

Neonatal Care and Neonatal Emergencies in Camelids

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Abstract

Neonatal care and neonatal emergencies are among the most common complaints in camelid practice. The present paper summarizes literature and the authors' experience relative to the care of the normal camelid neonate, with special emphasis on normal behavior and passive transfer of immunity. The main emergencies in South American camelids (SAC) and camels are discussed. The discussion includes congenital abnormalities, infectious and non-infectious diseases of the first week of life, and their medical management.

Résumé

Les soins néonataux et les urgences néonatales sont parmi les plaintes les plus communément rapportées en pratique des camélidés. Cet article fait le point à partir de la littérature et de la propre expérience de l'auteur sur les soins des camélidés nouveau-nés normaux et met l'accent sur le comportement normal et le transfert passif de l'immunité. Les principales situations d'urgence chez les camélidés sud-américains et les chameaux sont présentées. La discussion traite des anomalies congénitales, des maladies infectieuses et non-infectieuses durant la première semaine de la vie et de leur régie médicale.

Introduction

An epidemiological study in the United Kingdom reported that 4 to 11% of the deaths among llamas and 17 to 33% of deaths in alpacas occur during the first six months of life. A high proportion of these deaths occur within the first week of life.¹⁶ In South America, cria mortality rates may reach 50%, mostly due to *Clostridium perfringens* (types A and C).²³ In camels, early neonatal loss has been reported to be as high as 90% of all births in some countries, jeopardizing herd improvement and in some cases causing decimation of these species from the pool of production animals.^{2,32,37,48,50} Neonatal care and early recognition and treatment of neonatal ailments are of the utmost importance to reduce these losses.

Care of the neonate begins during the long gestation, as the strength and viability of the newborn is greatly influenced by the health of the dam.⁵³ The normal rate and growth pattern of the fetus can be altered by numerous factors including abnormal hormonal environment, nutrition, genetics, and infectious conditions.^{9,50} These factors can cause either a chronic or an acute disruption of the development of the fetus, resulting in either a stillborn or dysmature neonate, without any obvious clinical problems. With this in mind, prenatal care of the dam with proper nutrition, vaccinations, and knowledge of any concurrent health problems is important to enhance survival of the newborn.

Early diagnosis and aggressive treatment of neonatal disease, particularly infections, results in greater positive outcomes.¹⁹ The clinical signs are often nonspecific and vague, resulting in a neonate that is slow to adapt to extrauterine life or that dies suddenly in the first few days of life. If there is an intrauterine infection, the fetus may be born alive or may die in utero. Intrauterine infections of bacterial origin in the newborn camelid are recognized more commonly than viral infections. Infections acquired in utero rather than postpartum should be suspected if the newborn had elevated plasma fibrinogen in the first 12 to 24 hours of life, the placenta appears abnormal, or the dam exhibits vaginal discharge peripartum.^{1,19}

The newborn is subjected to severe stresses and some degree of oxygen deprivation during parturition, even with an optimal uterine environment, and it undergoes a tremendous transition during the postnatal period. During parturition it is possible that the neonate may suffer from a damaging degree of asphyxia secondary to hypoxemia or ischemia. Several mechanisms help the neonate to adapt to extrauterine life. The first is an increase in fetal cortisol concentration that triggers parturition and allows adequate levels of surfactant to be produced by the type II alveolar pneumocytes. In addition to elevated cortisol concentration, there is a catecholamine surge. A negative side effect of this physiological feature is that it may allow potential problems to be masked and the newborn to appear normal immediately postpartum, even though it may have substantial physiologic impairment.⁴⁹

The present paper reviews neonatal care of the newborn camelid as well as emergencies that may occur early in life.

Care of the Normal Newborn Camelid

The newborn cria should be evaluated within the first few hours of life to detect any abnormalities of development or maladjustment to extrauterine life. Physical and behavioral parameters of the normal newborn camelid are presented in Table 1. Assessment of the newborn cria includes evaluation of the epidermal membrane, respiration, heart function, and presence of obvious congenital abnormalities. The epidermal membrane should be removed with clean towels. It is normally translucent and may become yellow or brownish due to meconium staining in cases of fetal stress (fetal diarrhea) due to dystocia.

The cria should be weighed immediately after birth in order to monitor daily weight gain accurately. Regular weighing of the cria (daily for the first two weeks and every other week thereafter) is warranted to determine adequacy of milk production and intake.⁵⁷ Clients should be instructed to keep the placenta refrigerated for examination. The placenta should be weighed and examined thoroughly for completeness and signs of inflammation or infection.

Disinfection of the umbilical cord is the primary line of defense against infection. If the birth is observed or occurs in a clean birthing area, the umbilicus should be trimmed and dipped in 2 to 3% tincture of iodine. If the birth did not occur in a clean area, it is advisable to clean the umbilicus with dilute (0.5%) chlorhexidine solution or soapy water, and dip or spray the umbilicus with regular strength betadine solution.

After the initial evaluation, the newborn should be observed from a distance. The mother-cria bond is established through humming, nose-to-nose touching, and nuzzling the cria. If the newborn does not get up and nursing by three hours after birth, then a problem should be suspected and intervention is needed.

Evaluation of Passive Transfer of Immunity

The epitheliochorial microcotyledonary placenta of camelids does not allow passage of immunoglobulins from the dam to the fetus. Therefore, newborn camelids are born agammaglobulinemic and rely on passive transfer of immunity through colostrum intake.⁵⁸

Increased incidence of illness and death from infections in neonates is associated with inadequate passive transfer of immunoglobulin, as measured by low serum immunoglobulin concentrations in sick or dead neonates.⁵⁶ Conversely, successful immunoglobulin transfer is associated with low infection rates and the high likelihood of survival. Even though this is true, there are great differences among farms for immunoglobulin concentrations of healthy neonates. The effect of between-farm variations could involve factors such as management practices, including biosecurity measures, nutrition, vaccination, pathogen load, herd bloodlines, geographic location and climate, which would enable a neonate with failure of passive transfer to remain healthy.

There is a relative paucity of research in the area of colostrogenesis in camelids. However, data indicate that camelids do not selectively transfer immunoglobulin (specifically IgG1) from serum to the mammary gland prior to parturition.⁸ Periparturient camelids may produce and store IgG in the mammary gland in a gradual

Table 1. Biological parameters of normal healthy newborn camelids.

Parameter	Alpacas (<i>Vicugna pacos</i>)	Llama (<i>Llama glama</i>)	Camels (<i>Camelus dromedarius</i> and <i>C. bactrianus</i>)
Birth weight (kg)	7 to 11	9-15.5	30 to 50
Temperature (°C)	37.7 to 38.9		37.5-39
Pulse (bpm)	60 to 100		80-120
Respiration (bpm)	10 to 30		20-30
Time to standing (minutes)	30 (10 to 120)		30 (15-80)
Time to nursing (minutes)	45 (20 to 180)		30 (20-120)
Nursing frequency	Several sessions per hour lasting 1 to 3 minutes		
Meconium passage (hours)*	<18 hours		
Urination (hours)	<18 hours		
Daily gain kg (first 3 months of life)**	0.2 to 0.4 (alpaca), 0.4 to 0.8		0.5 to 1

*Meconium passage should occur about eight hours after a normal feeding.

**Most neonates will register a slight drop in weight in the first 24 hours.

manner near term. The concentration of IgG drops quickly in mammary secretion after parturition.^{8,20}

Colostrum production and quality depend on the normal preparation of the mammary gland to concentrate antibodies during pregnancy and its ability to lactate after birth. The quality of colostrum depends on several factors, including immune status of the dam and udder health. In many situations either colostrum production or quality may be compromised, putting the newborn camelid at risk of contracting infections in the first weeks of life.^{5,20,32,56} The lack of correlation between IgG concentration in colostrum and IgG in serum of camel calves suggests that intake and/or absorption are important factors in failure of passive transfer.³²

Absorption of colostrum antibodies is present for only a short period of time, and decreases significantly after 18 hours of life. Recommendations for colostrum intake in camelids are extrapolated from other species. Neonates should receive good quality colostrum at a rate of about 10% of their body weight in the first 12 hours, with preferably half given in the first six hours. However, many factors can negatively affect the absorption of immunoglobulin, such as cold weather or heat stress, lack of mothering, delivery by cesarean section, and metabolic disturbances.

Agalactia or poor mammary gland development is frequently seen in young females or following dystocia. In these situations, a strategy for colostrum supplementation should be immediately instituted. The best approach is to provide colostrum from the same species. If this is not possible, the second best choice is goat colostrum.⁴¹ Bovine, caprine and equine colostrum have all been used as a replacement in camels.^{3,46} However, the concentration of IgG in camel colostrum is higher than in that of horses and cattle.³² Beef cattle colostrum is preferred by the authors for supplementation of camel neonates. It is important that the source of colostrum be free from major infectious diseases (i.e. bovine viral diarrhoea virus [BVDV], Johne's disease and brucellosis).

Establishment of a colostrum bank is a possibility in camels and llamas. However, it is important to realize that the IgG concentration drops abruptly after the first two milkings.²⁰ If colostrum is collected from healthy dams and stored properly (i.e. frozen at -4.0°F [-20°C]), it should be usable for at least one year. Frozen colostrum should be thawed out slowly and brought up to body temperature before administration. Rapid thawing at high temperature or in a high-power microwave may denature the antibodies. Thawing is best accomplished by placing small quantities of colostrum-containing bags in a water bath.

As a general rule, colostrum administration should be started in cases of agalactia, mastitis, or if the newborn had not been seen suckling by 2 hours after birth. The best way to administer colostrum is

by bottle-feeding. In case of poor suckling reflex, colostrum may be administered via orogastric intubation (24-French catheter for SAC, foal nasogastric tube for camels). Care should be taken not to place the tube in the respiratory tract (trachea). The tube should be felt by palpation as it goes down the left side of the neck. It should be kept within the esophagus to provide closure of the esophageal groove and avoid depositing milk within the first stomach compartment, increasing the risks of fermentation.

The IgG status of the newborn is the most important risk factor for neonatal infectious diseases. Most insurance companies require determination of the passive immunity status for crias. Therefore, determination of IgG levels in the blood 18 to 24 hours after birth using a single radial immunodiffusion (SRID) has become a standard practice for newborn SAC. This technique is quantitative and specific.^{38,53-55} Since the SRID is species-specific it will not be accurate, if colostrum other than that of camelids was used. If these tests are not available, total protein (field technique) or serum globulin concentration may be used (Table 2).^{6,46,53} If passive transfer has been adequate, serum total protein and globulin should be at least 5.5 g/dl and 2 g/dl, respectively. However, it is important to remember that these parameters can be falsely increased in case of dehydration.

Prophylactic Treatments of the Newborn

The most common infections of newborn camelids in the first few days of life are clostridial diseases due principally to *Clostridium perfringens* type C and D and *Clostridium tetani*, *Escherichia coli* and coronavirus. Clostridiosis due to *C. perfringens* type A has been reported to cause severe losses among some populations of crias.^{13,21,43} Protection of the cria against these infections is provided by adequate colostrum ingestion and absorption from a vaccinated dam. Pregnant alpacas should be vaccinated and boosted four to six weeks before parturition. Administration of clostridial antitoxin should be considered if the cria did not have adequate passive transfer. Vaccination of crias in their first week of life is also proposed by some authors. Autologous vaccines may help reduce the effects of *C. perfringens* type A. In camels, vaccination of dams against *E. coli* may provide some protection if a farm is experiencing increased incidence of neonatal diarrhoea (Tibary and Anouassi, personal observations).

Recently, several alpaca breeders have been using bovine modified live vaccines against coronavirus given orally in the first 24 hours of life. This strategy has been reported effective in controlling coronavirus outbreaks, probably because of the close genetic relationship between the strains isolated from alpacas and those from

Table 2. Complete blood count and serum biochemistry in dromedary neonates before and after colostrum intake (n=35).

Parameter	Before colostrum intake	24 hours after colostrum intake
WBC ($10^9/l$)	13.9 ± 0.3	12.7 ± 0.3
RBC ($10^{12}/l$)	14.0 ± 0.1	14.2 ± 0.2
Hgb (g/dl)	45.1 ± 0.0	45.5 ± 0.2
PCV (%)	31.1 ± 0.3	31.1 ± 0.3
MCV (fl)	30.8 ± 0.7	27.7 ± 0.8
MCH (pg)	9.9 ± 0.2	8.9 ± 0.2
MCHC (g/dl)	26.1 ± 1.1	21.9 ± 1.1
Total protein (g/dl)	4.4 ± 0.1	5.2 ± 0.2
Albumin (g/dl)	3.03 ± 0.1	2.63 ± 0.0
Globulin (g/dl)	1.4 ± 0.0	2.6 ± 0.2
SGOT/AST (U/l)	55.4 ± 5.2	95.7 ± 20.5
LDH- L (U/l)	368 ± 31	664 ± 104
CPK (U/l)	307.2 ± 57.2	154.1 ± 26.8
BUN (mg/dl)	25.7 ± 1.2	18.3 ± 0.9
Creatinine (mg/dl)	3.7 ± 0.9	1.8 ± .1
Iron (mg/dl)	206.4 ± 16.7	75.7 ± 14.1
SGPT / ALT (U/l)	5.8 ± 0.7	12.7 ± 3.5
Gamma GT (U/l)	12.4 ± 1.2	67.4 ± 13.1
Alkaline phosphatase (U/l)	3324 ± 436	3381 ± 579
Calcium (mg/dl)	11.2 ± 0.3	9.7 ± 0.5

cattle.³⁰ The use of these vaccines in pregnant camelids to enhance colostral protection has not been fully investigated in SAC, and has been associated with abortion outbreaks. Use of the cattle vaccines in the dromedary has been successful both in the dam and the newborn (Anouassi and Tibary, personal observations).

Crias should receive vitamins A, D, and E, as well as selenium, in areas where it is needed. Crias not given vitamin D supplement have reduced growth rate during winter and may show clinical signs of rickets if born in winter.⁵² A dose of 1,000 IU vitamin D3/kg (1,000 IU/6.6 lb) body weight subcutaneously has been suggested for crias in late autumn and again in midwinter, and to adult females in midwinter to prevent vitamin D inadequacy.³¹

It has become a standard practice in North America to test all newborn SAC for BVDV (PCR-test) for early identification of persistently-infected (PI) animals.^{10,27,50}

Emergency Problems in the First 24 Hours of Life

Diseases seen in the first 24 hours of life are often associated with dystocia, abnormal pregnancy, failure of passive transfer, congenital abnormalities, digestive (meconium retention) or urinary (urine retention) problems, exposure or malnutrition.

Failure of passive transfer (FPT)

Failure of passive transfer is a major cause of neonatal mortality in camelids.^{24,32,38,54,55} In cases of FPT, hyperimmune warm (98.6°F; 37°C) plasma should be given IV or intraperitoneally at a dose of 15 to 25 mL/kg. A rate of 100 to 200 mL/hr has been suggested for IV administration in crias. However, faster rates have been anecdotally reported by practitioners. The intraperitoneal route is preferred in alpacas because of ease of administration and less complications. Serum may be administered IP in the right or left lower ventral abdomen or paralumbar fossa. A 16 or 18-gauge, 3-inch catheter is placed aseptically at a shallow angle to avoid puncturing or lacerating the gastrointestinal tract. The cria should be kept warm during the administration. Administration of plasma is not without risk, and the cria should be observed for any signs of shock. Pain associated with intraperitoneal injection of plasma may be managed by administration of a low dose of the nonsteroidal anti-inflammatory flunixin meglumine. If the cria is determined to be at high risk for developing infection, prophylactic broad-spectrum antibiotics such as ceftiofur sodium should be administered.

Congenital abnormalities

Congenital abnormalities seem to occur more frequently in SAC than in camels.^{7,36,46} The most common lethal congenital abnormalities that affect the camelid

neonates are: choanal atresia, atresia ani or coli, atresia vulvi and heart defects. Most commonly, affected animals will suffer from severe respiratory, circulatory or metabolic complications.⁵³ Heart defects (i.e. ventricular septal defect (VSD) or Tetralogy of Fallot) can be very severe and lead to death of the cria within a few hours, but most will survive for a few days to months with the only abnormality being failure to grow normally. Episodes of syncope after exercise have been observed by the authors in crias with severe heart defects.

Choanal atresia is suspected if the newborn is observed mouth breathing. Diagnosis can be confirmed by mouth-to-nose artificial breathing or by contrast radiographs, or computed tomography of the head after injection of a radiopaque substance in the nasal cavity to evidence the presence at the level of the choanae of a membranous or osseous separation between the nasal and pharyngeal cavities.^{22,25,40} Maxillofacial agenesis or dysgenesis ("wry face") may be associated with choanal atresia. Surgical correction of choanal atresia has been attempted, but most breeders elect euthanasia in bilateral cases. Respiratory distress associated with congenital goiter has been described in camels.⁴⁶

Atresia ani and atresia coli result in the blockage of intestinal transit and accumulation of fluid in the gastrointestinal tract. The neonate which may have normal activity and appearance in the first few hours becomes progressively bloated and depressed after nursing. Ultrasonographic and radiologic examination of the abdominal cavity allows confirmation of the diagnosis. Atresia coli may be mistaken for meconium retention. In the female, these abnormalities may involve the genital tract. Surgical correction of atresia ani has been described.¹¹

Congenital blindness associated with different ocular defects has also been reported, and will impact neonate behavior and wellness.^{15,26,44}

Angular limb deformities are very common in camelids. Less-severe cases will improve with time. Severe cases (>10°) require surgical correction.^{12,34} Polydactyly (extra number of toes) has been described in alpacas and is presumed to be due to an autosomal dominant gene.

It is important that the practitioner establish the diagnosis of congenital abnormalities with certainty, because some of these have a hereditary component.

Meconium retention

Meconium passage is usually noticed within 18 to 24 hours after birth. In normal active neonates, meconium passage will start usually within six hours after the first nursing. There is great variation of color and consistency of meconium in camelids. It may be pasty or stringy, tan to dark-tarry in color. Clinical signs of meconium retention include straining, squatting and tail-wagging. These signs progress to anorexia and signs

of abdominal discomfort. Initial treatment consists of one or two warm, soapy water enemas (20 to 40 mL). If after two enemas the meconium has not passed, intravenous fluids may be indicated. Multiple soapy water enemas may irritate the rectal mucosa, resulting in severe straining and rectal prolapse.⁴¹ In camels, the authors have used various preparations including magnesium sulfate with glycerin (50/50), human phosphate and acetylcysteine-containing preparations. The later are particularly helpful when the meconium is very dry and sticky. Neonates that have retained meconium may have other abnormalities and should be examined closely. Routine administration of enemas to every newborn cria should be discouraged.

Urine retention

Urine retention may be associated with congenital abnormalities of the urinary and genital tracts.³⁵ In males, urethral blockage (aplasia) results in bladder rupture. In females, vulvar agenesis or atresia vulvi present with an obvious bulging of the perineal area and are often painful due to the large quantity of urine in the uterus and abdominal distension.^{42,45} Unilateral and bilateral renal agenesis have been described in SAC.²⁸

Umbilical abnormalities

Accidents to the umbilicus are not uncommon. The simplest form is persistent bleeding, which can be treated with hemostasis provided by a hemostat or sutures. Persistent urachus is not as common as in other species. Umbilical hernias are relatively common, but most will resolve spontaneously or with belt (vet-wrap) management if less than 2.6 inches (3 cm). Umbilical hernias that persist or continue to increase in size require surgical repair. Umbilical herniation and rupture of the abdominal wall with evisceration have been seen by the author following dystocia due to a term uterine torsion, and may be due to twisting of the cord around the fetus. These are easily replaced surgically.

Exposure

Hypothermia and depression due to exposure or starvation are probably the most common acquired problems of the newborn camelid in the first 24 hours of life. These problems are often associated with crowding, primiparous females (poor mothering ability), agalactia or congenital abnormalities preventing the neonate from standing and nursing normally. They can be easily prevented by closely monitoring near-term alpacas, and providing a clean, warm environment for birthing. Resuscitation of the compromised cria requires providing a warm environment, and dealing with the failure of passive transfer, and dehydration. Hypothermia and depression may also be seen in crias with severe blood loss from the umbilicus or rupture.

Management of the High-Risk Neonate

Factors for high-risk neonates include prematurity, dystocia, prolonged obstetrical manipulations, delivery by cesarean section, placentitis, premature placental separation and prolonged pregnancy.

Since exact breeding dates are not always known, it is important to recognize the signs of prematurity in crias to prevent additional complications. Any cria delivered before day 315 of pregnancy should be considered premature. Premature births may be a consequence of an illness during pregnancy or due to a decision to induce parturition because of severe compromise to the dam. Recently, the authors have seen a high rate of premature births following an outbreak of respiratory diseases. Premature birth may also be a consequence to uterine pathology (i.e. placentitis or placental insufficiency).⁹ Premature camelids display specific phenotypic characteristics. These include a birth weight significantly (more than 20%) lower than the average for the farm (Table 3) and a thick epidermal membrane firmly attached to the foot pads and the mucocutaneous junctions. A “floppy” syndrome is often seen in premature camelids and includes inability to rise, to hold the head up or to maintain sternal recumbency and floppy ears (New World camelids) due to immaturity of the cartilage. The coat appears silky and the limbs are overextended at the carpus and fetlock due to laxity of the tendons and poor muscle tone. The incisors are not erupted and there is a lack of, or poor, suckling reflex.

Premature neonates adapt to extrauterine life very slowly. Due to the normal elevated fetal cortisol levels, they may appear healthy initially but become compromised a few hours later due to developing metabolic problems. These problems are often due to hypoxemia, acidosis, hypoglycemia and limited body reserves or poor thermogenic ability. Premature neonates are exposed to a wide range of respiratory and intestinal compromise due to immaturity of these systems. Respiratory distress may be evidenced by labored or even open-mouth breathing. This syndrome is likely due to lack of surfactants required for normal air sac expansions and inefficient oxygen absorption. Mortality rate is very high in these crias if they are not attended to immediately.^{45,47}

Table 3. Variation of birth weight in normal alpaca crias from a US herd.

	N	Mean (Kg)	SD	Minimum	Maximum
Females	49	7.76	1.27	3.76	11.25
Males	64	8.12	1.04	5.26	10.61
Total	113	7.98	1.18	3.76	11.25

Intestinal immaturity in premature crias predisposes them to failure of passive transfer even if colostrum is ingested orally in the first hours of life (failure of absorption). They also tend to be more at-risk for bloating and meconium retention due to poor gut motility.

Dysmature or hypoxic neonates are often the result of induction of parturition and severe illness during pregnancy. Excessively long gestation (>370 days) has been associated with increased risk for dysmaturity and neonatal deaths in the first three days of life. These neonates usually present with similar biophysical characteristics as the premature neonates, except that they may have normal body development.

Mature compromised crias are usually the result of lengthy obstetrical manipulations or birth by cesarean section. The degree of compromise depends on several factors.

There is a paucity of evidence-based medicine in emergency critical care of newborn camelids, and most of the available information is anecdotal and based on clinical experience with other species. Premature or stressed neonates require intensive care in the first few hours of life. They should be placed immediately in a warm environment. Baseline complete blood count (CBC) and blood biochemistry are indicated to determine status of hydration and electrolytes, blood glucose level, total protein and IgG at 24-36 hours (Table 2). At-risk patients should receive an intravenous plasma transfusion. If suckling reflex is absent, tube feeding is necessary and should be restricted to small volumes every two to three hours to reach 10 to 15% of body weight by 24 hours of life.

Oxygen supplementation may be required if respiratory distress is pronounced. Lung function should be monitored by blood gas analysis. Aminophylline, an adenosine A (2A)-receptor antagonist like caffeine, has been given for three days to stimulate the central nervous system, regulate breathing, and stimulate the type II pneumocytes to produce components for surfactant production.^{18,33} Intra-operational administration of aminophylline to the dam may be advantageous if a cesarean section is planned.^{14,18} Doxapram is routinely used to stimulate the central nervous system and relieve neonatal apnea following dystocia or c-section.^{17,58} We generally administer a small dose sublingual (5 mg in llamas and alpaca crias and 50 mg in camels) initially after a c-section or dystocia. In neonates with severely depressed respiration, this dose or up to twice the dose may be needed intravenously or intramuscularly. The neonate should be monitored closely for convulsions or hyperventilation.

Sepsis is a major concern in all neonates, particularly in the first 10 days of life. Predisposing factors for sepsis are similar to those described in other species, namely prematurity, placentitis, contaminated or

crowded birthing facilities, dystocia, FPT and lack or improper care of the umbilical stump.

In one study the median age at presentation of crias with sepsis was two days. Meningitis with severe clinical signs (opisthotonus, nystagmus, stiff legs, seizures, miosis) may be seen as early as two days of life. Presence of hypopion, uveitis and conjunctivitis indicate early septicemia.^{1,51} Septic neonates may also develop respiratory problems, diarrhea, meningoencephalitis and septic arthritis.^{1,19,51} Initial signs of septicemia are weakness, depression and anorexia. Both gram-positive and gram-negative organisms have been isolated from neonates with septicemia. The most common isolates include *E. coli*, *Enterococcus spp*, *Listeria monocytogenes*, and *Citrobacter spp*. Based on common isolates, the antibiotics of choice for camelids at high risk of sepsis include the following combinations: enrofloxacin and procaine penicillin G, enrofloxacin and ceftiofur, ceftiofur and gentamicin.^{1,19,53} Gentamicin should be used with care, as it can be extremely nephrotoxic to severely dehydrated newborn camelids or if there is already evidence of renal dysfunction. Although blood culture is always recommended and should be submitted, compromised neonates should immediately be started on broad-spectrum antimicrobial therapy via intravenous catheter placed in the jugular or saphenous vein.^{1,19,53} Crias presenting with anemia should be checked for *Mycoplasma hemolamae* infection.⁴ The outcome of medical management of septic neonates is generally favorable if there is no gastrointestinal or central nervous system involvement.¹⁹

Supportive treatment should include NSAIDs (ketoprofen 1.8 mg/lb [4mg/kg]/SID) to control pain and toxemia and anti-ulcer medication (omeprazole orally at 0.9 mg/lb [2 mg/kg] daily) to offset the effect of stress and NSAID. Dehydrated sick crias may show hyperglycemia, hypernatremia and hyperosmolarity. Intravenous fluid therapy is indicated in all dehydrated, hypoglycemic newborns; however, caution should be exercised as to the rate of fluids because camelids are more prone to pulmonary edema. Fluid therapy should be delivered by intravenous catheter (jugular or saphenous vein). Intraosseous fluid therapy may also be used.

The type of fluid should be determined based on glucose, electrolyte and blood gas evaluation. Generally, a balanced isotonic solution with 2% dextrose and bicarbonate to correct metabolic acidosis are sufficient. Dextrose concentration may be increased to 5% in hypoglycemic crias. Rate of administration should aim to correct half of the deficit over the first hour and the other half over the next two hours. Total or partial parenteral nutrition should be considered in severely depressed crias that are unable to nurse.^{29,39} Prognosis for life and normal growth depends primarily on the time between birth and providing emergency care. If

the umbilical cord is swollen or painful, ultrasonographic examination should be performed to determine if surgical resection is needed. Chronic infection may develop if this condition is not treated adequately, leading to growth retardation.

Conclusion

Early identification of at-risk or sick camelid neonates is critical for successful medical management and increased chance for a positive outcome. Factors that represent a high risk for neonatal distress include: dystocia, prematurity, prolonged pregnancy and premature placental separation. Camelids seem to be more sensitive to hypoxia during dystocia, and are more like foals than ruminants in that sense. Failure of passive transfer is the leading cause for sepsis. It is imperative that adequate amounts of colostrum are ingested before the first 18 hours of life, and passive transfer is verified by determination of IgG. Common isolates from septic neonates can provide a basis for choice of antimicrobials in sick camelid neonates. Early treatment of septic neonates (antimicrobials, fluids and parenteral nutrition) improves their chance for survival. Congenital defects seem to be more prevalent in South American camelids, and all crias should be thoroughly examined for these. Clinicians should emphasize client education regarding care of the pregnant dam, colostrum management and the importance of neonatal examination.

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