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Bovine Viral Diarrhea Beef-Herd Risk Assessment

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(Adapted from Grooms, et al., *Integrated BVD Control Plans for Beef Operation*. The Bovine Practitioner. 2009. Vol. 43, No. 2. pp 106 – 116)

Understanding where the greatest risk to a herd is relative to the introduction of bovine viral diarrhea (BVD) virus, is paramount to controlling or preventing economic losses to BVD. One of the first steps in the risk assessment process is determining if BVDv is present in the herd.

The virus can be present in the herd as transient infections or through persistently-infected animals. Transient infections are those acute viral episodes that infects the animal, to which the animal then mounts an immune response which often eliminates the disease from the animal following a period of reduced productivity due to the fact that the animal's immune system is trying to eliminate the virus. These infections can be spread from animal to animal depending on herd immunity.

Persistant infections, on the other hand, are caused by animals who are infected with disease *in utero*. When exposed during the critical window of time between the second and fifth month of gestation, the naïve fetal immune system may not recognize the virus as foreign. In this scenerio the virus is identified by the immune system as "self" or "normal" and thus the fetus and subsequent calf becomes persistently infected (PI). These PI animals shed the virus when born in remarkable amounts. While transient infections are most commonly found in herds, PI animals can add significantly to a herd's viral load when present.

The first box of Figure 1 ranks the cost and reliability of different techniques used to determine if the virus is circulating within the herd; ranked from least reliable (top) to most reliable (bottom). For example, the observation for clincial signs is much less costly and reliable than submiting biological (i.e, ear) samples for testing.

If BVDv is circulating in the herd the main objective becomes biocontainment. Biocontainment is simply defined as processes and procedures implemented to prevent further exposure or risk from a known disease or issue. With BVDv, the second box of Figure 1 illustrates two objectives to consider in biocontainment. These include minimizing the negative impact of infection and the elimination of circulating virus within the herd.

Vaccination and testing are critical components in biocontainment as it relates to BVD. The overall objective with these two tools is to increase herd immunity through vaccination and to identify PI's through testing. There are two different types of vaccines available for use against BVDv, they are commonly referred to as "killed" or "modified-live." There are pros and cons to using either inactivated (killed) or attenuated (modified live) vaccine preparations. Table 1 dicusses the advantages and disadvantages of both.

There are several methods used to diagnose the virus in the herd. Table 2 organizes these tests and discusses some of the limitations of each. The most common sample submitted is an ear notch, and the most common test preformed is antigen-capture ELISA (ACE). ACE testing of ear notches seems to be very reliable and has a relative low cost when compared to others. Ears are handy to sample from, but any skin sample will suffice.

Vaccination timing plays a large role in minimizing risk. Figure 2 illustrates the most and least reliable vaccination schedules and timing to prevent disease in calves and heifers. It is recommneded that vaccinating calves early (4 months of age) and often (giving boosters) will increase their immunity and decrease the risk for disease (Figure 2). For heifers and cows, making sure that they are boostered with a modified live BVDv vaccine, 30 days prior to breeding is the more reliable management pracatice for preventing PI calf development (Figure 2).

Table 1. Different Bovine Viral Diarrhea vaccine types.

Vaccine type	Advantages	Disadvantages	Notes
Killed	• Safe in all classes of cattle	• Shorter duration of immunity • Require two doses initially • May require frequent boosters	• Individual doses of killed vaccine can be aseptically removed from bottles over time.
Modified-live (MLV) or attenuated	• Rapid response • Can induce immunity with a single dose • Broader protection • Longer duration of immunity • Better efficacy for fetal protection	• Can cause abortion • Immunosuppression	• MLV vaccines must be reconstituted just prior to use and then must be used within two hours.

Bulls have been proven to transmit the disease both in semen and by direct contact. Do not forget to address disease mitigation in the bulls in the herd through development of a vaccine program for them that best reduces risk (Figure 2). The best recommendation includes the use of a cytopathic modified live virus in bulls. Bulls vaccinated with non-cyctopathic vaccine have shed virus in their semen. Most U.S. common modified live BVDv vaccines contain only cyctopathic strains of BVDv.

If virus is not circulating in the herd, then biosecurity becomes very important in minimizing the risk for introduction of the virus. Figure 1 suggests the most reliable management practices for reducing the risk of BVDv introduction. Initiating all of the recommendations of biosecurity in Figure 1 should reduce or eliminate most of the risk. Testing all replacement animals and implementing a strict 21-day quarantine is the most reliable way to minimize risk. This suggestion may also be the most restrictive.

This information is intended to be used as a reference from which to start the conversation for establishing management procedures to prevent loss from BVDv. In summary, understanding the risk for BVDv to your herd is critical to preventing, controlling, or eradicating the disease. The first step is to determine if the virus is already present in the herd. There are more reliable methods to help you determine if BVDv is present, with targeted testing being the most reliable and most costly (Figure 1). Depending on the answer to the question, “Is BVDv present?” you will either want to consider implementing principles of biocontainment (virus present) or biosecurity (virus not present) (Figure 1). Vaccination can be a good tool in minimizing the impact of BVDv in the herd or to be used in helping to prevent the development of PI animals. In general, using a modified-live virus preparation early and often (including 30 days prior to breeding in heifers) is the most reliable way to prevent PI animals (Figure 2). Remember, there are considerations to be aware of when choosing between the two types of vaccines (Table 1).

For further information concerning the prevalence of BVDv in your area, and for help in designing a vaccination/testing program for your herd, please consult your local veterinarian.

Figure 1. Is BVDV circulating in the herd?

Methods to answer the question:

Lowest Cost & Least Reliable ↕ Highest Cost & Most Reliable

1.	Observe for clinical signs of disease.
2.	Observe for clinical signs of disease. Submit samples from all aborted and underweight calves for BVDV testing.
3+2.	Submit blood samples for antibody detection from unvaccinated sentinel animals that are ≥ 7 months of age and have experienced close contact with all other animals in the herd at least one month prior to sampling.
4+2.	Submit ear notches from young calves for validated pooled PCR testing.
5+2.	Submit ear notches from young calves for individual testing (ELISA or IHC).
6+2.	Submit ear notches from young calves, non-calving females and bulls for individual testing (ELISA or IHC).

Answer: BVDV is circulating in the herd.

Objective 1: Minimize the negative impact of infection = biocontainment.

1.	Prevent direct commingling of untested, young calves with groups of pregnant females other than their lactating dams.
2.	Prevent fence line contact of untested, young calves with groups of pregnant females other than their lactating dams.
3.	Prevent contact of imported pregnant females (< 150 days of gestation) with other animals in the herd.

Objective 2: Eliminate circulating virus from the herd = biocontainment.

Higher Cost & More Reliable

1.		Before breeding cows, submit ear notches from *previously untested* young calves, non-calving females, and bulls for individual testing (ELISA or IHC).
	a.	Submit ear notches from *previously untested* dams of all calves that tested positive.
	b.	**Remove all PI animals from the herd.**
		1. If pregnant animals are present in the herd when the last PI animal is removed, submit ear notches from all calves born within the next 12 months. Remove any positive calves from the herd. Continue testing newly born calves until 12 months elapse with no positive calves born.

Follow-up: Consider re-evaluation of question on a scheduled basis and consider vaccination to minimize the negative impact of infection (See Figure 2). Consider options to keep herd free of BVDV (outlined below).

Answer: BVDV is NOT circulating in the herd.

Objective: Keep the herd free of BVDV = biosecurity.

Least Restrictive & Least Reliable ↕ Most Restrictive & Most Reliable

1.		Observe for clinical signs of disease in imported animals before adding to the herd. Submit samples from all aborted, sick, dying and underweight calves for BVDV testing.
2.		Prevent fence line contact of imported stocker calves with pregnant females. Import bulls, pregnant replacement heifers, and non-pregnant replacement heifers into the herd only after a negative BVDV test.
3.		Import stocker calves, bulls, pregnant replacement heifers, and non-pregnant replacement heifers into the herd only after a negative BVDV test.
4.		Import stocker calves, bulls and non-pregnant replacement heifers into the herd only after a negative BVDV test and 21-day quarantine.
	a.	Pregnant replacement heifers can only be imported if they are quarantined during pregnancy and the resulting calf is tested negative by ear notch IHC or ELISA before addition to the herd.
5.		Import bulls and non-pregnant replacement heifers into the herd only after a negative BVDV test and 21-day quarantine.
6.		Only import semen cryopreserved under guidelines established by Certified Semen Services (CSS) and embryos washed according to International Embryo Transfer Society (IETS) guidelines.

Follow-up: Consider re-evaluation of question on a scheduled basis and consider vaccination of susceptible animals to ensure that BVDV does not amplify and cause significant disease if introduced into the herd (See Figure 2).

Table 2. Summary of BVDV diagnostic tests and their uses.*

Diagnostic test	Relative cost	Specimen	Used for	Notes
Polymerase chain reaction (PCR)	Low to high	Serum, whole blood, tissue	Identifying persistently infected (PI) animals and acute infections	Rapid and sensitive. Can detect acute infections and vaccine virus within limited time frames post exposure.
Polymerase chain reaction (PCR)	Low to high	Skin - usually taken from ear	Identifying PIs	Skin samples can be pooled to reduce costs. Number per pool depends on laboratory. Rapid results.
Immunohistochemistry (IHC) of skin	Low	Skin - usually taken from ear	Identifying PIs	Fresh or formalin-fixed samples. Work closely with laboratory to provide preferred sample.
Antigen-capture ELISA (ACE)	Low	Serum or skin	Identifying PIs	Rapid results. Serum testing may be inhibited by passive immunity, thus not recommended for young calves.
Virus isolation	Moderate to high	Serum, whole blood, tissue samples – spleen, lung, small intestine (ileum), thymus	Identifying acute or persistent infections	Gold standard test for detecting BVDV; however, expensive, takes a long time to conduct, and requires specialized labs.
Virus neutralization or antibody ELISA	Low	Serum	Identification of virus exposure – NOT useful for detecting PIs	Detects immune response (titer) to BVDV.

Reason for testing	Suggested diagnostic test
Diagnosis of acute infection including: • sick animals • dead animal • abortion	• Virus isolation from tissues, serum or whole blood • PCR from tissue, serum or whole blood
Detection of PIs in calves younger than four months of age	• PCR on pooled skin samples • Skin IHC • Skin ELISA
Detection of PIs in calves older than four months of age	• PCR on pooled skin samples • Skin IHC • Skin ELISA • Blood ELISA

*Table adapted from Larson *et al*, *Bov Pract* 39:96-100, 2005.

Figure 2. How can vaccination for BVDV be used most effectively to minimize the negative impact of disease on a farm?

Vaccination of calves to prevent subsequent disease:

Least Reliable	1	Vaccination prior to four months of age with a single dose of killed virus administered to healthy calves that nursed adequate colostrum. **NOT RECOMMENDED**
	2	Vaccination after four months of age with a single dose of killed virus immediately before weaning, transport, and commingling. **NOT RECOMMENDED**
	3	Vaccination prior to four months of age with a single dose of modified-live virus administered to healthy calves that nursed adequate colostrum.
	4	Vaccination after four months of age with two doses of killed virus two to four weeks apart on the farm of origin with the second dose immediately before weaning, transport, and commingling.
	5	Vaccination after four months of age with a single dose of modified-live virus immediately before weaning, transport, and commingling.
	6	Vaccination after four months of age with two doses of killed virus four weeks apart on the farm of origin with the second dose at least two weeks before weaning, transport, and commingling.
	7	Vaccination after four months of age with a single dose of modified-live virus at least two weeks before weaning, transport, and commingling.
	8	Vaccination after four months of age with two doses of modified-live virus four weeks apart on the farm of origin with the second dose immediately before weaning, transport, and commingling.
Most Reliable	9	Vaccination after four months of age with two doses of modified-live virus four weeks apart on the farm of origin with the second dose at least two weeks before weaning, transport, and commingling.

Vaccination of developing heifers to prevent reproductive losses:

Least Reliable	1	Vaccination of heifers prior to breeding with a single dose of killed virus. **NOT RECOMMENDED**
	2	Vaccination of heifers with two doses of killed virus with the second dose at least 30 days before initial breeding.
	3	Vaccination of heifers with a single dose of modified-live virus at least 30 days before initial breeding.
Most Reliable	4	Vaccination of heifers with two doses of modified-live virus with the second dose at least 30 days before initial breeding.

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