Infectious Diseases of SACs

All four species are considered equally susceptible to the diseases mentioned. Furthermore, because SACs are closely related anatomically and physiologically to the Old-World camel, including the dromedary and Bactrian camel, we may extrapolate their infectious disease susceptibility.

Diseases Reported in the Alpaca and Llama

Enterotoxemia or Clostridial Disease.

Introduction and Cause. *Enterotoxemia* is the most important infectious disease in neonatal camelids. It is characterised by sudden death, with neonatal mortality rates as high as 50 per cent during the first month of life. The disease is also a problem for sheep enterprises.

Clostridium perfringens type A is usually involved. This bacterium mainly affects camelid neonates from one to four weeks' old. It lives in the soil and is normally found in the intestines of both humans and animals. Heavy rainfall, poor sanitation, and herd concentration encourage the spreading of the disease. *Enterotoxemia* can also be triggered by changes in normal digestive development that allow the bacteria to multiply, thus producing a potent toxin.

Diagnosis. During the camelid birth season, sudden deaths among newly-borns (*crias)* with good body conditions may indicate *enterotoxemia,* as do abdominal distention and neurological signs such as rapid convulsions and opisthotonus. Diarrhoea is usually not observed, except when sudden death is associated with viral or *E. coli infections*. During necropsy, fluid and gas accumulation, mainly in the small intestine, is commonly found. In some cases, changes in lung colour (congestion) and red spots on the external membranes of the intestines (haemorrhages in the intestinal subserosa) are also observed. Definitive diagnosis is achieved through laboratory detection of the *enterotoxin.*

Prevention and Treatment. Adequate care and management of neonates during the birth season will help prevent enterotoxemia. At present, no commercial vaccine exists, but one is being developed. Antimicrobial drugs and fluid and electrolyte replacement can be used in mixed *enterotoxemia* cases.

Alpaca Fever.

Introduction and Cause. A bacterial septicemia is caused by *Streptococcus zooepidemicus*, which rapidly becomes fatal. Often stress is the precipitating factor, with transport, shearing, and processing for any reason being the potential stress-creating conditions.

Diagnosis. Clinically, the disease is characterised by increased body temperatures (greater than 37°C), anorexia, weight loss, ascites, and relatively rapid death.

Prevention and Treatment. The disease can be prevented by minimising stressful situations; however, no absolute control measures have been found. It would appear that high-dose penicillin (10,000 U twice daily) is the therapy of choice.

Osteomyelitis of the Mandible.

Introduction and Cause. Firm swelling along the lines (*rami)* of the mandible are easily observed and palpated. Little or no pain may be associated with palpation. General signs of anorexia, fever, and depression are usually absent. Variable degrees of soft-tissue involvement are encountered, and a fistulous tract may lead from the lesion to the ventral border of the jaw.

Diagnosis. Any swelling of the mandibles should be considered suspicious. Surgical extirpation and microscopic examination of the lesions may aid in the diagnosis. Isolation and identification of the infective microorganism is necessary for definitive diagnosis.

Prevention and Treatment. No effective preventive measures have been developed. Early detection is imperative in order to facilitate a cure through drainage, as well as through sodium iodide and penicillin therapy.

Miscellaneous and Minor Bacterial Infections.

The following diseases have been reported at one time or another by veterinarians: their overall incidence is low and not of major economic importance.

Abscesses (*Corynebacterium* spp, *Actinomyces pyogenes*)
Anthrax (*Bacillus anthracis*)
Braxy or Malignant Oedema (*Clostridium septicum*)
Brucellosis (*Brucella melitensis* type 1)
Colibacillosis (*E. coli*)
Johne's Disease (*Mycobacterium paratuberculosis*)
Keratoconjunctivitis (*Staphylococcus aureus, Moraxella liquefacians*)
Necrotic Stomatitis (*Fusobacterium necrophorum*)
Listeriosis (*Listeria monocytogenes*)
Leptospirosis (*leptospira* spp)
Otitis (*Corynebacter pyogenes, S. aureus*)
Salmonellosis (*Salmonella* spp)
Tetanus (*Clostridium tetani*)
Tuberculosis (*M. tuberculosis, M. bovis, M. avium, M. microti*)

Diseases of Camels that May Affect SACs

These are listed not because of evidence of occurrence in SACs but as possible differential diagnoses, simply because of the similarities of the species. The following infectious diseases were reported to occur in the dromedary camel.

Anthrax
Brucellosis
Tuberculosis
Salmonellosis
Parteurellosis
Paratuberculosis (Johne's Disease)
Leptospirosis
Enterotoxemia types C and D

Viral Diseases
- Camel Pox
- Rabies
- Rinderpest
- Rift Valley Fever

Viral Diseases

The prevalence of viral diseases in SACs is unknown. Few clinically important viral diseases have been reported. Investigators have reported a few positive serologic test results, indicating exposure to viruses, but no evidence of clinical disease has been presented.

Whether or not lamoids are susceptible to a number of important viral diseases of other domestic or wild animals is still unknown. Perhaps lamoids have not been exposed to these viruses, or perhaps clinicians and researchers may not have conducted adequate virologic testing to discover them. For example, rinderpest has not been reported in SACs. Rinderpest does not occur in South America, but the *llama* has been experimentally tested and found susceptible to the rinderpest virus.

Current knowledge of lamoid viral diseases is rudimentary; we will describe very briefly some of the most important viral diseases that have been reported as clinical diseases or experimentally induced diseases.

Foot-and-Mouth Disease. This disease has been reported as an experimentally-induced disease in SACs, as well as in Old World Camels, and the species are relatively resistant to infection by the virus. The *llama* and *alpaca* are more likely to be involved in transmission of the virus, rather than in a severe clinical disease presentation.

Contagious Ecthyma. This has been reported as a clinical disease in the *llama* and *alpaca*. Signs and severity are similar to those seen in other small ruminants, with potential for transmission within the species. No specific treatment is recommended.

Rabies. As in all other mammals, this disease may occur when the animal is bitten by an infected animal. Signs are similar to those seen in other species. In some areas where the incidence of rabies is high, some veterinarians recommend the use of the killed vaccine in the *llama* and *alpaca*.

Herpes Virus. One herd of *alpaca* and *llama* imported into the United States from Chile was housed in an exotic animal farm where they became infected. Signs included blindness and neurologic signs, from nystagmus and head tilt to paralysis. Other clinical signs were dilated, non-responsive pupils, elevated body temperature, with permanent ocular damage. A virus indistinguishable from the equine herpes virus I was isolated from the affected animals. (If vaccines are to be used in the face of theoretical high risk, the product surely must be killed-virus vaccine and should be repeated often to attain immunity.)

Others. The following are some viral diseases with serologic evidence of formation of antibodies, but there have been no reports of natural disease.

- Blue Tongue
- Parainfluenza 3
- Bovine Respiratory Syncytial Virus
- Bovine Herpes Virus I
- Bovine Virus Diarrhoea
- Influenza A
- Rotavirus

Internal Parasites.

Gastrointestinal Nematodes. Gastrointestinal parasites are reported to cause significant disease in the *llama* and *alpaca*. Faecal examinations have recovered species-specific parasites, such as *Graphinema*, *Spiculopteragia*, *Camelostrongylus*, *Nematodirus lamae*, and *Lamanema*. In addition *Ostertagia*, *Trichostrongylus*, *Cooperia*, *Nematodirus*, *Bunostomum*, *Oesophagostumun*, *Trichuris*, *Capillaria*, and *Haemonchus* are all reported to occur in SACs, as well as cattle, sheep, goats, and some wild ruminants.

The clinical signs of gastrointestinal parasitism in lamoids are similar to those seen in infected cattle and sheep. Parasitised animals infected with the parasite do not grow or mature as quickly as non-parasitised animals. Other clinical signs in *llama* and *alpaca* with heavy gastrointestinal parasites are diarrhoea, dehydration, emaciation, and anaemia. All of these signs are more common in young animals.

Many anthelmintics, although not specifically labelled for treatment of gastrointestinal parasitism in lamoids, can be used safely. Febendazole and Invermectin provide the most effective and safest treatment, removing mature gastrointestinal parasites and acting against the inhibited stages of these parasites.

Liver Flukes. The liver fluke, *Distoma hepatica*, has been reported to occur in the *alpaca* and *llama*. If fluke infections are suspected in lamoids, it is necessary to do a specific examination of the faeces for the eggs. Although fluke eggs are passed in the faeces, they are not detected by techniques normally used to detect roundworm eggs.

If fluke infections occur in cattle and sheep or other domestic animals in an area, lamoids grazing the same pastures can become infected also. Various anthelmintic drugs can be used for the treatment of liver flukes, and clorsulon is one of them (Curatrem, Merk Sharp, and Dohme).

Lungworms. *Dictyocaulus filaria*, the lungworm of cattle and sheep, has been reported to occur in SACs also. *Distyocaulus* infections are acquired by animals grazing in pastures containing infective larvae. Mature worms living in the air passage produce larvae that are coughed up, swallowed, and passed in the faeces. Larvae recovered from fresh faeces, taken rectally from the animal, should be considered lungworm larvae. Lungworms in the *alpaca* and *llama* can be treated effectively with Fenbendazole, Levamisole, or Invermectin at the dose recommended for gastrointestinal parasites.

Protozoan Parasites. Al least six species of the protozoan parasite, *Eimeria,* are reported to occur in *llama* and *alpaca*: *Eimeria lamae*, *E. alpacae*, *E. macusaniensis*, *E. peruviana*, *E. punoensis*, and *E. ivitaenses*. All of these species are host-specific to SACs and will not infect other domestic or wild animals. It is also true that the coccidia of other domestic animals and wild ruminants are host-specific and will not infect SACs.

Most coccidia infections in lamoids are asymptomatic. In areas of heavy oocyst contamination under conditions of intensive husbandry, young animals may show signs of clinical coccidiosis. The primary clinical sign seen in young animals is diarrhoea. Fresh blood is seen only rarely in the faeces of infected *llama*, and given that the lesions are confined to the small intestine.

Coccidiosis can be prevented on most farms by good management. Clinical coccidiosis in lamoids should be treated with the sulphonamides: *sulphamerazine*, *sulphamethazine*, or *sulphaquinoxaline*.

Toxoplasmosis. Toxoplasmosis is caused by a single species, *Toxoplasma gondii*. All felids act as the definitive host and any mammal, including humans, can be the intermediate host for the organism.

Toxoplasma is an important cause of abortion in ewes and prenatal mortality in lambs. Abortions can occur at any time during gestation or, if the foetus survives in the uterus, the lamb may be born dead or alive but weak.

In the United States, at least two cases of abortion in the *llama* have been associated with rising titers of *Toxoplasma* in the female. The control of *Toxoplasma* on the farm is very difficult. Feed should be covered to prevent contamination by cat faeces (young cats especially) and insects.

Sarcocystosis. Sarcocystosis is caused by a coccidial protozoon, *Sarcocystis*, which has a predatory-prey life cycle. Three species of *Sarcocystis* have been reported: *S. tilopodi* that infects the *guanaco*; *S. aucheniae* in the *alpaca*, *llama*, and *vicuna*; and *S. lamacanis* infecting the *alpaca*.

Sarcocyst, often visible to the naked eye and containing thousands of merozoites, are found in the muscles of the heart and squeleton, and microscopic oocyst are found in the faeces of dogs and other predatory animals. The various species seem to be highly host-specific.

Diagnosis of the condition in the *alpaca* and *llama* depends upon recognition of the sarcocyst in the muscles. In dogs, cats, and humans, this depends upon finding microscopic oocysts or sporocysts in the faeces. There is no treatment for this disease.

External Parasites.

Sarcoptic and Psoroptes Mange. Sarcoptic mange or *sarna*, as it is called in the Andean Region, is caused by *Sarcoptes scabiei* var. *aucheniae* and another similar disease is produced by *Psoroptes aucheniae* and has been well-described in the literature on the four species of SAC.

The scabies' mite spends its entire life on the host, burrowing within the epidermis of the skin. The life cycle (from egg to adult) is completed in about 18 to 26 days in *Sarcoptes* and 10 to 12 days in *Psoroptes*. Under ideal conditions, the mite can survive on the host for only a few days. The presence of the mite provokes an inflammatory response that initially produces a papular dermatitis. Animals infected with *Sarcoptes* initially develop a pruritic, papular, erythematous dermatitis over the inguinal, axillary, ventral abdominal, perineal, and distal extremity areas. Affected regions gradually become alopecic, crusted, thickened, and hyperpigmented. *Psoroptic* mange is less important, with a low incidence in the *llama* and *alpaca*, and the lesions are found in the neck and ears.

Diagnosis is based on skin scraping. Scrapings should be deep, retrieving large amounts of debris. Material from the scraping may be placed on a slide and covered with 10 per cent KOH to clear the hairs and facilitate the microscopic observation of the mites and mite eggs.

Many therapies have been used for mange in lamoids. Recently the popular therapy has been Ivermectin formulate for bovine use.

Others. Many other external parasites and parasitisms have been reported in the Peruvian literature or elsewhere and they are not so important. They are given below.

- Meningeal worm, caused by *Parelaphostrongylus tenuis*.
- Tapeworms caused by *Monieza expanza*, *M. benedeni*, and *Thysanieza giardi*.

- Lice, produced by *Microthoracius proelongiceps*, *M.minor*, and *Damalinia aucheniae*.

- Ticks (*Amblyomma parvitarsum*)

- Dear nasal bot (*Cephenemia* spp.)

- Sheep botfly (*Oestrous Ovis*)

- Spinose ear tick (*Otobius megnini*)

- Hard ticks (*Ixodidae*, various spp.)

For more comprehensive and detailed information on parasites in SACs, refer to the appropriate section in the references at the end of this report.

Toxicology. Only a few instances of poisoning have been reported in SACs, yet it is likely that they are susceptible to many toxic plants and chemicals that affect other domestic and wild animals. It is beyond the scope of this report to discuss all of the agents that might cause toxicity in SACs.

Intoxication of lamoids by toxic plants in their natural habitat in the Andes is rare and less frequent than in sheep; lamoids may be resistant to the substances encountered over millennia. However, lamoids outside the Andes, removed from their native environments, are likely to ingest toxic quantities of any one species. Even though most toxic species are unpalatable and unlikely to be consumed in quantity unless extraordinary circumstances force the animal to do so (severe drought, transfer of animals to a completely new environment, and new flora). We will briefly consider a few toxicities actually documented in SACs and mention those considered highly likely according to Andean literature and literature from the USA.

Astragalus Poisoning. *Astragalous* spp. (locoweed) is characterised by progressive muscular and nervous incoordination in animals that have grazed where these plants are present and where the soil contains abnormally high levels of selenium. Plant alkaloids may cause brain lesions. There are at least six suspect species in the Peruvian highlands, but their selenium content is unknown. The disease is usually observed during the dry season (May to November).

Initially, affected animals put on weight. But, thereafter, they become progressively emaciated and show nervous signs such as staggering, impaired sight and hearing, and ultimately severe muscular incoordination. During the course of the disease, abortions may occur during any stage of pregnancy. Stillbirths and weak and/or deformed young (*cria*) are observed.

Treatment of astragalus poisoning is non-specific. As prevention lamoids should not be allowed to graze where these toxic plants grow. Affected animals may recover on fresh pastures.

Others. Other plants that are likely to be poisonous in Peru are listed below.

- *Baccharis coridifolia*
- *Claviceps purpurea*
- *Bromus catharticus*
- *Erodium cicutarium*

The only reports of plant poisoning in lamoids in the USA involve oleander, *Nerium oleander*, and various species of the family *Ericaceae*. Other plants considered likely to be toxic to lamoids are given below.

- *Triglochin maritima*
- *Veratrum californicum*
- *Zigadenus* spp.
- *Solanun* spp.
- *Datura metaloides*
- *Prunus virginiana*
- *Helenium hoopesii*
- *Ledum glandulosum*
- *Leucothoe davisiae*
- *Rhododendron occidentale*
- *Rhododendron* spp.
- *Ricinus communiis*
- *Nicotiana* spp.

As with toxic plants, most insecticides, heavy metals, pesticides, and caustic chemicals, that are toxic to a wide variety of mammals, are fully expected to be toxic to SACs. Some metabolic diseases (ketosis, hypocalcemia, and hypothyroidism) are of minor importance. The treatment of most of these conditions is based upon extrapolation from domestic ruminants.

However, some recommendations to avoid poisoning by plants are given.

1. When animals have been deprived of forage, as during transporting or corralling, they should not be put on ranges containing poisonous species until they are well fed.

2. Ample water should be provided so that animals will not be induced to eat increased amounts of forage following water deprivation and subsequent watering.

3. Animals should not be forced to remain on the range after they have used the good forage species. Otherwise, they will turn to less desirable, and often, poisonous plants.

4. The range land should not be so misused as to bring about the invasion of new species or the spread of poisonous species that already exist in amounts not dangerous to animals.

5. Preventing plant poisoning is much easier than curing it. Once poisoned, there is little chance of survival at any time and almost no chance under range conditions.

6. The people in charge of the herd should acquaint themselves with the symptoms of poisoning. At the very least, they should know the plant species in their area or region that cause problems.

Traditional Sanitary and Healing Practices

Traditional herders have a rich lore concerning sanitary curing practices to assure the well-being of their herds. This is intricately related to myth and religion and thus does not correspond necesarrily with contemporary veterinary conceptions.

Although mythological beliefs ascribe supernatural causes to many of the sicknesses of animals, herders are aware of the empirical factors to which they relate. Pasture availability and quality are perceived as critical to the flock's well-being. Poor feed will obviously affect the animals, lowering their resistance

to sicknesses as well as compromising their reproductive potential. However, due to prevailing, limiting environmental constraints and poor socioeconomic conditions, few preventive actions are taken. As a result reinfestation and recurrences are common. Lack of disinfection of corrals and night shelters aggravates this trend.

In the case of external parasites, such as scabies, burn oil (from motors or kitchen) is applied. Also SAC lard mixed with black sulphur powder obtained from volcanoes is used. Sometimes lard or soap mixed with commercial pharmaceutical products is applied. **Piojera (Microthoracius** and **Demalina)** are treated with ashes or with cinder mixed with lard. Internal parasites are confronted with either traditional herbal medicine, commercial pharmaceuticals, or a combination of both.

Sanitary actions are particularly important during the animals' pregnancy and with newly-borns during their nursing period. To stop offspring from extending lactation beyond what is considered adequate, some species of bitter plants are applied by hand to the females' udders.

Still waters are identified as the cause for widespread *Streptococcus zooepidemicus*. *Alpacas* affected by it are treated with several medicinal plants (such as lemon combined with *Escallonia mutis*) and pharmaceuticals. As with the rich plant pharmacopea used on humans in Andean medicinal traditions, healing plants used in folk veterinary medicine have received little if any attention from researchers.