

## **Infectious diseases in new world camelids**

Christopher Cebra

College of Veterinary Medicine, Oregon State University, Corvallis, OR

We have been lucky over the years that camelids in North America have had relatively few problems with contagious disease. Herd outbreaks of infections were rare. Individual infections were more commonly the result of opportunistic invasion of damaged tissues, rather than aggressive, spreadable infections. In recent years, our expanding knowledge and improvement in diagnostic methodologies have enabled us to identify a number of important infectious agents. Some of these are of very sporadic importance. Others appear to be more common. The amount of press they receive is not always directly proportional to their importance.

### **Viruses**

#### Rotavirus and coronavirus

These two viruses are recovered from crias with diarrhea. Coronavirus is common and has been associated with outbreaks of diarrhea affecting camelids of all ages. Coronavirus appears to be more contagious, and frequently affects the gastrointestinal tract. Rotavirus appears to be rare in the U.S, but is occasionally brought to a farm by one infected animal, only to spread over a couple weeks to all animals on the farm. The diarrhea is usually self-limiting, though young crias can require intensive fluid management. Diagnosis is achieved by electromicroscopy of feces. The camelid coronavirus is related to the bovine coronavirus, but it is not known whether bovine diagnostic tests detect it or whether it can cross-infect between species.

Treatment is mainly supportive. Prevention is chiefly through quarantine.

#### Bovine viral diarrhea virus

Bovine viral diarrhea virus (BVDV) has recently gained prominence in discussions of camelid herd health matters. Previously, the virus was thought to only transiently affect camelids and only cause mild signs. More recently, the syndrome of persistent infection (PI) has been detected in alpacas. Persistent infection is a well known syndrome in cattle and sheep and requires infection of a pregnant dam. If the strain of BVDV (Type Ib) is right, the dam becomes viremic, and the timing is right, the cria can be born with a lifelong viral infection. Infected crias typically grow poorly and are prone to bouts of other infections, but can also appear normal. Another important factor is that PI crias continue to shed the virus, and act as the source of infection for the next generation. The timing of infection to create the PI state is not known in camelids. In cattle it lasts most of the first 45% of pregnancy.

The original source of infection can be a bovid, a PI cria, or a person (or piece of equipment) who travels from farm to farm. Multiple genetic types have been identified in camelids, most likely due to separate cross-over events from another species, presumably a bovid. In camelids with exposure to cattle, unless the disease is eliminated from the cattle, and possibly deer, the risk will continue. In camelids without such exposure, personal hygiene and detection of PI crias are paramount.

Herd control involves several strategies. To determine if a herd has been exposed, serum antibody titers (red top tube) are determined. Vaccination of a herd, even though it might somewhat decrease (not eliminate) the chance of PI crias, ruins the usefulness of herd titers to determine exposure. By this thinking, herds without titers should be considered low risk, because they have not been, or are not currently being, exposed to the virus.

If a herd shows antibody evidence of exposure, finding the source is important. If cattle or deer can be ruled out, and a PI camelid is suspected, the polymerase chain reaction (PCR; purple top tube) is the test of choice for screening the herd. A positive PCR suggests the camelid is infected and should be isolated for retesting. A positive retest 3 weeks later suggests PI, though one cria reverted to negative after 8 weeks. Because of their risk to the herd, PI crias should not be allowed any contact with pregnant

camelids. A negative PCR, except in crias only a few months old, rules out the PI state for the life of the camelid.

The PI status can only develop in the gestating crias. Adults and crias on the ground can become infected, and may show some mild nasal, oral, or ocular discharge and irritation, but cannot become PI. Treatment for camelids with acute BVD is mainly supportive. Treatment of PI camelids may not be in the herd's best interest. Prevention is through elimination of all PI animals (ruminant or camelid) in contact with pregnant dams.

#### Viral encephalitides

West Nile virus and eastern encephalitis virus both can affect camelids. Only West Nile virus is present on the west coast, and it has not reached all areas. Both are spread from birds by mosquitoes and thus have strong seasonality. Unvaccinated camelids are at the greatest risk, especially when the disease first moves into an area, or when migrating birds arrive from various sources during mosquito season. A three-shot course of the killed virus vaccine, with a booster before mosquito season, appears to offer good protection.

The clinical signs involve neurologic dysfunction, including weakness, inability to hold the head upright, dullness, lethargy, and recumbency. Diagnosis is achieved by antibody tests. Many other species, including man, are susceptible, but camelids are not thought to produce enough virus to be considered infective to other species. Treatment is mainly supportive. Hyperimmunized plasma and specific antiviral drugs may be helpful.

#### Adenovirus

Adenovirus has been recognized for a long time, but its importance has always been questioned. Early research at Oregon State University suggested that most camelids were exposed, based on antibody titers, but evidence of clinical disease was rare. Putative lesions have been found in the gastrointestinal tract (erosions), liver (zonal hepatitis), and lung (pneumonia). These diseases appear to be uncommon, but can be severe in individual animals, especially crias. Detection is by antibody titer or isolation of the virus from diseased tissues. Adenoviruses create inclusion bodies that may be seen on microscopic examination of tissues. Currently, there are no firm recommendations for prevention.

#### Equine herpesvirus

Equine herpesvirus (EHV)1 gained some notoriety in the 1980s, but appears to be altogether rare. This herpesvirus spreads from equids to camelids and causes acute blindness, seizures, weakness, and other neurologic signs. It is usually fatal within a few days. The reported cases often had contact with zebras, not horses, and the only case the author has seen was in a llama with a confirmed immunodeficiency. Currently, there are no firm recommendations for prevention. Separation of camelids from equids, especially immunocompromised camelids and exotic equids, should decrease risk. Recent work suggests zebras have EHV9, which is not normally carried by domestic horses, but is infectious for a variety of species, but the development of camelid cases with confirmed EHV1 during the recent California outbreak also suggest that this virus is the main culprit.

#### Papillomavirus

The papillomavirus of camelids was first described in 2003. It induced single or multiple solid growths on the nose, lip, and cheeks. Masses occasionally wax and wane in size, and often regrow after excision. Although the nature of these appears similar to the equine sarcoid, and it has been suggested that the bovine papilloma virus may play a role, a unique camelid papilloma virus was identified in one case. It is not known how this spreads, but most papillomaviruses invade already damaged tissue. Animal to animal transmission is likely, but there may also be an immune component. Outbreaks are rare, suggesting that transmission is inefficient, or that the immune defect is rare. Diagnosis is by biopsy. Some may regress spontaneously, though most appear to persist until excised, and may regrow. Other treatments are not required.

### Contagious ecthyma/orf/soremouth

This parapox virus usually affects sheep and goats, and can spread from those species to camelids. Transmission does not require direct contact, because the virus is long-lived and can contaminate the environment. Thus, areas inhabited by infected sheep or goats up to a year previously could be sources. Once in a herd, orf could presumably become endemic, most severely affecting newborns each year while sparing immunocompetent adults.

The most common lesions are ulcerative and proliferative sores on the lips and nose. In other species, foot and udder lesions are also common, but those are not usually mentioned in camelids. In most animals, the lesions spontaneously regress within two months, but some, presumably immunodeficient, animals maintain infections several months longer. The disease causes discomfort on eating, which is most important in crias. Food intake or weight gain should be monitored to avoid more serious problems.

A vaccine exists for orf, but it can itself cause the disease. Its use may offer some advantage in the face of an outbreak, but it should not be used in orf-negative herds. People can get orf from infected animals or the vaccine, so wear appropriate protective gear and exercise caution.

### Rabies

Rabies is an uncommon disease on the west coast. It is worthy of mention mainly because it can spread to people and because vaccination in other species appears to afford good protection. Vaccination of camelids in rabies-prone areas is also recommended. Clinical signs of rabies can be very variable. They typically involved a behavior change, either duller or more aggressive, and some degree of swallowing dysfunction. Suspect camelids should be isolated at once and utmost caution taken to avoid contact with saliva or other body fluids.

## Bacteria

### *Mycoplasma haemolama*

*Mycoplasma haemolama* is a bacterium that parasitizes the blood. It was formerly known as *Eperythrozooa*. The parasite invades red blood cells and presumably leads to their destruction. Clinical signs can include anemia, fever, poor growth, weight loss, and lethargy. Most infected camelids show none of those signs, or very low grade anemia at worst. However, camelids with poor immune system function may show severe disease, including packed cell volumes in the low teens to upper single digits.

The mechanism of transmission is unknown. Because the parasite resides in the blood, the role of biting insects has been suggested. Additionally, it is possible that crias born to infected dams are themselves born infected. Our latest research suggests the infection is usually life-long. The numbers and clinical significance of the parasite are low when the camelid is healthy, but become more prominent when other diseases or stressors decrease immune system function. The older method of identification, examination of a blood smear, is useful for the clinical disease, but the newer PCR test is required to identify carriers. Tetracycline appears to be the most effective treatment, and may be used against the clinical disease.

### *Salmonella*

Salmonella is luckily still rare in camelids. This bacterium usually invades through the gastrointestinal tract, and can affect the gut, liver, and occasionally other organs. Clinical signs can include diarrhea, fever, lethargy, anorexia, weakness, and shock. It is becoming more common in horses and cattle, probably as those species become more intensively managed. Large farms, overcrowding, contact with other infected species, and feeding contaminated feedstuffs all increase risk. Diagnosing salmonellosis usually involves culturing the organism from infected feces or tissues. A bovine vaccine exists, but the low prevalence of infection in camelids rarely justifies its use.

## Clostridial diseases

Clostridial diseases including enterotoxemia and Type A clostridiosis are among the best known bacterial infections in camelids. In fact, in the U.S., they are not that common. Clostridial organisms are as deadly as they are because they make potent toxins. Botulism, tetanus, blackleg, and enterotoxemia are examples. Tetanus and botulism are both rare in camelids, the former potentially because of vaccination; the latter being associated on rare occasions with infected rodents milled into feeds. The muscle and liver clostridia are likewise rare, often being associated with wounds or liver flukes in other species. Enterotoxemia and Type A clostridiosis both affect the gastrointestinal tract. In South America, these are associated with the high cria mortality rate, but recent evidence suggests that they require previous gut damage to start their process. Coccidia are the most likely cause for this previous damage.

In the U.S., the intestinal clostridia occasionally affect or kill camelids. Signs are fairly short before the animal dies. Colic, low-grade diarrhea, fever, and severe lethargy may be seen. At Oregon State, *Clostridium perfringens* Type C is the usual isolate, even when Type A is suspected. Preexisting intestinal damage, again usually due to coccidiosis, is suspected in some cases. All ages are affected. In ruminants, rapid growth and high carbohydrate diets are implicated. In Oregon camelids, we have some concern about overingestion of lush spring pasture, but all in all, clostridiosis is not that common.

The disease is usually diagnosed by characteristic signs or culture. The culture must be performed antemortem or soon after death, because clostridia are found in the gut of normal camelids and rapidly proliferate postmortem.

## Alpaca fever/*Streptococcus zooepidemicus*

Alpaca fever is a sporadic but serious condition in this country. It is caused by *Streptococcus zooepidemicus*, a bacterium most commonly associated with respiratory disease in horses. Camelids may become infected by inhalation of bacteria, and also possible by ingestion or wound invasion. The bacteria enter the blood stream and infect various organs or body cavities. Sometimes the infection remains diffuse and other times it localizes into abscesses. The camelid shows signs based on the location of the infection. Common signs are fever, lethargy, weakness, decreased feed intake, increased respiratory effort, and colic. Diagnosis is made by culturing the organism from an infected site. Presumptive diagnosis can be made in camelid with compatible signs from which a pus-like fluid is recovered from the chest or abdomen. Treatment is supportive with the addition of antibiotics and anti-inflammatory drugs to decrease fever and inflammation. *S. zooepidemicus* is usually sensitive to many common antibiotics including penicillin, ceftiofur, and florfenicol.

This disease is considerable more common in South America and is associated with poor management. In North America, it is sometimes linked to exposure with horses. Many healthy horses have this bacterium in their nasal passages. Camelids usually keep their distance from horses and the risk of transmission appears to be low, but owners of both horses and camelids, or camelid owners with equine neighbors should use common sense to reduce the risk of transmission.

## Leptospirosis

*Leptospira interrogans* primarily colonizes the urogenital tract. The reservoir populations are most commonly cattle or deer, who both can become infected without necessarily becoming severely sick. Transmission can occur through direct contact with infected urine or with water contaminated by infected urine. The organism can cross into the body through most mucous membranes, and travels through the blood to the kidney or reproductive organs. It is primarily known as a cause of fetal loss or late term abortion in camelids. In rare cases it may also damage the kidneys or other organs. In the latter cases, other signs of infection, including fever, abnormal urine, lethargy, anorexia, or other systemic signs, may be present. Because the organism is hard to isolate, diagnosis is usually supported by demonstrating rising antibody titers in affected animals. Remember that in the case of fetal loss or abortion, the dam usually appears clinically normal.

### Caseous lymphadenitis

*Corynebacterium pseudotuberculosis* causes lymph node abscessation in small ruminants and occasionally camelids. In sheep, shearing is the major route of transmission and most of the abscesses are external. In goats, ingestion or inhalation are greater problems and many of the abscesses are internal. In camelids, both are possible. In the U.S. camelid population, it is rare, but it can be a serious problem in some herds, affecting multiple animals. Presumably, initial entry into the herd comes from contact with infected small ruminants, contaminated material, or contaminated shearing equipment. Pus draining from open abscesses is highly infective, and the organism can persist in the environment for some time. Antibiotics can be used to try to limit the severity of infection, but it is very hard to eradicate. Vaccines may limit severity in infected herds.

### Fungal diseases

#### *Cryptococcus*

*Cryptococcus* is associated with bird droppings and certain soil types. It is common around the Pacific Rim, particularly in the northwest U.S. and British Columbia. Spores are usually inhaled and can invade the lung or infect other organs via the blood. In Oregon, the two most common syndromes are chronic respiratory disease or neurologic diseases. The respiratory form is characterized by a rapid respiratory rate, exercise intolerance, and eventual weight loss and decreased feed intake. Death ensues within about two months. The neurologic form is marked by rapid onset of severe dullness, blindness, and lethargy. Affected animals usually die within a week.

Diagnosis can be reached by isolating the organism or potentially demonstrating antibody titers. Antifungal treatment may be attempted, but have not historically been successful. Man can get this disease. Direct transmission from animals to people is extremely rare.

#### Coccidiomycosis/valley fever

*Coccidioides immitis* spores lie dormant in dry soils and become airborne when the soil is disturbed. The organism is common in the drier areas of the southwest, though we have seen one case in Oregon. It is inhaled, and similar to *Cryptococcus*, can invade the lung or travel through the blood to remote sites. Any organ can be infected. Skin and bones are common sites. Signs are slowly progressive, and in any endemic areas, any camelid with chronic, progressive signs should be considered a suspect. Poor-doing is the most common sign, though more specific respiratory signs or thickened skin may also be seen.

Diagnosis can be reached by isolating the organism or potentially demonstrating antibody titers. Antifungal treatment may be attempted, but have not historically been successful. People can get this disease. Animals with diffuse diseases can very rarely spread it to people. Be cautious around camelids with compatible signs.

#### Dermatophytosis/ringworm

Ringworm is generally uncommon in camelids. When it occurs, it leads to fiber loss and skin crusting on the legs, perineum, and face. Winter housing may increase the risk of transmission for one camelid to another.

Diagnosis is by examining infected hairshafts under a microscope, biopsy, or dermatophyte culture. A variety of treatments exist. Most involve clipping the infected area and scrubbing it with antiseptics or specific antifungal agents.

### Vaccines

No specific camelid vaccines exist in North America. Most bovine and equine vaccines appear to be safe in camelids, but camelids often require more vaccine doses to achieve the same antibody response. Degree of protection is a total unknown.

Some vaccines make practical sense because they work well in other species and prevent horrible diseases. Examples of this are the tetanus vaccine and, in some places, rabies vaccine. The enterotoxemia vaccine (Type C&D toxoids) fits in a similar category. The muscle and liver clostridia (7-way vaccine) are rare and the vaccine is not benign. It should be used with caution in pregnant camelids.

Other vaccine usages arise as new diseases emerge. West Nile virus is an example of this. The bovine rotavirus/coronavirus may afford some protection against neonatal diarrhea. The leptosporosis vaccine may help prevent abortion. Of the myriad of vaccines available, most should only be used after determining their usefulness in your area.