

Review of health and performance effects of bovine viral diarrhea virus and testing for persistently infected feedlot cattle

Miles E. Theurer, DVM, PhD; **J. Trent Fox**, DVM, MS, PhD; **Travis McCarty**, DVM
 Veterinary Research and Consulting Services, LLC, Hays, KS 67601
 Corresponding author: Dr. Miles Theurer; milestheurer@gmail.com

Abstract

Bovine viral diarrhea virus (BVDV) is an important pathogen commonly associated with bovine respiratory disease in feedlot cattle, and has varying effects on animal health and performance outcomes. The objective of this paper is to provide a review of the literature evaluating the effects of continued exposure to cattle persistently infected (PI) with BVDV, as well as testing and removing PI cattle from pen cohorts, on calf health and performance outcomes. Nine studies evaluated health and performance outcomes of cattle exposed to a PI-BVDV calf in their pen vs pens of cattle not exposed. Two additional studies evaluated the effects of testing and removal of PI animals from pens on health and performance outcomes compared to leaving a PI-positive animal(s) in the pen with cohorts for varied periods of time. The literature evaluating the effects of testing and removing PI-BVDV calves from pen cohorts is limited, but does not suggest improvement in health and/or performance in calves by testing and removing PI-BVDV calves after arrival into the feedlot. Additional research is needed to evaluate the effect of testing and removing PI-BVDV calves prior to incorporating the practice in the field.

Key words: bovine viral diarrhea virus, persistently infected, PI, testing, review

Résumé

Le virus de la diarrhée virale bovine (VDVB) est un pathogène important associé au complexe respiratoire bovin chez les bovins en parc d'engraissement. Le VDVB a des effets variables sur la santé animale et sur les résultats de performance. L'objectif de cet article est d'examiner la littérature publiée concernant l'effet de l'exposition continue à des individus immunotolérants et du dépistage et du retrait des bovins immunotolérants des enclos sur la santé des veaux et la performance. Neuf études ont examiné les résultats de santé et de performance chez les veaux exposés ou non à des individus immunotolérants dans leur enclos. Deux autres

études ont évalué l'effet du dépistage et du retrait des veaux immunotolérants des enclos sur les résultats de santé et de performance par rapport à la situation où les veaux immunotolérants positifs sont laissés dans les enclos avec les autres. Le dépistage et le retrait des veaux immunotolérants des enclos a été peu étudié et ne semble pas améliorer la santé et/ou la performance des veaux lorsque qu'il est fait après l'arrivée dans le parc d'engraissement. Des recherches supplémentaires sont requises pour évaluer l'effet du dépistage et du retrait des veaux immunotolérants avant d'incorporer cette pratique sur le terrain.

Introduction

Bovine viral diarrhea virus (BVDV) is an important pathogen commonly associated with bovine respiratory disease (BRD) in feedlot cattle. This virus is capable of inducing BRD by itself, but is more commonly a co-pathogen causing BRD, largely due to immunosuppression.^{6,26,29} It may also be associated with mucosal disease.^{5,15,22}

Mortality of BVDV-PI (persistently infected) calves is greater than non-PI cohorts, most commonly due to congenital defects or secondary infections including BRD, arthritis, and enteritis.^{11,17,38} Persistently infected calves which enter the feedlot may range in appearance from unthrifty to clinically normal. Prevalence of PI calves which enter US feedlots has been reported to range from 0.2% to 0.4%.^{10,15,19,21,24} While the overall prevalence of PI is low, pens of cattle exposed to PI animals have decreased health and performance outcomes compared to pens not exposed to a PI animal(s).^{13,15,21,24}

Identification of PI-BVDV calves can be accomplished using immunohistochemistry, antigen capture-ELISA, polymerase chain reaction tests, and virus isolation. Sensitivity and specificity of these diagnostic methods are very good (97.6 to 100%).^{7,10,16,23,37} The objective of this article is to review the literature evaluating the effects of BVDV infection in pens of feedlot cattle, as well as the effect of testing and removing PI calves from pen cohorts, on calf health and performance.

Materials and Methods

Literature searches were performed in PubMed and Google Scholar to evaluate studies which reported exposure to BVDV and/or testing and removing PI-BVDV calves from pen cohorts. The study had to include natural disease exposure, and be printed in the English language to be included in the review. Summaries of all studies in the review were performed.

Health and performance outcomes from studies where pens of cattle were continuously exposed to PI-BVDV calves were compared to pens of cattle that were not exposed to

PI calves. Outcomes from pens adjacent to those housing PI-BVDV calves were included in the exposed group when possible. Separate health and performance outcomes were captured from trials which tested and removed PI cattle within 72 hours of processing compared to pens of cattle continuously exposed to a PI animal.

Results and Discussion

Continuous exposure to BVDV

A description of all studies included in the review are shown in Table 1. Bovine viral diarrhea virus has varying ef-

Table 1. Review of studies evaluating the impact of persistently infected bovine viral diarrhea virus (PI-BVDV) on animal health and performance outcomes and/or the effectiveness of testing and removing PI calves from pen cohorts compared to leaving the PI calf with pen cohorts.

Reference Number	Reference	Study description
1	Booker et al, 2008	Longitudinal study in which PI-BVDV calves were identified during initial processing and left with pen cohorts. Study population was auction market calves from western Canada. Calves were vaccinated upon arrival to feedlot and followed to closeout. Animal health and performance outcomes were compared among pens which contained a PI-BVDV calf to pens which did not contain a PI-BVDV calf.
3	Bryant et al, 2011	Vaccine study evaluating different trivalent modified-live viruses upon arrival to the feedlot in lightweight (599 to 724 lb) steers followed to closeout. All calves were tested for PI-BVDV at arrival processing. Animal health outcomes were evaluated in pens which contained a PI-BVDV calf compared to pens which did not contain a PI-BVDV calf.
8	Elam et al, 2008	Randomized trial to evaluate effects of short- or long-term exposure of PI-BVDV calves in 498 lb calves purchased from an Oklahoma livestock auction. Calves had been vaccinated at branding and freshly weaned. All calves were vaccinated against BVDV with a modified-live virus vaccine during arrival processing. One confirmed PI-BVDV was randomly assigned to pens in the direct short- and long-term exposure treatment group. The PI calf in the short-term exposure treatment group was removed 60 hours after placement, and the PI calf in the long-term exposure group remained with pen cohorts for duration of study.
12	Grooms et al, 2014	Randomized trial evaluating the effects of vaccination, timing of vaccination, and exposure to PI-BVDV calf on animal health outcomes in 500 lb ranch-origin calves. Data included in review were from calves vaccinated within 24 hours after arrival and exposed or not exposed to PI-BVDV calves, and monitored for 168 days.
13	Hay et al, 2016	Longitudinal study evaluating the effects of PI-BVDV calf in cohort compared to cohorts not containing a PI-BVDV calf on 50-day morbidity risk in Australian feedlots with unknown vaccination status.
15	Hessman et al, 2009	Study population was high-risk calves from southeastern United States followed to closeout and vaccinated with a modified-live BVDV type 1a and 2a vaccine upon feedlot arrival. Pens were divided into 5 exposure groups based upon PI-BVDV exposure and testing and removal strategy in a large commercial feedyard: 1) PI-BVDV calves were identified upon arrival processing and remained with pen cohorts; 2) PI-BVDV calves were removed within 72 hours from pen cohorts after arrival processing; 3) pen did not contain a PI-BVDV calf but adjacent pens did contain a PI-BVDV calf which remained through feeding period; 4) pen did not contain a PI-BVDV calf but adjacent pens did contain PI-BVDV calf and was removed within 72 hours after arrival processing; and 5) neither pen nor adjacent pens contained PI-BVDV calf.
21	Loneragan et al, 2005	Cohort study to evaluate the animal health outcomes in pens exposed to PI-BVDV calves and pens not exposed to PI-BVDV calves. Study population was auction-market light yearling steers vaccinated with a modified-live BVDV type 1a and 2a vaccine upon feedlot arrival. Exposure pens included adjacent pens in which PI-BVDV calf was present.
24	O'Connor et al, 2005	Longitudinal study in which PI-BVDV calves were identified during initial processing and left with pen cohorts. Study population was calves weighing \leq 793 lb on arrival at a commercial feedlot in Iowa and vaccinated with a modified-live virus BVDV vaccine upon feedlot arrival and followed to closeout. Animal health and performance outcomes were compared among pens which contained a PI-BVDV calf to pens which did not contain a PI-BVDV calf.
28	Richeson et al, 2012	Randomized trial evaluating the effects of PI-BVDV exposure on low-risk preconditioned calves and auction-market calves. Preconditioned calves (553 lb) were administered a 5-way modified-live virus at time of weaning and backgrounded for \geq 42 days. Auction-market calves (540 lb) were administered a 5-way modified-live virus vaccine at the time of arrival processing. Calves were followed for 42 days after arrival to feedlot.

fects on animal health and performance outcomes, which may be attributable to differences in virulence factors of BVDV strains, baseline health status of calves, concurrent disease, or unidentified risk factors.^{4,29,30} There is great variation in the type of BVDV strains in feedlot BRD cases.⁹ Prevalence of PI-BVDV in individual cohorts of cattle can be very high, and vaccination has been associated with mucosal disease in a large group of PI calves with BVDV.²² Knowledge of the incidence of morbidity and mortality, as well as causes of mortality, is recommended to make vaccination decisions for individual cohorts of animals.

Nine studies we reviewed compared calf health and performance outcomes for cattle exposed to a PI-BVDV calf (or calves) to those not exposed to PI cattle (Tables 1 and 2).^{6,10,12,14,19-23} One study reported improved average daily gain and feed conversion in non-exposed calves ($P \leq 0.05$),¹⁵ 2 different studies identified greater morbidity risk,^{14,21} and a separate study identified a greater percentage of chronics²⁸ in pens of cattle exposed to a PI-BVDV calf compared those not exposed.

In a study by Richeson et al, vaccination and preconditioning calves prior to feedlot entry reduced the impact on health and performance when exposed to calves PI with BVDV (Table 2).²⁸ Preconditioned calves were ranch origin, vaccinated, and weaned ≥ 42 days prior to entering the feedlot, whereas auction-market calves were comingled from multiple livestock auctions.²⁸ Auction-market calves had a greater incidence of chronically ill calves in pens exposed to a PI-BVDV calf compared to pens not exposed, but there was no difference in percentage of chronically ill calves in preconditioned calves in pens exposed or not exposed to PI animals.²⁸ Preparing calves to enter the feedlot through proper vaccination and weaning appears to reduce the impact that PI-BVDV exposure can have on health and performance outcomes. Vaccination with a modified-live virus vaccine reduced morbidity and mortality in BVDV challenge studies, indicating vaccination may be an effective practice against BVDV.^{18,35} Exposure of cattle to BVDV naturally or through vaccination prior to feedlot arrival mitigates some of the negative consequences of exposure to PI animals.¹²

Loneragan et al reported small differences between pens of feedlot cattle exposed to a PI-BVDV calf and cattle not exposed to a PI calf when exposure was defined to include just calves within the same pen as the PI-BVDV calf; however, greater differences were identified when exposure included calves in pens adjacent to a PI-BVDV animal (Table 2).²¹ The BVDV is shed through body excretions from infected calves, and interactions between pens frequently occur, including shared water tanks and grooming behavior, allowing for disease transmission to calves in pens adjacent to the pen housing an infected PI calf.^{2,21} Type 1b non-cytopathic BVDV can survive for up to 48 hours in water, galvanized metal, soil, and other fomites commonly used in production agriculture.³³

Different strains of the BVDV may affect the health and performance outcomes. Peddireddi et al comingled 10

Table 2. Calf health and performance outcomes of pens exposed to a persistently infected bovine viral diarrhea virus (PI-BVDV) calf compared to pens not exposed to PI-BVDV. Adjacent pens to pens which housed a PI-BVDV calf were included in the exposed group when possible to aggregate outcomes. Means within a row without a common superscript were statistically ($P \leq 0.05$) different.

Outcome	Unexposed	Exposed	Reference
ADG (lb/day)	3.51	3.47	1
	3.22	3.33	8
	3.24	3.19	12
	1.63 ^a	1.30 ^b	15
	2.67 [†]	2.60 [†]	28
	1.90 [‡]	1.85 [‡]	28
DMI (lb)	16.09	16.42	8
F:G	5.66	5.76	1
	5.00 [*]	4.98 [*]	8
	6.78 ^a	14.93 ^b	15
Morbidity (%)	10.99	11.64	1
	12.03	12.41	3
	0.0	0.0	8
	19.57 ^a	39.13 ^b	12
	8.7 ^a	22.5 ^b	13
	29.0	32.0	15
	5.14	7.36	21
	11.9 [†]	7.9 [†]	24
	29.3 [‡]	28.6 [‡]	24
	3.2 [†]	0.0 [†]	28
33.1 [‡]	30.2 [‡]	28	
Mortality (%)	2.83	2.22	1
	1.14	1.11	3
	2.17	2.17	12
	1.70	3.17	15
Chronic (%)	0.68	1.07	3
	2.8	4.2	15
	0.4 [†]	0.3 [†]	28
	1.1 ^{‡a}	7.6 ^{‡b}	28

*Values transformed from G:F

[†]Single source cattle

[‡]Comingled cattle

PI-BVDV calves with different strains of BVDV with 53 uninfected calves for 27 days in a single pen.²⁵ A single strain of virus from a PI calf infected 64% of uninfected calves, while 3 of the BVDV strains were never identified in the uninfected calves.²⁵ Transmission of different strains through a population may affect the impact of the disease on clinical outcomes.

Testing and removing PI-BVDV calves

Two studies in the review evaluated the effect of testing and removal of PI animals from the pen compared to leaving the PI animal in the pen on health and performance outcomes (Tables 1 and 3).^{8,15} Both of these studies included a group in which a PI calf was left with the group throughout the study. Neither study showed any difference in health or performance throughout the feeding period when testing and

removing PI animals compared to leaving a PI calf in the pen with cohorts which were not PI (Table 3).

Hessman et al reported a numerical difference in feed conversion and ADG in pens of feedlot calves where a PI-BVDV calf was removed following testing compared to pens of calves where the PI calf was left with cohorts¹⁵ ($P>0.05$; Table 3). Knowledge of biology and supporting results is needed to properly interpret P values,³⁹ and additional research is needed to further elucidate the value of testing and removing PI-BVDV calves from the pen cohorts.

Persistently infected calves are continuously viremic, and shed the virus through all body excretions.^{2,27} Non-PI calves are exposed to the virus during commingling, transportation, and rest periods provided to calves prior to initial processing, putting exposed calves at risk of immunosuppression prior to testing and identification of the PI calves.^{20,34} By the time PI-BVDV calves are identified, non-PI calves can be infected through horizontal transmission, offsetting the value of testing and removal of the PI calves (Table 3). Use of a quicker calf-side test, such as the Snap BVDV Antigen Test^a and CST-QuickTest,^b could allow for identification of animals within minutes after processing by testing for BVDV antigen from serum or ear notch tissue samples.¹⁴ Testing calves earlier in marketing channels could reduce exposure time for other animals in the group and potentially improve health and performance outcomes, but this has not been confirmed by research.

Two other studies evaluated the effect of testing and removing PI animals from the pens. Neither of the studies were included in the review due to the comparison groups not having a PI calf present.^{31,32} It was not possible to identify if the differences in animal health and performance were due to testing and removal of PI animals, or due to exposure to BVDV based upon study design. A comparison group with constant exposure to PI-BVDV calves needed to be included in the study to differentiate causes of health and performance outcomes between treatment groups.

Table 3. Health and performance outcomes from studies evaluating the effectiveness of testing and removing persistently infected bovine viral diarrhea virus (PI-BVDV) within 72 hours or continuous exposure to PI-BVDV calf. No outcomes were statistically different between continuous exposure to PI-BVDV calf or testing and removing PI-BVDV calf.

Outcome	Continuous PI-BVDV exposure	Test and remove	Reference
ADG (lb/day)	3.33	3.35	8
	1.21	1.30	15
DMI (lb)	16.42	16.29	8
	4.93*	4.85*	8
F:G	18.88	9.47	15
	0.0	0.0	8
Morbidity (%)	34.0	37.0	15
	3.6	3.5	15
Mortality (%)	3.6	3.5	15
Chronic (%)	4.6	5.0	15

*Values transformed from G:F

A potential limitation of this review is that we only evaluated health and performance effects of continuous exposure to BVDV, as well as testing and leaving or removing PI-BVDV calves from feedlot pens. Bovine viral diarrhea virus is a significant pathogen which affects calf health and performance outcomes, but knowledge of the prevalence and impact of the disease, cost of the testing strategy, and potential improvement in health and performance need to be considered prior to testing.³⁶ The literature does not suggest improved health and/or performance outcomes in calves by testing and removing PI-BVDV calves; however, if other business practices are performed at the same facility, such as replacement heifer development or a cow-calf production unit, testing for PI-BVDV calves may be warranted to reduce the risk of transmission of the disease to other production units.

Conclusion

Bovine viral diarrhea virus has varying effects of animal health and performance. There is a paucity of information regarding the effects of testing and removing PI-BVDV calves from pen cohorts, but the literature we reviewed did not indicate improved health and/or performance outcomes in calves by testing and removing PI-BVDV calves early in the receiving period. Additional research is needed evaluating the impact of testing and removing PI-BVDV calves prior to incorporating the practice in the field. Identification and management of BVDV control programs, as well as cost of implementing prevention practices, need to be considered before adopting the practice widespread.

Endnote

^aIdexx Snap BVDV Antigen Test, Idexx Laboratories, Westbrook, ME

^bCST-QuickTest, Central States Testing, Sublette, KS

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