or when the lateral thoracic vein is catheterized. Short and long extension sets are available, as well as small and large bore diameters. It is best to use an extension that screws into the hub of the catheter, to avoid dislodgement. In horses with low central venous pressures, disconnection of the line can result in significant aspiration of air, and cardiovascular collapse. Double extensions are also available, when there is need to administer another medication with the fluids.

<b>Material</b>	<b>Example</b>	<b>Comment</b>
Polypropylene	PE tubing, Medicut	Highly thrombogenic
Teflon	Angiocath	Less thrombogenic
Polyurethane	Mila	Much less thrombogenic
Silastic	Centrasil	Least thrombogenic

<b>Type</b>	<b>Description</b>	<b>Advantage</b>	<b>Disadvantage</b>
Butterfly	needle attached to tubing	Ease of use	Laceration of vessel vessel puncture and extravascular administration
Over-the-needle	Stylet inside catheter for venipuncture	Available in large diameter Ease of insertion	Limited length of catheter Not flexible Break at catheter and hub junction
Through-the-needle	Short needle is inserted, catheter is threaded through needle	All lengths available Flexible Peel-away needle	Technically more difficult to insert
Over the wire	Needle serves as guide to insert wire, which serves as guide for catheter	Flexible Long catheters available Ensures proper catheter placement	More technical expertise required to place Expensive

Catheter maintenance

Catheters are usually not covered with a bandage, so that any problem is quickly identified. Bandages may need to be applied in foals if they are tempering with the catheter. A triple antibiotic ointment may be applied at the insertion site on

the skin, to decrease infection. Catheters should be flushed with heparinized saline (10 iu/ml) four times a day if they are not used for fluid administration. When administering a medication, the injection cap should be wiped with alcohol prior to insertion of the needle. The injection cap should be changed daily.

Coil sets and administration sets

Coil sets are used for in stall fluid administration, and are essential as they allow the horse to move around, lie down, and eat without restraint. An overhead pulley system with a rotating hook prevents fluids from getting tangled.

Administration sets are used for short-term fluid or drug administration, and are available at 10 drops/ml and 60 drops/ml. When using a calibrated fluid pump, care should be taken to use the appropriate set calibrated for the brand of pump. Long coiled extension sets can then be used to connect fluids to the horse. Foal coil sets are also available that deliver 15 drops/ml.

Special foal fluid administration sets are available as pressurized bags that allow delivery of fluids at 250 ml/hour. These bags can be placed in a special harness on the foals' back, therefore avoiding entanglement with mare. Each bag can hold 500 ml, and can be refilled.

Pump delivery

Calibrated pumps are available that allow delivery at various rates. These pumps have alarms that signal for air in the line, empty fluid bag or catheter problems. The maximal fluid rate these pumps can deliver is 999 ml/hour, which is not enough for an adult horse. They are useful for recumbent foals or for combined drug infusions. For large volume fluid delivery, peristaltic pumps are available that can deliver up to 20 liters an hour. These must be under constant supervision when in use, as they will continue to run even if fluids run out. Large bore catheters should be used to avoid trauma from the jet effect on the endothelium of the vein.

Sites for intravenous catheterization in the horse

Common sites for insertion of intravenous catheters in horses include the jugular, lateral thoracic, cephalic and saphenous veins. When placed in any other location than the jugular, more frequent flushings are required, as these catheters tend to clot easier. Leg catheters are usually bandaged, because they are more prone to dislodgment than jugular catheters.

Oral feeding tubes

Oral fluid administration offers a good alternative to intravenous fluid therapy in animals that require maintenance fluids because of inability to swallow, or in horses with impaction colic. Enteral nutrition can also be administered for complete or partial enteral nutrition in foals and adults. Commercially available feeding tubes for foals, weanlings and adults enable fluid or liquid diet supplementation while allowing the horse to continue to nurse or eat.

**DESIGNING A FLUID THERAPY REGIMEN**

Fluid therapy can be administered as a maintenance or replacement regimen. Maintenance regimens are usually provided via the oral route in equine, and oral electrolyte formulations are available for this purpose. Intravenous maintenance fluids are lower in sodium and higher in calcium potassium and even magnesium than replacement fluids. Most commonly replacement fluids are given in equine, for the purpose of replacing fluids lost through dehydration and ongoing losses.

When designing a fluid therapy regimen, 3 questions must be answered:

- **What volume of fluid must be given?**
- **What type of fluid will be given?**
- **What will be the rate of administration?**

Volume of fluids to give:

= **maintenance requirements + correction of dehydration + ongoing losses**

Maintenance: 60 ml/kg/day (adult); 70-80 ml/kg/day (foal)

Dehydration

Based on physical exam

<b>% Dehydration</b>	<b>Heart Rate (BPM)</b>	<b>CRT (sec)</b>	<b>PCV/TP (%/g/L)</b>	<b>Creatinine (mg/dl)</b>
6%	40-60	2	40/7	1.5-2
8%	61-80	3	45/7.5	2-3
10%	81-100	4	50/8	3-4
12%	>100	>4	>50/>8	>4

**Correction of dehydration: estimate of dehydration (%) x body weight (kg)**

### Ongoing losses

Ongoing losses can sometimes be measured and recorded, for example when nasogastric reflux is present, but most commonly must be estimated. Patient monitoring is used to determine if the calculated fluid volume is meeting the ongoing losses. Monitoring, which includes heart rate, measurement of PCV/TP, and creatinine is done at least twice a day when patients are on intravenous fluids, but should be done more frequently (every 2, 4 or 6 hours) depending on the severity of cardiovascular compromise.

### Type of fluid

The type of fluid to give will depend on evaluation of the chemistry profile and disease state. The first step is to decide on the baseline fluid (saline, or balanced electrolyte solution) and the second step is to decide on which additives to add to the baseline fluid, depending on specific deficits or excesses, such as hypo/hyponatremia, hypo/hyperkalemia, hypo/hypercalcemia, hypoglycemia or acid-base disorders.

There are two categories of fluids commonly used for fluid replacement: **0.09% saline, and balanced electrolyte solutions (BES)**. Table 1 lists the composition of various fluids available. BESs are chosen when serum electrolytes are close to normal. All BES contain some potassium. Saline is higher in sodium and much higher in chloride than serum concentrations and is used when [Na] is lower than 125 meQ/L. Saline is also used in disease processes associated with high [K] such as hyperkalemic periodic paralysis, or renal failure, where a potassium free solution is preferred. In cases of long term maintenance fluid therapy (>4-5 days), if the oral route is not available, half strength basic fluids, to which are added potassium and calcium should be considered. Long-term fluid therapy with routine BES will result in hyponatremia, hypokalemia, hypomagnesemia and hypocalcemia.

In equine calcium and potassium supplementation are also included in routine fluid replacement, particularly when there is no oral intake because of gastrointestinal disease. Both electrolytes are important for smooth muscle function and vascular tone. Recently magnesium supplementation has also received interest.

Bicarbonate supplementation may also be required in horses with metabolic acidosis. Rules of thumb for bicarbonate supplementation in **acute** metabolic acidosis are:

- Normal respiratory function. If the horse is unable to exhale the generated CO<sub>2</sub> because of a respiratory problem, worsening of the acidosis will result.
- PH < 7.2. In acute acidosis, associated with dehydration, fluid replacement will result in restoration of urine output, and renal compensation will follow and usually be complete if the pH is > 7.2
- Administration of half of the calculated amount rapidly, followed by the rest over 12-24 hours.
- IV bicarbonate should not be given with calcium-containing solutions.

In chronic metabolic acidosis, particularly when there are ongoing losses of bicarbonate (ex: diarrhea), the full calculated amount is usually required, partially because the bicarbonate loss is distributed over all fluid compartments, not just the extracellular fluid. Oral bicarbonate is a good means of dealing with ongoing losses in horses with diarrhea.

Bicarbonate can be given orally as a powder, where **1 g NaHCO<sub>3</sub> = 12 meQ of HCO<sub>3</sub>**

### Rate of administration

In severe shock, a shock dose of fluids should be given in the first hour (60 ml/kg). This can only be done with pressurized bags or a pump.

In other situations, the rate of administration is calculated based on 24-hour requirements, and estimated as a volume per hour. It is important to keep tally of the fluids given to ensure that the correct amount was given.

### Oral Fluids

Oral fluid therapy regimens can be provided using the following fluid composition:

NaCl	10 gm
NaHCO <sub>3</sub>	15 gm
KCl	75 gm
K <sub>2</sub> HPO <sub>4</sub>	60 gm
Q 21 liters of water	

### Fluids used for resuscitation

#### **Fluids used to expand circulating blood volume:**

##### Isotonic crystalloids

- These fluids are administered intravenously and immediately reconstitute circulating volume. However, because they are crystalloids, they will distribute to the entire extracellular compartment within a matter of minutes. Since the ECF compartment is 3 times the volume of blood, 3 times as much isotonic crystalloid must be administered in order to gain the desired amount of volume expansions.

- Dose: 60-90 ml/kg/hr
- Fluid types: usually BES such as LRS

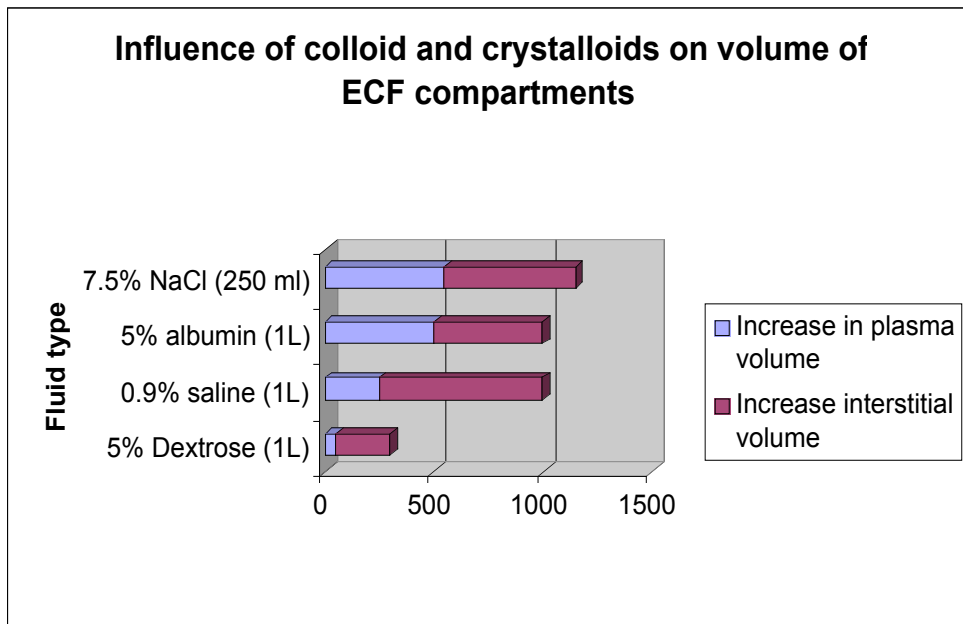
Hypertonic crystalloids (7.2% NaCl)

-These fluids are approximately 8 times the tonicity of plasma and ECF; the immediate effect therefore, is to pull by osmosis fluid from the interstitium into the vasculature. However, this effect is short lived. As the electrolytes redistribute across the ECF fluids shift again and the patient becomes hypovolemic again. The duration of effect of hypertonic solutions is directly proportional the distribution constant, which is the indexed cardiac output.

Dose: 4 ml/kg, administered as rapidly as possible  
 Fluid: 5 or 7% saline.  
 Must be followed up with isotonic volume replacement.

Colloids

Colloids are fluids that contain a molecule that can exert oncotic pressure. These molecules do redistribute to the ECF, but at a much slower rate than crystalloids, such as the duration of effect is prolonged compared to crystalloids. Table 3 provides a comparison of the efficacy of different colloids to expand the vascular volume. There are basically 2 types of colloids: natural colloids such as albumin, and synthetic colloids. Table 2 describes the different of colloids available. Natural colloids (Plasma or albumin) have the disadvantage that they are more antigenic, and can cause allergic reactions. Synthetic colloids have a much lower antigenicity, but they can cause bleeding disorders by their tendency to coat platelets, rendering them inactive. The incidence of this problem is much more common with smaller molecules such as Dextran 40.



Dose: 10 ml/kg of 6% solutions.

Comment: synthetic colloids do not register on the refractometer. Accurate evaluation of oncotic pressure can only be made using a colloid osmometer. If not available, clinical evaluation (presence of edema, poor circulatory volume and pressure) must be used.

Blood substitutes

These are hemoglobin solutions. There is currently only one commercially available hemoglobin solution, oxyglobin, made from bovine hemoglobin. Its major advantage is that it does not depend on 2-3 DPG for oxygen carrying capacity, such that it can be stored and is immediately able to transport oxygen. Unfortunately cost limits its usefulness in horses.

Dose: 15-30 ml/kg

### Whole blood

Whole blood is the ideal fluid for blood loss or platelet loss providing it is fresh blood and has been cross-matched. Remember that stored blood loses its oxygen carrying capacity, and that it can take several hours to restore it after administration.

Dose: 1 liter per liter of estimate blood loss, or 1 liter per 1% desired rise in PCV.