Practical fluid therapy and blood transfusions in camelids

Pamela G. Walker, DVM, MS, DipACVIM (LAIM)
Camelid Care Veterinary Services, 3971 Hoover Rd. 353, Grove City, OH 43123, pamwalker@hotmail.com

Abstract

Camelids require fluid therapy and blood transfusions for many reasons. Crias, just like calves, can have failure of passive transfer, diarrhea, and sepsis requiring fluid therapy and plasma transfusions. Adult camelids can require fluid therapy for many medical conditions such as gastric ulcers, diarrhea, and hepatic lipidosis to name a few. Blood transfusions are required in cases of severe parasitism either from gastrointestinal parasites or hemoparasites. With camelids, especially crias, there are certain precautions that must be addressed that will be discussed here.

Key words: camelid, fluid therapy, blood transfusion, oral fluids, IV catheter, partial parenteral nutrition

Résumé

La réhydratation et la transfusion sanguine sont nécessaires chez les camélidés pour plusieurs raisons. Les crias, comme les veaux, peuvent avoir un transfert passif insuffisant, une diarrhée ou une septicémie nécessitant la réhydratation et une transfusion de plasma. La réhydratation chez les camélidés adultes peut être nécessaire pour plusieurs raisons médicales comme un ulcère gastrique, la diarrhée et la lipidose hépatique pour n'en nommer que quelques-unes. La transfusion sanguine est requise dans les cas de parasitisme sévère causés par soit des parasites gastro-intestinaux ou soit des parasites du sang. Chez les camélidés et surtout les crias, il y a des précautions particulières à prendre qui seront discutées ici.

Introduction

Fluid therapy can be a lifesaving tool, but can also have dire consequences if done inappropriately. Both oral fluids and parenteral fluids will be discussed, along with appropriate times to use each. Due to the differences in crias and adult camelids, they will be discussed separately with blood transfusions to follow.

Fluid Therapy for Crias

Crias can require fluid therapy for several reasons; the most common being dehydration due to diarrhea from various infectious agents and neonatal sepsis. Mildly sick crias can become profoundly dehydrated in a very short period of time. Crias are very good at "hiding" they are sick, and then the owners report that the cria suddenly "crashed". Examination of camelids for dehydration can be challenging as they demonstrate only a few of the clinical signs we are used to monitoring in more traditional livestock species. Camelid crias do not demonstrate skin tent very well, especially in those crias that naturally have wrinkles when they are born. Enophthalmos does occur with dehydrated crias, and can probably be assessed in calves. The degree of oral mucus membrane moisture can be evaluated, but can be hard to interpret as normal crias can frequently be found with dry oral mucus membranes. Capillary refill time is consistently prolonged in dehydrated crias. One advantage we have when called to examine camelid crias is that owners frequently have a series of weights for comparison to help determine degree of dehydration. Another challenge encountered with crias is that glucose, electrolyte, and acid-base status are not predictable by mere clinical signs, so before any treatment is started it is highly recommended to perform laboratory evaluation. At a minimum, glucose concentration should be determined and if possible, PCV/TP, sodium and chloride concentrations along with a blood gas analysis if available.[a] Crias with hyperglycemia present with the same clinical signs as crias with hypoglycemia (non-responsive, seizuring); hand-held glucometers can be used to quickly determine glucose concentration.

Oral fluids are best reserved for crias < 8% dehydrated, not severely depressed, and can still stand. Most of these crias will still be nursing, but not aggressively and frequently display "fake" nursing behavior where they exhibit normal nursing posture, but are not actually latching onto the teat. It is best to use commercially available products such as **Pedialyte®**[b] for human infants and not use homemade mixtures. Pedialyte® has dextrose as its energy source. If using calf electrolytes, several factors need to be taken into consideration when choosing which product to use. It is best to avoid using the high glucose-containing solutions in most situations as this can cause osmotic diarrhea if the cria's diarrhea is due to maldigestion/malabsorption. Also, due to the tendency to develop hypernatremia, high sodium-containing solutions should not be used. Bicarbonate-containing oral solutions should also be avoided as they will neutralize third-compartment pH, predisposing to bacterial overgrowth and preventing milk from clotting, both of which will exacerbate the diarrhea. Crias should always be allowed to nurse their dam and be fed milk if on a bottle. Small amounts of milk are trophic to the gut and will aid in healing. Crias do not readily

develop academia; however, if metabolic acidosis is documented (pH < 7.20) then intravenous bicarbonate is indicated rather than oral (see below). Although it is preferred for crias to nurse the oral electrolytes from a bottle, it is a rare cria that will take fluids from a bottle if the cria has only ever nursed its dam (but the bottle should always be tried first!). If the cria does readily nurse water or electrolytes, then most likely the cria has hypernatremia. Tube feeding can be done safely if it is not done excessively. Using an 18 French red rubber feeding tube (without a speculum), most crias do not resent the procedure. Some crias will regurgitate around the tube, so a moderate to slow rate of oral fluid administration is best. Most 20 lb (9 kg) crias can tolerate 4 to 6 ounces given in 1 feeding, and this can be repeated in 4 hours. If oral fluids can not fully correct the dehydration and the cria continues to lose weight over the next 24 hours, then intravenous fluids should be started.

Intravenous fluids should be used in crias that are > 8% dehydrated, recumbent, severely depressed, or suspected to be septic. As with crias needing oral fluids, it is best to have baseline laboratory data before determining which fluids to choose. In most situations, a balanced isotonic electrolyte solution (acetate containing) such as Normosol®[c] or Plasmalyte®[d] is the best to use. As it is hard to determine if a cria is hypo or hyperglycemic without bloodwork, solutions with higher concentrations of dextrose should be avoided until blood glucose concentration can be determined. Start with 1 to 2% dextrose added (for each 1% dextrose needed, add 20 mL/L 50% dextrose). The glucose concentration of the cria should be monitored while on IV fluids to detect which direction the glucose is going. If high glucose-containing solutions are needed, slow weaning from glucose is required to avoid hyperglycemia or rebound hypoglycemia. Crias are prone to hypernatremia (and occasionally hyperchloremia) with or without diarrhea, so the cria's sodium concentration is important to determine before the type of fluid is selected. Crias may be hypokalemic with diarrhea, so potassium chloride (KCl) at 20 mEq/L can be safely added. If it is determined the cria has metabolic acidosis (pH < 7.2), then IV bicarbonate is the best to use. If the cria develops acidemia without diarrhea (rare), correcting half of the base deficit along with rehydration usually results in restoring correct acid-base balance (re-evaluate). If the acidemia is due to diarrhea, correction of ¾ to the entire base deficit may be needed, then re-evaluate the acid-base status.

- Calculate amount of bicarbonate needed:
  Body weight (kg) X 0.5 X base deficit =
  bicarbonate deficit in **mEq**
  Example: 9 kg cria with base deficit of 10
  9 kg X 0.5 X 10 = 45 mEq HCO_3 needed
- If using 1.3% HCO_3[e] (0.156 mEq/mL) then 45 mEq/0.156 mEq/mL = 288 mL needed
- If using 8.4% HCO_3[f] (1 mEq/mL) then need 45 mL – this small amount can be given along with Normosol® fluids for correction of the dehydration.

Crias with severe diarrhea lose large amounts of protein in their diarrhea, further diluted with IV fluids and require a plasma transfusion (regardless of initial IgG concentration). This has a dual purpose of increasing total solids and plasma oncotic pressure, plus added IgG to help the cria fight the cause of the diarrhea. Administration of plasma needs to be done carefully, using a blood filtration set. Reactions are uncommon, but start slow for the first 15 to 30 minutes and watch for any reactions (shaking, increased respiratory rate/distress, increased rectal temperature). Then administer the remainder over 2 to 3 hours. Too-rapid administration can cause respiratory distress and possible death in crias. The recommended amount is 14 mL/lb (30 mL/kg), which is 270 mL for a 20 lb (9 kg) cria. Commercially available plasma from Triple J[g] is usually about 250 to 280 mL per unit. Some crias require a second unit of plasma during the course of fluid therapy if there was only minimal improvement in demeanor and desire to nurse.

Fluid Administration. Correction of half of the calculated deficit over 2 to 3 hours can safely be done with most crias. Due to hypoproteinemia, camelids are very sensitive to pulmonary edema from rapid rehydration when receiving IV fluids, so monitor the cria carefully for pulmonary edema. If this is a concern, then replacement of the deficit should be done more slowly over 6 to 8 hours. After the dehydration, electrolyte, and acid-base balance is restored, maintenance fluids need to continue until the diarrhea subsides. Most crias with severe diarrhea cannot or are unable to nurse enough to maintain their hydration. Maintenance needs are 2 to 4 mL/kg/hr; use a higher rate if the severity of the diarrhea results in continued weight loss despite IV fluids. If the diarrhea and weight loss continue for more than 5 days, consider partial parenteral nutrition (PPN – see below). Several challenges exist when administering IV fluids to camelids. One is that catheters can be positional depending on neck position; this cannot be controlled with standard IV drip sets. Another challenge is there is usually a cria and a dam in the stall, so depending on how active the cria is, a drip set cannot be left attached to the cria. It is important to keep the cria and dam together, so an alternative is to create a small area with straw bales to house the cria until the most critical phase of treatment is done. If the cria is unable to hold its head up, be sure to wrap the bales in sheets/towels to prevent corneal ulcers forming from abrasions. Once the cria is more stable and mobile, the best method is to calculate the maintenance needs for 3 hours and slowly "bolus" this amount over 20 to 30 minutes. It is important to warm the fluids before administration to prevent further decrease in cardiac output, but even with this precaution crias will frequently start shaking towards the end of the fluid administration. It is also important to allow the cria to continue to nurse its dam or a bottle. These recommendations are for the average cria with dehydration. If the cria does not respond (improved demeanor, diarrhea decreasing, weight increasing), then consider referring to the nearest veterinary teaching hospital.

Catheter placement can be challenging in a dehydrated cria, especially if they have wrinkles! It is essential to have all the supplies ready before the patient is even restrained. It is also very stressful on the cria; most look much worse than when you started! After the catheter is placed and a small bolus of fluids given (200 mL) put the cria back with its dam to "recover" for 30 to 60 minutes before any further diagnostics/treatments are done. Use 2-inch, 18- or 16-gauge for most crias and 2-inch, 18- to 20-gauge for preemies. Also have this size handy if things start to go bad with any size patient! Traditionally the right jugular vein is used, but if needed, the left can also be used. Restraint is very important to the success of the catheter placement. Crias, even if depressed, have what I call a "wiggle" factor that can interfere at the worst possible time. If the cria is large enough, it can be standing and a person straddling the body, keeping the shoulders still with some knee pressure and the head and neck held against the human's body. There should also be someone keeping the hips still. If the cria is small and too depressed to stand, I find it easier to have the cria at table-top height with 1 person cradling the head/neck against their body and a second person keeping the hips still. I usually only have the cria loosely restrained while preparing the site, leaving the more confining hold until the time of actual catheter placement. In crias, the jugular vein can usually be visualized after the fiber is removed. In severely dehydrated crias, the jugular vein may have to be held off for a long time before filling and visualization is possible. After proper preparation of the neck, I recommend using a 15 blade (with lidocaine bleb) to make a small longitudinal cut through the skin over the jugular vein (tent the skin over the vein to avoid lacerating the jugular vein). This eliminates skin drag on the catheter and facilitates placement of the catheter. With this method and as added security, the catheter and extension set (6 to 7 inch extension set (I prefer JOR-467Z style) need to be sutured to the neck. I also recommend using triple antibiotic ointment on 4 X 4 gauze pads over the catheter insertion site when taping everything in place. See below for On-farm Care Instructions.

Additional Therapies and Summary: On-farm Fluid Therapy: Crias

- When: severe, liquid diarrhea, sepsis, failure of passive transfer
- Weight loss > 8% (which can happen overnight!)
- Cause: Cryptosporidium, viral, and sometimes Giardia diarrhea
- What to use: Normosol® OR Plasmalyte® (acetated Ringers)
- With careful catheter placement and education of clients, fluid therapy can be done on some farms, especially if owner has some medical background
- Before fluid therapy begins, baseline blood work is helpful
- Crias rarely become acidemic like calves
- Sodium (and chloride) concentration(s) tends to increase rather than decrease
- Potassium concentration will decrease some, so can supplement fluids with 20 mEq/L KCL
- Glucose concentration can be high or low, so must measure (can use a hand-held glucometer). Clinical signs look the same for both. If need to add glucose, add only 1 to 2 % dextrose (for each 1% dextrose needed, add 20 mL/L 50% dextrose) and monitor blood glucose regularly (1 to 2 X/day).
- **Maintenance fluid requirement**
  - 2 to 4 mL/kg/hr
  - 20 lb (9 kg) cria would need approximately 900 mL/day maintenance
- **Ongoing losses**
  - 10% dehydration is another 900 mL deficit
- Most crias **cannot** tolerate that much fluid in 1 24-hour period without developing pulmonary edema.
- Most crias (except preemies) can tolerate 200 mL crystalloids, given over ~ 30 minutes, 4 to 5 times/day
- Best to have 4 or 5 fluid sessions per "day" (15 to 18 hours), depending on severity of diarrhea/dehydration
- Important for cria and dam to have "sleep" time; in most cases, can stop fluids at midnight and resume at 7 am
- Crias with diarrhea also benefit from an IV plasma transfusion (even if initial IgG is good)
- Best to give plasma after part of the dehydration is corrected
- If concerned with sepsis, give the plasma transfusion early in the treatment; may need to give another unit the next day in severe cases (continued depression)
- Give plasma ONLY with a filtration set, over 2 to 3 hours. Very small crias may need to have the plasma administration divided into 2 sessions (in 1 day)
- Additional therapy
  - Naxcel®[h] 4 mg/kg, IV, BID
  - Banamine®[i] 0.55 to 1.1 mg/kg, IV after fluid therapy is initiated (monitor renal values). SID – BID. Good to give a dose before plasma transfusion.
  - Appropriate medication for type of diarrhea
  - Kaolin[j] (5 to 10 mL) and/or Imodium®[k] (3 mL) BID – TID; adjust as needed for size
  - Active culture, plain yogurt 10 to 20 mL, BID – TID
  - Deliver®[l] electrolytes (3 to 5 oz, PO, SID via esophageal tube). I use only if the diarrhea does not slow down after 2 days and the cria is still losing significant weight. Also, only in crias < 2 months.
- **On-farm instructions**
  - Keep cria and dam in an area by themselves

- Monitor for urination: crias urinate 6 or more times per day normally
- Weigh the cria 2 times a day
- Keep wrap over the extension set (to protect the injection cap clean)
- Clean the injection cap with alcohol wipe before each use and change injection cap daily
- Change needles on all syringes/IV lines daily
- Flush with heparinized saline (5 mL of 1000 unit/mL heparin added to 250 mL saline) after each use of catheter and last thing before going to bed.
- If you feel you need to use a Hep-lock (I have never needed to), make sure you have the caretaker REMOVE the heparin and NOT to flush it into the cria!!

Fluid Therapy for Adults

Adult camelids require fluid therapy for many reasons, including electrolyte imbalances due to dehydration and diarrhea; gastric ulcers, generalized ill thrift, hepatic lipidosis, renal disease, rumen acidosis, and cardiovascular shock. Adults, like crias, are equally as good at "hiding" that they are ill and may be presented as suddenly ill. Also adults, much as crias, can be challenging to determine degree of dehydration and unlike crias, may not have a recent weight to use in comparison. The best parameter is capillary refill time (CRT), PCV, and response to treatment. Enophthalmos may also be present in adults, but may be due to severe weight loss and not strictly dehydration.

Oral fluids can be used in mildly dehydrated adults. Most depressed camelids have lost their normal thirst response and do not drink an adequate volume to rehydrate themselves. However, most adults resent placement of an orogastric tube. I find that if a speculum is not used, most adults will tolerate the tubing with minimal stress (yes, they do chew on the tube). Goat or equine oral electrolytes can be used; avoid using products with bicarbonate. Most adult alpacas (150 lb [68 kg]) can be given 2 liters; llamas ((350 lb [159 kg]) 6 liters. Be cautious giving oral fluids too many times, as this can cause stratification in the first compartment if ileus is present (common if sick)). Oral fluids cannot be used successfully for long-term fluid therapy in adults.

Intravenous fluids are used with severe dehydration from any cause, plus situations in which longer-term support may be needed even though the dehydration is not severe, such as hepatic lipidosis, endotoxic shock, and blood loss. Just like in crias, it is hard to predict the acid-base and electrolyte abnormalities in adults so baseline laboratory evaluation is important to determine before fluid therapy is initiated (i-STAT® EC8+ by Abaxis). Most of the time, adults tend to be hyperglycemic, hypernatremic, hypoproteinemic with low potassium concentration and sometimes low calcium and phosphorous concentrations. A balanced isotonic electrolyte solution (acetate-containing) such as Normosol® or Plasmalyte® is best to use in most situations, using 0.9% sodium chloride with mild acidemia or lower sodium concentration (rare). In most situations, it is safe to add KCl at 20 mEq/L and calcium borogluconate at 25 mL/L to these fluids. If acidemia is present, use the adult form of the formula: body weight (kg) X 0.3 X base deficit = bicarbonate deficit in mEq. If treating hepatic lipidosis specifically, I recommend using partial parenteral nutrition (PPN – see below). This form of PPN can be administered just like normal fluids as a constant rate infusion or with the bolus method in more active adults or dams with crias. Maintenance fluid requirement of 4 to 6 mL/kg/hr can be used with severe dehydration; however, in many adults this amount may lead to pulmonary edema, especially if hypoproteinemia is also present. For most adults (if still drinking water), start with a lesser amount of fluids (3 to 5 L/day) and see if they respond. If pulmonary edema or submandibular edema develops, 1 to 2 units of plasma may be needed until the liver recovers.

Catheter placement is similar, in general to crias. It can be more challenging due to thickness of skin, especially in males, over-conditioned female alpacas, llamas, and also if severely dehydrated. As in crias, it can be very stressful and all supplies should be ready before the animal is restrained. If necessary, the use of butorphanol[m] (0.1 mg/lb [0.05 mg/kg], IM) can be administered to help with restraint. It is better to have light sedation than to add to the stress with more aggressive restraint. The jugular vein can be seen (after fiber removed) most of the time in female alpacas and younger male alpacas and thinner llamas. In the remainder of camelids, it is common to be unable to see the jugular vein, but to be able to detect it when the vein is held off and the vein is "thrummed" with your finger from above. This will help to locate proper placement area. It is better to start high (upper third of neck) with placement as there are fewer valves present for interference. If you suspect fluid therapy will be long-term, use extended-use catheters (Polyurethane JorVet-458D) 3.5 to 5.25 inch 14 or 16 gauge or 2 inch Terumo Surflash® 14G orange or 16G gray. I still prefer 6 to 7 inch extension set (JOR-467Z style) in adults. As in crias, after proper preparation of the neck I recommend using a 15 blade (with lidocaine bleb, 10 blade in llamas) to make a small longitudinal cut through the skin over the jugular vein (tent/bend the skin over the vein to avoid lacerating the jugular vein). This eliminates skin drag on the catheter and facilitates placement of the catheter. With this method and as added security, the catheter and extension set need to be sutured to the neck. I also recommend using triple antibiotic ointment on 4 X 4 gauze pads over the catheter insertion site when taping everything in place. See On-farm Care Instructions.

Additional Therapies and Summary: On-farm Fluid Therapy: Adults

- When (not all-inclusive list!)
  - Gastric ulcers/generalized ill thrift

- Hepatic lipidosis
- Renal disease
- Diarrhea

- What to use: Normosol® or Plasmalyte®
- Do baseline blood work before IV fluids started
- If concerned with renal failure, attempt to get urine sample to measure: specific gravity, protein (amyloidosis), ketones and glucose
- Current weight if possible
- **Maintenance fluid requirement**
  - 4 to 6 mL/kg/hr
  - 150 lb (68 kg) adult would need 6.5 L
  - This amount may lead to pulmonary edema in some adults. Especially as most adults with generalized ill thrift also have low albumin and total protein.
  - Most adults respond to 3 to 5 liters, divided into 3 to 4 fluid sessions per day
- Depending on how low the protein status, may need to give 1 or more units of plasma to avoid or to treat hypoproteinemia (pulmonary, ventral, submandibular edema)
- To help with protein synthesis, Aminosyn® 10%[n] with electrolytes can be added to the Normosol® fluid bag – see PPN recipe below
- **Partial Parenteral Nutrition Recipe[o]**
  - Normosol® 5 liters
  - Aminosyn® 8.5% (or 10% product) 1000 mL/5 liter (200 mL per 1 liter)
  - Dextrose 1 to 2% (may not need every time)
  - Vitamin B complex®[p] 20 mL in 5 liters
  - KCL 20 mEq/L if blood work indicates
  - It will all fit in the bag!!
- Additional therapy
  - Naxcel® 4 mg/kg, IV, BID
  - Banamine® 0.55 to 1.1 mg/kg, IV after fluid therapy is initiated (monitor renal values). SID – BID
  - Protonix®[q] 0.5 to 1 mg/kg, IV or SC, q 24 hrs **(best option)**
  - Butorphanol (low dose), if anorexic from abdominal pain of ulcers. Will have to titrate dose to avoid sedation effects. Will only last a short time, redose as needed.
  - Offer small portions of a variety of feeds and hay
  - Change water daily – warm if winter
  - If not eating at all, make a slurry out of alfalfa pellets, regular pelleted supplement and yogurt (can add in Vitamin E powder, etc). Blend well until it can be administered by syringe. (ask Dr. Walker for complete instructions)
  - If possible ulcers, food is an important treatment!
- Monitor PCV/TP: 2 to 3 times/week (or more)
- Reassess hepatic function at least weekly (or more)
- Closely monitor appetite, attitude, and weight (if possible)
  - Monitor for urination; adults urinate 3 or more times per day
  - Success is measured in increased appetite, appropriate weight gain, improved hepatic function
  - On-farm instructions the same as for crias
  - In addition, make sure a recent fecal has been done (with the correct method!)
  - If a small pasture is available and the patient is up to it, let them out for a short time each day to graze and enjoy the sun/outside.

Blood transfusion is often needed to treat anemia or as a source of protein. Mild to moderate anemia is relatively common and can usually be attributed to gastrointestinal parasites, haemoparasites, gastric ulcers or anemia of chronic disease (some of the common causes). Camelids are very resilient and do not readily show signs of moderate anemia. This means that by the time a problem is revealed, the animal is in severe hypovolemic shock and close to death. It is important to train your clients to routinely monitor mucous membrane color to detect changes so PCV can be measured before serious debilitation occurs. With most camelids the PCV needs to be below 8 to 10% (or 5% in some) before they are weak enough to be "down". Most camelids will need to have a blood transfusion with a PCV of < 10%; however, on the farm PCVs can rarely be immediately determined. When examination reveals an animal (usually "down") with very pale pink (FAMACHA 5) or white mucous membranes, there is no time to send blood away to determine PCV. These animals need blood immediately in order to have a chance of surviving. Treatment is centered on stabilizing the circulation and replacing a portion of blood. During the lag time between catheter placement and acquiring blood from an appropriate donor, crystalloid IV fluids should be given for shock plus prednisolone (1 to 2 mg/kg, IV – will have to be compounded). Prednisolone can be used in pregnant females as it does not cross the placenta. Donors should be unrelated, negative for *Mycoplasma haemolamae* (ideally if known), current on vaccinations and ideally have a PCV of 30% or higher. As a general rule, you can take 1% body weight every 2 to 4 weeks so a 200 lb (90 kg) animal can donate 1 liter of blood. I routinely take 1 liter from adult males and larger female alpacas. Cross matching is not necessary for a first-time transfusion and frequently there is no time. The amount of blood given can be a factor of available donors. Most adult alpacas will respond to 1 liter with only a small percentage needing additional units. When using blood collection bags,[r] it is best to place a catheter in the donor so needle movement will not be a factor in success of acquiring the blood. Refrigerate any blood not used the same day of collection.

Administering the blood should be done slow (1 drop/3 seconds) for the first 15 minutes. Heart rate and temperature should be monitored for signs of anaphylaxis. The remainder of blood should be given over 1 to 2 hours per 500 mL. The second unit of blood can be administered the next day – or

the same day if there is minimal response to the first unit of blood. Crystalloid fluids can be given at the same time as the blood and will help with rehydration and organ perfusion. Use of a blood filtration IV set to remove small clots is mandatory for administration. After the blood is administered, use of half-maintenance crystalloid IV fluids for a few days is important to help with organ perfusion and to prevent organ failure. Due to increased oxygenation, most patients will perk up during the first unit of blood and start to show interest in eating and possibly standing. Blood transfusions will help stabilize a critical patient, but the transfused RBCs will be eliminated over time; so once the animal is stable, attempt to determine the source of the anemia and treat appropriately.

If plasma is not available or cost-prohibitive, whole blood is an inexpensive source of protein and can be used as an adjunctive treatment of hypoproteinemia seen in conditions such as gastrointestinal parasites, gastric ulcers, and hepatic lipidosis. Specifically, for treatment of abdominal effusion or submandibular edema sometimes seen secondarily to the primary disease process.

Treatment of Anemia

Some animals, even with PCV as low as 9%, can be pretty bright and still able to stand. If economics preclude a blood transfusion and the animal is still able to stand, an attempt can be made to medically treat anemic animals. Caution the owners that medical management may fail, and it may be too late for blood transfusions to work at that time.

Iron Dextran[s] can be used in conjunction with Vitamin B12.[t] Iron is very irritating and will cause lameness if given IM, so only inject SC. To make the injection less irritating, the iron can be diluted using equal parts sterile saline. Iron can cross the placenta, so unless the life of the dam is at risk, iron should not be used in pregnant camelids. Iron is not readily eliminated from the body, so overdosing can be toxic. Oral iron supplementation alone is not effective in the treatment of iron deficiency anemia in ruminants. On occasion anaphylactic reaction can occur. No research has been done on the correct dose in camelids. The dose listed was obtained from a published article about treatment of iron-deficient llamas.[1] Also, this dose has been used clinically without apparent problems. Keep in mind that depending on the source of the anemia, the iron may be retained in the body and reincorporated into the new red blood cells. For example, with *Mycoplasma haemolamae*, the iron will be recirculated after the RBCs are destroyed. In that instance, additional iron will not be needed or even desired. The dose is 300 mg (alpaca adult), 500 mg (llama adult) SC, every 3 days for 3 treatments

Vitamin B12 helps the body absorb iron. Concentrations vary with different products. As with many medications in camelids, there is no labeled dose; however, it has been used clinically for many years in camelids with no apparent problems. At the end of the treatment, recheck the packed cell volume (PCV) to confirm improvement of anemia. The dose is 3,000 mcg (alpaca adult), 5,000 (llama adult), SC, daily for 7 days, then three times a week for 3 weeks

Acknowledgement

The author declares no conflict of interest.

Endnotes

[a] i-STAT® EC8+, Abaxis, 3240 Whipple Road, Union City, CA
[b] Pedilyte®, Abbott Laboratories, 100 Abbott Park Road, Abbott Park, Illinois
[c] Normosol®, Pfizer Inc. 235 East 42nd Street New York, NY
[d] Plasmalyte®, Baxter, One Baxter Parkway, Deerfield, IL
[e] Sodium Bicarbonate 1.3%, Nova-Tech, Grand Island, NE
[f] Sodium Bicarbonate 8.4%, Nova-Tech, Grand Island, NE
[g] Triple J Farms, 777 Jorgensen Place, Bellingham, WA
[h] Naxcel®, Zoetis, 10 Sylvan Way, Parsippany, NJ
[i] Banamine®, Merck, 2000 Galloping Hill Road, Kenilworth, NJ
[j] Kaolin Pectin 4®, VetOne, 3041 West Pasadena Drive, Boise, ID
[k] Imodium®, Johnson & Johnson, One Johnson & Johnson Plaza, New Brunswick, NJ
[l] Deliver®, Agri-Labs, 915 Cardinal Ct, Auburn, IN
[m] Butorphanol-Dolorex®, Merck, 2000 Galloping Hill Road, Kenilworth, NJ
[n] Aminosyn 10%®, Hospira, 275 North Field Drive, Lake Forest, IL
[o] Dr. Chris Cebra, College of Veterinary Medicine, OSU, Corvallis, OR
[p] Vitamin B Complex, Agri-Labs, 915 Cardinal Ct, Auburn, IN
[q] Protonix®, Pfizer Inc. 235 East 42nd Street, New York, NY
[r] Blood bag prefilled with CPDA, Jorgenson, 1450 Van Buren Ave, Loveland, CO
[s] Iron Dextran, Duravet, 100 S.E. Magellan Drive, Blue Springs, MO
[t] Vitamin B12, VetOne, 3041 West Pasadena Drive, Boise, ID

Reference

1. Morin DE, Gary FB, Weiser MG, Johnson LW. Hematologic Features of Iron Deficiency Anemia in Llamas. Veterinary Pathology 1992; 29:400-404.