Japanese Journal of Veterinary Research 60(Supplement): S41–S49, 2012

REVIEW

Preventive strategy for BVDV infection in North America

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Received for publication, December 13, 2011; accepted, December 21, 2011

Abstract

Despite 60 years of vaccination, bovine viral diarrhea virus (BVDV) infections remain a source of significant economic loss for producers in the United States. Control program design in the United States varies by region based on the incidence of BVDV, density of animal populations, animal movement, contact with wildlife populations, level of producer compliance, variation among circulating BVDV strains, prevalent type of production unit or industry and support offered by state institutions. The Upper Peninsula BVDV Eradication Program in Michigan, the Montana BVD-PI Herd Biosecurity Project, the Washington State BVDV Testing program and the Alabama Voluntary BVD Control Program illustrates four different regional approaches. All four programs are voluntary rather than government mandated and a large component of each was the identification and removal of animals persistently infected with BVDV. The Washington, Montana and Alabama programs focus on herd screening to eliminate PI's but did not have eradication as a goal. The Michigan program was unique in that its goal was to eradicate BVDV from a defined geographic region. While the Washington, Alabama and Montana programs were beneficial to individual producers they did not have a significant impact on the prevalence of BVDV. In contrast, the Michigan program has reduced incidence of herds harboring PI animals in the region. Organizers of all four programs noted that compliance with control programs was directly linked to education and the presence of a support network composed of fellow producers, engaged veterinarians and knowledgeable diagnosticians.

Key words; bovine viral diarrhea virus, control program, testing, eradication, persistent infection

Introduction

Both species of bovine viral diarrhea viruses (BVDV), bovine viral diarrhea virus 1 (BVDV1) and bovine viral diarrhea virus 2 (BVDV2) are endemic to the United States (U.S.). BVDV have been isolated in the U.S. from domestic species such as cattle, sheep, milking goats and alpaca and wildlife species such as bison, mountain goat and white tailed deer.[21] The impact of the virus on the U.S. livestock industry led the Academy of Veterinary Consultants to adopt a position statement, issued in 2001, that reads as follows; *"The beef and dairy industries suffer enormous*

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loss due to effects of bovine diarrhea virus (BVDV) infection. The highly mutable nature of BVDV and the emergence of highly virulent strains of BVDV contribute to limited success of present control programs. Also, persistently infected cattle are the primary source of infection and effective testing procedures are available to identify those infected carriers.

Therefore, it is the resolve of the Academy of Veterinary Consultants that the beef and dairy industries adopt measures to control and target eventual eradication of BVDV from North America."

Early efforts to control BVDV in the U.S. focused on vaccination. Vaccines against bovine viral diarrhea viruses (BVDV) have been available in the U.S. since the 1960's and vaccination has been shown to be efficacious under controlled conditions.[8] However a half century of vaccination, as a stand-alone control measure, has not resulted in the elimination of BVDV related clinical disease or a significant reduction in BVDV losses for U.S. producers[13,16]. The incidence of BVDV in the U.S. cattle herds (as defined by herds with one or more animals persistently infected with BVDV) has remained fairly constant, averaging about 9% over the past 25 years of testing.[4,7,24–27,29]

As in other countries the chief vectors for introduction of BVDV into naïve herds are persistently infected animals (PIs). Persistent infection has been demonstrated in multiple species besides cattle and is the result of in utero infection in the first one third of gestation. The failure of vaccination to reduce the incidence of BVDV in the United States plus the success of BVDV eradication and control efforts in Europe,[15,18,23,28] have led to the realization that vaccination must be combined with elimination of persistently infected animals and institution of biosecurity measures.

The U.S. federal government has no initiatives aimed at BVDV control and eventual eradication. Thus, a U.S. control program will need to be producer driven. While there is interest among producers in BVDV control, current market conditions are not favorable for new control initiatives. The U.S. national inventory of cattle currently stands at 100 million (Table 1). This is the lowest cattle inventory since the USDA started recording the July cattle inventory in 1973.[20] The 2011 calf crop is expected to be the smallest in over 60 years. The reduction in calf crop is attributed to high feed prices, a severe drought in the Southern Plains, and a weak U.S. economy impacting on cow/calf producers, many of whom rely on off-farm employment to cover operating expenses. Reduced cattle numbers and a weak economy negatively impact on producers' interest and ability to participate in control programs.

Variations in the U.S. that work against a "one size fits all" approach to BVDV control

There are significant differences across the U.S. in the prevailing type of production unit, the density of cattle populations, animal movement, contact with wildlife populations, level of producer interest/compliance and support offered by state institutions.

Historically dairy production in the U.S. was concentrated in states located in the Northeastern and upper Midwest sections of the country. The past two decades have seen a large shift to production in Western states and an increase in the size of dairies (Table 2). Since 2001, the number of operations with 500 or more head of milk cows has increased by 20 percent.[1] Such herds now account for over 60% of U.S. milk production, which is an increase of over 20% in 10 years. The fastest growth has been in the number of herds with 2000 cows. The number of these herds has more than doubled, from 325 to 740, in the last decade.

The beef industry in the U.S. has two major components, cow/calf operations and feeder operations. While all 50 states have some beef production the highest concentration of beef

Table 1. Summary of U.S. Cattle Inventory, July 2011[a]

	Number of animals (in millions)	Change from 2010
Total inventory	100.0	Decreased 1.1%, Lowest inventory since 1973
Dairy cows that have calved	9.2	Increase of 0.5%
Beef cows that have calved	31.4	Decreased 1.1%
Calf crop	35.5	Down 0.5%, smallest calf crop since 1950
Replacement heifers dairy	4.2	Increased 3.7%
Replacement heifers beef	4.2	Decreased 4.5%
Sent to Commercial Slaughter	34.2	Predicted decrease of 0.4%

[a]Data from July 2011 Semi-Annual Cattle Inventory[20]

Table 2. Dairy production and herd size in the U.S.[b]

Top five producing states	Size of operation	Number of herds	Milk production	Milk cow inventory
California, Wisconsin, New York, Idaho, Pennsylvania	Total	65,000		
	Herd size greater than 500 cows	3,350	60%	56%
	Herd size less than 500 cows	61,650	40%	44%

[b]Data from the 2010 NASS report[1]

Table 3. Beef production and herd size in the U.S.[c]

Top five producing states	Cow/calf production		Feedlot	
			Size of Feedlot	% of total cattle on feed
Texas, Kansas, Nebraska, Iowa, Colorado	Total number of herds	742,000	Less than 1000 head	17.9
	Herd size greater than 100 cows	10%	1000–7.999 head	17.1
	Herd size less than 100 cows	90%	8000–15,999 head	11.1
			16,000–31,999 head	18
			32,000 or greater	35.9

[c]Data sources are July 2011 Semi-annual Cattle Inventory Summary[20], Cattle-FAX[6] and Economic Research Service/USDA[22]

production, both feedlot and cow/calf, is centered in five states located in the Midwest and Southwest regions of the country (Table 3). The national inventory of beef cows is over three times higher than that of dairy cows (Table 1). Beef cow/calf herds tend to be smaller, averaging 42 cows per herd. The average dairy herds is over three time larger, averaging 130 cows per herd.

The difference in the number of animals managed between different types of production units may be a determining factor in a producers experience and interest in BVDV control. Based on surveys conducted by the National Animal Health Monitoring System (NAHMS) nearly four times as beef cow/calf producers have not heard of BVDV as opposed to dairy producers (Table 4).[7,27] The likelihood of being familiar with BVDV increased with the size of the cowherd in the production unit. This may be associated with the likelihood of having first hand experience with a PI in their production unit, as the incidence of having a PI increases with herd size (Table 5). Currently more feedlots managers (94%)[2] routinely vaccinate against BVDV than managers in either dairy (75%)[25] and beef cow/

Table 4. U.S. producer familiarity with BVDV[d]

Level of familiarity	Dairy Producers	Beef Producers
Fairly knowledgeable	31.3	33.8
Knew some basics	47.6	33.5
Recognized the name, not much else	18.6	23
Had not heard of BVDV before	2.5	9.6

[d]Data from NAHMS 2007 dairy study and 2007–2008 beef cow/calf study.[7,25,27]

Table 5. Incidence of BVDV by herd size in U.S. dairy and beef cow/calf operations[e]

Dairy (bulk milk tank test)			Beef cow/calf (ear notch test of calves)	
Less than 100	100–499	More than 500	Less than 100	Greater than 100
0	3.5	12.8	1.6	12.1

[e]Data from NAHMS 2007 dairy study and 2007–2008 beef cow/calf study.[7,25,27]

calf (41%)[3] operations. The use of vaccination increases with herd size and feedlot size. The results of testing of feedlot animals for persistent infection are reported more frequently in the literature than testing of animals in dairy or cow/calf production units. The more frequent use of vaccines and testing in feedlot operations may be related to a greater likelihood of a feedlot harboring a PI animal. Recent publications have estimated the prevalence of BVD PI in beef feedlots to be between 0.2 and 0.4%.[10,12,17] As 87% of U.S. feedlots house greater than 1000 head of cattle (Table 3) it is probable that the majority of U.S. feedlots house a PI. This suggests that the majority of feedlot managers have seen first hand the effects of the PI animals on production. In addition, feedlot managers have access to studies detailing the economic impact of PI animals on performance in feedlots.[5,9,11] Similar information regarding the economic impact to dairy and beef cow/calf producers is not available. While feedlot operators may be the most motivated to control BVDV, it is generally accepted that the most effective control programs will focus on preventing and removing persistently infected animals from cow-calf operations.

Regional BVDV control programs

The Upper Peninsula BVDV Eradication Project (UPBEP) in Michigan, the Montana BVD-PI Herd Biosecurity Program (MBHBP), the Washington State Bovine Viral Diarrhea Control Eradication Program (BVDCEP) and the Alabama Voluntary BVD Control Program (AVBCP) illustrate four different regional approaches (Table 6) that have been used in BVDV control in the U.S. All four programs were supported by a consortium, that consisted variously of producer groups, state diagnostic laboratories, state and federal agriculture extension programs, the U.S. Department of Agriculture (USDA) and/or commercial biologics companies. Producer participation was voluntary rather than government mandated and a large component of each was the identification and removal of animals persistently infected with BVDV. In addition each program provided educational programs aimed at increasing producers understanding of BVDV and the problems it causes.

The detected incidence of PI positive herds was similar in all four programs, ranging from 13.3 to 3.9 percent. The rate of PI detection, in samples tested, was also similar in all programs, ranging from 0.10 to 0.92 percent. These results suggest that, in agreement with earlier studies, a

Table 6. Comparison of four regional control programs in the U.S.

Program	Time period	Herds (animals tested)	Herd status	PI	Cost of test to producer	Population tested	Production unit type	Online Information
Washington State BVD Control and Eradication Project[e]	2008–2009	60 (9881)	13.30%	0.92% of calves tested	$1.00	84% calves, 16% older animals	beef	http://www.vetmed.wsu.edu/bvdcep/vets/BVDCEP%20Oct%202008%20Results.pdf
Montana BVD-PI Herd Biosecurity Project[f]	2006–2009	585 (190,000)	6.5 %	0.10%	$1.95	primarily calves	beef	http://www.mtbqa.org/news/09BVDPI/2009%20Overview.pdf http://www.mtbqa.org/bio6.cfm http://www.ag.ndsu.edu/HettingerREC/beef/2008-beef-day-presentations/AAHRECBiosecurity-BVD-PIScreening.pdf
Alabama Voluntary BVDV Control Program[g]	2006–Present	335 (21,879)	4.7 % (2008 and 2009 only)	0.25%	$3.00	Not determined	Not determined	http://www.alafarmnews.com/index.php?option=com_content&view=article&id=579:from-the-state-vets-office&catid=38:from-the-state-vets-office
Michigan Upper Peninsula BVDV Eradication Project[h]	2008–2011	232 (17,917)	3.90%	0.13%	No cost	whole herd	mixed beef and dairy	http://cvm.msu.edu/alumni-friends/continuing-education/bvdup

[e]Program instituted and supported by Washington State University (WSU) Extension, Veterinary Clinical Sciences and Animal Sciences Departments and the Washington Animal Disease Diagnostic Laboratory (WADDL)

[f]Program instituted and supported by Montana State University and Montana Stockgrowers Association

[g]Program instituted and supported by Alabama Beef Cattle Improvement Association, Alabama Cattlemen's Association (ACA), Alabama Cooperative Extension System, Alabama Department of Agriculture and Industries, Alabama Farmers Federation (ALFA), Alabama Veterinary Medical Association, Auburn University College of Agriculture, Auburn University College of Veterinary Medicine, National Animal Disease Center, and the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services.

[h]Program instituted and supported by Michigan State University Extension, College of Veterinary Medicine and Diagnostic Center for Population and Animal Health and supported by the Michigan Department of Agriculture, Animal Industry Division, the United States Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services, and Pfizer Animal Health

minority of BVDV herds harbor a PI animal. Further analysis of participating producer practices indicated that the larger the herd the more likely a producer was to posses basic information on BVDV and to include BVDV testing and vaccination as part of their standard herd health program.

Alabama Voluntary BVD Control Program

The AVBCP was the first program of the four to go into effect and is the only program that remains fully operational. Its' stated goal is to provide a cost effective method for controlling BVDV in Alabama cattle operations. There are three components to the program. One component is Education/Management. This component included holding introductory meetings for producers and veterinarian to explain the purpose of the AVBCP, publishing articles in producer magazines and presenting seminars at annual veterinary and producer meetings. The second component was herd testing. Producers are provided with tools and materials to collect and ship ear notch samples. The cost of testing is $3.00 USD per test. The results of testing, from 2006 to 2009, is summarized in Table 6. A third component of the program was herd enrollment. This was the least successful component of the program. The purpose of this component was to offer certification for BVDV PI "free" or "test-negative" herd status for herds that met the testing criteria. So far no herds have expressed interest in official enrollment. At this point the developers of the program have no metrics for determining the impact of the program.

Montana BVD-PI Herd Biosecurity Project

The next of the four control efforts put into practice was the MBHBP. It was created as a segment of the Montana Beef Quality Assurance program. The stated goal of the project was to reduce the risk of introducing BVDV into Montana beef herds by providing cow-calf producers with BVDV education, BVDV herd risk assessment, testing protocols to screen herds for PI cattle, and strategies to optimize herd biosecurity and management. It began by providing technical assistance and testing supplies to Montana ranchers so that they could screen their herds for PI animals. This program focused on testing ear notches from calves. The ear notch samples were pooled[14] and tested by polymerase chain reaction. The subsidized cost to the producer was $1.95 USD per test. Participants had the opportunity to complete a risk assessment profile for their production unit. Data compiled from the program was used to estimate the relationship among common management practices and herd BVDV status.[19] It was found that vaccinating heifers and bulls prior to introduction to the resident herd correlated with reduced rates of BVDV positive herd status. There was also a correlation between prior BVDV education and improved producer understanding and compliance with BVDV control protocols. Such producers were less likely to engage in high risk management practices such as using communal grazing. However they were more likely to engage in other high risk management practices such as transfer of pregnant heifers into resident herds. These findings suggest that either beef producers do not recognize the risk posed by import of pregnant animals from outside raiser facilities into the herd or other constraints such as pasture management, labor allocation or forage availability forces managers to adopt this practice in order to optimize herd production.

Washington State BVD Control and Eradication Project

The goals of this project were to Promote cow-calf herd health by facilitating implementation of infectious disease control best mangement practices and herd screening for BVDV

persistently infected animals to control and reduce the prevalence of BVDV in the state of Washington's cow-calf herds. The proposed approaches were to assist producers in establishing best management practices and subsidize herd testing for BVDV persistently infected animals. In addition this project had research components aimed at identifying genetic regions that result in resistance to BVD and determining the cost of BVD to the cattle industry. This effort was successful in generating a best management practices document and an on-line continuing education course for veterinarians covering BVDV basics and testing. However less than half of the anticipated number of producers enrolled and the project was ended after two years. No research results have been reported in the literature.

Michigan Upper Peninsula BVDV Eradication Project

The objective of this project were to initiate a BVDV eradication project in a predetermined geographical region. The goals were identifying benefits and obstacles associated with eradication in order to develop a feasible model that could be adopted nationally for BVDV eradication.

The Upper Peninsula of Michigan (UP) is the northern of the two major land masses that make up the U.S state of Michigan. The UP is bounded on the north by Lake Superior, on the east by St. Mary's Rive, on the southeast by Lake Michigan and Lake Huron on the southwest by the U.S. state of Wisconsin. The UP contains 16,452 square miles (42,610 km^2), most of which is heavily forested and not suitable for farming. The upper peninsula of the state of Michigan was selected because it is geographically isolated, has relatively few cattle production units and there is very little import of cattle into the region.

One of the unanticipated problems was obtaining a accurate and complete list of all cattle owners and operating production units in the PI. The only public records available were dairy producer licenses. There were no records for beef cow-calf, feedlot, heifer or bull raiser units. Thus the project had to rely on mass communication and word of mouth. To create awareness of the project, articles were included in the monthly newsletter published by the Michigan State University Extension Office and producer magazines. A total of 51 meetings were held and 19 different direct mailing pieces were sent to producers. A total of 26,148 cattle in 294 production units were enrolled in the program. This represents 53% of the cattle in the UP and 59% of the total cattle production units. A producer survey sent to 497 cattle producers in the UP in 2011 was completed and returned by 140 producers (28%). Of those responding, 61 percent said that they will not test all new cattle coming into the herd, 59 percent will isolate new cattle for 30 days before introducing them into the herd and 58 percent will used their BVDV PI free information to help them market their cattle.

Lessons learned

It appears that enthusiasm for BVDV control programs in the U.S. declined between 2006 and 2011. While there are a number of contributing factors to the decline in interest by producers, the economic decline in the U.S. had a major impact. Increased production costs and declining profit margins left producers with limited funds for testing. However, this decline in interest may be temporary. The current uptick in dairy markets may revive interest. Beef cow numbers must increase if beef production is to be maintained. Rebuilding herds is usually accompanied by increased traffic in bred heifers. Increased traffic in bred heifers in the past has resulted in increased risk of BVDV PI introduction into herds. Increased incidence of BVDV could results in increased demands for BVDV control.
Based on their observations, the organizers of the UP BVDV eradication project make the

following recommendations;

1. Target an entire region at one time in order to capitalize on the enthusiasm and interest of a new disease management program. Interest seems to wane in the ensuing years of a program.
2. Ensure that adequate manpower is available to manage the workload.
3. Create a written plan detailing required resources and manpower with a realistic time line.
4. There must be a marketing and communication plan for the entire length of the project.

A lesson learned from all four projects is that BVDV control programs are as much about working with people as they are about the technical aspects of detection, vaccination and biosecurity.

Acknowledgement

The author thanks Dr. Dan Grooms (Michigan State University), Dr. John Wenz (Washington State University), Dr. Brad White (Kansas State University) and Dr. Soren Rodning (Auburn University) for their help in writing this manuscript.

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