Upon arrival 2,142 feeder calves were divided into two groups. A total of 1,064 head were vaccinated with only one injection of Re-17 mutant *Salmonella typhimurium* bacterin-toxoid and placed in eight pens adjacent to and alternating with nine pens containing the 1,078 head of nonvaccinated controls. This study indicated that the vaccinated group was statistically superior to the control group in terms of both first and second sick pulls. Statistically significant differences were noted between vaccinated and control groups when medical costs per head and number of second treatment hospitalization days were compared, as well as a trend toward fewer deaths in the vaccinated group. The results of this study suggested that the Re-17 mutant *Salmonella typhimurium* bacterin-toxoid significantly decreased the respiratory disease morbidity and severity in the vaccinated group.

The Effects of Re-17 Mutant *Salmonella typhimurium* Bacterin-Toxoid on Bovine Respiratory Disease in Feedlot Heifers

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Introduction

It has been suggested that gram-negative endotoxemias are important components of secondary pneumonias associated with Bovine Respiratory Disease Complex during the first 60 days in the feedyard.[1] Anti-core-antigen antibodies were found to aid in the control of Pasteurella sp. Endotoxemia in feeder calves[1] and also to cross-protect calves from gram-negative endotoxemias due to Escherichia coli and Salmonella sp.[2,3] The primary purpose of this study was to determine the extent of the antibody protection from endotoxemia provided by one injection of the Re-17 mutant *Salmonella typhimurium* bacterin-toxoid (Endovac-Bovi® : IMMVAC, Inc., Columbia, MO) to long-hauled lightweight crossbred feedlot heifers.

Materials and Methods

A total of 2,142 head of crossbred heifer calves averaging 475 lbs in bodyweight and originating in the southeastern U.S. were received at a western Kansas feedyard between October 18 and November 15, 1991. The calves had been shipped in trucks for at least 30 hours. The first truckload of heifers that arrived were designated to serve as controls or to receive Re-17 mutant *Salmonella typhimurium* bacterin-toxoid (Endovac-Bovi) by the flip of a coin. The next truckload received the Re-17 mutant *Salmonella typhimurium* bacterin-toxoid (Endovac-Bovi). Threreafter, consecutive truckloads were alternately designated as controls and vaccinates. The day following arrival, the calves were individually identified with eartags and placed in one of 17 alternate and adjacent pens holding 116 to 137 head each. Adjacent control and vaccinated groups shared fence line water supplies and were able to nose each other through division fences.

There were 1,064 vaccinates and 1,078 controls in the study. Upon initial processing at the feedyard each heifer in the vaccinated group received one injection of Re-17 mutant *Salmonella typhimurium* bacterin-toxoid (Endovac-Bovi) along with a viral respiratory vaccine combining modified live infectious bovine rhinotracheitis (IBR), parainfluenza$_3$ virus (PI$_3$), bovine virus diarrhea (BVD), and bovine respiratory syncytial virus (BRSV) viral antigens combined with five Lepto antigens (Bovishield 4 + L5®: SmithKline Beecham, Exton, PA) a seven-way clostridial vaccine (Ultrabac®7: SmithKline Beecham), an intranasal viral vaccine containing IBR and PI$_3$ (TSV-2®: SmithKline Beecham), and ivermectin (Ivomec®: Merck Agvet Division, Rahway, NJ). Each heifer in the control pens was administered the same vaccines and parasiticide but Re-17 mutant *Salmonella typhimurium* bacterin-toxoid (Endovac-Bovi) was excluded. No booster vaccinations were administered. Every heifer in both the control and vaccinated groups was treated with ceftioufur (Naxcel®: Upjohn, Kalamazoo, MI) and tylosin (Tylan®: Elanco Products Co., Indianapolis, IN) for 3 days beginning with the day of receiving and initial processing.

The morbidity and mortality were monitored in this study for 60 days following arrival at the feedyard during the period that cattle are most susceptible to respiratory disease problems typically associated with the bovine respiratory disease complex (BRDC).

Ill cattle were removed from the feeding pen and placed in the hospital pen for further observation and treatment when listlessness, prolonged recumbency, depression, hyperpnea, dyspnea, anorexia, and/or diarrhea were observed by the pen riders. First sick pulls were routinely treated with spectinomycin (Spectam®: Sanofi Animal Health, Inc., Overland Park, KS) and erythromycin (Erythro®: Sanofi Animal Health, Inc.). Repeat sick pulls were treated with procaine penicillin and injectable sulfadimethoxine.

Methods used to analyze that data included chi-square and analysis of variance techniques with classifications for treatment, pull, treatment vs. pull, treatment vs. pen, and error. The variable of analysis was the arc sine of the square root of the fraction treated. Treatment means were compared using a F-test with 1 and 33 degrees of freedom.

Results

The Re-17 mutant *Salmonella typhimurium* bacterin-toxoid significantly ($P < 0.005$) decreased initial sick pulls: 13.4% or 142 head of the vaccinates compared to 18% or 194 head of the nonvaccinated (Table 1). The vaccine also significantly ($P < 0.005$) decreased second sick pulls: 3% or 35 head of the vaccinates compared to 7.1% or 77 head of the nonvaccinates (Tables 1 & 2). Seventeen head or 1.6% of the vaccinates compared to 29 head or 2.7% of the nonvaccinates died ($P = 0.11$) (Table 1).

The vaccinated group was superior in both first and second sick pulls, $P = 0.03$ and $P = 0.02$, respectively, on a per pull comparison of vaccinates and controls (Table 2). The probability of the average fraction of treated cattle in the vaccinated and control groups being equal was 0.08. Cattle were all of the same origin (the southeastern U.S.), indicating the difference was not due to a difference in the place from which the cattle originated.

Discussion

The results of this study strongly suggest that the Re-17 mutant, *Salmonella typhimurium* bacterin-toxoid reduced overall morbidity and mortality by increasing response to medical treatment. These results were noteworthy, especially in terms of BRDC since the author observed that more than 80% of the ill cattle treated in this study exhibited the clinical signs of BRDC and because a majority of the ill cattle that have died during the feeding period have exhibited the signs of BRDC.[4] It was assumed that the reduced medical costs and mortality resulted in improved beef production.

The control and vaccinated groups of calves involved in this study were not intermingled in each pen; however, they were fed in adjacent pens which allowed contact through the fence and were uniformly processed and fed. The measured advantages of the vaccinates compared to controls represented the effect of a one-dose administration program of the Re-mutant *Salmonella typhimurium* bacterin-toxoid. Because the cattle in the study were administered only on of a recommended two-dose regimen, the significant statistical differences between vaccinates and controls were especially interesting.

Conclusion

It is generally believed by feedlot managers and veterinarians that cattle are the most vulnerable to BRDC during the first 60 days of feedlot confinement. Based on the results of this study the combining of Re-17 mutant *Salmonella typhimurium* bacterin-toxoid administration with the routinely administered IBR, PI_3, BRSV, and BVD viral antigens was useful to both the veterinarian and producer in terms of reducing respiratory disease morbidity and medical costs during the initial 60 days of the feeding period.

References

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TABLE 1
Medicine/Hospitalization

	Vaccinates	μ ± SEM	Controls	μ ± SEM	Difference	Total or SIG.
Medical Costs $	$2,081		$3,144		$1,062	$5,225
Medical Costs $/Hd		$2.00 ± 0.38		$2.94 ± 0.37	$0.94	P < 0.005
No. Hd Dead & %	17 (1.6%)		29 (2.7%)		12	P = 0.11
No. Hd 1st Rx	142	17.75 ± 3.53	194	21.56 ± 2.50	52	P < 0.005
No. Hd 2nd Rx	35	4.38 ± 3.53	77	8.56 ± 2.50	42	P < 0.005
1st Rx Hosp. Days	426	17.75 ± 3.53	582	64.67 ± 7.49	156	N.S.
2nd Rx Hosp. Days	105	13.13 ± 3.1	231	25.67 ± 6.25	126	P < 0.005

μ = mean
SEM = Standard error of the mean

TABLE 2
Treatment Data

Vaccinates										
Pen No.	1	2	3	4	5	6	7	8		Total
Hd	130	137	130	131	137	137	132	130		1,064
1st Rx	27	21	16	2	17	30	24	5		142 [a]
2nd Rx	7	3	7	0	7	7	2	2		35 [b]
Controls										
Pen No.	1	2	3	4	5	6	7	8	9	Total
Hd	121	117	116	117	116	120	121	130	120	1,078
1st Rx	34	18	20	26	26	10	13	27	20	194 [a]
2nd Rx	18	12	13	4	16	6	3	4	1	77 [b]

[A] P = 0.03
[B] P = 0.02