Colloid oncotic pressure (COP) is the force that opposes capillary hydrostatic pressure and favors retention of fluid in the fluid compartment of the vascular space. Many disease states can cause COP to drop, which in turn can result in a decrease in vascular volume and/or interstitial edema formation. Both of these processes can ultimately lead to poor tissue perfusion and oxygenation as well as compromise of organ function.

Colloid solutions contain substances that exert colloid oncotic activity and are suspended in isotonic fluid. Natural and synthetic colloids are available and are becoming more commonly used in veterinary medicine. Natural colloids include plasma, whole blood, and concentrated human albumin; synthetic colloids are a complex mixture of molecules with varying molecular weights that provide oncotic pull as a result of the large number of molecules present in the solution. Examples of commonly used synthetic colloids are 6% hetastarch and dextran 70 (Table 1).

Two instances in which colloids are used in veterinary medicine are in the therapy of shock and hypoproteinemia. In cases of shock, the disease process is generally acute in nature. By definition, patients in shock have a condition of profound hemodynamic and metabolic disturbance characterized by failure of the circulatory system to maintain adequate perfusion of vital organs. Shock may result from inadequate blood volume (hypovolemic shock), inadequate cardiac function (cardiogenic shock), or inadequate vasomotor tone (septic shock). Historically, crystalloids have been the primary fluid choice in veterinary medicine for restoring vascular volume and organ perfusion in patients in shock. However, colloids are becoming more frequently used in these situations as adjunct therapy to standard crystalloid resuscitation. Colloids are especially useful in patients with head trauma or pulmonary contusions. Because only 25% to 30% of the administered volume of crystalloids remains in the vascular space, an administration rate of up to 90 ml/kg/hr may be needed for resuscitation from shock. Excessive amounts of crystalloid fluids can cause interstitial edema. One of the benefits of colloids is that resuscitation can be achieved with a much lower volume (20 to 30 ml/kg) because they remain in the vascular space for a longer period. Colloids are also frequently used in patients with septic shock. Extreme vasodilation and increased vascular permeability contribute to hypotension. The large size of the oncotic particles in colloids such as hetastarch may help prevent “vascular leak syndrome” associated with sepsis.

Patients with hypoproteinemia (specifically, hypalbuminemia) will also have a decreased vascular volume because albumin is the principal oncotic component in plasma. In chronic cases, fluid compartments tend to adapt and equilibrate. Often, the interstitium has a lower albumin level in these patients compared with normal animals. Therefore, fluid therapy must be tailored to the patient to ensure adequate vascular volume and hydration as well as to prevent overhydration and fluid overload. Colloids can play an important and helpful role in managing these patients.
**TABLE 1**

**Colloid Solutions**

<table>
<thead>
<tr>
<th>Solution</th>
<th>Average Molecular Weight (daltons)</th>
<th>Half-Life</th>
<th>COP (mm Hg)</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human albumin 25%</td>
<td>69,000</td>
<td>Unknown in cats and dogs; 15–20 d in humans</td>
<td>100</td>
<td>Albumin</td>
</tr>
<tr>
<td>Hetastarch 6%</td>
<td>450,000</td>
<td>25 hr</td>
<td>30</td>
<td>0.9% NaCl</td>
</tr>
<tr>
<td>Dextran 70</td>
<td>70,000</td>
<td>25 hr</td>
<td>60</td>
<td>0.9% NaCl</td>
</tr>
<tr>
<td>Oxyglobin</td>
<td>200,000</td>
<td>30–40 hr</td>
<td>40</td>
<td>Modified lactated Ringer’s solution</td>
</tr>
<tr>
<td>Plasma</td>
<td>69,000</td>
<td>17–19 d</td>
<td>20</td>
<td>Albumin, coagulation factors, antithrombin</td>
</tr>
</tbody>
</table>

**DIAGNOSTIC CRITERIA**

**Historical Information**

**Gender/Age/Breed Predispositions:** None.

**Owner Observations**

- Animals that have an acute drop in vascular volume or oncotic pressure are likely to be weak and depressed and may collapse suddenly.
- With a more chronic loss of proteins that results in a drop in COP, owners may notice peripheral edema formation (pitting edema, “stocking up”), abdominal distention secondary to fluid accumulation, or respiratory distress if pulmonary edema or pleural effusion is present.

**Other Historical Considerations/Predispositions**

- Diseases that result in chronic protein loss include protein-losing nephropathy (PLN), protein-losing enteropathy (PLE), and hepatic failure:
  - Owners of animals that have **PLN** may note polyuria/polydipsia, weight loss, inappetence, and/or vomiting.
  - Owners of animals that have **PLE** may notice various combinations of vomiting, diarrhea, weight loss, and inappetence in addition to the edema formation.

**Physical Examination Findings**

**Acute Drop in Vascular Volume**

- Pale mucous membranes, tachycardia, weak pulses, and prolonged capillary refill time.

**KEY TO COSTS**

- $ indicates relative costs of any diagnostic and treatment regimens listed.
- $ costs under $250
- $$ costs between $250 and $500
- $$$ costs between $500 and $1,000
- $$$$ costs over $1,000
• Other findings depend on the disease process; for example, ascites may be noted in a patient with acute abdominal hemorrhage secondary to splenic hemangiosarcoma.

• Specific cases that may benefit from colloid resuscitation:
  — **Head trauma:** Anisocoria, miotic pupils, decreased or absent pupillary light responses, dementia, severe depression, nystagmus, head tilt, epistaxis, or hemorrhage from ears.
  — **Pulmonary contusions:** Tachypnea, labored respirations, or crackles and wheezes on auscultation.

**Chronic Decrease in COP**
• “Third spacing” of fluid is often noted: Ascites, peripheral edema of the extremities, and pleural effusion.
• Poor body condition as a result of weight loss.

**Laboratory Findings**

**Acute Drop in Vascular Volume**
• May initially be normal if the process is peracute.
• Findings depend on the underlying disease process (e.g., anemia, hypoproteinemia, and thrombocytopenia are likely in a dog with a ruptured splenic hemangiosarcoma).
• Trauma patients may have anemia and hypoproteinemia secondary to acute blood loss.
• Elevated lactate levels may be seen in patients with poor perfusion.
• Elevated muscle and liver enzymes may be seen in trauma patients.

**Chronic Decrease in COP**
• **PLN:** Normal globulin, hypoalbuminemia, possibly azotemia and hypercholesterolemia, proteinuria, possibly anemia.
• **PLE:** Panhypoproteinemia, possibly hypercholesterolemia, lymphopenia.
• **Hepatic failure:** Low blood urea nitrogen, hyperglycemia, hypoalbuminemia, hypcholesterolemia, and elevated levels of bilirubin, alkaline phosphatase, and alanine aminotransferase.

**Other Diagnostic Findings**

**Acute Drop in Vascular Volume**
• Other findings depend on the underlying disease process (e.g., loss of abdominal detail on radiographs may be a result of ascites [blood]; peritoneal fluid [blood] and splenic mass may be noted on abdominal ultrasonography if splenic hemangiosarcoma has ruptured).
• Trauma patients may have fractures; radiographic evidence of pulmonary trauma, including patchy, alveolar infiltrates, pneumothorax, and rib fractures; ventricular arrhythmias on electrocardiography; and/or hypoxemia on arterial blood gas analysis.

**Chronic Decrease in COP**
• **PLN:** Loss of abdominal detail on abdominal radiographs if ascites is present; pleural effusion or interstitial pattern on thoracic radiographs; peritoneal fluid, decrease in kidney size, and loss of normal corticomedullary definition of the kidney on abdominal ultrasound; glomerulonephritis or amyloidosis on kidney histopathology; possible systemic hypertension.
• **PLE:** Abdominal radiography may be normal; thoracic radiography may reveal pleural effusion or an interstitial pattern; abdominal ultrasonography may show thickened appearance of intestinal walls as well as a loss of normal layering and enlarged mesenteric lymph nodes; endoscopy may show granular appearance to duodenal mucosa or pinpoint white areas if lymphangiectasia is present; intestinal histopathology will likely determine the cause of the PLE (e.g., lymphoplasmacytic enteritis, lymphangiectasia, lymphosarcoma).
• **Hepatic failure:** Abdominal radiography may reveal microhepatia; abdominal ultrasonography may show parenchymal changes in the liver or acquired portosystemic shunts; histopathology of the liver may show cirrhosis, fibrosis, or the like.

**Summary of Diagnostic Criteria**

**Acute Drop in Vascular Volume**
• Evidence of poor peripheral perfusion or shock.
• Central nervous system or pulmonary trauma.
• Evidence of shock in trauma patients with neurologic signs or difficulty breathing.

**Chronic Decrease in COP**
• Hypoproteinemia (total solids <3.5 g/dl) or hypoalbuminemia (albumin <1.5 g/dl).
• Evidence of third spacing of fluid (i.e., peripheral edema, ascites, pleural effusion, and pulmonary edema).

**Diagnostic Differentials**

**Acute Drop in Vascular Volume**
Hypovolemic, distributive, cardiogenic, or septic shock: Ruled out based on diagnostic testing including (but not limited to) complete blood count, chemistry panel, urinalysis, coagulation profile, blood cultures, abdominal and thoracic radiography, abdominal ultrasonography, electrocardiography, and cardiac echocardiography. Diagnostic testing should be conducted after fluid resuscitation and initial stabilization of the patient.
Chronic Decrease in COP
Must differentiate between PLE, PLN, hepatic failure, chronic low-grade blood loss, vasculitis, and other effusive states (e.g., peritonitis, pyothorax): Ruled out based on diagnostic testing including (but not limited to) complete blood count, chemistry panel, urinalysis, urine protein:creatinine ratio, bile acids, coagulation profile, abdominal and thoracic radiography, abdominal ultrasonography, abdominocentesis/thoracocentesis, and endoscopy or exploratory laparotomy.

TREATMENT RECOMMENDATIONS

Initial Treatment
Acute Drop in Vascular Volume
• A combination of a colloid and a crystalloid can be used:
  — Dogs: 5 to 20 ml/kg of 6% hetastarch or dextran with 15 to 30 ml/kg of an isotonic replacement crystalloid (e.g., lactated Ringer’s solution, Normosol-R).
  — Cats: 5 to 15 ml/kg of 6% hetastarch with 10 to 20 ml/kg of an isotonic replacement crystalloid.
• Whole blood (5–15 ml/kg) may be needed in certain cases (e.g., ruptured hemangiosarcoma, arterial bleeding secondary to trauma). Packed erythrocytes may be used when whole blood is not available. $–$$

Chronic Decrease in COP
• A combination of a colloid and a crystalloid can be used (or a colloid alone if the animal is well hydrated):
  — Dogs: 20 ml/kg/day of 6% hetastarch.
  — Cats: 10 to 15 ml/kg/day of 6% hetastarch.
• Hypoproteinemic patients with third spacing of fluids should be considered for colloid therapy, as should hypoproteinemic patients that require anesthesia for diagnostic testing.
• Note: Many patients with a chronic decrease in COP have compensated with fluid compartment shifts and do not require colloid therapy. Additionally, many of these diseases will require medical therapy to correct the cause of the hypoproteinemia, and it is generally not feasible to continue colloid therapy during chronic medical management.
• Fresh plasma or fresh-frozen plasma can be used but is not an optimal colloid because it may take 20 ml/kg of plasma to raise the serum albumin level by 0.5 g/dl. $–$$

Alternative/Optional Treatments/Therapy
• Hemoglobin-based oxygen-carrying solutions (Oxyglobin, Biopure) can be used in dogs in increments of 5 ml/kg up to a total dose of 30 ml/kg. This product should be used with caution in cats (it is not approved for use in this species), and a total dose of 20 ml/kg in 24 hours should not be exceeded. $–$$
• Human albumin solutions are available in 5% and 25% concentrations. Anecdotal reports exist in veterinary medicine that these solutions can be used in dogs. Published doses are 10 ml/kg for the 5% solution and 2 ml/kg for the 25% solution. $–$$

Supportive Treatment
• Crystalloid fluids as indicated to maintain fluid and electrolyte balance.
• Antibiotics may be needed if a disruption of the gastrointestinal mucosal barrier has occurred or if the patient is septic.

Patient Monitoring (Table 2)
• Hydration status, electrolytes and protein levels, and COP (if possible) should be monitored to determine fluid type and amount needed to maintain patient.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Optimal</th>
<th>Minimum/Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR (bpm)</td>
<td>Dogs: 80–100</td>
<td>80/140</td>
</tr>
<tr>
<td></td>
<td>Cats: 180</td>
<td>160/220</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>30–40</td>
<td>20/60</td>
</tr>
<tr>
<td>Total protein (g/dl)</td>
<td>6–7</td>
<td>3.5/9</td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td>2.5–3.5</td>
<td>1.5/4.5</td>
</tr>
<tr>
<td>COP (mm Hg)</td>
<td>18–24</td>
<td>14/30</td>
</tr>
<tr>
<td>Urine output (ml/kg/hr)</td>
<td>1–2</td>
<td>0.5/6</td>
</tr>
<tr>
<td>Central venous pressure (cm H₂O)</td>
<td>5–10</td>
<td>0/12</td>
</tr>
<tr>
<td>Mean arterial blood pressure (mm Hg)</td>
<td>80–120</td>
<td>60/140</td>
</tr>
<tr>
<td>Venous oxygen (mm Hg)</td>
<td>40–50</td>
<td>30/60</td>
</tr>
<tr>
<td>Blood lactate (mmol/L)</td>
<td>&lt;2.5</td>
<td>3/&gt;10</td>
</tr>
</tbody>
</table>

$–$$ To avoid volume overload in trauma cases, colloids can be combined with 7% hypertonic saline at 4 to 6 ml/kg IV over 1 to 2 minutes, followed by 5 ml/kg IV boluses of colloid q10–15min up to four times. Crystalloid fluids at a rate of 5 to 15 ml/kg/hr can be added to maintain perfusion. It is optimal to maintain the systolic blood pressure at 80 to 140 mm Hg. $
continued. Animals are at risk for developing edema whenever the total protein drops below 3.5 g/dl, albumin drops below 1.5 g/dl, or COP is less than 14 mm Hg. If the underlying disease can be successfully managed, the edema and ascites may resolve in 1 to 2 weeks, but the rate of edema resolution depends on the resolution of the underlying disease process.

Treatment Contraindications
- Colloids should be used with extreme caution if at all in patients with significant cardiac disease or anuric or oliguric renal failure.
- Central venous pressure monitoring should be available.
- Cats do not tolerate volume loading to the degree that dogs do, so colloids should be used at lower doses in cats.
- Colloids should not be used in patients with signs of volume overload (central venous pressure >12 cm H₂O, radiographic evidence of cardiogenic pulmonary edema).

PROGNOSIS

**Favorable Criteria**
- Systolic blood pressure 80 to 120 mm Hg.
- Colloid oncotic pressure 18 to 24 mm Hg.
- Albumin greater than 1.5 g/dl.
- Total protein greater than 3.5 g/dl.
- Urine output at least 1 to 2 ml/kg/hr.
- Blood lactate less than 2.5 mmol/L.
- Resolution of ascites and peripheral edema.

**Unfavorable Criteria**
- Acute drop in vascular volume.
- Lack of response to initial resuscitation.

**On the News Front**
- New applications for synthetic colloids include use in combination with hypertonic saline to avoid volume overload, especially in trauma patients.
- Hemoglobin-based oxygen-carrying solutions, of which Oxyglobin is the only approved solution for dogs, provide not only oxygen-carrying capacity but also are relatively potent colloid solutions.
- Human serum albumin has been studied in dogs in experimental situations in the past, but studies are under way to determine its use in the clinical situation.
Colloid Therapy

- Nonresponsive hypotension.
- Chronic decrease in COP.
- Severe hypoalbuminemia.
- Evidence of thromboembolic disease.
- In patients with PLN: Nephrotic syndrome (hypoalbuminemia, hypercholesterolemia, proteinuria, and peripheral edema all present) or azotemia.
- In patients with PLE: Peritonitis secondary to leakage of intestinal surgery site, severe underlying disease (neoplasia, pythiosis), continued hypoproteinemia, lack of response to medical therapy, or continued severe vomiting and diarrhea.

Recommended Reading


