PEER REVIEWED

Effect of Trivalent Modified-Live Virus Respiratory Vaccine on Performance, Health, and Carcass Traits of Lightweight Feeder Steers

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Abstract

A total of 3,615 lightweight feeder steers were used to compare the effects of trivalent (infectious bovine rhinotracheitis virus and bovine viral diarrhea virus types 1 and 2) modified-live virus (MLV) vaccine products on performance, health, and carcass traits of cattle in a commercial feedlot setting. The three trivalent MLV vaccination products compared were Express® 3 (Boehringer Ingelheim Vetmedica, Inc., St. Joseph MO), Bovi-Shield GOLD® IBR-BVD (Pfizer Animal Health, New York, NY), and Vista® 3 SQ (Intervet/Schering-Plough Animal Health, Summit, NJ). No differences ($P \geq 0.30$) in feed conversion, final weight, or gain performance were detected among vaccination treatments. The percentage of BRD morbidity was similar ($P=0.15$) among treatments, averaging 12.3% overall. Furthermore, no vaccine treatment differences ($P \geq 0.36$) were observed for relapse percentage, mortality or railer incidence, regardless of cause.

All cattle used in the study were tested for persistent infection (PI) with BVDV, and the prevalence of cattle testing positive for PI-BVDV was similar ($P=0.56$) among the vaccine treatments and averaged 0.27% overall. Cattle which tested positive for PI-BVDV were not removed from the study pens, and after data were pooled, health and performance did not differ for pens with or without a PI-BVDV pen mate. When utilizing lightweight feeder steers with relatively low BRD-associated morbidity and mortality, there was no difference in performance, health, and carcass trait observations among the three trivalent MLV vaccine products evaluated.

Keywords: bovine, BRD morbidity, BVDV, persistent infection, PI, vaccine

Résumé

On a utilisé un total de 3615 bouvillons d'engraissement légers afin de comparer l'effet de trois vaccins trivalents à virus vivants modifiés (virus de la rhinotrachéite infectieuse bovine et virus de la diarrhée virale bovine du type 1 et 2) sur la performance, la santé et les caractéristiques de carcasse chez des bovins dans un parc d'engraissement commercial. Les trois vaccins à l'étude étaient l'Express® 3 (Boehringer Ingelheim Vetmedica, Inc., St. Joseph MO), le Bovi-Shield GOLD® IBR-BVD (Pfizer Animal Health, New York, NY), et le Vista® 3 SQ (Intervet/Schering-Plough Animal Health, Summit, NJ). Il n'y avait pas de différence ($P \geq 0.30$) dans la conversion alimentaire, le poids final ou le gain de performance entre les trois groupes de vaccination. Le pourcentage de morbidité causée par les maladies respiratoires bovines était similaire entre les traitements ($P=0.15$) et était de 12.3% en moyenne, tous groupes confondus. De plus, aucune différence n'a été notée ($P \geq 0.36$) entre les traitements en ce qui a trait au pourcentage de rechute, à la mortalité ou à l'incidence de réforme, peu importe la cause.

Tous les bovins à l'étude ont été testés pour l'immunotolérance au virus de la diarrhée virale bovine. La prévalence d'immunotolérance était similaire ($P \geq 0.56$) entre les trois groupes (0.27%, en moyenne). Les bovins immunotolérants n'ont pas été retirés des enclos d'étude et après avoir combiné les résultats, la santé et la performance ne variaient pas significativement entre

les enclos avec ou sans animaux immunotolérants. Chez les bouvillons légers, dans un contexte où les maladies respiratoires bovines ont peu d'impact sur la morbidité et la mortalité, il n'y avait pas de différence au niveau de la performance, de la santé et des caractéristiques de carcasse entre les trois types de vaccins trivalents avec virus vivants modifiés à l'étude.

Introduction

Numerous respiratory viral vaccines with various antigen combinations are available for the prevention of bovine respiratory disease (BRD). Each vaccine product has unique characteristics such as amount of antigen content, specific strains of inactivated and/or live-attenuated virus, and presence or absence of an often proprietary adjuvant. Pentavalent, modified-live virus (MLV) vaccines are designed to provide immunity against infectious bovine rhinotracheitis virus (IBRV), bovine viral diarrhea virus (BVDV) types 1 and 2, bovine respiratory syncytial virus (BRSV), and parainfluenza-3 virus (PI3V). In a previous study comparing a pentavalent to trivalent (IBRV, BVDV types 1 and 2) MLV respiratory vaccine product from the same manufacturer, no difference in BRD morbidity, relapse rate, or BRD mortality was observed; however, in the same study another pentavalent MLV vaccine product with different viral strains showed improved health outcomes.[2] Another study reported morbidity and chronic illness were less for cattle administered a trivalent MLV vaccine with *Mannheimia haemolytica* bacterin-toxoid, compared to a MLV vaccine containing IBRV, BVDV type 1, BRSV, and PI3V with *Mannheimia haemolytica-Pasteurella multocida* bacterin-toxoid.[9]

The objective of this trial was to compare the effects of three different trivalent MLV respiratory vaccines on performance, health, and carcass quality of lightweight feeder steers fed in a commercial feedlot setting.

Materials and Methods

Cattle

Ten blocks totaling 3,615 lightweight feeder steers were utilized to evaluate the effects of initial and revaccination of a trivalent MLV respiratory vaccine on performance, health, and carcass traits. Cattle were purchased and delivered to a commercial feedlot from October 19 to November 14, 2005. To qualify for inclusion into the research trial, source groups were required to have purchase weights between 450 and 750 lb (205 and 341 kg). Experimental cattle were primarily English-Continental breed crosses originating from Colorado, Idaho, Kansas, Kentucky, Missouri, Montana, New Mexico, Oklahoma, Utah, and Texas. Cattle that met trial qualifications were assigned randomly to one of three trivalent MLV vaccine treatments until each set of pen replicates was completed. As a result, each pen within replicate had similar backgrounds, ages, and average arrival weights. Across all pens, average initial weights ranged from 599 to 724 lb (272 to 329 kg).

Processing

Immediately after arrival to the feedlot, cattle remained separated by source and were temporarily held in a receiving pen until processing. Hay, starting ration, and water were provided *ad libitum*, and steers were generally processed within 36 hours of arrival. Prior to initial processing, cattle were sorted and weighed as a group by treatment on a ground-scale to determine initial weight. At initial processing, cattle were administered the following items:

- Serially-numbered lot ear tag with processing date.
- Color-coded ear tag corresponding to the last digit of the lot number that indicated treatment.
- Respective trial vaccine containing MLV IBRV and BVDV types 1 and 2 antigens: EXP3[a], subcutaneous (SC); BOV3[b] intramuscular; or VIS3[c] SC:
  - 2 mL for all products and administered in left neck
  - A designated syringe was used for each vaccine
  - Each vaccine originated from a single serial lot
- *Mannheimia haemolytica* toxoid[d] (2 mL SC in the right neck) and/or tilmicosin phosphate[e] (1.5 mL/100 lb (45 kg) body weight SC in the left neck) were administered to cattle categorized as high-risk, and a five-day post-treatment evaluation period was implemented for cattle receiving metaphylaxis.
- Ivermectin[f] (5 mL/animal SC in the left neck)
- Permethrin[g] was administered except for replicate 7 (16 mL/animal topically down the backline).
- Implant: 16 mg estradiol and 80 mg trenbolone acetate[h] implant administered in the caudal aspect of the left ear

Replicate 3 was withdrawn from the trial due to administration of the incorrect vaccine to one of the sources within two of the three pens within the replicate. Consequently, an additional replicate (11) was added to the trial to equal 10 replicates. Other than purchase origin, previous health and vaccination history of cattle used in the current study was unknown. A total of 541 cattle originated from auction markets (EXP3, n = 183; BOV3, n = 178; VIS3, n = 180), were considered high-risk for developing signs of BRD, and received metaphylaxis with tilmicosin phosphate and/or *Mannheimia haemolytica* bacterin-toxoid during initial processing. The remaining cattle (n = 3074) mostly originated directly

from the ranch, were not considered high-risk, and did not receive metaphylaxis during initial processing. Gender was assessed, and cattle found to be bulls were left intact and noted. A total of 12 bulls were placed on trial (EXP3, 8 bulls; BOV3, 2 bulls; VIS3, 2 bulls).

An ear notch tissue sample was collected from each animal during initial processing and was tested to determine if calves were persistently infected (PI) with BVDV using reverse transcriptase polymerase chain reaction in pools of 100 samples at the Rocky Ford Diagnostic Laboratory (Rocky Ford, CO). If BVDV was detected in a 100-sample pool, antigen capture ELISA was performed on individual samples used within the pool to determine which sample(s) were BVDV positive. To be consistent with standard procedure of the feedlot (no PI-BVDV testing and removal) and to investigate effects of a PI-BVDV pen mate during the feeding period, animals identified as PI-BVDV were not removed from their study pen.

Steers were reimplanted with a terminal combination implant of 24 mg estradiol and 120 mg trenbolone acetate[i] at approximately 93 days on feed (range 81-111 days). All replicates were revaccinated with their respective trial vaccines at the time of terminal implantation.

Animals sold early because of unsatisfactory performance or response to treatment for BRD or other problems were classified as railers. Cattle that died were necropsied by personnel as trained by the consulting veterinarian, and cause of death was noted.

Treatment Assignment

Vaccine treatment and pen assignments were predetermined by randomly drawing treatment group order out of a hat. The first treatment group selected was assigned the lowest lot and pen number. Allotment to treatment group occurred equally within each truckload or source. All truckload lots required to fill a block (i.e. replicate of three pens) were received at approximately the same time (maximum of seven-day duration). Randomization of animals within a truckload to vaccine-processing group occurred by sorting animals three head at a time into each of three treatments. This process was repeated for every truckload of cattle until all blocks (10 pen replicates/treatment) were completed. Consequently, each block of three pens was comprised of cattle of similar age, background, health status, initial weight, and breed type.

All cattle within replicate were placed in pens of the same size, with feed bunks facing the same direction and in the same or adjacent feed alleys. The same pen rider(s) and antibiotic treatment regimen was used for all pens within replicate to minimize health biases. Pen riders and animal health technicians were blinded to treatment allocation.

A diagnosis of BRD was made when a calf showed clinical signs of depression (e.g., inattentive to activity in the pen, lowered head and drooped ears, inappetance), absence of clinical signs attributable to other body systems, and a rectal temperature ≥104°F (40°C). BRD-associated relapses were defined as steers treated two or more times for BRD, regardless of location in the feedlot. An animal that relapsed was only counted once.

Feed

Cattle were fed three times daily; diet and bunk management strategies were identical for all pens within a replicate. Feed amounts offered were recorded for each pen on a daily basis and dry matter content of the ration was analyzed weekly. Monensin[j] and tylosin[k] were fed for the entire feeding period, and ractopamine[l] was fed for approximately the last 28 days of the feeding period.

Marketing

Pens within each replicate were marketed at constant days-on-feed according to visual evaluation of body fat and feed intake patterns routinely used by feedlot management. Pens within each replicate were managed similarly for final weighing, shipment, and slaughter. Within replicate, pens were processed, reimplanted, and shipped in the same order as randomly assigned prior to the trial initiation. All steers were harvested at a commercial packing plant from May 2 to June 14, 2006, with routine carcass data collected for all cattle.

Statistical Analyses

All performance data (i.e. continuous variables) were analyzed using the PROC MIXED procedure of SAS[m] as a randomized complete block design, with pen as the experimental unit. For all categorical data such as morbidity, mortality, and all categorical carcass parameters including quality grade and yield grade, head counts (events) within each pen for each parameter were analyzed using the events/trials syntax of the PROC GLIMMIX procedure of SAS as a randomized complete block design, with pen as the experimental unit. For all analyses, replicate and treatment were included in the model as class variables. Treatment was considered as a fixed effect, and replicate was considered a random effect.

Results and Discussion

Performance, carcass, and health data are presented in Tables 1, 2, and 3, respectively. Although initial weight was statistically different (P=0.03) among treatments (average = 640 ± 11.8 lb; (291 kg)), biological differences due to the small numerical difference in initial weight were likely inconsequential. Cattle

were fed for 198 days. When analyzed either on a live- or carcass-weight basis, no differences in final weight were detected ($P \geq 0.30$). Additionally, dry matter intake ($P=0.75$) or average daily gain ($P \geq 0.42$) did not differ among treatments. Cattle administered BOV3 had a greater ($P=0.03$) percentage of Yield Grade 1 carcasses than VIS3 cattle; however, no other differences in carcass traits were observed ($P>0.10$).

Table 1. Feed and gain performance of feedlot steers vaccinated at arrival and revaccinated at day 93 with different trivalent modified-live respiratory vaccines (LS Means).

Item	EXP3[a]	BOV3[b]	VIS3[c]	SE	*P*-value
No. pens	10	10	10		
No. steers received	1,207	1,203	1,205		
No. steers shipped	1,186	1,190	1,189		
Initial weight[d], lb	635	644	640	11.8	0.03
Final weight, lb					
Live-weight basis[e]	1,289	1,291	1,292	12.6	0.91
Carcass-weight basis[f]	1,274	1,284	1,285	11.9	0.30
Days-on-feed	198	198	198	0.00	1.00
DMI, lb/day	18.1	17.9	18.0	0.21	0.75
Average daily gain[g], lb					
Live-weight basis[h]	3.25	3.27	3.27	0.04	0.91
Carcass-weight basis[f]	3.17	3.23	3.23	0.04	0.42
Feed:Gain[g],					
Live-weight basis[h]	5.56	5.48	5.51	0.08	0.79
Carcass-weight basis[f]	5.70	5.55	5.58	0.09	0.43

[a]Express® 3, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
[b]Bovi-Shield GOLD® IBR-BVD, Pfizer Animal Health, New York, NY
[c]Vista® 3 SQ, Intervet/Schering-Plough Animal Health, Summit, NJ
[d]Weight at feedlot
[e]Shrunk (4%) weight at feedlot of cattle that were harvested
[f]Adjusted to 64.0% dressing percent
[g]Deads-in
[h]Based on unshrunk initial weights and shrunk final weights

Table 2. Carcass traits of feedlot steers vaccinated at arrival and revaccinated at day 93 with different trivalent modified-live respiratory vaccines (LS Means).

Item	EXP3[c]	BOV3[d]	VIS3[e]	SE	*P*-value
Hot carcass weight, lb	815	822	822	7.6	0.30
Dressing[f], %	63.25	63.62	63.62	0.17	0.22
Prime, %	0.43	0.17	0.34		0.56
Choice, %	38.87	39.54	42.48		0.20
Sub-Select, %	7.44	5.98	5.91		0.24
Yield Grade 1, %	11.68[ab]	12.56[a]	9.69[b]		0.09
Yield Grade 2, %	44.67	46.07	46.55		0.65
Yield Grade 4, %	5.17	6.93	6.59		0.20
Yield Grade 5, %	0.30	0.52	0.52		0.62

[a,b]Means in the same row with different superscripts differ ($P < 0.05$)
[c]Express® 3, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
[d]Bovi-Shield GOLD® IBR-BVD, Pfizer Animal Health, New York, NY
[e]Vista® 3 SQ, Intervet/Schering-Plough Animal Health, Summit, NJ
[f]Based on shrunk final weight at feedlot

Table 3. Health performance of feedlot steers vaccinated at arrival and revaccinated at day 93 with different trivalent modified-live respiratory vaccines (LS Means).

Item	EXP3[a]	BOV3[b]	VIS3[c]	SE	*P*-value
Rectal temperature at first pull, °F	105.0	104.9	104.9	0.12	0.85
BRD morbidity[d], %	11.50	11.45	13.93		0.15
Relapse[e], %	2.26	2.79	2.94		0.54
PI-BVDV[f], %	0.15	0.30	0.37		0.56
Mortality-BRD, %	0.50	0.17	0.25		0.36
Mortality-all causes, %	1.49	0.91	1.16		0.45
Railer-BRD, %	0.08	0.24	0.32		0.48
Railer-all causes, %	0.91	1.00	1.24		0.71

[a]Express® 3, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
[b]Bovi-Shield GOLD® IBR-BVD, Pfizer Animal Health, New York, NY
[c]Vista® 3 SQ, Intervet/Schering-Plough Animal Health, Summit, NJ
[d]Cattle that were pulled and treated for the first time for BRD-related diagnosis
[e]Cattle that were pulled and treated again for a BRD-related diagnosis, regardless of location in the feedlot. An animal that relapsed more than one time was only counted once
[f]Percentage of animals in respective treatments testing positive for persistently infected bovine viral diarrhea virus

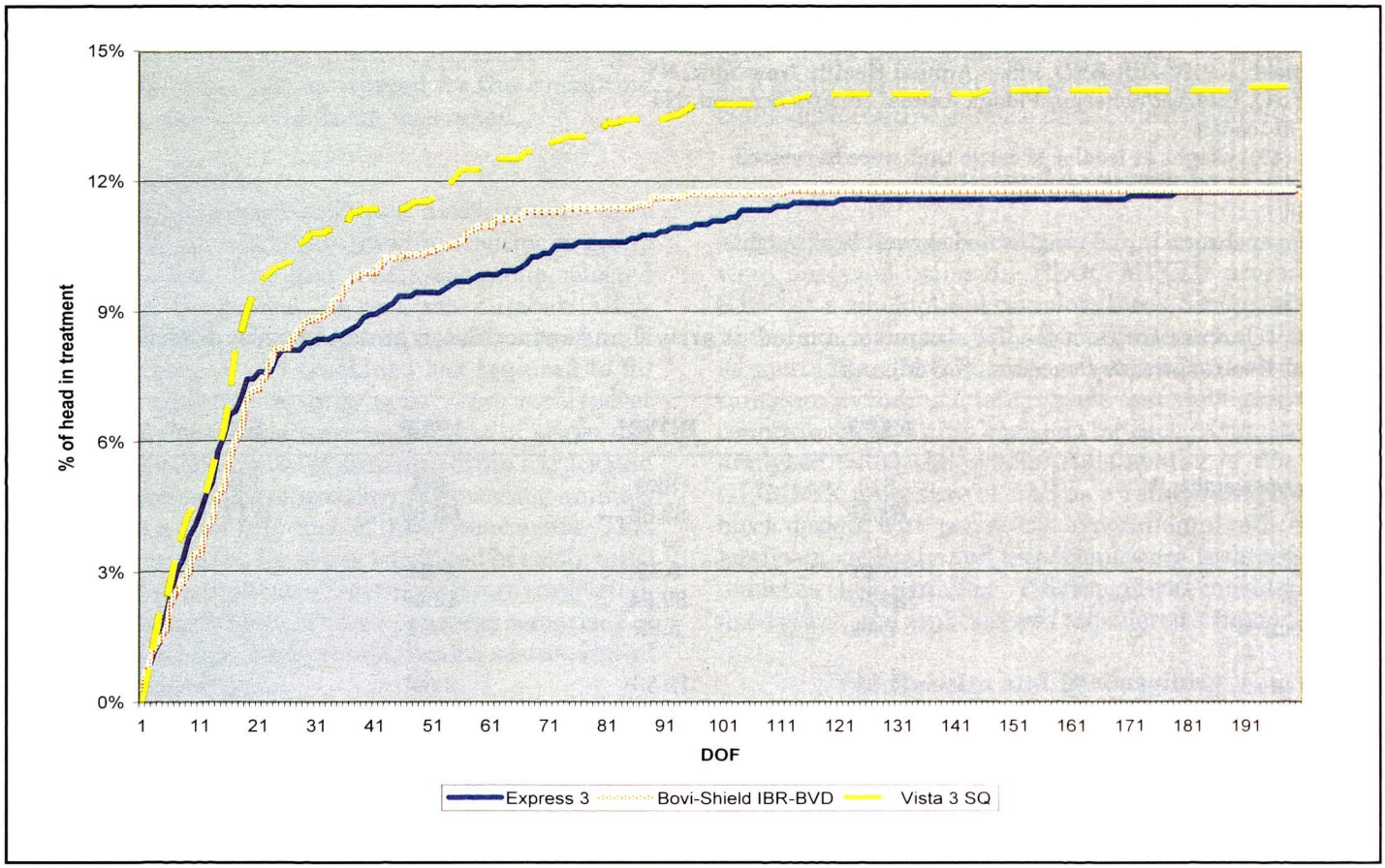

Figure 1. Cumulative morbidity rates due to BRD in feedlot steers vaccinated at arrival and revaccinated at day 93 with different trivalent modified-live virus vaccines.

Rectal temperature at first pull averaged 104.9°F (40.5°C) and did not differ (P=0.85) among treatments. The incidence of BRD morbidity was not statistically different (P=0.15), with BRD morbidity of 11.45, 11.5, and 13.93% for BOV3, EXP3, and VIS3, respectively. Cumulative morbidity rates due to BRD are shown in Figure 1. The average day of revaccination was day 93. Because a negative control was not included, disease prevention and cost effectiveness associated with revaccination in the current study were unknown; however, the majority of BRD occurred by day 60, and few BRD episodes occurred subsequent to revaccination. In a preconditioning study conducted by Step *et al*, BRD morbidity rate was reduced for cattle vaccinated once with a pentavalent MLV respiratory vaccine compared to cattle vaccinated twice, although feed efficiency during the finishing period was improved for twice-vaccinated cattle.

Of the 43 mortalities on the trial, only 11 were diagnosed as BRD-related mortalities (EXP3, n = 6; BOV3, n = 2; VIS3, n = 3); the predominant diagnosis for mortality was digestive-related (n = 22). The BRD mortality rate of 0.31% observed for the current trial was much less than the estimated industry average of 1.4%.[5] No differences were detected ($P \geq 0.36$) for mortality or railer incidence, regardless of cause.

Of the 3,615 cattle enrolled in the trial and tested for the prevalence of PI-BVDV, only 11 animals were PI-BVDV-positive (EXP3, two PI animals; BOV3, four PI animals; VIS3, five PI animals), resulting in an overall prevalence rate of 0.27%. However, the distribution of PI-BVDV animals was such that nine of the 30 pens in the trial contained at least one PI-BVDV animal (EXP3, two PI pens; BOV3, four PI pens; VIS3, three PI pens), resulting in a pen-level prevalence rate of 30%. Due to poor performance, two PI-BVDV animals were railed (culled) on days 84 and 92 from two VIS3 pens that each had two PI-BVDV cattle; one PI-BVDV animal assigned to an EXP3 pen died on day 29 due to BRD; whereas eight PI-BVDV animals remained in their treatment pen for the duration of the trial. The incidence of PI-BVDV animals did not differ (P=0.56) among vaccine treatments (Table 3).

The standard protocol for this commercial feedlot does not include removal of PI-BVDV animals from the pens, so the data was evaluated to assess the impact of potential health and performance differences of pens with or without a PI-BVDV animal. Because little difference was observed due to vaccine treatment, the data were pooled in order to assess potential health differences of pens with or without a PI-BVDV animal (Table 4). Three non-PI-BVDV study pens were adjacent to at least one confirmed PI-BVDV-positive study pen, and the PI-BVDV status of calves in adjacent, non-study pens was not known. The impact of a possible PI-BVDV animal(s) in those pens on the health and performance of calves in the adjacent experimental pens was not assessed, which may have confounded results. No differences were found in BRD morbidity (P=0.82) or mortality (P=0.32) between pens which had at least one PI-BVDV animal present and those that did not contain a PI-BVDV animal. Additionally, there were no differences in performance or carcass traits (data not shown). Our findings are in agreement with other PI-BVDV exposure studies in which overall BRD morbidity was relatively low.[1,3,8] In general, research trials that observed significant health differences due to PI-BVDV exposure also observed greater overall BRD morbidity among experimental cattle.[4,7] Therefore, interactions of physiological stress, immunosuppression, and concurrent infection with viral/bacterial pathogens in addition to BVDV may influence individual or pen-based susceptibility to PI-BVDV exposure and the resulting health outcome.

Table 4. Health performance of feedlot steers in pens with and without a persistently infected bovine viral diarrhea virus animal (LS Means).

Item	PI-BVDV[a]	Non-PI-BVDV[b]	*P*-value
Pens	9	21	
BRD morbidity[c], %	12.41	12.03	0.82
Relapse[d], %	2.91	2.16	0.30
Mortality-BRD, %	0.38	0.14	0.32
Mortality-all causes, %	1.11	1.14	0.95
Railer-BRD, %	0.26	0.04	0.23
Railer-all causes, %	1.07	0.68	0.31

[a]Persistently infected bovine viral diarrhea virus animal(s) present in pen

[b]No persistently infected bovine viral diarrhea virus animal present in pen

[c]Cattle that were pulled and treated for the first time for BRD-related diagnosis

[d]Cattle that were pulled and treated again for a BRD-related diagnosis, regardless of location in the feedlot. An animal that relapsed more than one time was only counted once

Conclusions

The EXP3, BOV3, and VIS3 MLV respiratory vaccines compared in the current study contain different viral genotype strains and adjuvants, but are designed to provide immunity against the same viruses (IBR and BVDV types 1 and 2). When utilizing lightweight feeder steers with relatively low overall BRD morbidity and mortality, there were no differences among the vaccine products tested in terms of performance and most health and carcass trait outcomes.

Endnotes

[a]Express® 3, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
[b]Bovi-Shield GOLD® IBR-BVD, Pfizer Animal Health, New York, NY
[c]Vista® 3 SQ, Intervet/Schering-Plough Animal Health, Summit, NJ
[d]Presponse® SQ, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO
[e]Micotil®, Elanco Animal Health, a subsidiary of Eli Lilly and Co., Greenfield, IN
[f]Promectin® Injection for Cattle and Swine, Vedco, Inc., St. Joseph, MO
[g]Permectrin®, KMG Chemicals, Inc., Houston, TX
[h]Revalor®-IS, Intervet/Schering-Plough Animal Health, Summit, NJ
[i]Component® TE-S, Ivy Animal Health, a subsidiary of Eli Lilly and Co., Overland Park, KS
[j]Rumensin®, Elanco Animal Health, a subsidiary of Eli Lilly and Co., Greenfield, IN
[k]Tylan®, Elanco Animal Health, a subsidiary of Eli Lilly and Co., Greenfield, IN
[l]Optaflexx®, Elanco Animal Health, a subsidiary of Eli Lilly and Co., Greenfield, IN
[m]SAS Institute Inc., Cary, NC, Software Version 8

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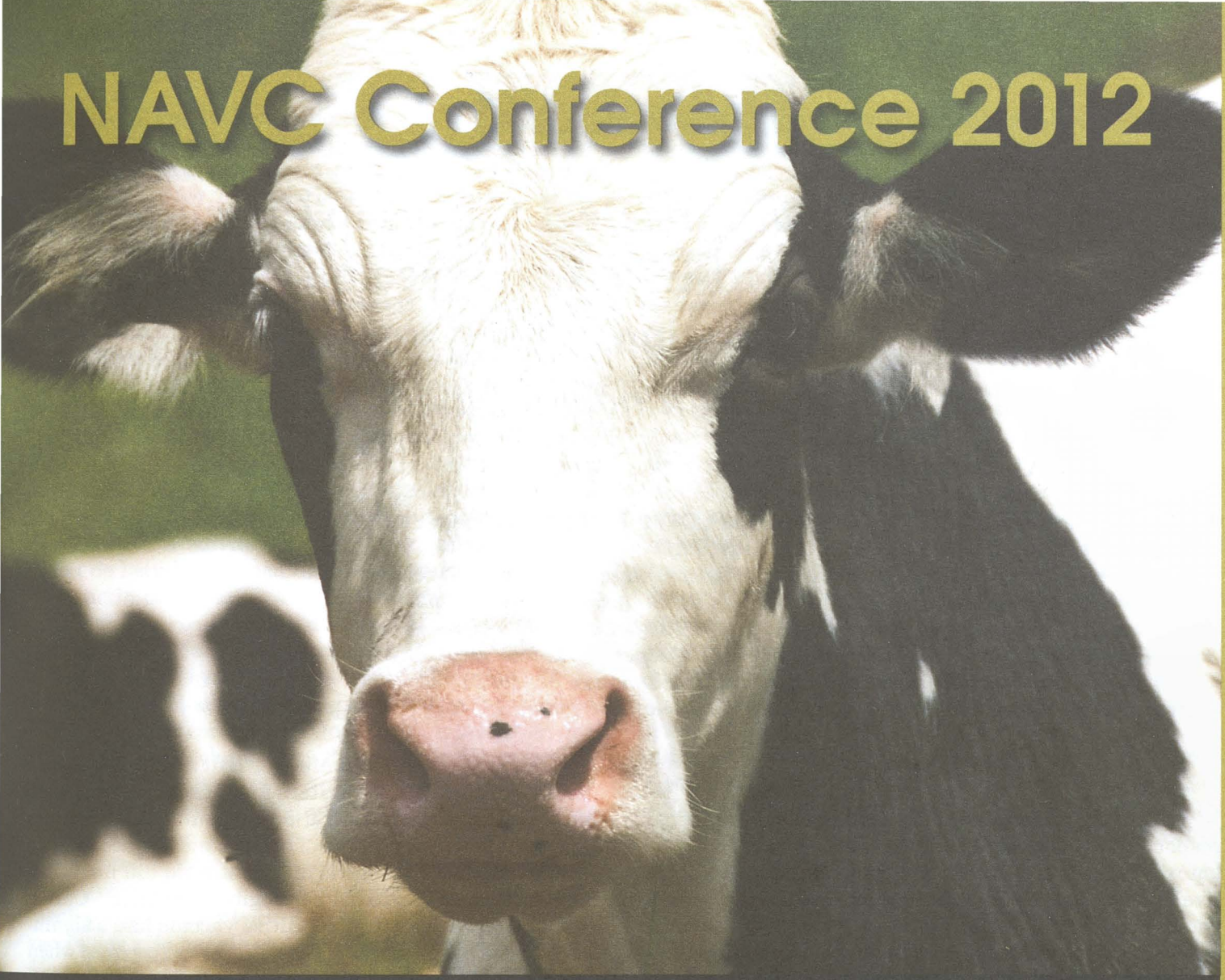

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