

AGRI-PRACTICE – BACTERIOLOGY

A total of 352 head of Holstein steers averaging 530 lbs in bodyweight were vaccinated upon arrival at a feedyard with Re-17 mutant *Salmonella typhimurium* bacterin-toxoid and commingled with 351 head of controls averaging 538 lbs. The steers were uniformly intermingled in pens holding approximately 140 head each. The health maintenance costs; weights at 30, 60, and 275 days; overall feed conversion; and weight gains were calculated, recorded for each group and pen, and statistically compared. There were significant ($P < 0.05$) differences between vaccinated and control groups in terms of bovine respiratory disease complex (BRDC) health costs when medicine/hospitalization, treatment days, and second sick pulls were compared. There was not a significant difference in the number of total deaths, 15 controls, and 13 vaccinates, but there was only one vaccinate death due to BRDC compared to five controls. The results of this study suggest that health maintenance costs in the vaccinated cattle were significantly lowered by vaccination with the Re-17 mutant *S. typhimurium* bacterin-toxoid.

Effect of Re-17 Mutant *Salmonella typhimurium* Bacterin-Toxoid on Respiratory Disease and Production

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Introduction

Endotoxemias associated with bovine respiratory disease complex (BRDC) have been effectively controlled in lightweight Holstein feeder steers by Re-17 mutant *Salmonella typhimurium* bacterin-toxoid (ENDOVAC-Bovi® United States Department of Agriculture-licensed *S. Typhimurium* Bacterin-Toxoid: IMMVAC, Inc., Columbia, MO).¹ These anti-core-antigen antibodies have also been shown to cross-protect ponies and calves from gram-negative endotoxin septicemias due to *Escherichia coli* and *Salmonella* sp. organisms.²⁻⁶ It was demonstrated in previous investigation that the toxoid component of the mutant bacterin-toxoid stimulated the immune system of calves to produce high levels of anti-endotoxin antibodies in response to the bacterin.⁷ Specifically, the detoxified endotoxin, E3, significantly stimulated the lymphocytes such that they divided and manufactured antibodies earlier and in higher numbers in response to the vaccine in contrast to antigen administered without E3.⁷

The purpose of this study was to determine how the antibodies provided the mutant bacterin-toxoid would effect the endotoxemias produced by gram-negative organisms associated with BRDC in middleweight Holstein steers.

Materials and Methods

A total of 703 head of Holstein steers of common origin averaging 534 lbs in bodyweight arrived at the feedyard on 2 consecutive days. The steers were worked and weighed the day following arrival and identified with sequentially numbered ear tags. They were designated as two groups: odd numbers representing vaccinated steers and even numbers representing controls. They were randomly assigned to five pens of approximately 140 head each with 70 vaccinates and 70 controls commingled in each pen. The 351 controls averaged 538 lbs body weight per head, and the 352 vaccinates averaged 530 lbs per head. Each of the 352 steers in the treated group received its first bacterin-toxoid injection (ENDOVAC-Bovi®) along with the other routine vaccines (Bovishield 4 + 5®: SmithKline Beecham, Exton, PA and Ultrabac 7®: SmithKline Beecham: Exton, PA) and dewormer (Ivomec®: MSD AgVet, Rahway, NJ). A booster of the mutant bacterin-toxoid was administered to each steer in the treatment group along with the other routine boosters (Bovishield and Ultrabac 7) 10 days later. The 351 control steers were also dewormed (Ivomec) and injected with the routine vaccines (Bovishield and Ultrabac) followed by boosters (Bovishield and Ultrabac).

Pen riders, who did not know which ear tag numbers corresponded to control and treatment groups, removed ill cattle from the fattening pens and placed them in the hospital pen for further observation and treatment when they exhibited listlessness, central nervous system (CNS) depression, nasal discharge, coughing, hyperpnea, dyspnea, or anorexia. Body temperature of ill steers was monitored daily during hospitalization. Ill steers from either the control or vaccinated group were treated the same based on the medical diagnosis. Cattle with the diagnosis of BRDC were treated first with a second generation cephalosporin

(Naxcel®: Upjohn Company, Kalamazoo, MI) plus penicillin G (PFI-PENG®: Pfizer, Inc., New York, NY) at first sick pull until body temperature returned to normal and at the second sick pull were retreated with tylosin (Tylan®: Elanco Products Co., Indianapolis, IN) and ampicillin (Polyflex®: Fort Dodge Laboratories, Fort Dodge, IA) until body temperature returned to normal. Pen riders were unable to identify which steers were first pulls or relapses.

Treatment days, medication/hospital costs, and deaths were recorded for subsequent analysis. Dead cattle were necropsied and diagnoses made on the basis of gross lesions and laboratory examinations of tissues sent to a veterinary diagnostic laboratory.

The vaccinated and control steers in each pen were separated according to odd and even numbers and weighed on Days 0, 30, 60, and 275 days of the feeding period, and weight differences between the two groups were calculated and compared. Feed conversion ratios were calculated and the two groups were compared.

Analysis of variance (ANOVA) and chi-square techniques were used to statistically analyze the data. Differences were significant when P was ≤ 0.05 .

Results

The medical costs (medicine plus hospitalization) of \$2.36 per head for treating BRDC in the vaccinated group were significantly ($P < 0.04$) less than the \$3.66 per head cost for the controls. The \$799 health maintenance cost for the vaccinate group was significantly ($P < 0.05$) different than the total of \$1,231 for the controls and resulted in a \$431 difference in favor of the vaccinates (Table 1).

There was a significant ($P < 0.05$) decrease in second pulls for treatment of BRDC of the calves vaccinated with the mutant bacterin-toxoid. Initial sick pulls due to BRDC were 32 vaccinates vs. 40 controls. The four second pulls in the vaccinated group were significantly ($P < 0.05$) different from the 13 in the control group. The 135 treatment days for vaccinates were significantly ($P < 0.02$) different from the 239 days for controls (Table 1).

The total weight gained by the vaccinated group was 213,162 lbs compared to 207,979 lbs by the control group – a 5,183 lb difference. At Day 0 the vaccinates weighed slightly less than the controls with the average weight per steer of 530 and 538 lbs, respectively. The controls averaged 640 lbs bodyweight and the vaccinates 633 lbs at 30 days. The average 60-day weight for the controls was 747 lbs and 736 lbs for the vaccinates. The average weight at 275 days for the vaccinates was 1,178 lbs and 1,180 lbs for the controls – an average gain of 628 lbs for the vaccinates and 618 lbs for the controls (Table 2). The difference required 7.51 lbs of feed per pound of gain while the controls required 7.52 lbs (Table 2). The differences in total weight gained, average weight per head gain, and feed conversion ratios between the vaccinates and controls were not significant. The 5,183 lbs of extra beef produced by the vaccinated compared to the controls at \$73.40 per cwt amounted to a total difference of \$3,804 or \$11.20 per head extra income without deducting the cost of the Re-17 mutant *S. typhimurium* bacterin-toxoid.

An overall death rate of 4% resulted from a total of 28 dead out of 703 head. Only seven steers died during the first 60 days, one from respiratory disease. Death losses in the vaccinated group were 13 head or 3.7%, and death losses in the control group were 15 head or 4.3%. The one death due to BRDC accounted for a 0.28% rate in the vaccinated group and the four deaths in the controls accounted for a 1.14% rate. Necropsies were performed on all 28 steers that died, and examination of gross lesions resulted in the following diagnoses: BRDC/pneumonia in five head (one vaccinate, four controls); bloat in nine head (four vaccinates, five controls); Salmonellosis in five head (two vaccinates, three controls); acidosis in four head (three vaccinates, one control); and liver necrosis in five head (three vaccinates, two controls) (Table 3).

Tissues from 17 necropsied steers were submitted to a veterinary medical diagnostic laboratory for histologic examination, virus identification, and bacterial culture. Histologic examination confirmed bronchopneumonia in four respiratory cases; *Hemophilus somnus* and bovine respiratory syncytial virus (BRSV) were also identified in the tissues of one of the four steers exhibiting histopathologic lesions of bronchopneumonia. Bovine virus diarrhea (BVD) virus was identified via fluorescent antibody examination in another steer that demonstrated histologic evidence of pulmonary congestion and edema. *Salmonella* sp. organisms were isolated from the tissues of four steers. Hepatic necrosis was the histologic diagnosis in four steers; one of these steers also exhibited the histologic lesions of pneumonia. Tissues from three steers yielded non-conclusive diagnoses (Table 3).

Discussion

The difference between controls and vaccinates was significant when numbers of ill cattle exhibiting the signs of BRDC were compared. The advantage that the vaccinates exhibited over the controls was most apparent when the number of retreated steers in each group were compared. The mutant bacterin-toxoid significantly reduced medical expenses in terms of total medical costs and treatment days.

During the 275 days of this feeding period a severe winter storm hit at 105 days following entry of the steers into the feedlot. Deep mud characterized the surface in the feeding pens for 2 months following the storm. These conditions were regarded as severe for western Kansas feedyards in wintertime and were reflected by the low daily gain. As noted in Table 3, deaths occurred at a more rapid rate soon after the October 31 storm. Although neither the death rate nor the spectrum of necropsy lesions in these Holstein steers was unusual in the author's experience, the time on feed was longer than usual and the rate of gain less than usual.

It was noteworthy that of the five respiratory deaths during the 275-day feeding period, only one was a vaccinated steer. The total death loss in the vaccinated group was not significantly different than in the control group.

In this study, using the mutant bacterin-toxoid along with the viral antigens appeared to be effective against BRDC. Other devastating septicemic disorders in cattle^{1-3,6} are known to be associated with *E. coli* and *Salmonella* sp. Additional studies will further define the extent of the cross-protection that can be provided. Economic losses due to gram-negative endotoxemias in cattle of all ages may be effectively reduced with this new immunological technology.

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TABLE 1
Bovine Respiratory Disease Complex (BRDC) Medicine/Hospitalization Data

	Vaccinates	Controls	Difference	Significance
Med/Hosp ± SEM	799 ± 208	1,231 ± 204	431 ± 236	P < 0.04
Med/Hosp Costs/Hd \$ ± SEM	2.36 ± 0.6	3.66 ± 0.49	1.3 ± 0.69	P < 0.05
BRDC Treatment Days	135	239	104	P < 0.02
No. First BRDC Pulls	32	40	8	N.S.
No. Second Pulls	4	13	9	P < 0.05
No. Third Pulls	0	8	8	P < 0.02
No. Fourth Pulls	0	3	3	N.S.
No. Fifth Pulls	0	3	3	N.S.
No. Sixth Pulls	0	1	1	N.S.

SEM = Standard error of the mean; Hd = head

TABLE 2
Weight and Gain Data

	0 Days		30 Days		60 Days		275 Days		Summary		Total Gain
	Wt/Hd	Wt/P	Wt/Hd	Wt/P	Wt/Hd	Wt/P	Wt/Hd	Wt/P	GA/Hd	GA/Pen	
CON											
Average	538	188,214	640	223,555	747	259,340	1,180	396,193	618	41,596	
SEM	33	1,574	32	1,409	31	1,359	33	1,834	20	1,766	
											207,979
VAC											
Average	530	185,958	633	220,355	736	255,500	1,178	399,120	628	42,632	
SEM	29	1,606	29	1,370	31	1,429	20	399	10	1,164	
											213,162

SEM = Standard error of the mean; Wt/Hd = Weight per head; Wt/P = Weight per pen; GA/P = Gain per pen; GA/Hd = Gain per head

TABLE 3
Necropsy Diagnostic Data

Date		Gross Diag	Lab Diag
7/18/91	V	BLT	NT
7/22/91	V	SA	SA
7/28/91	V	HN	NT
8/10/91	C	HN	HN, BP
8/16/91	V	HN	HN
8/30/91	C	BRDC	BP/BRSV/HEM
8/31/91	C	SA	HN
9/17/91	V	AD	NT
9/19/91	C	BLT	NT
9/22/91	V	AD	NT
9/24/91	C	BLT	NT
9/25/91	V	SA, HN	HN
9/30/91	V	BLT	NT
10/06/91	C	BRDC	BP
10/08/91	C	SA	SA
10/09/91	V	BLT	NT
10/28/91	C	BRDC	BVD, CV, PE
11/01/91	V	SA	SA
11/04/91	C	HN	HN
11/08/91	C	SA	SA, BP
11/08/91	C	BLT	NT
11/08/91	C	BLT	NT
11/08/91	V	AD	NC
01/01/92	C	BLT	SA
01/16/92	C	AD	NC
03/08/92	V	BLT	NT
03/18/92	C	BRDC	NC
03/20/92	V	BRDC	BP

C = control; V = vaccinate; AD = acidosis; BLT = bloat; BP = bronchopneumonia; BRDC = bovine respiratory disease complex; BRSV = bovine respiratory syncytial virus; BVD = bovine virus diarrhea virus; CV = corona virus; ENT = enteritis; HEM = *Hemophilus* sp.; HN = hepatic necrosis; NC = non-conclusive; NT = tissue not available; PE = pulmonary edema; SA = *Salmonella*