PEER REVIEWED

Effects of Short-term Exposure of Feeder Cattle to Calves Persistently Infected with Bovine Viral Diarrhea Virus

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Abstract

Research using 2,954 auction-derived feeder steers and heifers was conducted at a single commercial feedlot in Kansas to determine the effects of testing for cattle persistently infected (PI) with bovine viral diarrhea virus (BVDV) at 10-14 days-on-feed (DOF), and removing them at 13-18 DOF. After removal of test-positive animals, the effect of the short-term exposure (STE) to PI cattle on health, performance and carcass characteristics was determined.

The percentage of calves exhibiting signs of illness was increased ($P<0.01$) in cattle with STE to PI-BVDV. Cattle with no exposure (NE) to PI-BVDV calves had a morbidity rate of 18.8%, while a 29.6% morbidity rate was observed in pens of calves with STE to a PI-BVDV calf. Characterization of the temporal pen morbidity rate of STE and NE calves revealed that 31.7% of all STE and 15.3% of NE illness occurred in the first seven DOF. Additionally, the incidence of cattle treated for bovine respiratory disease in STE calves was 2.17 (95% CI 1.73 to 2.72) initial treatments per 1,000 head-days at risk, whereas the incidence of treatment of calves in NE pens was 1.28 (95% CI 0.98 to 1.68) initial treatments per 1,000 head-days at risk. Short-term exposure to PI-BVDV calves had no effect on retreatment rate, death loss, or performance.

There was no evidence of a BVD-PI exposure X sex interaction ($P=0.62$) for carcasses that graded USDA Choice or better, but there was a main effect of sex ($P<0.01$). There was evidence of a BVD-PI exposure X sex interaction for Yield Grade 2 or greater carcasses ($P=0.03$). In this study, testing at 10-14 DOF was too late in the feeding period to eliminate the initial morbidity spike that occurred during 0-7 DOF, and the subsequent morbidity differences between calves with STE or NE to PI calves.

Keywords: bovine, BVDV, persistent infection, morbidity

Résumé

Les effets de l'identification et du retrait des bovins immunotolérants porteurs du virus de la diarrhée virale bovine (BVDV) entre les jours 10 et 14 d'engraissement ont été étudiés dans un parc d'engraissement commercial du Kansas avec 2954 taures et bouvillons d'engraissement d'encan. Après avoir retiré les animaux testant positifs, l'effet d'une exposition brève à des bovins immunotolérants a été déterminé au niveau de la santé, de la performance et des caractéristiques de la carcasse.

Le pourcentage de veaux montrant des signes de maladie avait tendance ($p < 0,01$) à être plus élevé chez les bovins exposés brièvement aux animaux immunotolérants. Le taux de morbidité chez les bovins non-exposés aux animaux immunotolérants était de 19% comparé à 30% dans les enclos avec des veaux exposés. Une analyse de l'évolution temporelle de la morbidité dans les enclos indiquait que la maladie prenait place dans les premiers sept jours d'engraissement dans 31,7% des cas chez les animaux exposés et dans 15,3% des cas chez les animaux non-exposés. De plus, l'incidence de traitement des bovins pour des maladies respiratoires était de l'ordre de 2,17 (I.C. 95% : 1,73-2,72) traitements initiaux par 1000 têtes-jours à risque alors que cette même incidence chez les veaux non-exposés était de 1,28 (I.C. 95% : 0,98-1,68) traitements initiaux par 1000 têtes-jours à risque. Une brève exposition à des veaux immunotolérants n'a pas eu d'effet sur le taux de nouveau traitement, le nombre de veaux morts ou la performance.

Il n'y avait pas d'évidence d'interaction entre l'exposition aux animaux immunotolérants et le sexe ($p = 0,62$) au niveau des carcasses classées *USDA Choice*

ou mieux. Toutefois, il y avait un effet du sexe en général ($p < 0,01$). Il y avait une interaction entre l'exposition aux animaux immunotolérants et le sexe pour les carcasses de classe 2 ou mieux ($p = 0,03$). Dans cette étude, l'identification dans la période de 10 à 14 jours d'engraissement était trop tardive pour éliminer le pic initial de morbidité qui prend place durant la première semaine et pour éliminer les différences subséquentes de morbidité entre les veaux exposés et non-exposés aux veaux immunotolérants.

Introduction

Infection with bovine viral diarrhea virus (BVDV) contributes to a variety of economically important disease syndromes in beef cattle, including bovine respiratory tract disease and immunosuppression of stocker and feedlot cattle.[4] In breeding herds, the outcome of BVDV fetal infections in susceptible heifers and cows is dependent on the age of the fetus when exposed. Infection can result in abortion, stillbirth, congenital malformations and birth of persistently infected (PI) calves. Persistent infection of a calf occurs when a susceptible heifer or cow is exposed to a non-cytopathic BVDV during pregnancy at approximately 45 to 125 days of gestation.[6] Cattle PI with BVDV can shed copious amounts of BVDV into the environment through secretions and excretions, including nasal discharges, saliva, semen, urine, tears and to a lesser extent, feces.

Relatively few cattle are PI at arrival into a feedlot. The prevalence of feeder cattle PI with BVDV entering feedlots is estimated to be 0.3%.[5] PI cattle are important sources of virus for animals in direct or close contact. In a recent study, the risk of initial treatment for bovine respiratory disease (BRD) was 43% greater in cattle exposed to a PI calf.[6] Persistently infected calves tend to have lower growth rates, and often die from classic mucosal disease or other diseases during the feeding period.[11]

Given the potential risk of increased morbidity associated with exposure to PI calves, it is important to understand the impact of identifying and removing these animals to limit their exposure to other cattle and therefore limit costs associated with treatment (labor and medicine). Our objective was to identify PI feeder cattle at 10-14 days-on-feed (DOF), remove them at 13-18 DOF, and to determine the effect of short-term exposure to PI-BVDV on health, performance and carcass characteristics.

Materials and Methods

Cattle and sample collection

A total of 2,954 (932 steers, 2,022 heifers) auction-derived feeder cattle arrived at a 12,000-head capacity feedlot in Kansas between August 24, 2005 and November 15, 2005. Within 24-36 hours after arrival, cattle were administered injectable doramectin,[a] a modified-live viral vaccine containing bovine herpesvirus type 1 (IBR), parainfluenza type 3 (PI3), BVDV (types 1 and 2) and bovine respiratory syncytial virus,[b] as well as a steroid implant[c] administered subcutaneously in the caudal aspect of the ear. After initial processing, cattle were housed in 19 pens (range 52-255 head/pen) and managed in accordance with routine feedlot practices. Ten to 14 days after processing, cattle were administered a second modified-live 5-way viral vaccine[d] and a multivalent clostridial bacterin-toxoid.[e]

At the time of revaccination, a single fresh skin (ear notch) sample was collected from each steer or heifer, placed in phosphate-buffered saline solution and tested for BVDV antigen using antigen capture ELISA (ACE) at the Animal Medical Center, Great Bend, Kansas.

Animals exhibiting clinical signs consistent with bovine respiratory disease (BRD) during the study were removed from their home pen and treated with antimicrobials as necessary. Cattle diagnosed with BRD were first treated with tulathromycin;[f] non-responsive animals were treated with florfenicol,[g] and finally with ceftiofur sodium[h] if a second retreatment was necessary.

Antigen Capture ELISA

Detection of BVDV antigen in skin specimens (ear notch) was performed by use of a commercial antigen capture ELISA (ACE) kit.[i] Results were calculated by the following equation: standardized OD = (raw OD of sample – raw OD of negative control)/(raw OD of positive control – raw OD of negative control). Samples with standardized OD values < 0.20 were considered negative, and those with OD values > 0.39 were considered positive. Samples with values from 0.2 to 0.39 were retested with detector reagents with or without antibody. Calves that tested positive at the time of revaccination were removed from their home pen, isolated and retested for BVDV 21 days later by immunohistochemistry (IHC) at the Kansas State University Diagnostic Laboratory for confirmation of PI status.

Treatment Groups

Cattle that tested positive for BVDV by ACE were removed from their home pen at 13-18 DOF. Twenty-one days after the original ACE test, positive animals were retested using IHC. After confirmation of BVDV PI-positive status, the pen of origin was considered to have short-term exposure (STE) to PI-BVDV. Pens with STE were compared to pens that had no exposure (NE) to PI-BVDV, i.e. all animals in the home pen were tested for PI-BVDV and all were negative. The average arrival

weight of cattle in the 14 NE pens ranged from 567 to 738 lb (258-335 kg), while the average weight of cattle in the five STE pens ranged from 586 to 608 lb (266 to 276 kg). Cattle in STE and NE pens were followed through close-out and harvest.

Health and Performance Data

Feedlot data were collected from electronic records maintained at the feedlot. Data obtained from close-out records included in-weight, end-weight, days-on-feed, average daily gain (ADG), dry matter intake (DMI), feed-to-gain ratio (F:G) and feed cost of gain per pound. Health data were recorded daily by trained feedlot personnel. Data gathered from the animal health computer system[j] included respiratory morbidity rate, number of treatments, death loss and treatment costs.

Statistical Analysis

Data were analyzed using commercially available statistical analysis software.[k] Pen-level response variables were generated and analyzed using regression techniques. Continuous response variables were analyzed using general linear models, whereas discrete binomial response variables (events/trials) were analyzed using generalized linear models with a logit link function. The interaction of exposure and sex was evaluated and, if not significant, dropped from the model. Further, if the main effect of sex was not significant, it too was dropped from the model while the main effect of exposure was forced in the model. A time by exposure effect on counts of initial treatment was evaluated using negative binomial models and repeated measures methodologies in that within-pen dependency over time was modeled using compound-symmetry matrices. Model predicted estimates of incidence of initial treatment for respiratory disease and associated confidence intervals were calculated from the final model. Statistical significance was established at $P<0.05$.

Results

Of the 2,954 head tested for PI-BVDV, 10 were positive for a prevalence of 0.35%. At the pen level, five of 19 pens (26.3%) had exposure to a PI-BVDV calf; four of the five pens contained more than one PI animal. All ACE-positive calves were positive when retested using IHC. The morbidity rate increased in pens of cattle with STE to PI-BVDV ($P<0.01$; Table 1). The temporal pattern of morbidity was investigated. Cattle in STE pens had increased morbidity compared to cattle in NE pens during the first seven DOF (Figure 1). There was no evidence of a BVD PI exposure period interaction ($P>0.25$), but there was a main effect of BVD PI exposure on morbidity rates ($P=0.02$). The incidence of BRD treatments in STE cattle was 2.17 (95% CI 1.73 to 2.72) initial treatments per 1,000 head-days at risk, whereas the incidence of BRD treatments in NE cattle was 1.28 (95% CI 0.98 to 1.68) initial treatments per 1,000 head-days at risk (Figure 2). Short-term exposure to PI-BVDV calves had no effect on the percentage of calves that were retreated ($P=0.82$), and death loss among STE cattle was similar to NE cattle ($P=0.69$; Table 1).

A BVD PI exposure X sex interaction was observed for the final weight of finished cattle. Upon further examination, heifers in NE pens had heavier final weights than heifers in STE pens, whereas steers with STE to a PI-BVDV animal were heavier at harvest than steers with NE. This was likely because steers with STE were fed 22 days longer than steers with NE. Therefore, the main effects of STE or NE to a PI BVDV animal are presented. There was no difference in average daily gain (ADG; $P=0.34$), dry matter intake ($P=0.33$), feed-to-gain ratio ($P=0.57$) or cost of gain ($P=0.24$) between STE and NE cattle (Table 2). There was no evidence of a BVD PI exposure X sex interaction ($P=0.62$) for car-

Table 1. Effect of short-term exposure (STE) to cattle persistently infected with BVDV on feeder cattle morbidity and mortality.

Item	NE	STE	SEM	*P*-value
Morbidity, %	18.8	29.6	5.4	<0.01
Retreat, %	14.4	21.7	4.7	0.82
Death loss, %	4.3	5.6	1.8	0.69

NE – no exposure to PI cattle
STE – short-term exposure to PI cattle

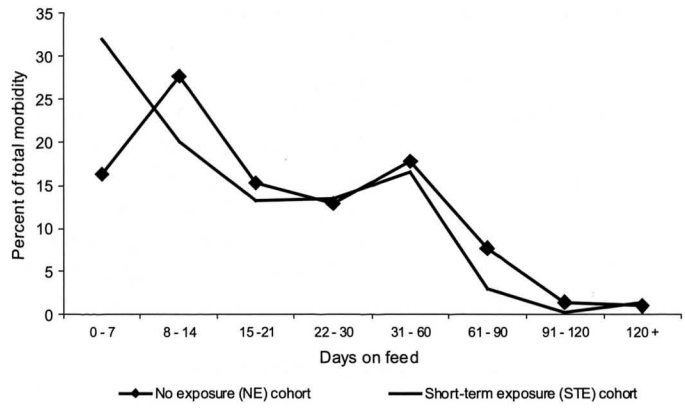

Figure 1. Temporal morbidity of feeder cattle with or without exposure to PI-BVDV. The percent of total respiratory morbidity (y-axis) that occurred during the feeding period was plotted against days-on-feed (x-axis).

casses that graded USDA Choice or better, but there was a main effect of sex ($P<0.01$). There was evidence of a BVD PI exposure X sex interaction for USDA Yield Grade 2 or greater carcasses ($P=0.03$).

Discussion

This study was conducted to measure the effects of testing and removing PI-BVDV feeder cattle after arrival in the feedyard. Based on the morbidity results, testing at 10-14 DOF was too late in the feeding period to eliminate the initial morbidity spike that occurred during the first seven DOF. Short-term exposure to PI-BVDV cattle had no effect on retreatment rate, death loss, performance or carcass characteristics.

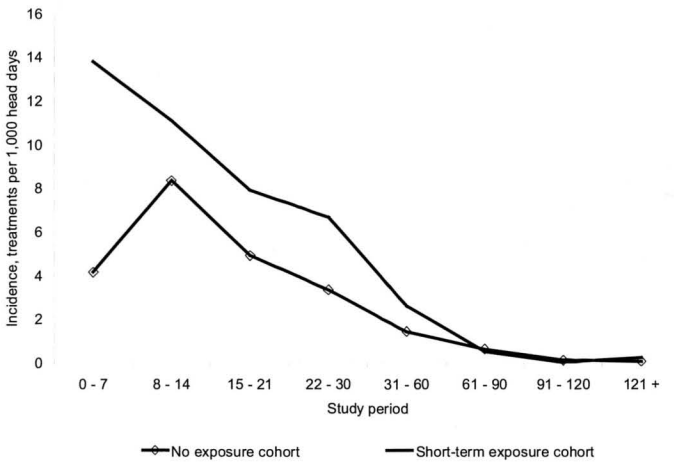

Figure 2. Epidemic curve for cohorts either exposed or not exposed to an animal PI with BVDV among feedlot cattle. Exposure was defined to include cattle in a pen that contained a PI animal. Data for the epidemic curve are number of initial treatments for respiratory tract disease per 1,000 head days at risk.

Table 2. Effect of short-term exposure to cattle persistently infected with BVDV on feeder cattle performance.

Item	NE	STE	SEM	*P*-value
In wt, lb	626	599	30.2	0.44
Out wt, lb	1142	1163	16.2	0.28
DOF	197	219	11.4	0.10
ADG, lb/d	2.53	2.46	0.07	0.34
DMI, lb/d	16.4	15.7	0.68	0.33
F:G	6.5	6.4	0.17	0.57
COG, $/lb	.60	.62	0.01	0.24

NE – no exposure to PI cattle
STE – short-term exposure to PI cattle
DOF – days-on-feed
ADG – average daily gain
DMI – dry matter intake
F:G – feed-to-gain ratio
COG – cost of gain

In contrast to other published reports,[2,5,8] 18.8% of NE cattle and 29.6% of STE cattle were treated for illness during the feeding period. Loneragan *et al* reported no difference in morbidity rates for cattle within a pen that contained a PI animal and pens that did not contain a PI animal.[5] In a second analysis by Loneragan *et al*, morbidity was defined more broadly to include cattle considered exposed in the first analysis and cattle in pens adjacent to a pen housing a PI animal. In this scenario, cattle exposed to a PI animal were at 43% greater risk of treatment for respiratory disease.[5]

Short-term exposure to a PI-BVDV animal had no effect on performance. This was unexpected because of the increased morbidity rate observed during the first seven DOF. A summary of results from the Texas A&M Ranch to Rail Program (1992-1997) showed that cattle treated for health problems during the finishing period had 0.11 to 0.55 lb (0.05-0.25 kg) less ADG than untreated cattle.[7] Similar reductions in ADG in cattle treated for respiratory disease were reported by Van Donkersgood *et al* (2.44 vs 2.75 lb/d; 1.11 vs 1.25 kg/d).[12] Additionally, Hutcheson *et al* and Sowell *et al* demonstrated that DMI was decreased in cattle that were sick after arrival into the feedyard compared to healthy cattle.[3,10]

In a feedlot study conducted by Gardner *et al*, steers treated for respiratory disease had lower final live weight, ADG, hot carcass weight, less external and internal fat and more desirable yield grades. Additionally, treated steers had a higher prevalence of carcasses that graded USDA Standard than steers never treated.[1] Similar results were reported in a feedlot vaccine study where morbidity was improved, but there was no difference in carcass characteristics between treatment groups.[9]

Clinical signs of BRD and transient viral infections are often similar in feeder cattle. There is no practical mechanism in feedlot production settings to accurately differentiate the cause of fever in feeder cattle. Both the current study and the study by Schunicht *et al*[9] were looking primarily at viral exposure and viral vaccination protocols. It is conceivable that transient viral infections may be less detrimental to the overall health and performance of cattle compared to bacterial pneumonia. More specific classification of BRD etiology and its effects on performance are justified.

Based on differences in morbidity rates between STE and NE groups, 11 more cattle would be treated with antimicrobials in 100-head pens which had a calf PI with BVDV versus a non-PI pen with similar head count. In our study, tulathromycin was used as the first treatment for respiratory disease. If using a treatment

cost of $3.45/cwt when using tulathromycin, and assuming the weight of sick calves is 600 lb (273 kg), and 11 extra calves would be treated in a STE pen holding 100 head, the additional cost for medicine alone is $228 greater than in a NE pen. If testing earlier in the feeding period would reduce the morbidity effect, there could be as much as a $228/100 head savings, or $2.28/head, in medicine cost alone. Cost of testing to identify PI animals can be partially offset by reducing the medicine cost, depending on the cost of testing. Conceivably, testing at arrival processing and removing PI cattle earlier in the feeding period may reduce the morbidity difference in pens exposed to PI animals to the level of non-PI pens.

Conclusions

Testing and removing PI-BVDV calves at 13 to 18 days-on-feed was too late in the feeding period to avoid a morbidity effect due to PI-BVDV exposure. However, death loss, performance and carcass characteristics were not different in cattle exposed to PI-BVDV cattle compared to cattle never exposed. Further characterization of the optimal time for testing and removal of PI-BVDV feeder cattle is needed to minimize morbidity for in-contact cattle.

Acknowledgements

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Endnotes

[a] Dectomax injectable, Pfizer Animal Health, New York, NY
[b] Arsenal 4.1, Novartis Animal Health, Greensboro, NC
[c] Component E-S, Vetlife, West Des Moines, IA
[d] Vista 5 SQ, Intervet, Millsboro, DE
[e] Vision 7, Intervet, Millsboro, DE
[f] Draxxin, Pfizer Animal Health, New York, NY
[g] Nuflor, Schering Plough Animal Health, Union, NJ
[h] Excenel, Pfizer Animal Health, New York, NY
[i] Idexx Laboratories Inc., Westbrook, ME
[j] Walco International, Amarillo, TX
[k] SAS System for Windows 9.1.3, SAS Inst. Inc., Cary, NC

References

1. Gardner BA, Dolezal HG, Bryant LK, *et al*: Health of finishing steers: effects on performance, carcass traits, and meat tenderness. *J Anim Sci* 77:3168-3175, 1999.
2. Guichon PT, Haines D, Jim GK, *et al*: Investigation of the rate of bovine viral diarrhea virus (BVDV) in undifferentiated fever of feedlot cattle. *Proc Am Assoc Bov Pract* 39:272-273, 2006.
3. Hutcheson DP, Cole NA: Management of transit stress syndrome in cattle: nutritional and environmental effects. *J Anim Sci* 62:555-560, 1986.
4. Larson RL, Miller RB, Kleiboeker SB, *et al*: Economic costs associated with two testing strategies for screening feeder calves for persistent infection with bovine viral diarrhea virus. *J Am Vet Med Assoc* 226:249-254, 2005.
5. Loneragan GH, Thomson DU, Montgomery DL, *et al*: Prevalence, outcome, and health consequences associated with persistent infection with bovine viral diarrhea virus in feedlot cattle. *J Am Vet Med Assoc* 226:595-601, 2005.
6. McClurkin AW, Littledike ET, Cutlip RC, *et al*: Production of cattle immunotolerant to bovine viral diarrhea virus. *Can J Comp Med* 48:156-161, 1984.
7. McNeill JW, Paschal JC, McNeill MS, *et al*: Effect of morbidity on performance and profitability of feedlot steers. *J Anim Sci* 74(Suppl. 1):135, 1996.
8. O'Connor AM, Sorden SD, Apley MD: Association between the existence of calves persistently infected with bovine viral diarrhea virus and commingling on pen morbidity. *Am J Vet Res* 66:2130-2134, 2005.
9. Schunicht OC, Booker CW, Jim GK, *et al*: Comparison of a multivalent viral vaccine program on animal health, feedlot performance, and carcass characteristics of feedlot cattle. *Can Vet J* 44:43-50, 2003.
10. Sowell BF, Branine ME, Bowman JGP, *et al*: Feeding and watering behavior of healthy and morbid steers in a commercial feedlot. *J Anim Sci* 77:1105-1112, 1999.
11. Taylor LF, Janzen ED, Ellis JA, *et al*: Performance, survival, necropsy, and virological findings from calves persistently infected with bovine viral diarrhea virus originating from a single Saskatchewan beef herd. *Can Vet J* 38:29-37, 1997.
12. Van Donkersgoed JF, Schumann FJ, Harland RJ: The effect of route and dosage of immunization on the serological response to a *Pasteurella haemolytica* and *Haemophilus somnus* vaccine in feedlot calves. *Can Vet J* 34:731-735, 1993.

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