Bovine Viral Diarrhea Virus

Figure 1. Is this newborn calf infected with BVDV? (Photo courtesy USDA:ARS Image Gallery).

What is bovine viral diarrhea?

Bovine viral diarrhea is a viral disease of cattle and other ruminants that is caused by the bovine viral diarrhea virus (BVDV). BVDV is a member of the pestivirus genus. There are four recognized species within the pestivirus genus. These species are BVDV-1, BVDV-2, border disease virus of sheep and classical swine fever virus, previously known as hog cholera virus.

What are some signs that a herd may be affected by BVDV?

The clinical signs of BVDV infection are highly variable, including a spectrum from few to no signs to very severe signs that kill the animal. The signs can be determined by the genotype of the virus, whether the infection was recently acquired (i.e., acute) or has been acquired for months (i.e., chronic), whether the animal is pregnant, as well as other factors. Some of the signs of acute infection are fever, lethargy, loss of appetite, ocular discharge, nasal discharge, oral lesions, diarrhea, and decreasing milk production. Chronic infection may lead to signs of mucosal disease.

Generally, what are the most common consequences of BVDV infection?

The most common consequences of BVDV infection are respiratory and reproductive problems. Problems due to BVDV-related reproductive disorders may be the most important economically. There is some evidence that suggests that the losses due to BVDV in the United States are increasing.

What is the most commonly recognized birth defect caused by BVDV infection?

The most commonly recognized birth defect or congenital defect is cerebellar hypoplasia. The signs of cerebellar hypoplasia in newly born calves are ataxia, tremors, wide stance, stumbling, and failure to nurse. The defects are severe enough that compensation will not occur, and the calves may die.

Economically speaking, why should beef producers be concerned about BVDV?

BVDV adversely affects both health and productivity. The losses due to transient infection are diarrhea, decreased milk production, reproductive disorders, increased occurrence of other diseases, and death. The losses from fetal infection include abortions; congenital defects; weak and abnormally small calves; unthrifty, persistently infected (PI) animals; and death among PI animals. During outbreaks of acute BVD, the losses were estimated to be $50 to $100 per cow in the herd. During outbreaks of severe acute BVD in Canada around 1998, the losses were estimated to be $40,000 to $100,000 per herd, or $400 per cow in the herd.

Has the economic impact of BVDV been assessed at a national level?

The impact has been assessed in Denmark and Norway, but not in the United States. The cost of BVDV in Denmark prior to its eradication program was estimated to be $20 million per one million calf births. The losses were estimated to be $57 million

per one million calf births when the effects of virulent strains were estimated. The economic loss in Norway prior to its eradication program was estimated to be $10 million per one million calf births. The lower number corresponds to a lower prevalence in Norway. In Canada, the total annual cost for an average 50-cow dairy herd was estimated around year 2002 to be $48 per cow.

Are there breeds of cattle that are more susceptible than other breeds to BVDV infection?

No. There is no information that suggests that some breeds of cattle are more susceptible than other breeds to BVDV infection.

What are risk factors for BVDV infections?

The risk factors for BVDV infections are often a reflection of the risk of direct or indirect contact with PI cattle. The suspected risk factors include livestock trade, pasturing animals, use of common pasture for infected and susceptible cattle, cattle density, number of infected neighboring herds, broken fences, animal contact between herds (e.g., livestock exhibitions), weak hygiene, and presence of other susceptible ruminants, such as sheep and wildlife. A goal of Beef 2007/2008, a national study of the United States beef cow-calf industry, is to more clearly define the risk factors for BVDV infection.

How is BVDV transmitted?

BVDV transmission may occur vertically (i.e., before birth), leading to congenital infection of the fetus, or the transmission may occur horizontally (i.e., after birth). Congenital infections may cause resorption, abortion, stillbirth, or live-birth. Congenitally infected fetuses that survive *in utero* infection (i.e., the live-births) may be born as BVDV-infected calves. The BVDV infection in these calves will persist during the entire life of the calf, and they will shed BVDV continuously in the farm environment.

Why is it important to prevent BVDV infection in bulls?

Both acute and persistent infections may decrease the reproductive soundness of bulls. The primary affect of infection in bulls is the subsequent potential for venereal transmission during breeding and the shedding of BVDV in semen. Susceptible cows may become infected following artificial insemination with contaminated semen. The semen from acutely infected bulls will pass a breeding soundness examination, which will increase the risk of transmission to susceptible cows. BVDV infection was transmitted by a single bull to 55 cows in one herd and to several other herds that had been free of BVDV.

Is there a way to certify that semen is free of BVDV?

Yes. BVDV contamination of distributed semen is prevented by practicing standardized testing and quarantine procedures in AI semen collection facilities. Certified Semen Services, Inc., or CSS, is a cooperative in which membership ensures that the standardized procedures are utilized appropriately. Use of semen from CSS-certified collections is recommended to prevent introduction of BVDV via semen.

Can BVDV infect a fetus during late gestation?

Fetuses infected during late gestation are immunocompetent and capable of mounting an effective immune response against BVDV. However, the risk is greater that these calves will experience a serious postnatal health hazard. Calves born with BVDV-neutralizing antibodies, an indicator that these calves had become infected before birth, were twice as likely to experience a severe illness during the first 10 months of life, when compared to calves born without BVDV-neutralizing antibodies.

Does BVDV infection affect the fetus differently at different stages of gestation?

Transmission of BVDV to the fetus at 30 to 45 days of gestation decreases conception rates and the viability of the embryo. Fetuses that become infected from 30 to 125 days of gestation and survive the infection will be born as BVDV-infected calves. The BVDV infection will persist for the life of the calf, hence the term “persistent infection,” or PI. Transmission of BVDV to the fetus after 120 to 150 days of gestation may result in abortion, stillbirth, congenital defects, or birth of a live, normal-appearing calf. Congenital anomalies are the most frequent outcome of infections that occur during days 125 to 175 of gestation. Fetuses that become infected after 175 days are more resistant to infection because they are immunocompetent; however, these fetuses are more likely to experience a serious health problem during the first 10 months of life.

How does a fetus become a PI fetus?

A PI animal acquires BVDV infection *in utero* before its immune system becomes functional. The fetus is not immunocompetent at the time of infection; thus, it cannot offer resistance to the BVDV that caused

the infection. The infection will persist.

What are the sources of PI animals?

There are two sources of PI animals. The first source is transmission of BVDV from a PI cow to her fetus. The calf will most likely become a PI calf. The second source of transmission is acute infection of a pregnant cow during the first 120 to 150 days of gestation. The rate at which PI animals are accumulated in a herd is dependent on the prevalence of PI among the pregnant cows and the proportion of pregnant cows that acquire an acute infection during the first 120 to 150 days of gestation.

How do acute BVDV infections occur?

Acute infection is the result of horizontal transmission to a susceptible animal following contact either with an acutely infected animal that is shedding BVDV, or with a PI animal that sheds BVDV continuously. Acute infection may be acquired through several routes of transmission.

What are some routes of BVDV transmission?

BVDV may be shed in excretions and secretions, including nasal discharge, tears, saliva, urine, feces, milk and semen. These routes apply to both acute infections and to PI animals. BVDV may be transmitted during embryo transfer, rectal examination, and artificial insemination. The virus may survive in cool, protected environments for several days; thus, susceptible animals may acquire BVDV from contaminated fomites such as nose tongs, halters, milk bottle nipples, balling guns, etc. A small needle that was contaminated with fresh blood from a PI animal was used successfully to infect susceptible cattle with BVDV.

What are the most important determinants of the rate of transmission of BVDV within a herd?

There are four determinants that are thought to be important: (1) prevalence of PI animals, (2) rate of animal-to-animal contacts, (3) virulence of the virus strain(s), and (4) the susceptibility of cattle to new and indigenous strains in the herd.

What are the most important determinants of the rate of transmission of BVDV from one herd to another herd?

The strength of the herd biosecurity program is the most important determinant of BVDV transmission. The main factor associated with high herd seroprevalence was introduction of new animals into the herd. Use of semen from an infected bull spread BVDV to several closed, BVDV-negative herds. Other determinants of transmission are across-the-fence contact between susceptible cattle and infected cattle, and their body secretions and excretions; embryo transfer involving introduction of pregnant recipients carrying a PI fetus (even if the recipient cows are not infected); inappropriate use of modified live virus (MLV) BVDV vaccines, and feeding waste milk or hospital milk from dairies with lactating PI cows.

Can ruminants (e.g., sheep, goats) other than cattle become infected with BVDV, and are these ruminants important in transmission of the virus?

Ruminants other than cattle can become infected with BVDV, but the risk of transmission from these ruminants to cattle is unknown. Because cattle and other domestic and wild ruminants may share the same pastures, ranges, and water sources, the susceptibility of these other ruminants to BVDV is important, especially to BVDV control programs. Similarly, the extent of transmission of BVDV from cattle to sheep, goats and wild ruminants is equally important. BVDV has been found in sheep, goats , and pigs undergoing natural infections.

What can be done to minimize the transmission of BVDV?

One strategy is to make infected cattle less infectious, and this can be achieved by increasing the antibody titer. Cattle that have antibodies at the time that they acquire acute BVDV infection do not shed as much virus, and they will shed virus for a shorter period of time. Antibodies may be increased by feeding adequate, high-quality colostrum to calves and by vaccination of older cattle. The most important strategy to decrease herd infectiousness is to identify and remove PI cattle because these cattle shed more virus than acutely infected cattle. Other strategies include decreasing contact between animals by housing calves in individual isolation hutches, decreasing cattle density, increasing feed bunk space and water troughs, double fencing, and decreasing the number of animals in a pasture or corral. A final strategy is to decrease the proportion of susceptible cattle, a strategy in which high-quality colostrum and strategic vaccination also are important.

What role does colostrum play in protection against BVDV?

Colostrum can protect calves from BVDV infection during the first 2 to 4 months of life, depending on the quantity and quality of colostrum consumed at birth. The extent of protection depends on the

effectiveness of the colostrum management program. After the first 2 to 4 months, colostrum antibodies decay to levels that will not protect against infection, so other measures must be taken to protect calves.

Does BVDV increase the severity of diseases in cattle that may already be affected by other bacteria and viruses?

When cattle are diagnosed with pneumonia, BVDV is found frequently along with other bacteria and viruses. These infections are referred to as co-infections. Some of the other bacteria and viruses are bovine herpesvirus-1, parainfluenza-3 virus, bovine respiratory coronavirus, bovine respiratory syncytial virus, *Pasteurella*, *Mycoplasma*, and *Hemophilus*. BVDV may increase the severity of these infections because BVDV causes immunosuppression in infected animals. In other situations, BVDV may increase the virulence of the pathogens.

Are there control programs to limit losses due to BVDV in herds?

Yes. The primary goals of BVDV control programs are to prevent fetal infections, which would eliminate the reproductive losses, and to decrease losses due to transient infections. Control is achieved with a combination of removal of PI cattle, vaccination, and enhanced biosecurity. Specific programs have been designed for beef cow herds, dairy herds, and stocker/feedlot herds. Although these programs have been designed, the extent to which they are being utilized by beef producers in the United States is unknown. Nationally speaking, the U.S. Academy of Veterinary Consultants issued a statement in 2002 to support eradication of BVDV in North America.

Are there BVDV virus control and eradication programs in other countries?

Sweden was among the first countries to introduce a national BVDV eradication program. Their program, introduced in 1993, is the basis for BVDV eradication programs in other countries. For example, an eradication program in Denmark was begun around 1994. Both the Swedish and Danish programs have been highly successful. A voluntary control program was begun in the German federal state Saxony-Anhalt around year 2000.

Are there vaccines for BVDV?

Yes, there are two broad categories of BVDV vaccines, the same as for many other viruses. The two categories are modified live virus (MLV) vaccines and killed virus (KV) vaccines. MLV BVDV vaccines contain fewer antigens than KV vaccines because the virus replicates in the vaccinated animal, and the replication boosts the immunogenic mass. Generally speaking, MLV vaccines require only one dose during the initial immunization step. MLV vaccines require rigid handling procedures because the vaccine is susceptible to deactivation beyond certain temperatures; MLV vaccines also can be deactivated by some chemicals. KV vaccines are different from MLV vaccines in that KV vaccines require more antigens per dose than MLV vaccines; thus, KV vaccines are more expensive. More than one dose of KV vaccine must usually be given during initial immunization, requiring a herd to be gathered more than once for vaccination. However, KV vaccines are less susceptible to deactivation by temperature extremes, and they are less susceptible to deactivation by chemicals.

Are BVDV vaccines contraindicated in some cattle? Can BVDV be transmitted via vaccines sometimes?

Yes, MLV BVDV vaccines should not be given to pregnant cattle because the fetus will become infected. The fetal infection may lead to abortion, stillbirth and developmental defects. The alternative to using MLV vaccines in pregnant cattle is to use KV vaccines.

What is the duration of immunity of BVDV vaccines? How long will the vaccinated animals have protection?

The duration of immunity has been reported to be as short as 140 days to as long as 18 months. Regardless of this duration, revaccination will increase antibody titers rapidly, and this increase will assist with protection against BVDV infection.

Are BVDV vaccines easily accessible?

Yes. Approximately 11 MLV BVDV vaccines were manufactured by 10 different U.S. pharmaceutical companies in 2005. Approximately 8 KV BVDV vaccines were manufactured by 7 of those same U.S. pharmaceutical companies in 2005. These vaccines are available under many different trade names. Beef producers should consult their local veterinarians to decide which vaccines are most appropriate for their geographical locations.

What laboratory tests are available to diagnose BVDV?

Several laboratory tests are available to diagnose BVDV. These tests include virus isolation, immunohistochemistry (IHC), polymerase chain reaction (PCR) and serology. A given test may be more advantageous in one situation versus

another. The IHC is suitable for herd screening because samples may be collected from cattle of any age, sample collection is easy, the samples are stable during transport and handling, and the test result is not affected by passive antibodies from the dam. The PCR is useful for pooled samples of blood or milk because minute amounts of virus may be identified using PCR. However, both virus isolation and PCR may require testing a second sample within 3 weeks of the first sample to differentiate transient infection from persistent infection.

Figure 2. Collection of an ear notch lab specimen from a calf to diagnose BVDV. (Photo courtesy of Dr. Craig Jones, Boehringer Ingelheim Vetmedica, Inc.)

Are humans susceptible to BVDV? Is BVDV important to human health?

Humans are not susceptible to BVDV. However, immunosuppression is one of the consequences of BVDV infection. Immunosuppression may increase the susceptibility of an infected animal to other viruses and bacteria, and some of these viruses and bacteria may be important to human health. Examples of these viruses and bacteria are infectious bovine rhinotracheitis virus, bovine respiratory syncytial virus, rotavirus, coronavirus, bovine popular stomatitis virus, *E. coli*, and *Salmonella spp.* Humans may acquire infections due to some species of *E. coli* and *Salmonella*.

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