Fluid Therapy for the Critically Ill Patient
Simone Schuller, Dr med vet, DEA, DECVIM-CA

Fluid therapy is frequently used in the treatment of critically ill patients. It can be life saving in certain instances (e.g. patients with hypovolaemic shock) and in others it may improve recovery and outcome. Fluid therapy differs from other treatments in that there are no “recipes” that can be followed that will guarantee a successful outcome. Appropriate use of fluid therapy therefore requires a good understanding why the fluid is being administered, considering the outcome you want to achieve and the pros and cons of the different fluid groups in achieving those outcomes.

Whenever you are administering fluid therapy to a patient, you should consider the following questions:

1. Does the patient need fluids – if so why?
2. Which fluid is most appropriate?
3. At what rate shall I give the fluid?
4. For how long shall I give the fluid?
5. What am I hoping to achieve by fluid administration and how will I monitor to ensure this occurs?
6. What possible adverse effects of fluid therapy may I encounter and how shall I monitor for these?

The two major reasons for fluid therapy in the critically ill patient are hypovolaemia and dehydration. It is very important to understand the difference between these two conditions. Many emergency patients will have components of both, however when treating a patient, hypovolaemia should always be addressed first.

To understand the difference, we have to take a look at the body fluid compartments. About 60% of the body is water. One third of the body water is extracellular and two thirds are intracellular. The extracellular water is further subdivided into interstitial and intravascular water.
Hypovolaemia occurs when fluid is lost primarily from the intravascular compartment. Even loss of small volumes of fluid from this compartment has profound physiological consequences with the development of hypovolaemic shock. Hypovolaemia is seen commonly with haemorrhage and severe rapid fluid loss from the gastrointestinal tract. Fluid therapy for hypovolaemia should aim for rapid replacement of the lost intravascular volume to restore tissue perfusion.

Dehydration on the contrary represents fluid loss from all three body fluid compartments. It occurs with more gradual fluid losses where there is time for water to move between body fluid compartments. Total fluid losses may be much larger than with hypovolaemia. As fluid losses have occurred from all body fluid compartments but we must allow time for the fluid to redistribute back into the interstitium and cells and choose a fluid that is able to do this. Hence treating dehydration involves using a crystalloid fluid and giving it slowly to replace estimated fluid losses usually over 24 hours.

Assessment of hypovolaemia

Assessing a patient for hypovolaemia should include the following parameters, which inform us on the degree of vascular filling and peripheral perfusion.

- Heart rate and rhythm
• Pulse quality (including palpation of femoral and metatarsal pulse)
• Correlation of pulse and cardiac auscultation (i.e. pulse deficits)
• Mucous membrane colour
• Capillary refill time (CRT)
• Cardiac auscultation

In uncomplicated hypovolaemic shock, these parameters follow a consistent course in dogs as outlined below. However, parameters should be assessed in the context of the patient’s history and physical examination results. Suspected causes of hypoperfusion other than simple hypovolaemia should be aggressively investigated.

<table>
<thead>
<tr>
<th>Clinical sign</th>
<th>Mild compensatory</th>
<th>Moderate</th>
<th>Severe decompensatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate (bpm)</td>
<td>130-150</td>
<td>150-170</td>
<td>170-220</td>
</tr>
<tr>
<td>MM colour</td>
<td>Normal to pinker than normal</td>
<td>Pale pink</td>
<td>White, grey or muddy</td>
</tr>
<tr>
<td>CRT</td>
<td>Vigorous &lt;1 sec</td>
<td>Reduced vigour 2 sec</td>
<td>&gt; 2 sec or absent</td>
</tr>
<tr>
<td>Pulse amplitude</td>
<td>Increase</td>
<td>Moderate decrease</td>
<td>Severe decrease</td>
</tr>
<tr>
<td>Pulse duration</td>
<td>Mild decrease</td>
<td>Moderate decrease</td>
<td>Severe decrease</td>
</tr>
<tr>
<td>Metatarsal pulse</td>
<td>Easily palpable</td>
<td>Just palpable</td>
<td>absent</td>
</tr>
</tbody>
</table>

Cats do not follow the pattern of CV changes as outlined in the table above as reliably as dogs. Hypovolaemic cats can present bradycardia instead of tachycardia.

**Assessment of dehydration**

Unlike hypovolaemia, dehydration is difficult to assess accurately. Parameters such as skin tent, dry mucous membranes and sunken eyes may be used. Generally patients should be categorized as mildly (5%), moderately (8%-10%) or severely (12-15%) dehydrated as this allows an initial fluid rate to be calculated, however it is important to be aware that this fluid
rate is calculated on the basis of very subjective data. Frequent assessment of the patient and flexibility with the fluid plan is necessary for a successful outcome.

**Treatment of hypovolaemia**

Treatment of hypovolaemia aims for rapid intravascular volume replacement. A number of fluid options are available and there is no such thing as a “perfect” fluid therapy plan. The most important thing is to continue to carefully monitor the patient and re-evaluate your plan on the basis of response in each individual patient.

**Replacement isotonic crystalloids**

Crystalloids are cheap and are almost invariably the choice fluid in hypovolaemic patients. However they will redistribute with time to the interstitial and potentially intracellular space. In many cases this is no bad thing as the patient has a component of dehydration too, however in patients with hypoproteinaemia, they may increase the risk of peripheral oedema forming especially if multiple boluses are required. Crystalloids should be given as boluses and the response to each bolus should be assessed before giving further fluid boluses. A “full shock” bolus is considered to be 60-90 ml/kg in the dog and 40-60 ml/kg in the cat. The severity of the hypovolaemia will determine what proportion and how quickly the shock dose is given.

**Hypertonic saline**

This represents a concentrated solution of NaCl that has approximately 8x the osmolality of plasma. As such it creates a temporary osmotic gradient between the intravascular and interstitial space and tends to draw fluid from the interstitium into the vasculature. It is a very efficient and rapid volume expander but does rely on there being “available” fluid in the interstitium. It should therefore not be used in patients who may have a component of dehydration. As the NaCl will redistribute, the haemodynamic effects is temporary and thus a dose of hypertonic saline must always be followed by other crystalloid fluids. The hypertonic saline dose is 4-7 ml/kg in the dog and 2-4 ml/kg in the cat given over 5-10 minutes. Its main advantage is that the volume of fluid administered for a given haemodynamic effect is relatively small. This makes it a useful fluid for resuscitation of large breeds (e.g. Great Danes) with severe hypovolaemic shock. In cats it is principally used in patients with
concurrent hypovolaemic shock and head trauma as there is some evidence that it is the resuscitative fluid of choice in this situation.

Hypotonic fluids
This group includes products such as 0.45% NaCl and 0.18% NaCl + 4% dextrose. This group of fluids should NEVER be used in hypovolaemic patients or at rapid rates – the administration of hypotonic fluids in this situation can lead to a severe and rapid decrease in serum sodium that is potentially fatal.

Colloids
Colloids represent fluids with larger molecules that tend to be retained within the intravascular space and exert an osmotic effect there tending to hold fluid in the vasculature. As such they have a more profound haemodynamic effect for the same dose than crystalloids. A typical “shock” bolus of colloid is 10 ml/kg. There are various products on the market: gelatin based products such as Haemaccel® and starch based products such as Voluven® or Pentastarch®. Generally, the starch based products are more expensive but have longer persistence.
Although colloids may seem like a logical choice in hypoperfused patients, they have a number of disadvantages and are expensive. Colloids have the potential to cause a dose dependent coagulopathy. Colloids do definitely have a place in the management of hypoperfused patients especially with concurrent hypoproteinaemia, but they are rarely the first choice fluid.

Treatment of dehydration
Dehydration is usually treated with isotonic crystalloid replacement fluids with the estimated deficit being replaced over 24 hours. Ongoing losses and maintenance requirements must also be accounted for during this period. Isotonic replacement fluids are most suitable in the majority of cases as most common disease processes lead to electrolyte losses alongside the fluid loss that also need to be replaced. Rarely, patients with true hypotonic fluid loss are encountered; it is in these patients that hypotonic fluid administration may be required. Even then they should be used cautiously and serum electrolytes should be closely monitored.