PEER REVIEWED

Case report: Emergence of bovine viral diarrhea virus persistently infected calves in a semi-closed herd

Pamela J. Ferro,[1] PhD; **Malcomb G. Fearneyhough,**[1] DVM; **Clint Calvert,**[2] DVM; **John D. Neill,**[3] PhD; **Julia F. Ridpath,**[3] PhD
[1]Texas A&M Veterinary Medical Diagnostic Laboratory, College Station, TX 77843
[2]Alvarado Veterinary Clinic, Alvarado, TX 76009
[3]USDA-ARS, National Animal Disease Center, Ames, IA 50010
Corresponding author: Dr. Pam Ferro, pferro@tvmdl.tamu.edu

Abstract

Bovine viral diarrhea virus continues to have significant economic impact on the cattle industry worldwide. The virus is primarily maintained in the cattle population due to persistently infected (PI) animals. Herd surveillance, along with good vaccination programs and biosecurity practices, are the best way to mitigate losses and production of PI animals. Two PI calves were identified in a semi-closed beef herd with excellent management practices, highlighting the continued significance and persistence of this virus in the cattle population.

Key words: BVD, persistent infection, PI, biosecurity

Résumé

L'impact économique du virus de la diarrhée virale bovine pour l'industrie bovine demeure important partout dans le monde. Les animaux immunotolérants sont la principale source de ce virus dans le cheptel bovin. La surveillance des troupeaux de même que de bons programmes de vaccination et de biosécurité sont les meilleurs moyens afin de réduire la perte et la baisse de production des animaux immunotolérants. On a identifié deux veaux immunotolérants dans un troupeau de bovins de boucherie semi-fermé ayant pourtant de très bonnes pratiques de régie. Ces cas mettent en lumière la persistance et l'importance que continue d'avoir ce virus dans le cheptel bovin.

Introduction

Bovine viral diarrhea virus (BVDV), first described in the 1940s,[2] continues to inflict significant economic injury on the cattle industry worldwide. The virus is maintained in the cattle population by the presence of persistently infected (PI) individuals. The PI condition may develop in the fetus when the dam and fetus are infected with a BVDV during the first 30 to 125 days of pregnancy. When infected during this stage of *in utero* development (prior to immunocompetence), the fetus does not mount an immune response against the virus, and the virus becomes recognized as self. Many of these types of infections will result in fetal death and abortion. If pregnancy goes to term, the calf will produce and shed massive amounts of BVDV for the rest of its' life, becoming a primary source of infection for other animals. Estimates of the prevalence of PI calves arriving at feedlots in the US is between 0.1 and 0.4%, similar to estimates for US beef cow-calf operations (0.17%).[9] There are 2 genotypes of BVDV (BVDV-1 and BVDV-2) and several subgenotypes (BVDV 1a-k and BVDV 2a and BVDV 2b),[7] as well as 2 biotypes (cytopathic and non-cytopathic) within genotypes. Only the non-cytopathic strains of BVDV induce persistent infections, which account for the majority of virus isolates.[9] The cytopathic biotypes arise by mutation and recombination in the viral genome of the non-cytopathic strains. Within the US cattle population, there are 3 major subtypes, BVDV 1a, BVDV 1b, and BVDV 2a, with the BVDV 1b subtype being most predominant.[7] A wide range of clinical manifestations, ranging from subclinical to fatal, can be observed in both the acutely infected and the PI animal. The clinical presentation and outcome of infection depend on numerous factors, with the host influences being the most important, such as immune status, pregnancy status and gestation of the fetus, and concurrent infections. Vaccines currently used in the US consist of BVD 1a cytopathic and non-cytopathic strains as well as BVD 2 noncytopathic; currently no available vaccines contain BVD 1b.

Case History

A large well-maintained cow-calf operation in Central Texas with a good vaccination and herd health program, including annual screening for BVD by antigen-capture ELISA (ACE) on ear notches. No clinical signs of BVD were observed in the herd, and cows and calves were routinely vaccinated and dewormed as standard practice. Routine vaccination included vaccination of bulls, cows, and heifers pre-breeding with a killed-virus vaccine containing: BVDV, parainfluenza-3 (PI3) virus, bovine respiratory syncytial virus (BRSV), and infec-

tious bovine rhinotracheitis virus (IBR) antigens. Calves were vaccinated within the first 2 months of age with an intranasal modified-live vaccine containing IBRV, PI3V, and BRSV; at preweaning and weaning calves were given killed-virus vaccine containing IBRV, BVDV, BRSV, and PI3V. No new animals had been introduced into the facility; however, the ranch had both show animals and a concurrent production animal operation on the premise. Show animals routinely left for events and returned to the ranch. Show animals were kept in separate pastures from the production animals; however, the pastures shared a common fence with nose-to-nose contact possible.

Clinical Findings and Diagnostics

The previous year all cattle on the ranch were tested for BVDV by antigen-capture ELISA (ACE) on ear notches, and all animals tested were negative. In the current year the decision was made to rescreen the herd as part of their herd-health management plan. Results of the most recent testing identified 2 calves 6-months of age (IDs 83C and 112C) in the production herd as positive for BVDV by ACE tests on ear notch; cows tested negative. Three weeks later, blood from the positive calves was collected and submitted to the Texas A&M Veterinary Medical Diagnostic Laboratory (TVMDL) for virus isolation and ACE testing of serum; both calves were positive on both tests. Samples and isolates were sent to the National Animal Disease Center for genotyping. Genotyping was performed by phylogenetic analysis of 5' untranslated region,[6] and both isolates were determined to belong to the BVDV 1b subgenotype and were identical to each other (Figure 1), indicating a single introduction in the herd.

Outcome

Show animals are now housed in a facility completely separate from the main cow herd. All introductions to the herd go directly to a newly developed isolation facility, until tested BVD-negative. This isolation facility has no common fences with surrounding pasture cattle. Additionally, any "visiting" cattle are housed in an isolation facility during their stay. Use of a modified-live vaccine prior to breeding will be incorporated into the vaccination program.

Discussion

Despite advances in understanding of BVDV, its associated diseases, and methods for control, infections with BVDV remain a source of significant economic losses in the beef and dairy cattle industry worldwide. Not only are cattle susceptible to infection, BVDV infections have been reported in a variety of other species, including New World camelids (alpacas and llamas) and white-tailed deer.[1,5] The efficiency of transmission by acutely infected animals varies by viral strain and biotype, and only occurs during the limited window when the animal is viremic following infection and before the animals' immune response becomes functional.

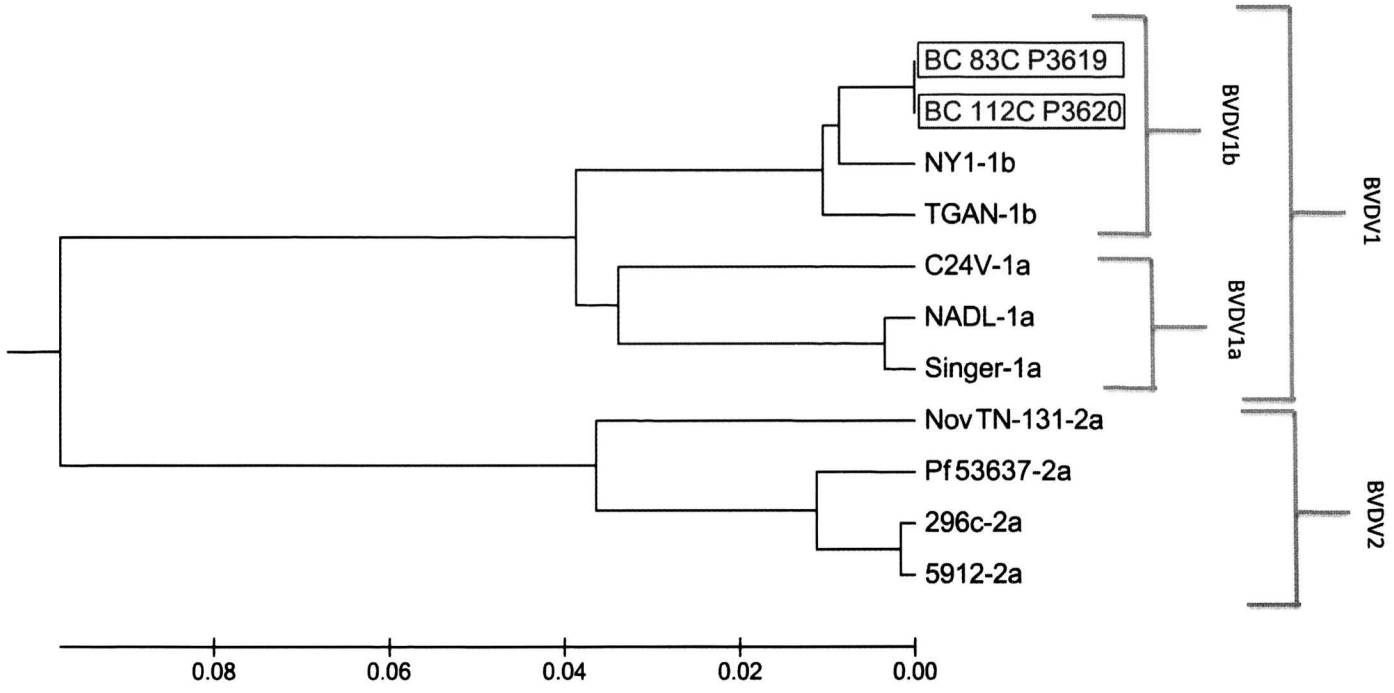

Figure 1. Phylogenetic analysis of bovine viral diarrhea virus (BVDV) isolated from the 2 calves (blocked and grayed; BC 83C, BC 112C); as references, vaccine strains Singer-1a, NADL-1a, C24V-1a, NY1-1b, 296c-2a, 5912-2a, and laboratory reference strains TGAN-1b, NovTN-131-2a, Pf53637-2a were included in the analysis. Genotyping was based on comparison of sequences from the 5' untranslated region (5'-UTR).

In contrast, the virus is very efficiently transmitted by PI animals, which have no immune response to the virus, and thus shed virus continuously. The offspring of PI dams are invariably persistently infected; however, the largest source of PI animals is naïve cattle, usually heifers, which are infected during the first trimester of pregnancy. While the virus can be transmitted by transiently infected animals, the PI animal is much more efficient for transmission. Therefore, the PI animal represents a significant threat to the health and profitability of a cattle operation.

Although impossible to know the sequence of events that allowed the introduction of BVDV into this cattle operation, a plausible explanation is the show cattle were acutely infected while away from the ranch, and subsequent nose-to-nose contact with pregnant cattle through the fence, contact with shared fomites,[8] or flies[3] at the critical gestation time (between 30 and 125 days of gestation) resulted in the 2 PI calves. Since the PI calves were identified, considerable resources have been directed at improved biosecurity. Also, as customary in the cattle industry, friends and relatives traveling with cattle will occasionally be invited to stay overnight while moving to and from shows and sales. While this is a common practice, biosecurity can be compromised. Travelers with cattle are still accommodated at this ranch; however, the visiting cattle are held in the isolation facility. The management program and biosecurity measures implemented following identification of the 2 PI calves includes a revised vaccination program incorporating the use of a modified-live vaccine prior to breeding, and improved awareness of the principles of biosecurity. The lessons learned in this case are significant and should be of value to anyone owning or providing support for a cattle operation.

From a management and control perspective, vaccination programs to establish enhanced herd immunity are essential. However, vaccination programs must be integrated with sound biosecurity practices, including quarantine (no direct contact) of high-risk cattle for approximately 3 weeks prior to introduction into an established BVD-free herd. Periodic laboratory testing to insure management programs are effective is also essential.[4] For BVD screening (calves/animals older than 3 months), the ACE test is excellent to identify PI animals. The test is performed on a fresh skin (ear notch) or serum, and is a relatively inexpensive alternative to the more labor intensive immunohistochemistry test.

Acknowledgements

The authors would like to thank Patricia Frederico for excellent technical support in genotyping the isolates. The authors declare no conflict of interest.

References

1. Cantu A, Ortega SJ, Mosqueda J, Garcia-Vazquez Z, Henke SE, George JE. Prevalence of infectious agents in free-ranging white-tailed deer in northeastern Mexico. *J Wildl Dis* 2008; 44:1002-1007.
2. Goens SD. The evolution of bovine viral diarrhea: a review. *Can Vet J* 2002; 43:946-954.
3. Gunn HM. Role of fomites and flies in the transmission of bovine viral diarrhoea virus. *Vet Rec* 1993; 132:584-585.
4. Houe H, Lindberg A, Moennig V. Test strategies in bovine viral diarrhea virus control and eradication campaigns in Europe. *J Vet Diag Invest* 2006; 18:427-436.
5. Passler T, Walz PH, Ditchkoff SS, Brock KV, DeYoung RW, Foley AM, Givens MD. Cohabitation of pregnant white-tailed deer and cattle persistently infected with bovine viral diarrhea virus results in persistently infected fawns. *Vet Microbiol* 2009; 134:362-367.
6. Ridpath JF, Fulton RW, Kirkland PD, Neill JD. Prevalence and antigenic differences observed between *Bovine Viral Diarrhea Virus* subgenotypes isolated from cattle in Australia and feedlots in the Southwestern United States. *J Vet Diagn Invest* 2010; 22:184-191.
7. Ridpath JF, Lovell G, Neill JD, Hairgrove TB, Velayudhan B, Mock R. Change in predominance of *Bovine Viral Diarrhea Virus* subgenotypes among samples submitted to a diagnostic laboratory over a 20-year time span. *J Vet Diagn Invest* 2011; 23:185-193.
8. Stevens ET, Thomson DU, Wileman BW, O'Dell S, Chase CL. The survival of bovine viral diarrhea virus on materials associated with livestock production. *Bov Pract* 2011; 45:118-123.
9. Walz PH, Grooms DL, Passler T, Ridpath JF, Tremblay R, Step DL, Callan RJ, Givens MD. Control of bovine viral diarrhea virus in ruminants. *J Vet Intern Med* 2010; 24:476-486.

VIRA SHIELD®

FLEXIBLE

IMPLEMENTATION INTO ANY
WHOLE-HERD PROTOCOL

SAFE

FOR YOUR ENTIRE HERD,
INCLUDING PREGNANT COWS,
HEIFERS AND NURSING CALVES

POWERFUL

LONG-LASTING† REPRODUCTIVE,
RESPIRATORY AND LEPTO **PROTECTION**

FIND OUT WHY IT'S THE **#1 INACTIVATED VACCINE CHOICE FOR CATTLE PRODUCERS***

Elanco.us/ViraShield

Elanco™

*Based on CESSA 2015 market share data. †12-month duration of immunity against lepto hardjo-bovis.
The label contains complete use information, including cautions and warnings. Always read, understand and follow the labels and use directions.
Elanco® Vira Shield® and the diagonal bar are all trademarks owned or licensed by Eli Lilly and Company, its subsidiaries or affiliates.
©2016 Eli Lilly and Company, its subsidiaries or affiliates. NCH 36103-3 USBOVSH0060


Elanco
Titanium®
A DOSE OF CONFIDENCE
Easy on cattle[1] and your bottom line.
Titanium® vaccines have no impact on feed intake and result in little to no post-treatment side effects, so you can keep your cattle on track with health management solutions that don't interrupt your day-to-day operations or affect your bottom line.[1,2] It's BRD protection that doesn't impact performance, so you can be confident in every dose.
ELANCO.US/TITANIUM
Elanco
FULL VALUE BEEF
The label contains complete use information, including cautions and warnings. Always read, understand and follow the label and use directions.