Epidemiology and Control of BVD in the U.S.

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Abstract:

The apparent prevalence of bovine viral diarrhea virus (BVDV) persistently infected cattle has been found to be low in U.S. dairies, beef herds and feedlots. Current management practices within U.S. cattle industries that impact the epidemiology of BVDV infections include purchasing untested cattle, lack of biosecurity procedures, large herd sizes, mixing cattle from multiple sources, high cattle densities in dairy and feedlot operations, synchronous breeding of beef herds, communal grazing and widespread vaccination. Evidence for BVDV infection has been found in farmed and free-ranging wildlife in North America; however the risk of BVDV transmission from wildlife to cattle is not known. The perception of a low prevalence of BVDV herd infections, the unrestricted sale of PI cattle, lack of economic data, intensive marketing of vaccines, reluctance to accept federal regulations, and a "gambler's" attitude among producers are impediments to implementation of a national systematic BVD control program. Since 2004, voluntary BVDV control programs have been organized in nine states reflecting the recognition of BVD as an important and preventable problem in the U.S.

The Epidemiology of Bovine Viral Diarrhea Virus in the U.S.:

There are 104.3 million cattle in the U.S. distributed over 1 million farms, ranches, feedlots and other premises covering a broad spectrum of environments and diverse cattle production systems (NASS, 2008). While bovine viral diarrhea virus (BVDV) transmission and associated diseases are the same as found elsewhere, differences in cattle management practices in the U.S. result in clinical manifestations at the herd level that are different from those observed in Europe, and which present challenges to controlling the viral infection.

Prevalence of BVDV infections in U.S. cattle.

An important difference between European cattle prior to the institution of bovine viral diarrhea (BVD) eradication programs, and the U.S. is the low prevalence of BVDV persistent infection in U.S. cattle. Data collected from recent surveys of beef cattle indicate that the prevalence of persistently infected (PI) animals in the U.S. cattle population is low, ≤0.3% in surveys of beef herds (Wittum et al., 2001; O'Connor et al., 2007), feedlots (Loneragan et al., 2005, Fulton et al., 2006), and dairies (Houe et al., 1995; Munoz-Zanzi et al., 2003). The prevalence of BVDV-infected beef herds, as defined by PI animal detection within herds, is 4% for beef cattle (Wittum et al., 2001; O'Connor et al., 2007). The prevalence of BVDV-infected dairy herds is 15% based on PI cattle detected in Michigan herds (Houe et al., 1995), and 1.7% in a national survey based on detecting BVDV by RT-PCR in bulk milk samples (USDA 2007). In the latter report, the percent of BVDV RT PCR positive dairy herds ranged from 0% in herds with less than 100 cows to 12.8% in herds with ≥500 cows.

The apparently low prevalence of BVDV-infected beef herds based on PI animal detection is likely to be an underestimate of true herd prevalence. Some BVDV-infected beef herds may be misclassified as uninfected herds if there is no PI animal alive at the time of testing. Test methods that are currently available do not detect PI fetuses, and the infection at the herd level continues when these calves are born. Surveying dairy herds by reverse transcriptase-polymerase chain reaction (RT-PCR) assays of bulk milk samples may result in the misclassification of herds as uninfected if there are no PI animals in the lactating cow herd. This testing strategy underestimates the prevalence of infected herds as the young stock, which is not surveyed by this method, is more likely to include PI animals than older cattle.

Accurately determining the prevalence of BVDV infection in individual cattle or herds in the U.S. is problematic for a number of reasons. Herd sizes are relatively large and testing every individual animal is neither logistically or economically feasible. Although testing strategies for pooled samples have been developed, they do not replace the need to obtain samples from each animal (Kennedy et al., 2006). An estimated 80% of cattle in the U.S. are vaccinated with either inactivated or modified live viral vaccines containing BVDV (USDA 1995; USDA 2007); consequently, BVDV seroprevalence is high, and the serologic tests are unable to distinguish between vaccinated and naturally infected cattle (Paisley et al., 1996). The testing strategies used in Europe to identify BVDV-infected herds based on serology are not useful in this situation as they would misclassify vaccinated-uninfected herds as being BVDV-infected. Thus, testing U.S. herds is a challenge for any rigorous BVD control program.

If the prevalence of BVDV-infected herds in the U.S. is truly low, then one could surmise that control of BVDV-associated diseases by eradication could be easily accomplished. The low prevalence, however, also means that a large proportion of U.S. herds are susceptible to the introduction of BVDV infections. As the sale of PI animals is not prohibited, epidemics of BVDV-associated diseases occur each year as the viruses are introduced into these herds through the purchase of PI cattle or cows bearing PI fetuses. BVDV-associated diseases are not reportable and the diseases may be misdiagnosed; therefore, there is no data enumerating BVDV-associated cases. Occurrences of diseases are only captured in a few case reports.

Cattle management in the U.S. that impact BVDV infections:

The trend in U.S. dairies has been towards fewer farms and larger herd sizes. The rapid growth of large dairies has increased the demand for bred replacement heifers. Risk factors for herds with positive BVDV RT-PCR bulk milk tank samples include large herd size (>500 cows) and purchasing animals (USDA 2007). To meet the demand, heifers are raised and bred in commercial facilities where thousands of cattle from multiple origins are co-mingled. Contact with PI animals in these facilities during the breeding period generates PI fetuses. When these heifers return to dairies, they give birth to PI calves which then are a source of BVDV infection for the rest of the herd. Dairy herd expansion may occur more rapidly than optimal for the facilities and personnel resulting in crowding and insufficient attention to biosecurity and sanitation measures. Inadequate separation of pregnant cows from young stock including PI calves leads to additional fetal infections. In registered herds where the genetic value of individual animals is emphasized, PI cattle may be retained in the herd despite poor health and phenotype. (Rauff et al., 1996; Rush et al., 2001). Infertility as judged by the percent of cows >150 days open is higher (18.2%) for BVDV-infected operations compared to noninfected dairies (USDA 2007), and supports the finding that infertility in heifers has been linked to congenital BVDV infection (Munoz-Zanzi et al., 2004). As infertility is an important factor in culling decisions made on dairies, a cycle of culling infertile cows necessitating increased purchases of at-risk heifers. BVDV RT-PCR positive dairies are more likely to use BVDV-containing vaccines than non-infected operations suggesting that vaccines are being used in response to problems perceived to be due to BVDV infections (USDA 2007). An important difference between dairy and beef herds with respect to the epidemiology of BVD is that breeding in dairy herds occurs over the entire year. Exposure of the cows to a PI animal results in the infection of fetuses whose ages cover the entire gestational period. Calves with congenital defects resulting from BVDV infection are more likely to be born into dairy herds which aids in recognition of herd infection.

Beef herds engage in similar high risk practices as dairy herds including the purchase of untested cattle. The purchase of pregnant heifers and utilization of heifer development feedlots has become common in the beef industry and like the dairies, generate PI fetuses which then serve as the source of infection for the cow herd when the heifers return and calve. In addition, ranchers share summer pastures where cows in their first trimester of pregnancy may contact PI calves from other herds (Sanderson et al., 2000). The practice of synchronous, seasonal breeding in beef cattle has a marked impact on the manner in which BVDV-associated reproductive losses present. Contact with a single PI calf can infect a large proportion of cows during the first trimester of pregnancy. In this scenario, the first observation is a distinct rise in infertility cases determined at pregnancy examination. Typically, this is followed by explosive abortion "storm" beginning one month prior to the planned calving interval and followed by increased stillbirths, the birth of stunted calves and weak, non-viable calves. In some cases, BVDV epidemics result in losses of 50% of the calf crop. In contrast to diary herds, classic congenital defects such as cerebellar hypoplasia are infrequently observed in beef herds due to the early gestational age of fetuses at the time of exposure of cow-calf herds to PI calves.

There are two possible outcomes following the epidemic year of BVDV infection. If a PI calf is not born or does not survive into the breeding season, then BVDV infection of the herd will not be sustained and the herd will be uninfected. Detection of BVDV antibodies in the cow herd at this point would falsely classify the herd as infected (Van Campen et al., 1998). Secondly, the herd can enter an endemic state of infection if a PI calf survives into the breeding season. In endemically infected beef herds, approximately 50% of the calves will have become infected by the time they are weaned due to contact with PI calves present in the same cohort (Cleveland et al., 2004). Calfhood infections may be clinically inapparent during the period that the calf is protected by maternal antibodies, but manifest as diarrhea and pneumonia when maternal antibodies wane. The rest of the calf crop may be impacted by BVDV in more subtle ways such as lower weaning weights and rate of gain (Waldner and Kennedy, 2008). In either scenario, cows rendered immune by the initial infection will protect subsequent pregnancies from antigenically similar BVD viruses for the rest of their life. Their offspring will not be PI or suffer other consequences of congenital infection; however, their offspring will be susceptible to infection. If susceptible heifers are retained in the herd and remain unexposed, e.g., by virtue of being raised separately from the cow herd, they serve as the source of additional PI animals following exposure to PI calves when they enter the cow herd and are bred.

On average, 10,000,000 head of cattle are on feed in the U.S. in just under 1,000,000 premises. Approximately one-third of the inventory is fed in feedlots with over 1,000 head of cattle (NAAS 2008). By necessity, maintaining this inventory requires purchasing cattle from multiple sources and co-mingling animals at high animal densities. In addition, calves pass through several sales facilities prior to entry into the yard which represents another opportunity for exposure to pathogens. The percentage of PI cattle entering feedlots is low; however, cattle in adjacent pens as well as with the home pen are subject to infection. In some cases, the immunosuppressive effects of BVDV likely play a role in increased risk of morbidity and mortality due to respiratory disease (Loneragan et al. 2005). However, other surveys of beef cattle failed to find any significant effect of PI calves on herd health (O'Connor et al., 2007). In terms of transmission, the feedlot is an endpoint for the viruses, and would not impact their maintenance in the breeding cattle population. The economic impact on feeder calves is more easily apparent which explains the interest in BVDV control from this segment of the cattle industry.

<u>Wildlife and other sources of BVDV:</u>

The U.S. enjoys ample populations of wild species of ruminants which share range and forage with domestic cattle. Serologic surveys have indicated that these animals become infected with BVDV and other pestiviruses (reviewed by Van Campen et al., 2001a). Evidence for PI white-tailed and mule deer have been found in several states (Chase et al., 2008; Duncan et al., 2008b; Pogranichniy, et al., 2008; Van Campen et al., 2001b), and PI white-tailed fawns have been generated experimentally by the inoculation of pregnant does (Duncan et al., 2008a). Clearly, free-ranging wildlife species are a potential source of infection for cattle; however, transmission from wildlife to cattle has not been demonstrated to have occurred in nature and the risks of infection from this source have not been examined. Recently, the persistent infection of alpacas with a noncytopathic type 1b BVDV was reported (Carman et al., 2005). The monetary value placed on individual alpacas, the aggressiveness with which breed associations pursued PI testing and the small number of PI crias identified makes this species an unlikely source of infection for cattle. Few surveys of Pestivirus infections have been conducted in domestic sheep and goats in the U.S. that might indicate the extent of these infections or whether these populations pose a risk to cattle.

<u>BVDV Control and Eradication Programs in the U.S.:</u>

Prior to 2004, BVDV control largely rested on the use of inactivated and modified live BVDV vaccines. For decades, BVDV vaccines included either the Singer or NADL cytopathic type 1a BVD viruses. These vaccines were used to prevent both fetal infections with accompanying reproductive losses as well as to prevent diseases due to acute infections. The recognition of type 2 BVDV associated with severe disease and occurrence of fetal losses in vaccinated cows (Van Campen et al., 2000) led to the inclusion of a cytopathic type 2 BVDV in many vaccines. Since then experimental challenge of vaccinated cows has established the superiority of MLV BVDV vaccines in providing fetal protections; however, concerns about safety and subtle effects of live viral vaccines on health remain a factor in their use (Ellsworth et al., 2006; Grooms et al., 2007; Schnackel et al., 2007). A significant consequence of the widespread use of BVDV vaccines is the inability to use serologic techniques for the diagnosis of BVD herd infections and for surveillance purposes in U.S. cattle. As important is the perception by producers that BVDV vaccines will prevent the introduction of BVDV into their herds. Given this mindset, biosecurity measures to prevent the introduction of BVDV and other pathogens are often ignored.

In 2003, the Academy of Veterinary Consultants published a position statement promoting the control and eventual eradication of BVD from the U.S. (http://www.avc-beef.org/links/BVDLinks.asp). This announcement was followed in Jan. 2004 by development of a voluntary BVD control program offered in conjunction with Colorado State University (http://www.dlab.colostate.edu/BVDControlProgram/bvdcontrolprog_main.cfm). Since then, the number of BVD prevention and control programs has expanded to include Alabama (http://www.aces.edu/counties/Marion/files/bvd.pdf), Georgia, Mississippi (http://www.mbah.state.ms.us/disease_programs/bvd/MS_PI_BVD_Program.pdf), Montana (http://www.mtbqa.org/news/2007%20Montana%20BVD-PI%20Herd%20Screening%20Project.doc), Oregon (http://ans.oregonstate.edu/bvd/index.html) and Washington (http://www.vetmed.wsu.edu/bvdcep/) with a focus on beef herds. New York has a BVD control module offered through their extension service that is tailored to dairy farms (http://nyschap.vet.cornell.edu/module/bvd/bvd.asp). An exciting addition to this list is the BVD eradication program (http://www.msue.msu.edu/workspaces/one.cfm?workspace_id=28413&object_id=455181) offered to beef and dairy herds in the Upper Peninsula of Michigan through the extension service of Michigan State University.

All programs are voluntary, associated with a university and organized in conjunction with other beef or dairy quality assurance programs. Program elements include: 1) education about BVDV transmission and diseases, 2) required testing procedures, 3) documentation of biosecurity practices to prevent the re-introduction of BVDV, and 4) verified use of a vaccination schedule. A wide range of resources are available to veterinarians, diagnosticians and producers seeking information about the control and prevention of BVDV infections. These subjects have continued to receive extensive coverage in magazines and the websites of veterinary medical and producer organizations, by university extension personnel and vaccine companies. Consultation on BVD control is provided at no cost to the producer by extension personnel, clinical faculty at veterinary teaching hospitals and by diagnostic laboratories. Two BVD control programs have funding for to partially cover the costs of testing and limited funding for indemnification of owner's of PI animals. The biosecurity requirement in some programs means the development of a written biosecurity plan by each producer, and the systematic element of follow-up testing in subsequent years is encouraged. Funding the existing programs is a constant challenge. To date, BVD control programs have relied on grants from producer organizations, state departments of agriculture, vaccine and pharmaceutical companies, and university resources.

Currently mandatory, systematic BVD control programs similar those in several European countries do not exist in the U.S. (Lindberg et al., 2006). The concept of BVD control by eradication has been slow to find acceptance in the U.S. Impediments include reluctance to institute a government-regulated control program. Available data indicating a low prevalence of BVDV infection in beef and dairy herds and uncertainty on the part of individual producers about the economic benefits of BVDV control. The lack of a clear danger is compounded by the "Gambler's" mentality among individual cattle producers. The low herd prevalence validates the general belief that the application of BVDV vaccines is a "cure-all" rather than an aid in prevention of BVDV infections. However, producers and veterinarians who have experienced losses due to BVDV-associated diseases are more motivated to adopt preventive measures. Producer and veterinarians' awareness of the potential impact is the impetus behind the BVDV testing recently adopted by bull sales, purebred stock sales, livestock shows and specific feedlots. The proliferation of BVD control and eradication programs in the U.S. is encouraging and highlights recognition of BVDV's importance to cattle health.

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