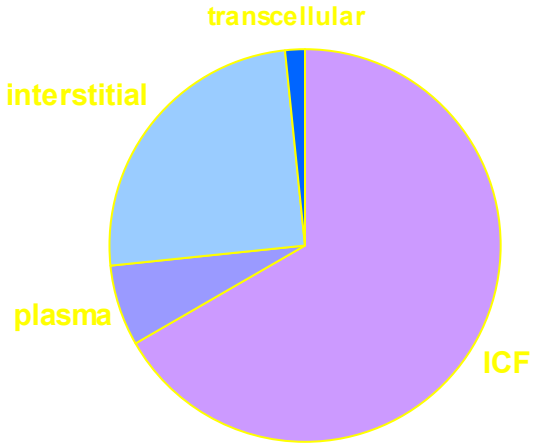
You Can Lead a Horse to Water…
5 Easy Steps to Equine Fluid Therapy

Amelia Munsterman, DVM, MS, DACVS

Introduction:

Reasons to administer fluid therapy

1. To maintain adequate hydration
2. To restore losses due to dehydration
3. To replenish ongoing fluid losses
4. To overhydrate for therapy of a disease



Five Steps to a Fluid Therapy Plan:

1. Assess your patient's needs
2. Determine route of administration
3. Determine type of fluids
4. Formulate plan
5. Reassess patient and reformulate plan

Step 1: *Assessing your patient's needs*

When does a patient need fluids? If …

- If the horse appears dehydrated clinically. This would include:
  - Physical exam findings-tacky mucous membranes, slow jugular fill when it is held off, cool extremities, prolonged skin tent on neck or on eyelid, increased heart rate, and increased CRT
  - Bloodwork values that may point to dehydration include hemoconcentration (increased PCV and total protein) or increased creatinine which may point to prerenal azotemia.
  - The percentage dehydration relates to amount (%) of body weight lost (Note: Anything less than 5% dehydration is not readily apparent on exam).

% DH	HR (bpm)	CRT (sec)	PCV/TP (%;g/L)	creatinine (mg/dL)
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	>101	>4	>50; >8	>4

- If the horse has encountered nephrotoxins
  - Ie. a large dose or an extended course of non-steroidal anti-inflammatories, aminoglycosides, blisterbeetles, rhabdomyolysis
- If the horse has evidence of renal insufficiency
  - Suggested acutely by an increase in BUN and creatinine (azotemia), but realize that these chemistry values can be affected by muscle breakdown, protein intake, and liver insufficiency.
  - Can be evaluated by urinalysis (signs of renal dysfunction include isosthenuria, increased protein or cellular casts)
- If the horse has a condition that requires overhydration
  - Such as overhydrating to soften and break down an impaction in the colon, cecum or ileum

- Includes diseases that result in ongoing losses (anterior enteritis with concurrent gastric reflux, severe diarrhea)
- Includes diseases that may require dilution of toxins (ie. endotoxemia)

Step 2: *Select your route of administration*

Comparison of IV versus Oral (per nasogastric tube) fluid therapy:

IV	Oral
More expensive	Cheap fluids and equipment
Equipment: IV catheter, extension, fluid administration set, +/- pump	Equipment: NG tube, pump (+/- fluid administration set and carboy)
Slower (maximum 5-7 L/hr)	Allows rapid administration (10-12 L/hr)
Requires constant monitoring	Competent owners can monitor
Method required if refluxing	Cannot be used if refluxing
Relies on circulation to dissolve impaction	Directly infiltrates impactions
Risks-phlebitis, embolus of air, catheter embolus	Risks-pharyngitis, lack of absorption if >8% DH

IV fluid therapy:

IV fluids require consideration of the access point (vessel), catheter required (size, rate of fluid administration, thrombogenicity, cost), selection of the appropriate extension set, and fluid administration set, and need for a pump.

Vessels commonly used in horses are the jugular, saphenous, lateral thoracic, and cephalic. A comparison of them is as follows:

Vessel	Advantages	Disadvantages	Catheter size
Jugular V.	Easy to access, Achieves fastest rate	Thrombosis has significant morbidity	Foal-16 g-14 g Adult-14 g (10 g for shock dose, remove in 24 hrs.)
Cephalic V.	few	Easy to dislodge, difficult to place due to vein rolling, requires bandaging	Foal-18-16 g. Adult-16 g., 3 inch
Lateral Thoracic V.	Less morbidity than jugular, less likely to kink	Difficult to place due to vein rolling	Adult- 14-16 g, 5 inch, over the wire
Saphenous V.	few	Not recommended for adults, easy to dislodge	Foal 16 g. 3 inch

Catheters can be compared based on size, length, introduction method, and thrombogenicity, which determines maximal duration. Catheter sizes are usually compared based on the gauge, which increases as the outside diameter of the catheter decreases. The typical catheter sizes used in horses are listed above. As the catheter size increases, the flow rate can also increase (often the catheter is the smallest gauge piece of tubing in the system, and therefore set the rate). Remember that flow rate is directly correlated to the diameter of tubing and the length of the tubing, and inversely correlated to the viscosity of the fluids administered. Catheters also differ in their pliability and the body's reaction to its material. This is termed the *thrombogenicity* of the catheter, and can also be increased as the size of the catheter increases. Catheters introduced over a wire that is placed in the vessel are typically more pliant, and therefore less likely to cause a clot, than a catheter slid into the vessel off a needle or trocar. These over-the wire catheters are also typically more expensive, but last much longer than a catheter off a needle.

Catheter material	Brand names	Type	Thrombogenicity	Duration
Polypropelene	Medicut	Over the needle	+++++	<24 hours
Teflon	Angiocath	Over the needle	++++	48 hours
Polyurethane	Mila/Arrow	Over the needle or wire	++	3 weeks (needle) to 60 days (wire)
Silicone	Centrasil	Over the needle or wire	+	60 days

In regards to the remaining components of the fluid administration set (the extension set form the catheter and the fluid administration set from the fluid bag), it is helpful to remember that the fluid rate is set based on the height of the fluids above the horse if gravity flow is used. This can severely limit fluid administration rates if adequate height is not obtained. If a fluid pump is used, the administration rate can be set, but pumps are typically only available to administer fluid rates for foals. Backpack rubber elastomer pumps (Mila) can be used for foals to allow them to stay with the mare, and to prevent fluid line tangling. Adults can use an arthroscopy (peristaltic) pump to administer shock doses of fluids, but these pumps can damage the vessel wall due to the force and turbulence they create.

Enteral fluid therapy:

Enteral fluids can be relatively simple, due to the use of fluid boluses. In this case, a standard NG tube and NG pump can be used in the adult hers to administer fluids every 2-4 hours. Continuous fluid administration can be provided by an adult feeding tube, attached to the same fluid administration coil as the IV fluids. A carboy (large plastic drum) is used to store the fluids, or, used IV fluid bags can be used as well. In foals, similar feeding tubes can be used, but regular NG tubes are not tolerated. Oral fluids (non-milk) in foals are rarely indicated, due to their liquid diet that provides the majority of their fluid needs, as well as the specifics of their diseases.

Step 3: *Determine the type of fluids you would like to administer*

The type of fluids you select is based on where you want your fluid to go (ie the vascular space), the route of administration, and the fluids you have available in both volume and price. Hypotonic fluid (5% dextrose, water) will distribute evenly to all fluid compartments, which may not provide the cardiovascular support most fluid therapy is needed for. Isotonic crystalloids (Normasol, Lactated Ringer's) will distribute mainly to the extracellular fluid (2/3) and plasma (1/3), so to replace blood and fluid losses, approximately 3 times the blood volume lost is needed to replenish plasma volumes. Hypertonic fluids are used in small volumes (2-4 ml 7.2% saline/kg) and will pull fluid due to its hypertonicity from the intracellular space into the bloodstream and interstitium. This effect is short-lived (<45 minutes), and must be supplemented with crystalloids for lasting effects. Colloids [plasma (4-8 ml/kg), whole blood, Hetastarch (10-20 ml/kg)] will pull fluids into the bloodstream by increasing the plasma oncotic pressure, and are also used in small volumes. Their effects last longer that hypertonic saline, but are used sparingly due to cost, availability, and side effects such as coagulopathies and immune reactions. Again, colloids must also be followed by crystalloids to maintain their effect.

Oral fluid therapy plans often utilize hypotonic fluids (water) or crystalloid solutions (balanced salt solutions). Selection is based on the expected time that fluids will be needed, since long term water supplementation in a horse off feed can deplete electrolytes.

Enteral Fluid Electrolyte Solution Recipe:

Electrolyte	Trade name	mmol	Grams/Liter
Sodium	Mix-N-Fine Salt	135	5.27
Potassium	Morton's Salt Substitute	5	0.37
Bicarbonate	Arm and Hammer Baking Soda	45	3.78
Chloride	Note: chloride is complexed to sodium and potassium in the salts listed above	95	(not necessary- added in with the above salts)

IV fluid therapy can utilize hypotonic, crystalloids, as well as hypertonic saline and colloid solutions depending on the electrolyte and fluid status of the patient. Again, selection is often based on cost and availability. A long term, or maintenance, fluid plan will usually indicate a maintenance-type crystalloid, which would require the addition of potassium and calcium to the solutions and possibly a 0.45% saline solution to prevent sodium overload. However clinically, *in adult horses*, the high sodium concentration of resuscitation crystalloids (Normasol R, Plasmalyte A, Lactated Ringers) is often overlooked, and potassium and calcium are added to these fluids for regular maintenance therapy. Fluid therapy for resuscitation typically includes high rate crystalloids (10 liters/hour in 500 kg horse) or hypertonic saline for immediate expansion of the vascular space, followed by crystalloid fluid therapy.

Fluid Types for Horses:

type of fluid	mosm/L	Na	K	Ca	Mg	Cl	Buffer	pH	avg. molecular wt. kDa	COP
Normal equine plasma	285	135	3.5	11.7	1.9	105		7.35	60	20-25
0.9% saline	308	154				154	none	5.0		
Lactated ringers	273	130	4	3		109	lactate	6.6		
Plasmalyte A	294	140	5		3	98	acetate gluconate	7.4		
Normasol R	294	140	5		3	98	acetate gluconate	6.6		
Hypertonic saline (7.2%)	2464	1232				1232				
Blood	285	135	3.5	11.7	1.9	105		7.35	60	20-25
Hetastarch									69	30

Step 4: *Formulate your fluid therapy plan:*

A fluid therapy plan contains three parts:

1. Dehydration fluid deficit in liters
   - -Equal to the weight of the horse in kilograms times the percent dehydration
     ie. a 500 kg horse that is 8% dehydrated=
     0.08 x 500 kg = 40 liters
2. Daily maintenance needs of the horse in liters
   - -Note that this can be doubled or tripled to treat diseases that require overhydration (ie. impaction)
   - -Equal to 40 to 60 ml/kg/day
     ie. for a 500 kg horse
     60 ml/kg/day x 500 kg = 30 liters
3. Fluids needed for ongoing losses
   - -Such as fluids lost hourly in diarrhea or nasogastric reflux
   - -may be quantitated each time the horse is refluxed, or estimated based on the volume of feces, and alterations in physical parameters of dehydration

The sum of these three parts is the fluid plan for the horse.

Additives are only necessary if the horse has been off feed for 48 hors or more, or if the horse is expected to continue fluids for longer than 48 hours. Common additives include potassium (20-40 mEq/L), calcium (25ml 23% calcium gluconate/L) and magnesium (4-16 mg/kg). With potassium, rates greater than 0.5 mEq/kg/hour are cardiotoxic, so it is important to monitor intake, and to not supplement potassium in resuscitation (high rate) fluids. Calcium is more forgiving and excess amounts will be excreted in the urine.

Step 5: *Reassess patient and determine if fluid plan is adequate:*

Therapy can be monitored by physical examination (heart rate, skin turgor, edema), and urine output, which should increase. Hematologic values such as total protein and PCV may be variable, but creatinine and BUN may be sued to assess renal perfusion. Venous blood gasses measuring lactate, base excess, and $PvCO_2$ can be used to assess tissue perfusion. Over or under hydration can also be assessed by central venous pressures from a jugular catheter or oscillometric blood pressures.