

BVD Virus: A Newly Recognized Serious Health Problem

By Nancy Carr, MD and Susy Carman, DVM, Ph.D.



Pat and Helen Distrow

Bovine viral diarrhea virus (BVD virus or BVDV), a serious problem in cattle, has now been proven to also cause illness, abortions, and most important of all, the persistently infected (PI) state in apacacs. The virus's ability to produce persistently infected crias, the main way this disease would be spread, and its ability to cause abortions are extremely important for the alpaca industry.

At this point, the vast majority of knowledge about BVDV and the disease that it causes, bovine viral diarrhea (BVD), is about its effects in cattle, where it is considered one of the most significant viral infections, causing major economic losses. The information presented next is a brief synopsis of BVDV in cattle.

Despite the name, many animals with BVD do not have diarrhea. Other manifestations of the virus include subclinical infections, immunosuppression, abortions, congenital defects, persistent infection, and mucosal disease. The majority of infected cows are either

subclinically ill (do not appear unwell) or only mildly unwell with low fever and diarrhea. Because BVDV depresses the immune system, some animals will become ill with other infections, usually pneumonia. Others will have a classic case of BVD with fever, discharge from the nose and eyes, erosions of the muzzle

and in the mouth, and severe diarrhea. Still others may have severe hemorrhagic (bloody) diarrhea and die. Severity of illness is influenced by the age of the animal and its immunological and physiological status, and the particular strain of the virus involved.

BVD and the Fetus

The most important aspect of BVDV is its effect on the developing fetus. BVDV can cause abortions at any stage of gestation – from early embryo loss up to stillbirths at term. Even a subclinically infected cow can abort, and abortions may occur up to several months after exposure to the virus. A unique feature is that if the cow is exposed to the virus at a critical phase of her gestation (approximately 40 - 120 days) and does not abort, she will produce a persistently infected (PI) calf. Because the developing fetus is not immune-competent at that stage of development, it becomes immunotolerant to the virus (does not recognize the virus as foreign). The fetus is

unable to make an immune response to rid itself of the virus, and once born, is a permanent carrier and sheds huge concentrations of the virus in every secretion – tears, nasal discharge, saliva, urine, and feces.

PI calves are the major source of the spread of BVD – they shed several billion viral particles a day – about a thousand times more than what is shed by an acutely infected, non-PI animal. The only way to be PI is to be born PI. Some PI calves appear completely normal, but most are “poor-doers” – poor weight gain, weak, and susceptible to other diseases such as pneumonia; many PI calves die before they are a year old. Infection of the pregnant cow with BVD later in pregnancy can result in calves that are not PI but that have congenital defects such as cerebellar hypoplasia (underdevelopment of the part of the brain that controls balance and co-ordination), cataracts, blindness, hypotrichosis (sparse hair growth) or general growth retardation.

BVDV and Camelids

Acute infection with BVDV occurs through the nose or mouth by contact with secretions from an infected animal (usually a PI animal) – saliva, nasal discharge, tears, urine, or feces – either directly from the infected animal itself or from items that have been contaminated with those secretions, such as water troughs. BVDV is very infectious. An acutely infected but non-PI animal sheds virus for a relatively short length of time (4 - 10 days, possibly up to two weeks), in comparison with a PI animal, which sheds virus for its entire life.

The incubation period is 5 to 7 days.

The virus cannot survive long in the environment – a maximum of 2 weeks. Because it is a virus, antibiotics are of no use in treating it. There are hundreds of different strains of the virus, which can also be categorized under type 1 (BVDV1) or type 2 (BVDV2) and by the terms cytopathic or non-cytopathic. PI animals always have a non-cytopathic strain of BVDV. An entity called mucosal disease occurs only in PI animals – they become superinfected with an antigenically similar cytopathic strain of the virus (usually from a mutation in their own non-cytopathic strain, or from a modified live vaccine); this leads to severe diarrhea and inevitably death. Vaccines for cattle are available for BVD; however they do not confer 100% immunity.

There is not much published information concerning BVDV and camelids. Articles published to date on BVDV and camelids have generally concluded that BVDV is not much of a concern. In an article titled “A Medical Marvel” in the Winter 1999 edition of *Alpacas Magazine*, Randy Larson, DVM stated what was likely the commonly held viewpoint at that time: “BVD is an example of a significant disease of cattle that causes undetectable problems in alpacas. BVD and other common cattle viruses just do not cause problems in alpacas.” Additionally, *Medicine and Surgery of South American Camelids* (page 469) makes mention of BVDV only as a cause of congenital defects and impaired immunologic competence in calves and lambs.

In 1994, Dr. Donald Mattson reported on a study of 270 llamas from 21 herds in Oregon; 4.4% of them had antibodies to BVDV. Seven of the twelve llamas that had antibodies were from one farm where cattle were in contact with the llamas. In 2000, Belknap et al. from Colorado State University reported on three cases of BVDV isolated from llamas (a stillborn fetus and two sudden deaths in adults that had been losing condition) and concluded that BVDV should be considered as a cause of death in young and old New World camelids. *The*

Complete Alpaca Book also makes mention of that statement (page 451) and also that it may be one of the causes of diarrhea in crias (page 400).

First Case?

In 2002, Goyal et al. in Minnesota reported on what appeared to be the first case of BVDV isolated from a still-born alpaca; there were no gross or histopathologic changes of any significance seen, but BVDV was detected by reverse transcriptase polymerase chain reaction (rt-PCR) from a pool of tissues, and BVDV was isolated from cell cultures. Immunohistochemistry, a test commonly used to detect BVDV in tissues taken at the time of autopsies, was negative.

In 2003, Wentz et al. reported on the effects of experimental infection with BVD on llamas and their fetuses, and on the seroprevalence of BVDV [detection of antibodies that would signify the animal had been exposed to BVDV at some time in the past] in llamas and alpacas. They concluded that llamas may be infected with BVDV but have

few or no clinical signs, and that inoculation of llamas with BVDV during gestation did not result in fetal infection or PI crias. Seroprevalence in a sample of 223 llamas and alpacas was 0.9%. They also concluded that the most likely source of BVD infection in camelids may be cattle.

Dr. Donald Mattson from Oregon State University (OSU) stated in June 2004 (personal correspondence) that in their llama herd at OSU there had been one sick llama with BVD (it had diarrhea) but that its two herd mates did not become sick. They developed a brief, low-level antibody response to BVDV. None of the contact animals developed diarrhea and none had detectable antibodies when tested four weeks after the initial case was diagnosed. He also knew of a case in southern Oregon with a herd of 20 llamas where only one showed signs of illness. He stated that they had only seen BVDV-infected camelids when they had been in contact with cattle that are shedding the virus, and that he had test-

Need to Know

- BVD virus, a major problem in cattle, has now been shown to also cause illness, abortions, and, most important of all, the persistently infected state in alpacas.
- If the alpaca is exposed to BVDV during early pregnancy she can produce a persistently infected (PI) cria that sheds huge amounts of virus its whole life and is the major source of the spread of BVD.
- The only way to be persistently infected (PI) is to be born persistently infected.
- Because a PI cria may not show any signs of illness for several months or longer, the potential for BVD to spread between herds is significant because of the practice of females with cria at side going to other farms for breeding.
- It is unknown yet how common BVD in alpacas is – this has the potential to have a profound impact on the alpaca industry.
- All aborted or stillborn fetuses and unusually low birth weight or “poor-doing” crias should be tested specifically for BVDV, as there are usually no pathological changes to suggest BVDV. Your veterinarian should consult with a veterinarian virologist or lab that does BVDV testing about the appropriate tests to be ordered.
- Please copy this article for your veterinarian.

At this point, the prevalence of BVDV in alpacas is unknown.

Pat and Helen Dishaw



ed hundreds of samples from llamas and alpacas and never found a PI camelid.

However, there is now proof that BVDV does cause illness, death, abortion, and most important of all, the PI state in alpacas. We assume this also applies to llamas. The consequences of this for the alpaca and llama industries may be profound.

This discovery was made at a farm in Ontario. There was illness, including one death; several early pregnancy losses; and an aborted fetus that tested positive for BVDV. One of the females who had been subclinically infected (exposure to BVDV as confirmed by antibody testing) at two months' gestation subsequently delivered a persistently infected (PI) cria. This is the first recorded case of a PI alpaca, but evidence shows that BVDV had been brought to the farm by another PI cria that died without being tested. The cria's mother most likely contracted BVDV during her pregnancy in Alberta (resulting in her producing a PI cria), and the source of that infection most likely would have been another PI alpaca.

The majority of alpacas infected at Farm A in Ontario were subclinically

infected, and it was only apparent by antibody testing that they had been infected. [Note: having antibodies does not mean that the animal is unwell or contagious; it shows that the animal was exposed to the virus at some point in the past and mounted an immune response; this could be from a subclinical infection (never appeared unwell); a clinical infection (appeared unwell); or from immunization. For example, most of us would have antibodies to chickenpox from having that illness as children.]

The alpacas that were unwell had symptoms that ranged from having the appearance for a few days that their mouths were uncomfortable eating their pelletized supplement; to being off feed and depressed; to one death from hepatic lipidosis (that condition would have resulted from decreased feed intake). None of them had diarrhea. Many of them, even those subclinically infected, showed stress breaks in their fleece.

The cria who was presumed in hindsight to be PI and the source of the infection (he died without being tested) arrived at Farm A at the age of 3 months when his mother came for

breeding. He had been born at full term on Farm B, also in Ontario, at a very low birth weight of 9 pounds. He had done fairly well for the first six weeks of life, but then developed repeated infections, mostly pneumonia, had a frequent runny nose, and he had very poor weight gain. He died at the age of 8 months after severe diarrhea. (This was his first episode of diar-

rhea since having a bout with coccidia when he was much younger). Farm B, where he spent the first three months of his life, had positive BVDV antibody levels in alpacas that had been in contact with him.

His mother had been on Farms C and D, in Alberta, in her early pregnancy (when she would have contracted her subclinical BVD infection resulting in her producing this PI cria); Farm C had many abortions and Farm D had two stillbirths and a cria that died at 36 hours of age in the same year that this female delivered her presumed PI cria.

Farms C and D have alpacas with positive BVDV antibody levels, including the dams of the aborted fetuses, stillbirths, and crias that died. Although it is possible that the mother (who is not PI) became acutely infected at Farm D and transmitted BVD to Farm C during the short time she would have been shedding virus, it is more likely there were separate cases of PI animals on both those farms causing the infections. None of the farms involved had any contact with cattle.

The proven PI cria, called Gabriel,

born on Farm A (to a female who had been infected by the above presumed PI cria) also had a very low birth weight of 12 pounds for the farm he was born on. He had excellent weight gain to 33 pounds at the time of his euthanization (at a little over six weeks of age), after two sets of blood tests confirming he was PI. The fate of all proven PI animals is to be euthanized. He had chronic diarrhea, but was not unwell with it and was perky and active.

How Widespread?

At this point, it is unknown just how prevalent BVD is in alpacas. Alvarez et al. reported in 2002 that 11.5% of alpacas in a rural community of Cusco in Peru had antibodies to BVDV. The other reported case of BVDV in a still-born alpaca fetus was in Minnesota, and the llama cases were in Colorado, so this is not just a Canadian situation.

The practice of sending females with cria at side off to other farms for breeding is one of the main ways BVD could spread. A PI cria may not show any signs of being unwell, and yet be infecting every animal it comes in contact with. Also, a pregnant female going to a new owner may be carrying a PI fetus that, once born, will infect all the alpacas at the new home.

This case shows how BVDV traveled approximately 3,500 kilometers (over 2,000 miles) from Alberta to Ontario. Some PI cattle continue to appear healthy; it is unknown how many PI alpacas may continue to appear nor-

mal. It is also unknown what is the exact range of gestation in alpacas that infection of the dam will result in the birth of a PI cria. Cattle have a 9-month gestation, and it is in the period of approximately 40 -120 days of gestation that there is a high risk of the fetus becoming PI if the mother is infected with BVD.

Alpacas have a reputation for being easy aborters, and it is not unusual to hear of a poor-doing cria – it is entirely possible that some of these cases may have been due to BVDV. Unless your vet specifically tests for BVDV, there is no way of knowing that it is present. In both the stillborn fetus from Minnesota and the aborted fetus from Ontario, there were no pathological changes to suggest BVDV – it was only by testing for the presence of the virus itself that it was found.

In the euthanized PI cria, there were no pathological changes to suggest he had BVDV – but virus isolation from blood and most tissues was positive. The adult alpaca that died after what must have been an acute BVD infection had autopsy findings of hepatic lipidosis, but it would have been BVD that caused her appetite to decline, resulting in the hepatic lipidosis. In her case, there would not have been virus detected, as it would be too long after the initial acute infection – she would have to have had antibody testing. It is possible that some of the unexplained cases of hepatic lipidosis in alpaca herds have been caused by BVD.

Schwantje and Stephen's paper, "Communicable Disease Risks to Wildlife from Camelids in British Columbia," reported a positive BVDV antibody rate of 6% in a sample of 175 llamas from twelve farms, with the rate per farm varying from 0% for many farms to a high of 22% on one farm.

This paper also reported on a survey of 90 llama and alpaca farms, asking about illness and death in the preceding year. The primary cause of death (26% of cases) was neonatal failure to thrive or stillbirths. The report also reviewed the diagnoses of llama and alpaca submissions to the B.C. Animal Health Centre between 1993 and 2000. 9% of the diagnoses were idiopathic (meaning no cause found) abortion. It is quite possible there is a connection between BVDV and some of those cases of neonatal failure to thrive, stillbirths, and abortions.

Until aborted and stillborn fetuses and autopsied animals are tested specifically for the presence of BVD virus or antibodies, depending on the clinical situation, we will not know how prevalent this is. Only a completely closed herd (no animals coming into the herd) with good bio-security measures (all visitors with footwear not contaminated by manure; no fence line contact with other livestock) can be sure to be safe from BVDV.

Testing for BVDV is complicated, with different tests being used in different situations. Having antibodies (blood test) to BVDV shows that the animal

The practice of sending females with cria at side off to other farms for breeding is one of the main ways BVD could spread. A PI cria may not show any signs of being unwell until it is older, and yet might be infecting every animal with which it comes in contact.



A reasonable recommendation is that all aborted or stillborn fetuses, all unusually low birth weight and 'poor doing' cria and all unexplained deaths be tested for BVD virus and/or antibodies, depending on the case.

Nancy Carr, MD



Gabriel, the PI cria.

was exposed to the virus (from a clinical or subclinical infection, or from immunization), but it is unknown how long antibodies are detectable for after exposure. PI animals would not have antibodies (unless they were tested as newborns soon after ingesting their mother's antibody containing colostrum).

Testing for PI

To detect the PI state, the animal has to be tested for the virus itself, and there must be two positive tests three weeks apart to prove the PI state, in case the first positive test was an acute infection (and not from being PI). Virus isolation is the 'gold standard' test for detecting BVDV – it can be done on blood (live animal) or tissue (dead animal). The ELISA blood test for the virus is used to detect PI animals over the age of three months (the maternal antibodies from colostrum interfere with the test before that age, and also sometimes interfere with virus isolation.)

The ELISA test on skin biopsies or ear notches can be used to detect PI calves under the age of three months. The PCR test (blood) is not affected by maternal antibody and is also used to detect PI animals under the age of

three months. Immunohistochemistry is used on formalin fixed tissue from autopsies. However, as noted above, this test was negative in the stillborn fetus in Minnesota despite BVDV being detected by PCR and virus isolation; immunohistochemistry was positive in the aborted fetus in Ontario.

Your veterinarian should consult with a veterinarian virologist or with the lab that he/she uses for BVDV diagnosis in cattle. Most labs doing BVDV testing are affiliated with universities, or are state or provincially funded; not many private labs offer BVDV testing.

For the veterinarians reading this article: the aborted alpaca fetus from Farm A was positive for BVDV type 1 on virus isolation from skin and positive for BVDV in multiple tissues using immunohistochemistry on formalin-fixed tissue. Gabriel, the PI cria, was found to be positive for BVDV type 1 at birth (using virus isolation on placenta); at 3 days of age (using virus isolation from buffy coat cells and PCR on both EDTA blood and plasma); at 25 days of age (using virus isolation on both EDTA blood, plasma, and PCR on both EDTA blood, plasma), and at 6 weeks of age (using virus isolation on buffy coat cells, plasma, serum and multiple tissues, including skin and brain, PCR on both plasma and serum). At 6 weeks of age Gabriel was also IDEXX BVDV ELISA positive, using fresh ear notch and positive for BVDV in immunohistochemistry tests using multiple tissues, including skin and brain. He continued to be antibody negative for both BVDV type 1 and type 2 until euthanasia.

Recommendations

At this time, a reasonable recommendation is that all aborted or

stillborn fetuses, all unusually low birth weight and 'poor doing' cria and all unexplained deaths be tested for BVD virus and/or antibodies, depending on the case. If BVDV is found, then further testing should be done to determine how the virus entered the herd – specifically, is there still a PI animal present, or has it gone back to another farm? Any cria subsequently born to females who were pregnant when BVD was active in the herd should be tested to see if they are PI.

It is important that you bring this information to the attention of your veterinarian, as it will be at least a year before it is published in a veterinary journal. It would also be very helpful if you or your vet notified the lab in your area where aborted fetuses or autopsies are sent for testing about this, so that testing specifically for BVDV will become routine in abortions, stillbirths, and unexplained deaths in alpacas.

The complete story of how this discovery was made has been written up and called "BVD Virus and Alpacas – The Detective Story." It is available for downloading from the Canadian Llama and Alpaca Association website, www.claacanada.com, or from Nancy Carr (see below).

Addendum

Just before going to press, we have received a report from an alpaca owner in Nova Scotia who recently had three abortions and one cria death. All the eighteen alpacas over the age of one year on his farm have tested positive for BVDV antibodies. His alpacas have not had contact with any alpacas from any of the farms mentioned in this article.

References

- 1) Alvarez, S.; Rivera, G.H.; Pezo, D.; and Garcia. W. (2002): "Deteccion de Anticuerpos Contra Pestivirus en Rumiantes de una Comunidad Campe-sina de la Provincia de Canchis, Cusco," *Rev Investig Vet Peru*, 13(1), 46-51
 - 2) Belknap, E.B., Collins J.K., Larsen R.S., Conrad K.P. (2000): "Bovine Viral Diarrhea Virus in New World Camelids," *J Vet Diagn Invest*, 12(6), 568-70
 - 3) Fowler, M. (1998), *Medicine and Surgery of South American Camelid*, Ames, Iowa.
 - 4) "Isolation of Bovine Viral Diarrhea Virus From an Alpaca," *J Vet Diagn Invest*, 14(6), 523-5
 - 5) Hoffman, E. (2003), *The Complete Alpaca Book*, Santa Cruz, California: Bonny Doon Press.
 - 6) Larson, R. DVM, "A Medical Marvel," *Alpacas Magazine*, Winter 1999, 122
 - 7) Mattson, D. (1994), "Viral Diseases," *The Veterinary Clinics of North America: Food Animal Practice: Update on Llama Medicine*, 10 (2), 346-347
 - 8) Schwantje H., Stephen C. (2003), "Communicable Disease Risks to Wildlife From Camelids in British Columbia." [on-line]. Available: http://wlapwww.gov.bc.ca/wld/documents/wldhealth/camelid_risk03.pdf
 - 9) Wentz P.A., Belknap E.B., Brock K.V., Collins J.K., Pugh D.G. (2003), "Evaluation of Bovine Viral Diarrhea Virus in New World Camelids," *J Am Vet Med Assoc*, 223 (2), 223-8
- Nancy Carr, MD owns "Alpaca Farm A," (Silver Cloud Alpacas), near Elginburg in eastern Ontario. She would like to assure readers that her herd is now completely healthy and not contagious, and in fact is one of the very few herds in North America where all the crias have been tested to make sure they are not PI. She can be reached at carralpacas@sympatico.ca or (613) 376-3389 or through her web site, www.silvercloudalpacas.com.
-
- Susy Carman, DVM, PhD is in Diagnostic Virology, Animal Health Laboratory, Laboratory Services Division, University of Guelph, Box 3612, Guelph, Ontario N1H 6R8. Email: scarman@lsd.uoguelph.ca. Phone: (519) 824-4120, ext. 54551.