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Fluid Therapy: General Practical Recommendations For Camelids

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The camelid industry is relatively new and ever-evolving, as is our knowledge about these animals. Camelids differ from ruminants in several ways and in many situations they must be treated differently. Llama and alpaca caseloads tend to rise from year to year, both in the Western College of Veterinary Medicine hospital and in other referral practices, and it is essential that veterinarians keep up with the latest information available in this developing medical field. Further, since recommendations given today may not be valid in the near future, veterinarians must remain open to considering new ideas.[1] This issue of *Large Animal Veterinary Rounds* reviews general fluid therapy principles and indicates some practical recommendations for camelids. The concepts discussed are based on current literature, research, the available reference material, and the personal experience of well-respected camelid veterinarians around the world.

The primary aim of fluid therapy is to increase cardiac output by increasing cardiac preload and, therefore, increasing oxygen delivery to the tissues. By means of fluid therapy, it is also possible to change blood pH, electrolyte concentrations, and acid-base balance. Fluid therapy is indicated for animals with dehydration, for replacement of fluid and electrolyte losses, for increasing colloid osmotic pressure, and for treating the failure of passive transfer, among others.[2-5]

Formulating a fluid therapy plan: Three basic decisions

When developing a fluid therapy plan, there are 3 basic decisions to be made and, therefore, 3 basic questions to be answered.[4,5] These are:

- How much fluid does the animal need?
- What type of fluid should be given?
- Which route of administration should be used?

How much fluid does the patient need?

To develop a fluid therapy plan, the following factors are essential in calculating the total fluid requirement per day: fluid deficits, maintenance needs, and concomitant fluid losses.

Fluid deficits

Fluid deficits are calculated based on the degree of dehydration and the total body weight (BW) of the patient. The degree of dehydration is expressed in percentage of body weight and is estimated based on clinical assessment (physical examination) and laboratory parameters.[2-5] Camelids are very well adapted to cope with dehydration and the estimation of fluid deficits is not as easy as compared with other species.[6]

Physical examination is very important, not only for estimating clinical dehydration, but also for identifying the underlying disease process. The total body water content is about 60% of BW in adults and 80% of BW in neonates. It is distributed in two main body fluid compartments: the intracellular and extracellular compartments. The fluid of the intracellular and the extracellular compartments differs in composition (eg, electrolytes, proteins, etc). The total volume and composition of body fluids are maintained relatively constant in most physiological conditions as required for homeostasis. Two-thirds of the total body water content (40% of BW) is intracellular fluid (ICF) and one-third (20% of BW) is extracellular fluid (ECF). One-fourth of ECF is plasma (5% of BW) and three-fourths of ECF (Figure 1) is interstitial fluid (eg, fluid surrounding cells, connective tissue, bones, cerebrospinal fluid [CSF], gastrointestinal content, etc.).[7,8] Fluid can be lost from either one or both fluid compartments and the clinician can determine which fluid

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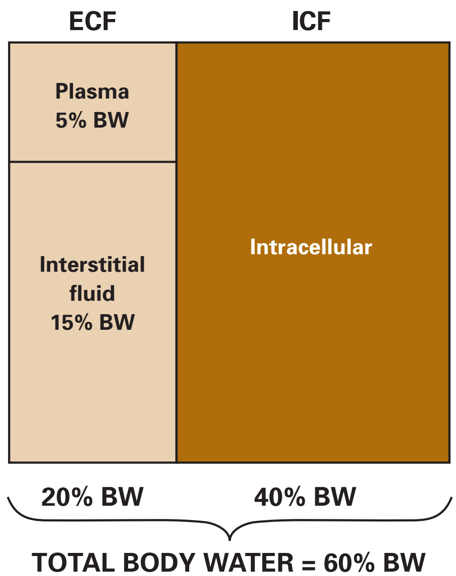
Figure 1: Distribution of body fluids in adult animals expressed as percentage of body weight (% BW). Water is the main component of all body fluids which are distributed into different compartments.



compartment is affected by means of a physical examination and laboratory data.

In large animal species, hydration status is commonly assessed by clinical parameters, such as heart rate, skin tent, colour and moisture of mucous membranes, capillary refill time, and urine output.[2] Camelids have special characteristics that make the clinical estimation of dehydration somewhat problematic. Camelids have firm skin that does not tent readily, which makes skin tent evaluation difficult. Frequency of urination can help the clinician determine hydration status; however, camelids have low urine production and output in comparison with other species. They can voluntarily stop drinking and this is a common scenario in hospitalized camelids. As a rule, less than 3 urinations per day may indicate dehydration. Mucous membrane moisture is probably one of the best ways to clinically assess hydration status in camelids. Slightly tacky mucous membranes is interpreted to be approximately 5% dehydration, tacky mucous membranes is interpreted as about 8% dehydration, and dry mucous membranes indicates ≥10% dehydration. The clinician should always estimate the percentage of dehydration based on as many clinical parameters as possible and not base the estimate on only one clinical sign, such as the moisture of mucous membranes (Table 1).[3,6]

Packed-cell volume (PCV) and total protein (TP) are commonly used to assess hydration status. In a dehydrated animal, both PCV and TP are expected to increase due to a decrease in plasma volume. Sick camelids tend to develop anemia and hypoproteinemia, making the use of PCV and TP unreliable for assessing hydration.

Azotemia, an increase in creatinine and/or blood urea nitrogen (BUN) concentrations, may indicate dehydration (prerenal azotemia). Other causes of azotemia, such as renal disease (renal azotemia) and urinary tract obstruction or urine leakage (postrenal azotemia), should be ruled out.

Blood lactate concentration can increase in cases of poor peripheral circulation due to dehydration. An increase in blood lactate concentration will lead to a high anion gap and metabolic acidosis. These abnormalities are rarely found in camelids.[2,3,6]

Once the percentage of dehydration is estimated from the physical examination and laboratory data, the fluid deficits are calculated using the following formula:

FLUID DEFICITS (L) = % Dehydration × BW (kg)

Example: An 80 kg alpaca with 5% dehydration:
Fluid deficit = 5% × 80 kg = 4 L

Daily maintenance needs

Ongoing normal water loss in resting adults is about 50-60 mL/kg of BW per day. These normal losses account for water lost through the urinary and gastrointestinal tract (sensible losses) and during respiration and sweating (insensible losses). The total amount of body water in neonates is higher than in adults, averaging about 80% of BW. The fluid maintenance needs in neonates can be up to 100 mL/kg of BW per day.

There is scant information regarding daily fluid maintenance needs in camelids. Camelids, in general, do not cope very well with the administration of large amounts of fluids given in short periods of time. They tend to develop hypoproteinemia that causes a decrease in colloid osmotic pressure and, subsequently, edema. The formation of pulmonary edema can impair gas exchange within the alveoli, and cause respiratory distress and death. Generally, it can be achieved by providing 5% of BW in fluids per day, such that maintenance fluid needs are replenished and the risks of developing hypoproteinemia and edema are low.[6,7]

Concomitant fluid losses

Pathologic or abnormal water losses occur in patients with severe diarrhea, polyuria, or third-space sequestration of fluids.[7] These losses must be taken into account and combined when calculating the total amount of fluids to be given in 24 hours. It is difficult to estimate how much water is lost during such pathologic conditions and, when dealing with camelids, the clinician should be cautious in calculating concomitant fluid losses in order to prevent overhydration and edema formation.[6]

Rate of fluid administration

A rate of administration (expressed in mL/hr) can be established by determining the total amount of fluids to be given in 24 hours (the sum of fluid deficits plus maintenance requirements plus concomitant losses) and then dividing by 24 (hours). In other large animal species, for adults, the fluid deficit is generally replaced over 2-3 hours; in neonates, one-half of the total deficit is administered in the first 6 hours and the rest over 12-24 hours.[2] In camelids, it is safer to eliminate the fluid deficit over 24 hours to reduce the risk of overhydration, unless there is a specific indication or need to replace the fluids over a shorter period of time.[6]

What type of fluid should be given?

The patient requirements

Individual patient requirements and the specific electrolytes or substances that must be replaced determine the type of fluids to be given. Therefore, the clinician must know whether there is any serum electrolyte (eg, sodium, potassium, chloride, bicarbonate, calcium, magnesium, and phosphorus) imbalance, acid-base disorder, or glucose abnormality that requires correction. These

Table 1: Clinical signs to estimate fluid deficit.				
Dehydration	**Mucous membranes**	**Capillary refill time (seconds)**	**Heart rate (Beats per minute)**	**Other clinical signs**
5% (mild)	Normal – mildly tacky	<2 (normal)	Normal (60-90)	Mildly depressed
8%-10% (moderate)	Tacky	2-3	>110	Depressed, sunken eyes
12% (severe)	Dry	>5	>130	Moribund, severely sunken eyes, cold extremities

abnormalities are best assessed by serum biochemistry or blood gas analysis, and in some situations they may also be suspected by considering the history and underlying disease.

In camelids, hypernatremia and hyperchloremia are reported to be more common than their opposites. Normal values of sodium and chloride serum concentration in camelids are higher than those in normal cattle. Hypokalemia is also reported to be a common finding.[3,6]

Acid-base abnormalities are not as frequent in camelids as they are in other ruminants, probably because they do not share the same pathologic conditions or because such pathologic conditions are not as common in camelids. For example, neonatal diarrhea is not as common in crias as it is in calves. Metabolic acidosis is frequently seen in cases of poor peripheral circulation and dehydration. In these cases, an increase in blood lactate is usually seen. Acidosis is also common in cases of sepsis, terminal lipidosis, and long-standing intestinal obstruction. Metabolic alkalosis along with hypochloremia suggests a diagnosis of cranial gastrointestinal obstruction.

Hyperglycemia is usually the most marked abnormal finding in sick camelids, but it seldom has a correlation to a specific disease. Hypoglycemia is rare, except in neonates or animals with advanced liver disease.[6,9]

Fluid choices

Once an electrolyte imbalance or an acid-base abnormality has been diagnosed, in order to correct it in the individual patient, the type of fluid that best suits the patient's needs should be chosen. There are two main types of intravenous (IV) fluids: crystalloids and colloids. Crystalloids are usually used to replace fluid deficits, for daily maintenance requirements, and to replace electrolytes or dextrose, whereas colloids are mainly used in situations in which it is necessary to increase plasma oncotic pressure or to provide immunoglobulins and acute phase proteins (eg, plasma transfusion).[10,11] In most clinical scenarios, a well-balanced polyionic solution (crystalloid) is the best option to replace fluid deficits and to provide daily maintenance requirements.

Crystalloids are solutions containing solutes (electrolytes and nonelectrolytes) that have access to all body compartments. Examples of crystalloids are dextrose 5%, 0.9% sodium chloride, 0.45% sodium chloride, lactated Ringer's solution, Plasma-lyte™, etc. There are three types of crystalloid solutions:

- *Hypotonic*: 5% dextrose in water, etc.
- *Isotonic*: 0.9% sodium chloride solution, Ringer's solution, Plasma-lyte™, Normosol™, etc.
- *Hypertonic:* 7.5% sodium chloride solution.

Crystalloid solutions are freely permeable to cell membranes; therefore, after a short period of equilibration (about 30 minutes), only about 20% of the infused solution will remain within the intravascular space. Some crystalloids may also alter the blood pH and the acid-base balance by means of changing the strong ion difference (SID) or because of the alkalinizing agents (eg, lactate, acetate, gluconate) contained in some crystalloid solutions (Table 2).[12]

Colloids contain large molecular weight substances that remain in the intravascular space and do not access other body compartments. Dextran, hetastarch, and plasma are examples of colloid solutions.[5]

Plasma is commonly used to treat failure of passive transfer and/or sepsis in crias and also to provide albumin in hypoalbuminemic patients who have a reduction in intravascular colloid osmotic pressure (COP). Under normal conditions, 75% of the normal plasma COP is exerted by albumin.[2,6,9,13]

Sick camelids tend to mobilize fat and develop lipemia; in this situation, administration of partial parenteral nutrition is recommended. Some clinicians also give insulin during the course of partial parenteral nutrition treatment.[6,14-17]

Which route of administration should be used?

Fluids can be given via IV, oral, subcutaneous, intraperitoneal, or intraosseus routes. The most common and practical routes of fluid administration in camelids are oral and IV.

Oral fluid administration

The oral route is the most physiologic and should be used whenever possible. Patients receiving fluids by other routes should also have drinking water available, unless there is a specific reason for not giving oral fluids (eg, gastric reflux or ileus). In crias, the amount of ingested drinking water or milk should be taken into account and added when calculating the total volume of fluids the patient is receiving per day.

In camelids, oral fluids can be administered by orogastric intubation. The nasal passage of camelids is narrow, so it is preferable to pass the orogastric tube through the mouth using a mouth speculum. A segment of garden hose (20-25 cm in length) or other type of semirigid plastic tube can be used as a

Table 2: Selected crystalloid solutions and a summary of their main electrolyte composition compared to plasma.

Fluid	Na^+ (mEq/L)	K^+ (mEq/L)	Cl^- (mEq/L)	Ca^{2+} (mEq/L)
Plasma	150	4	110	5
Normosol®	140	5	98	5
Lactated Ringer's (LRS)	130	4	109	3
Ringer's	147	4	156	5
Saline (0.9% NaCl)	154	0	154	0

mouth speculum to help guide the orogastric tube into the esophagus and to avoid damaging the tube with the sharp cheek teeth. Alternatively, a block of wood with a hole drilled through the centre can also be used as a mouth speculum. The block is introduced in the interdental space and the tube is then fed through the hole located in the centre of the block.

The orogastric tube can be either passed all the way down the esophagus into C1 (the first of 3 parts in the camelid digestive system), or kept within the esophagus, if it is desired to bypass the deposition of fluids into C1. Palpating the tube adjacent to the cervical trachea, hearing bubbles upon abdominal auscultation when blowing on the end of the tube, or checking for bubbles when the end of the tube is placed in a container of water confirms that the tube is in the esophagus/C1 and not in the respiratory tract.[3,6]

Restraint can be accomplished by sedation (to reduce stress and to facilitate intubation) or just by holding the head and neck with a halter (in the case of small alpacas and neonates). Many drugs can be used alone or in combination for sedation, tranquilization, or immobilization. Xylazine, an alpha-2 agonist, can be used for sedation, however, it is associated with undesirable side effects such as decreased heart rate and cardiac output, decreased thermoregulation, hyperglycemia, and respiratory depression. Butorphanol in combination with xylazine is a good choice when sedation is needed. It is a centrally acting narcotic agonist-antagonist analgesic and can be given intramuscularly, IV, or subcutaneously in a dose range from 0.02–0.1 mg/kg.[3]

Up to 3.5% of total BW in fluids can be administered at one time by orogastric intubation. Giving more fluid volume can increase the risk of regurgitation. It is recommended to intubate camelids no more than three times per day.[6]

When the goal is to replace fluids and salts by orogastric administration, an oral electrolyte solution with either the same or similar plasma osmolality is the best choice. There are several oral electrolyte solutions made for calves and pigs, but no specific solution designed for camelids is available in the market. These oral electrolyte solutions usually contain less sodium and chloride (about 120 mEq/L) and more potassium (about 10 mEq/L) than plasma. Some oral electrolyte solutions for calves and pigs also contain sugar (about 20 g/L and 70 g/L for the "high energy" [HE] solutions). In these solutions, the sugar is added only to increase the absorption of the electrolytes and not as a source of energy. The amount of energy provided by those electrolyte/sugar solutions lasts for a very short period of time. Crias do not handle sugar very well. Once the renal threshold is reached, the sugar is excreted in the urine along with water and some of the HE solutions may induce further dehydration; as a result, it is recommended to avoid these types of electrolyte/sugar solutions even at regular strength.[17,18]

The type and amount of electrolytes to be replaced should be assessed by a serum biochemistry panel and/or blood gas analysis for a careful and appropriate choice of fluid type to administer orally or by any other route.[2,6,9]

IV fluid administration

The IV route is the route of choice for very sick animals or for those who have suffered acute fluid loss. The IV route is also used when accurate administration of fluid volume and rate is needed; this is usually achieved by running the fluids through an infusion fluid pump in a hospital setting. All crystalloids, colloids, plasma, whole blood, hypotonic fluids (eg, 0.45% sodium chloride, 2.5% dextrose in water) or hypertonic solutions (eg, 7% sodium chloride) and viscous solutions (eg, lipid solutions) are suitable for IV infusion.[2,4-6]

The jugular vein is most commonly used for IV catheterization. In camelids, jugular catheterization can be done either high in the neck near the ramus of the mandible or low in the neck near the thoracic inlet. The position and shape of the omohyoideus muscle differs in camelids compared with cattle and horses. In the latter species, the omohyoideus muscle forms the deep border of the jugular furrow through most of the cervical region. In camelids, the jugular vein near the ramus of the mandible is more superficial and lies superficial to the omohyoideus muscle, which separates the vein from the carotid artery for only a short distance. Unfortunately, the downside of the high-neck approach is that the skin is very thick at this location and visual observation of the vein is extremely difficult in adults.

The jugular vein continues down to the thoracic inlet going deep to the sternomandibularis muscle. At the level of the sixth cervical vertebrae, the prominent transverse processes are easily palpated and can be used as a landmark for the low-neck venipuncture approach. At this level, the jugular vein runs approximately halfway between the trachea and the transverse processes of the cervical vertebrae and can be easily distended and observed. The disadvantage of the low-neck venipuncture approach lies in a higher risk of puncturing the carotid artery. One of the advantages of this approach, however, is that the skin at this level is thinner than at the high-neck location.

Valves within the jugular vein prevent backflow of blood to the head and can interfere with catheterization in both the high-neck and low-neck locations. These valves can be bicuspid or tricuspid and are distributed along the jugular vein from the head to the thoracic inlet.[3]

Catheters should always be placed aseptically. Once the landmarks for venipuncture are determined and the jugular vein location is identified, a small area of fibre is clipped and surgically scrubbed prior to placing the catheter. A small bleb of local anesthetic is injected and the skin is tented away from the jugular vein. A full-thickness stab incision is made using a #15 surgical blade. The catheter is then inserted and secured by sutures to the skin. Catheter sites should always be clean and dry. This can be achieved by placing a 10 cm × 10 cm sterile gauze over the outer catheter and bandaging the neck completely around without applying too much pressure (Figure 2). When IV catheters are not being used they should be flushed with heparinized saline (0.9% sodium chloride solution with 5 U heparin/mL added) every 6 hours to prevent clotting.[3,6]

Figure 2: **Intravenous catheter in a cria. The catheter site should be kept clean and the vein underneath the bandage should be examined once or twice daily for evidence of edema or inflammation.**

Monitoring efficacy of fluid therapy

A fluid therapy approach should be planned through addressing the needs of the patient. The disease process in an animal is a dynamic event, and the selection of the amount and type of fluids to be given may vary depending on the underlying problem and the response to therapy. The most important part of a successful fluid therapy plan is to continuously check the patient response and adjust the therapy plan as needed.[2,4,5]

There are several ways of monitoring the efficacy of the fluid therapy:

- ***Physical examination*** is one of the most important tools for monitoring efficacy of fluid therapy and for assessing changes in the animal's condition. It should be conducted several times per day, especially during the first hours of therapy, to prevent overhydration, document rehydration, detect concurrent fluid losses, and assess the patient's overall condition.
- ***BW changes*** can be useful in assessing hydration status in neonatal crias. It is a good practice to measure and record BW once a day.
- ***Serum biochemistry panel and/or blood gas analysis*** should be repeated to determine if the electrolyte or acid-base abnormalities previously found are resolving or have already resolved. In patients initially presenting normal electrolyte values, continued electrolyte determinations are advisable, to detect possible variations due to volume expansion and changes in the underlying disease process.[2,4,5]
- ***Frequency of urination/urinalysis*** can provide further information about hydration. In camelids, <3 urinations per day can be interpreted as a sign of dehydration.[4-6]

Complications of IV fluid therapy

Failure to correct dehydration

Failure to resolve dehydration may occur because of incorrect initial estimations of fluid deficits, larger than expected concomitant fluids losses, or new concomitant fluid losses developed after the fluid therapy plan was made and subsequently missed during serial physical examinations. It may also occur due to catheter positional flow issues or other mechanical problems related to the IV fluid set. The problem should be identified and corrected.

Phlebitis and thrombophlebitis

Phlebitis and thrombophlebitis are common complications in hospitalized animals receiving IV fluid therapy; therefore, frequent evaluation of the catheter site is recommended. Since the site of catheterization is usually wrapped and not visible, it is easy to miss the presence of phlebitis or thrombophlebitis. Checking the catheter site and placement at least once a day is recommended. This should be done during routine physical examinations. Thrombophlebitis can be recognized by the presence of swelling, heat, edema, or exudate around the catheter. Sometimes a thrombus can be suspected upon palpation, if the catheterized vein feels firm and stiff. When thrombophlebitis is suspected, the catheter should be aseptically removed and submitted for bacteriological examination to rule out an infectious process. Further diagnostics (eg, ultrasonography) can be pursued to assess the extent of the lesion and the patency of the vein.

Fluid extravasation

Fluid extravasation can occur when the catheter is displaced and the infused fluids infiltrate the surrounding tissues. A sudden increase in size of the area around the catheter and the presence of subcutaneous edema indicate the possibility of fluid extravasation.

Overhydration

Overhydration is more common in camelids than in cattle or horses. Camelids receiving IV fluids tend to develop hypoproteinemia and subsequent pulmonary edema. It is important to be cautious in estimating fluid deficits and in setting the rate of fluid administration. Using IV infusion pumps guarantees an accurate delivery of fluid volume according to patient needs and decreases the risk of overhydration.[2,4-6]

Discontinuing fluid therapy

Fluid therapy can be discontinued when the patient is well hydrated and is drinking enough water and eating enough feed to maintain a normal hydration status. Ideally, the rate of fluid administration should be gradually reduced over a period of 12-24 hours.[2,4,5]

Summary

There are three questions to be addressed when formulating and implementing fluid therapy: ***How much fluid is needed; What type of fluid; Which route of administration?*** Physical examination findings and laboratory parameters are key determinants for answering these questions. The volume of fluid administration is calculated based on an assessment of dehydration, maintenance volume needs, and concomitant fluid losses. Special characteristics of camelids make the estimation of hydration status a more complicated task than in other large animal species. Information taken from history, physical examination, and blood work provides clues as to the nature and amount of fluid lost from the body. Calculation of the rate of fluid administration should be performed carefully to prevent volume overload, hypoproteinemia, and edema. The route of fluid administration depends on the type and degree of fluid and electrolyte derangement, its onset, and the composition of fluids to be given. The IV route is the option of choice when a precise delivery of fluid volume is needed.

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References

1. Brown K. *Small Ruminant Didactic Camelid Medicine & Surgery.* Madison, WI: University of Wisconsin School of Veterinary Medicine; 1998.
2. Corley K. In: Smith BP. *Large Animal Internal Medicine.* 3rd ed. St. Louis, MO: Mosby, Inc.; 2002:682-692.
3. Fowler ME. *Medicine and Surgery of South American Camelids. Llama, Alpaca, Vicuña, Guanaco.* 2nd ed. Ames, IO: Iowa State Press; 1998.
4. Autran de Morais H, Chew DJ, Kohn CW, DiBartola S. Disorders of fluid balance, fluid therapy and transfusion therapy. In: Fenner WR. *Quick Reference to Veterinary Medicine.* 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2000:253-276.
5. DiBartola S. Introduction to fluid therapy. In: DiBartola S. *Fluid Therapy in Small Animal Practice*. 2nd ed. Philadelphia, PA: WB Saunders Co.; 2000: 265-306.
6. Cebra CK. Practical fluid therapy. *Proceedings of The North American Veterinary Conference*, Orlando, FL; January 7, 2006:273-275.
7. Guyton AC, Hall JE. *Textbook of Medical Physiology.* 11th ed. Philadelphia, PA: Elsevier Saunders Inc.; 2006:291-306.
8. Ganong WF. *Review of Medical Physiology.* 21st ed. Columbus, OH: McGraw-Hill Companies, Inc.; 2003:1-8.
9. Cebra CK. Camelid blood test interpretations. *Proceedings of The North American Veterinary Conference*. Orlando, FL; January 7, 2006:268-271.
10. Wernery U. Camelid immunoglobulins and their importance for the newborn; A review. *J Vet Med B Infect Dis Vet Public Health*. 2001;48:561-568.
11. Weaver DM, Tyler JW, Scott MA, Wallace LM, Marion RS, Holle JM. Passive transfer of colostral immunoglobulin G in neonatal llamas and alpacas. *Am J Vet Res.* 2000;61:738-741.
12. Constable PD. Clinical assessment of acid-base status: Comparison of the Henderson-Hasselbalch and strong ion approaches. *Vet Clin Pathol*. 2000;29(4): 115-128.
13. Marx G. Fluid therapy in sepsis with capillary leakage. *Eur J Anaesthesiol*. 2003; 20:429-442.
14. Tornquist SJ, Van Saun RJ, Smith BB, Cebra CK, Snyder SP. Hepatic lipidosis in llamas and alpacas: 31 cases (1991-1997). *J Am Vet Med Assoc*. 1999; 214:1368-1372.
15. Van Saun RJ, Callihan BR, Tornquist SJ. Nutritional support for treatment of hepatic lipidosis in a llama. *J Am Vet Med Assoc*. 2000;217:1531-1535.
16. Hovda LR, McGuirk SM, Lunn DP. Total parenteral nutrition in a neonatal llama. *J Am Vet Assoc*. 1990;196:319-322.
17. Rainger JE, Dart AJ. Enteral fluid therapy in large animals. *Aust Vet J.* 2006;84: 447-451.
18. Constable PD, Thomas E, Boisrame B. Comparison of two oral electrolyte solutions for the treatment of dehydrated calves with experimentally-induced diarrhoea. *Vet J.* 2001;162:129-140.

Abstract of interest

Forestomach acidosis in six New World camelids

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Forestomach acidosis was diagnosed in 2 llamas and 4 alpacas. All were young, group-housed, sexually intact males. Clinical signs included forestomach atony, lethargy, ataxia, diarrhea, and tachycardia. Forestomach distention was observed in only 1 llama. Clinicopathologic abnormalities included low forestomach fluid pH, hyperchloremia, hypokalemia, and metabolic acidosis. Although camelids differ from domestic ruminants in typical management practices and behavioral, anatomic, and physiologic characteristics, they are, nonetheless, susceptible to forestomach acidosis. Gastric fluid analysis was essential for an accurate diagnosis. Four of 6 camelids recovered after PO and IV treatment with alkalinizing agents and fluids, antibiotics, and thiamine.

J Am Vet Med Assoc. 1996;208(6):901-904.

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Dr. Marqués has stated that he has no disclosures to announce in association with the contents of this issue.

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