Components and Goals of Programs to Control BVDV

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Cattle producers, with their veterinarians, face challenges to prevent losses due to bovine viral diarrhea virus (BVDV). It is a diagnostic challenge to determine with certainty whether or not BVDV is circulating among a population (herd) of cattle. When the virus is present it is a challenge to minimize its pathology or to eliminate the virus from the herd, and if the virus is not currently present in a herd it is a challenge to prevent its introduction (Fig. 1). Although it requires effort, these challenges can be overcome and BVDV has been successfully controlled on many beef cattle operations.

Biosecurity is the action taken to prevent the introduction of a disease agent, while biocontainment describes the actions taken to control a pathogen already present in the herd (Dargatz *et al* 2002). We now know that BVDV is best transmitted and maintained within and between cattle populations by cattle persistently infected (PI) with, BVDV. The BVDV-PI animal is generated when a fetus comes infected with BVDV during the first 125 days of gestation (McClurkin *et al* 1984). Cattle PI to BVDV shed high amounts of virus, serve as reservoirs of the virus and they are the most important sources of virus transmission (Brock *et al* 1991, Paton *et al* 1989, Werdin *et al* 1989).

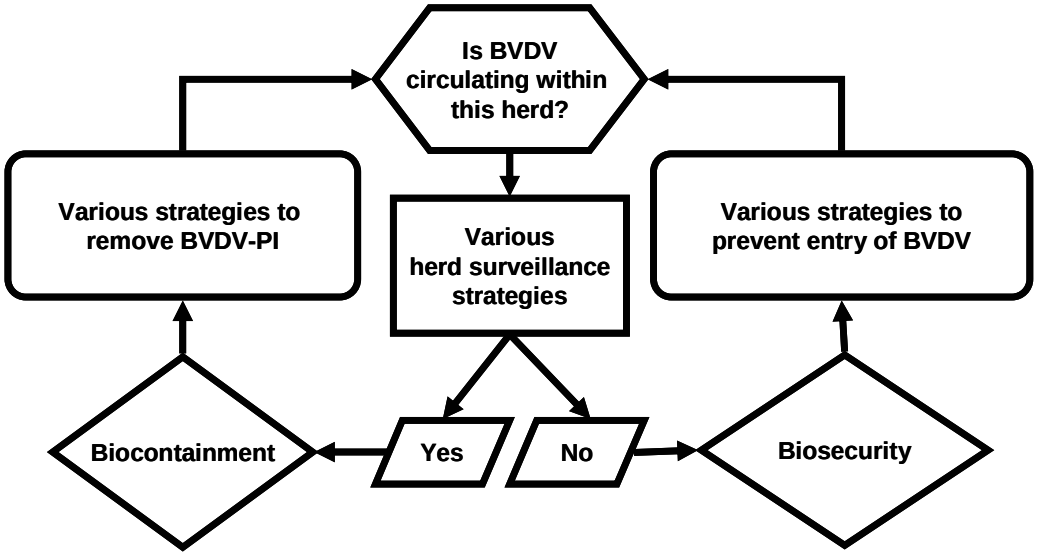

Figure 1. The relationship between herd surveillance, biosecurity and biocontainment for BVDV. Modified from Smith DR, Grotelueschen DM. 2004. Vet Clin N Am 20 (1) 131-149.

The ability to accurately determine the BVDV status of cattle within a herd is vital to BVDV control (Smith and Grotelueschen 2004)(Fig. 2). During a diagnostic

investigation of animal health problems, it may become evident that cattle within a herd are infected with BVDV. However, the virus may be present in many herds without any suspicion of the producer or veterinarian (Houe and Meyling 1991). Without a reliable method to determine the BVDV status of a herd it is difficult to know if the appropriate strategy should be one of biocontainment or biosecurity, and it becomes difficult to monitor and assess the successfulness of the strategies applied. Several reliable diagnostic methods now exist to detect BVDV-infected cattle. Because of the rarity of the BVDV-PI, accurate diagnostic information must be available from essentially all cattle within the herd, regardless of the diagnostic method.

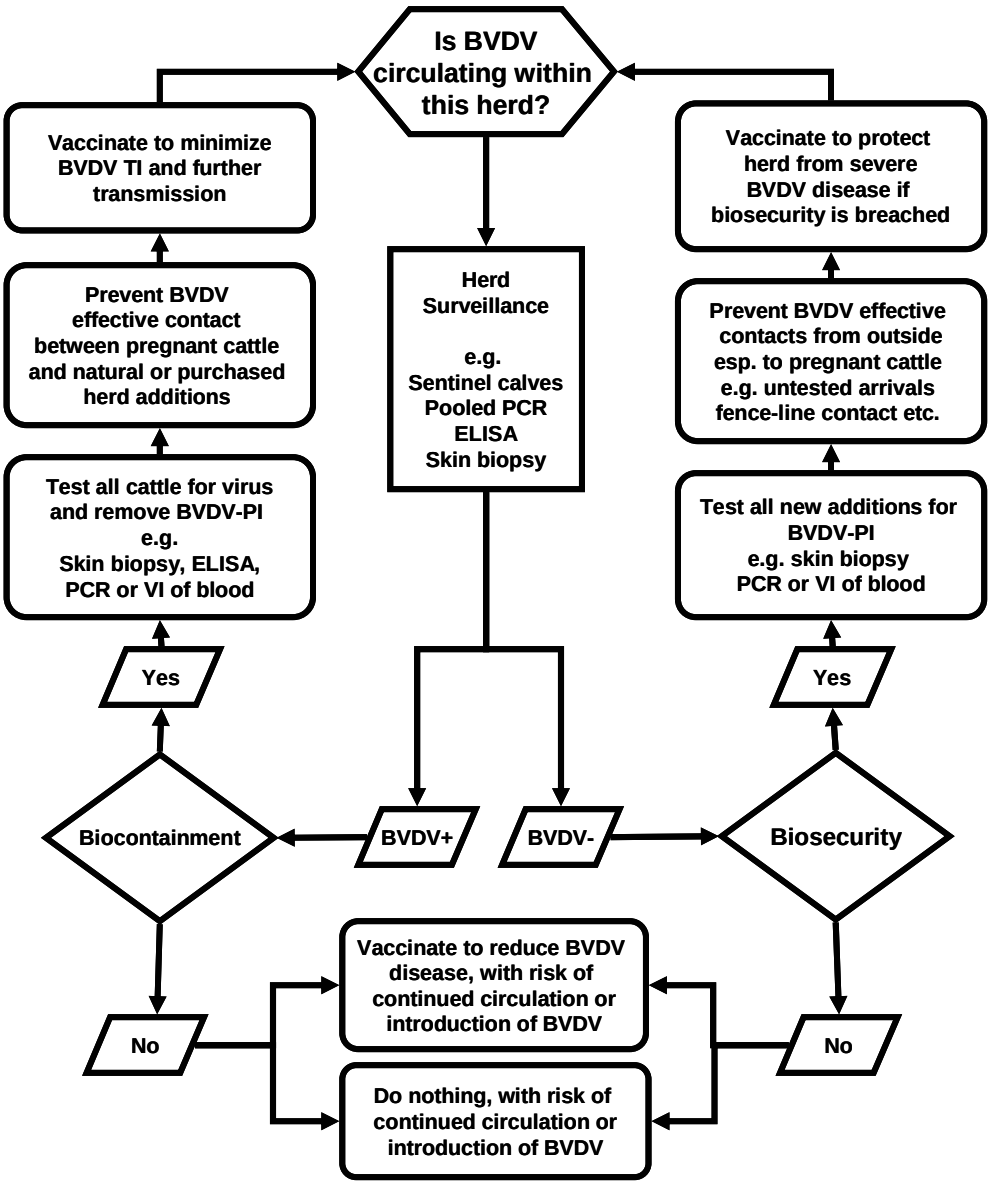

Figure 2. Decision tree for BVDV surveillance, biocontainment and biosecurity. Modified from Smith DR, Grotelueschen DM. 2004. Vet Clin N Am 20 (1) 131-149.

The specific methods by which biosecurity and biocontainment are accomplished could vary depending on the cattle production system. In spite of the various routes of BVDV transmission, preventing contact between susceptible animals and the BVDV PI animal is a key component for the biosecurity and biocontainment of BVDV (Moerman *et al* 1993). The opportunities for contact with PI cattle and the options to prevent contact vary with different types of cattle production systems. For example, seasonal calving systems differ from continuous calving systems by whether or not gestating cattle are present at the same time potentially PI calves are being born. It may not be possible to control BVDV exposure in some production systems; for example, when herds are commingled on range, or when there is unavoidable fence-line contact with other cattle.

The decision to implement biosecurity or biocontainment strategies for BVDV should be based on a careful risk assessment which should include a cost-benefit analysis (Larson *et al* 2002). Costs include the expense of tests, time and manpower to collect samples and maintain records, and the provision of facilities to separate cattle and manage cattle to prevent transmission. The benefits of removing BVDV from a herd include reduced losses from death and disease, improved productivity, and greater reproductive performance (de Verdier Klingenberg K. *et al* 1999, Werdin *et al* 1989). In certain production systems reliable demonstration of BVDV PI-negative status may add market value to seedstock or cattle moving into other production systems such as heifer development operations or beef finishing feedyards. An economic model of beef cow-calf systems showed positive returns from following a biocontainment strategy in circumstances where herd history suggested the presence of PI cattle (Larson *et al* 2002).

The general principles of infectious disease control are applied to the strategies of biosecurity and biocontainment, as appropriate to the production system. These general principles as applied to BVDV are to increase the resistance of the host (individual or herd) to BVDV TI, prevent effective contacts that result in transmission of BVDV, and most importantly to remove or prevent introduction of BVDV PI cattle (Kelling *et al* 2000). Continued surveillance is necessary to demonstrate successful elimination and continued absence of BVDV from the herd.

Biocontainment of BVDV

The goal of BVDV biocontainment is to minimize the occurrence, or severity, of disease associated with BVDV infection, or to completely eliminate the virus from the herd. Biocontainment includes actions to increase host immunity, remove PI cattle from the herd, and prevent effective contact between BVDV-infected and BVDV-susceptible cattle (Kelling *et al* 2000, Smith and Grotelueschen 2004) (Fig. 2).

Host immunity

Vaccines have been used for many years to stimulate immunity against BVDV. Vaccinated cattle are less likely to exhibit clinical signs of disease due to TI (Bolin 1995) and vaccination programs may reduce transmission of BVDV through a cattle population (Thurmond *et al* 2001). Prevention of TI in susceptible pregnant females through vaccination can reduce numbers of BVDV PI calves born when exposure does occur. Vaccines administered prior to breeding have reduced fetal infection resulting in fewer PI

calves following experimental BVDV challenge (Brock and Cortese 2001,Cortese *et al* 1998,Dean *et al* 2003,Frey and Eicken 1995,Zimmer *et al* 2002). Vaccination does not entirely prevent birth of BVDV PI calves even though the risk may be reduced (Kelling *et al* 1990, Kelling 2004). Vaccination alone has not been demonstrated to be an effective strategy for eliminating BVDV from cattle herds (van Oirschot *et al* 1999). However, BVDV has been eliminated from herds with or without vaccination in combination with other strategies to remove and prevent entry of PI cattle and prevent effective contacts (de Verdier Klingenberg K. *et al* 1999,Werdin *et al* 1989).

Elimination of the BVDV PI

In contrast to herd-surveillance, the goal of testing for biocontainment is to accurately determine the BVDV PI status of each individual in the herd. Because the PI animal is the primary source of virus transmission it is essential that all PI cattle be found and removed from the herd. A negative test result of a calf indicates a negative PI status for the dam; however, the dams of PI calves must be tested because they might also be PI. Because the testing is intensive, the cost to remove PI animals from a herd is initially high. Pooled-sample strategies may lessen the cost of detecting PI cattle; however, the performance of these, and other, herd test strategies to accurately determine the status of the herd, and each individual within the herd, must be evaluated carefully. Leaving a single PI animal to remain in the herd breaches the biocontainment effort.

Virus detection assays, including ELISA, PCR, and examination of skin biopsies (ear-notch test) have been used to detect PI cattle. The use of IHC to examine skin biopsies has some practical advantages over other test methods because the sample is easily collected by the producer, the virus is detected even in the presence of circulating maternal antibodies, once in formalin the samples are relatively stable even under harsh environmental conditions that may lessen the quality of other diagnostic specimens, a single positive test is indicative of PI, and microscopic examination of the stained tissue increases test specificity (Brodersen 2004). Animals that have been previously tested by skin biopsy are readily identified by the visible biopsy notch in the ear.

Virus has been observed to circulate for months or years in the absence of PI cattle (Moerman *et al* 1993) although it is not clear if BVDV will circulate indefinitely by TI transmission alone (Cherry *et al* 1998, Innocent *et al* 1997, Sorensen and Enevoldsen 1994). The potential for even temporary continued presence of TI in the absence of PI cattle underscores the importance of efforts to prevent effective contact between pregnant cattle and cattle potentially TI with BVDV so that new PI reservoirs are not generated.

Preventing effective contacts

Effective contacts primarily occur through direct contact with cattle infected and shedding BVDV, especially BVDV-PI cattle. Therefore, preventing transmission of BVDV (effective contact) is primarily accomplished by controlling animal movement. In most cattle production systems effective contacts are minimized by physically separating groups of cattle rather than individuals. From a biocontainment standpoint it is most important to protect pregnant cattle from BVDV exposure. Breeding bulls should also be protected from exposure to potentially PI or TI cattle to avoid venereal transmission of

BVDV. The subpopulations of cattle in a BVDV-infected herd that are most likely to be PI or TI are young-stock or commingled cattle. Incoming sources of cattle also present a risk for PI exposure. These cattle include purchased additions and (especially in the BVDV-infected herd) newborn calves. These sources should be quarantined and tested for PI prior to exposing them to others in the herd.

Biosecurity of BVDV

If there is no indication that BVDV is present within a herd then the issue is biosecurity (Fig 2). The goal of a BVDV biosecurity program is to prevent the introduction of BVDV into the cattle herd and preventing transmission of virus to susceptible cattle (Kelling *et al* 2000). The principles of disease control as discussed under biocontainment also apply to biosecurity except that sources of direct or indirect BVDV exposure come from outside the herd rather than from within. Again, the most important subpopulation to protect from exposure is pregnant cattle, especially those in early gestation. The herd must be protected from direct exposure to cattle from other herds that may be BVDV TI or PI. Examples of these exposures include fenceline contact, movement to and from fairs or exhibitions, an new herd additions. Actions must be taken to prevent indirect exposure to BVDV from fomites such as contaminated clothing, shared feed or water troughs.

Quarantine of new additions for at least 3 weeks helps to prevent exposure of the native herd to arriving BVDV TI cattle. Each new addition must be tested for BVDV PI while in quarantine or prior to arrival so that these primary reservoirs of virus can be removed before they are commingled with the native herd. New additions that arrive pregnant should not calve in the presence of pregnant cattle from the native herd. The calves born to pregnant new additions must be isolated from the native herd until their BVDV PI status can be determined.

Beef feedyards and heifer development operations present a special biosecurity challenge because the opportunity to introduce BVDV PI animals into these systems is increased by the frequent introduction of cattle usually commingled from multiple sources. The presence of PI cattle may affect the health and performance of pen-mates (Grooms *et al* 2002, Loneragan *et al* 2002) and dairy or beef heifers exposed to BVDV during gestation at a heifer development facility may later give birth to PI calves in destination herds. BVDV exposure could be minimized in these facilities by testing all new arrivals and removing PI cattle during a quarantine period of 2-3 weeks and prior to entering into the primary facilities (Smith 2002).

Elimination of BVDV PI early in the production system, such as at the cow/calf level, benefit the cattle industry at subsequent points, such as at feedyards and heifer development enterprises. Ideally, procurement of animals from biosecure herds and animals previously BVDV PI tested negative would eliminate the risk for BVDV exposure from PI animals in these types of operations.

Infectious disease models show that after BVDV is eliminated the cattle become increasingly susceptible to new infections and the possibility increases of an outbreak with severe clinical signs following a new BVDV exposure (Cherry *et al* 1998,Innocent *et al* 1997,Sorensen and Enevoldsen 1994). Thus, in the absence of strict biosecurity, recurring patterns of re-infection with severe clinical signs are expected every few years following elimination of the virus. In North America and other regions, where BVDV is common and re-exposure is likely, it remains prudent to continue vaccination after eliminating the virus from the herd.

Summary

Bovine viral diarrhea virus (BVDV) causes losses to cattle production worldwide. Our understanding of the epidemiology of BVDV has advanced, and with recent developments in diagnostic methodology it is now possible to control this important disease. However, losses due to this virus will continue until effective actions are taken within cattle operations to prevent further transmission. Important steps for BVDV control are herd surveillance to determine the presence of virus, biocontainment to eliminate the virus from herds where it is present, and biosecurity to keep the virus out of the herds where it is absent. Each step of BVDV control presents challenges to, and requires commitment from cattle producers and their veterinarians.

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