Lesions and effects of location for administration of clostridial bacterin-toxoid vaccines on growth performance and eating and drinking behaviors in newly arrived calves at a feedlot

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Objectives—To determine the effect of location for administration of clostridial vaccines on behavior, growth performance, and health of calves at a feedlot, the relative risk of calves developing an injection-site reaction or being misdiagnosed as having bovine respiratory disease complex (BRDC), and the percentage of subcutaneous injection-site reactions that were detectable on carcasses after the hides were removed.

Animal—170 newly arrived calves at a feedlot.

Procedure—Eating and drinking behaviors of calves during the initial 57 days after arrival were observed at a commercial feedlot, using an electronic monitoring system. Calves were assigned randomly to receive a clostridial vaccine (base of ear or neck). Data on reactions at the injection site were collected.

Results—Mean daily gain (MDG) for the initial 57 days did not differ significantly between treatments. Risk of being misdiagnosed as having BRDC was not associated with location for administration of vaccine. Calves vaccinated in the base of the ear were at higher risk of having an injection-site reaction at day 57 or at slaughter. Eighty-nine percent (95% confidence interval, 52 to 100%) of injection-site reactions in the neck could not be located on the carcasses after hides were removed. Calves vaccinated in the neck drank significantly fewer times per day during the first 57 days than calves vaccinated in the base of the ear.

Conclusions and Clinical Relevance—Location for administration of a clostridial vaccine did not significantly affect health, growth performance, or eating behavior. Most subcutaneous injection-site reactions were not detectable after the hide was removed. (*Am J Vet Res* 2000;61:1169–1172)

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The National Beef Quality Audit and numerous independent investigations have identified the top issues involving quality in several areas of the beef industry.[1-4] Injection-site lesions ranked second or third among purveyors, restaurateurs, retailers, and packers.[1,2] The Beef Quality Assurance Group Audits revealed that the incidence of lesions from slaughter steers or heifers in top sirloin butts was 21.6 and 6.2% in 1990 and 1997, respectively, and 8.5 and 4.4% in rounds in 1994 and 1997, respectively.[5] The most practical method for avoiding injection-site lesions in the top sirloin butt and round is to give all injections at locations cranial to the point of the shoulder. Quality assurance programs have led the industry to pursue better techniques, routes, and locations for administration of vaccines and antibiotics. There have been a paucity of reports on the effects that these management practices may have on the behavior, growth performance, and health of cattle.

Effects of parenteral administration of a multivalent bacterin-toxoid vaccine against 7 clostridial species on eating behavior or **mean daily gain (MDG)** has not been widely reported. Stokka et al[6] reported that giving a second dose of a vaccine against 7 clostridial species resulted in a decrease in feed consumption of 20% by 4 days after the second vaccination; however, body weights were not significantly different in vaccinated or nonvaccinated calves on day 0, 30, 61, or 190 of that study.

Methods used previously to evaluate eating and drinking behaviors of cattle may not account for the effects of restricted social, dominance, eating, and drinking behaviors. Recent development of an electronic monitoring system[7,a] allows continuous observation of eating and drinking behaviors in a commercial production setting without disrupting other typical behaviors.

The purposes of the study reported here were to determine the effects of SC administration of a multivalent parenteral bacterin-toxoid vaccination against 7 clostridial species in the base of the ear versus in the neck on eating and drinking behaviors and growth performance in calves, the relative risk of calves vaccinated in the base of the ear developing an injection-site reaction or being misdiagnosed as having **bovine respiratory disease complex (BRDC)**, and the percentage of SC injection-site reactions in the neck area of a car-

cass that would be detectable after the hide was removed.

Materials and Methods

Animals—Two groups of heifer calves were observed during the initial 57 or 62 days after arrival at a feedlot (day 0 = day of arrival). The first group of 85 calves originated from auction markets in the southeastern United States (10 auction markets in 2 states) and subjectively was classified by feedlot personnel as being at high risk for developing BRDC. The calves arrived at the feedlot in November 1997 with a mean ± SD body weight of 249.5 ± 15.64 kg. Calves were processed within 12 hours after arrival and received a vaccine[b] that contained modified-live **infectious bovine rhinotracheitis (IBR)** virus, killed **bovine viral diarrhea virus (BVDV)**, killed **parainfluenza-3 (PI-3)** virus, a nasally administered vaccine[c] that contained modified-live IBR and PI-3 viruses, a bacterin-toxoid[d] against *Mannheimia haemolytica* (formerly *Pasteurella haemolytica*), a multivalent bacterin-toxoid[e] against 7 clostridial species, a macrolide antibiotic,[f] a dormectin dewormer,[g] an orally administered probiotic, yeast, and vitamin drench,[h] and an estradiol benzoate-testosterone implant.[i] Calves were boostered with a modified-live vaccine[j] against IBR virus 8 days after arrival.

The second group of 85 calves originated from auction markets in the southeastern United States and subjectively was classified by personnel at the feedlot as being at high risk for developing BRDC. These calves arrived at the feedlot in January 1998 with a mean body weight of 234.5 ± 18.18 kg. Calves were processed within 6 hours after arrival and received the same processing regimen as the first group of calves, except the second group of calves did not receive a bacterin-toxoid[d] against *Mannheimia haemolytica*; however, they did receive 2 multivalent bacterin-toxoids[e,k] against 7 clostridial species and a zeranol implant.[l] All calves had an electronic identification device placed in 1 of their ears. Initial body weight, electronic identification number, dehorning or tipping of horns, and any specific identification items (tags from auction markets, eartags for vaccination against brucellosis, or coat color) were recorded at processing.

Feedlot—This study was conducted at a 40,000-calf capacity commercial feedlot located near Hereford, Tex. Management was typical for a feedlot of this size.

Collection of data on eating and drinking behaviors—Data on eating and drinking behaviors were collected, using an electronic monitoring system.[7,a] Mean duration of eating and drinking recorded during this study was the duration of time spent at the feedbunk or waterer. An eating or drinking event was defined as the presence of a calf at the feedbunk or waterer for ≥ 5.25 seconds, with a new eating or drinking event recorded if the calf left the feedbunk or waterer for ≥ 300 seconds but subsequently returned. Data for calves that were removed or missing from their pen for ≥ 2 hours on a specific day were deleted for that day.

For analysis, the eating and drinking behaviors of calves were summarized for 7 arbitrarily determined time periods (1 to 3, 4 to 5, 6 to 10, 11 to 27, 28 to 57, 1 to 27, and 1 to 57 days after arrival). For each of these time periods, mean daily frequency and duration of eating and drinking were calculated for each calf in the study population.

Experimental design—A randomized block design was used. Before processing of each group, a coin was used to determine which treatment the first calf through the processing chute would receive. Treatments then were alternated on the remaining calves as they passed through the chute. All clostridial vaccines were administered in the subcutaneous tissues. In the first group, the treatments alternated between administration of a multivalent bacterin-toxoid vaccine against 7 clostridial species[e] in the neck and administration of the same bacterin-toxoid vaccine in the base of the ear. In the second group, treatment consisted of administration of a multivalent bacterin-toxoid vaccine against 7 clostridial species[e] in the base of the ear and another bacterin toxoid[k] in the neck in half of the calves, whereas the other half of the calves were administered both multivalent bacterin-toxoid vaccines against 7 clostridial species[e,k] in the neck. Hence, all calves in the second group received 2 doses of clostridial vaccine.

For data collection and analysis, calves were allocated to groups on the basis of location of vaccination. The ear group comprised calves that had received a vaccination in the base of the ear from group 1 and the base of the ear as well as the neck from group 2. The neck group comprised calves that had received a vaccination in the neck from group 1 and both vaccinations in the neck from group 2.

Collection of data on weight gain—Body weight of each calf of the first group was recorded on days 0 and 62 of the study, and body weight of each calf in the second group was recorded on days 0 and 57. Mean daily gain for each calf was calculated for the initial 57 or 62 days of the feeding period. Mean daily gain for the entire feeding period was calculated by use of the following equation:

([hot carcass weight of calf/dressing percentage of pen] – arrival weight of calf)/No. of days at feedlot

Collection of data on health of calves—Calves were observed daily by experienced feedlot personnel for clinical signs of BRDC. Feedlot personnel were unaware of group assignment for each calf. Identification of calves removed from their pen and treatment regimen for calves removed because of BRDC were recorded.

On day 57 (group 2) or 62 (group 1), the neck and base of the ear were palpated for evidence of injection-site lesions by a trained technician who was unaware of treatment status of each calf. Width and length of each lesion were measured, using a ruler.

Collection of data on feed—Data for daily feed activities were collected, including time of feed deliveries, quantity of feed delivered, and diet composition. Both groups of calves were sequentially fed 4 diets. The initial diet contained approximately 37% roughage and 73% concentrate and was formulated to contain 78 to 80% dry matter, 1.10 Mcal of **net energy for gain (NEg)**/kg, and 13.5% crude protein on a dry-matter basis. The final diet was formulated to contain 78 to 80% dry matter, 1.54 Mcal of NEg/kg, 13.5 to 14.0% crude protein on a dry-matter basis, and approximately 13% roughage and 87% concentrate. The first group of calves was fed for 214 days. The second group of calves was fed for 190 days. Daily rate of feed intake was calculated for each group of calves, using the following equation:

(Feed delivered to pen/No. of calves in pen)/ Average eating duration

Data from the slaughter facility—Cattle were marketed in a typical manner for the feedlot. Data collected at the slaughter facility included slaughter sequence, electronic identification number, pulmonary lesions, hot carcass weight, injection-site lesions evident while the hide was still on the carcass, and injection-site lesions evident after the hide was removed. Using a ruler, an evaluator (MJB) who was unaware of the group assignment of each calf measured the

largest dimension of each injection-site lesion while the hide was still on the carcass. The injection-site lesion after the hide was removed was recorded, trimmed, measured (using a ruler), and weighed by another investigator (LJP) who also was unaware of the group assignment for each calf.

Statistical analysis—Effects of administration of clostridial vaccine on eating and drinking behaviors and growth performance were assessed, using multivariable ANOVA procedures of a statistical program.[m] For each of these outcomes, a model was specified that included treatment group, group replicate, arrival weight, and clinical BRDC as independent variables. Effects of location for administration of clostridial vaccine on the rate of injection-site reactions and the rate of clinical BRDC were assessed, using the Pearson χ^2 test.[n]

Results

Location for administration of bacterin-toxoid vaccines against 7 clostridial species did not significantly affect frequency or duration of eating or duration of drinking on days 1 to 3, 4 to 5, 6 to 10, 11 to 27, or 28 to 57 after arrival. Twenty–seven- and 57-day mean frequency and duration of eating as well as duration of drinking did not differ significantly between calves vaccinated in the neck and those vaccinated in the base of the ear. For days 11 to 27, 27, and 57 after arrival, mean frequency of drinking for calves vaccinated in the neck was 0.50 visits/d less than for calves vaccinated in the ear, which was a significant decrease.

Least-squares means of MDG on days 57 or 62 did not differ significantly ($P = 0.71$) for calves vaccinated in the base of the ear (mean ± SEM, 1.38 ± 0.11 kg), compared with values for calves vaccinated in the neck (1.41 ± 0.12 kg). Power calculations ($\alpha = 0.05$, $\beta = 0.20$) indicated the experimental design provided the ability to detect a difference of 10% in 57- or 62-day MDG. Least-squares means of MDG for the entire feeding period did not differ significantly ($P = 0.45$) for calves vaccinated in the base of the ear (1.28 ± 0.07 kg), compared with values for calves vaccinated in the neck (1.25 ± 0.07 kg). Power calculations ($\alpha = 0.05$, $\beta = 0.20$) indicated the experimental design provided the ability to detect a difference of 8% in MDG for the entire feeding period.

Results of the Pearson χ^2 analysis indicated that detection of injection-site reactions on day 57 (or 62) were significantly ($P \leq 0.01$) associated with the risk factor of receiving the clostridial vaccine in the base of the ear. Relative risk of calves vaccinated in the base of the ear developing injection-site reactions on day 57 (or 62) was 2.89. Of 79 calves vaccinated in the base of the ear, 41 (52%) had palpable injection-site reactions, whereas only 14 of 78 (18%) calves vaccinated in the neck had palpable injection-site reactions. Thus, of 55 calves with palpable injection-site reactions, 41 (74%) were vaccinated in the base of the ear. Mean value of the largest dimension of injection-site lesions on day 57 (or 62) was 8.59 and 8.36 cm for calves vaccinated in the base of the ear and in the neck, respectively.

Results of the Pearson χ^2 analysis indicated that detection of injection site-reactions at time of slaughter were significantly ($P \leq 0.01$) associated with the risk factor of receiving the clostridial vaccine in the base of the ear. Relative risk of calves vaccinated in the base of the ear developing injection-site reactions that were palpable at slaughter was 4.16. Of 84 calves vaccinated in the base of the ear, 37 (44%) had palpable injection-site reactions at slaughter. Thus, of 46 calves with palpable injection-site reactions at slaughter, 37 (80%) were vaccinated in the base of the ear. Mean value of the largest dimension of injection-site lesions at time of slaughter was 6.89 and 10.89 cm for calves vaccinated in the base of the ear and in the neck, respectively. Eight of 9 (89%; 95% confidence interval, 52 to 100%) of the injection-site reactions in the neck could not be located on the carcasses after the hides were removed.

Results of the Pearson χ^2 analysis indicated that BRDC-removal status was not significantly ($P = 0.42$) associated with location for administration of clostridial vaccine. Of 83 calves vaccinated in the base of the ear, 23 (28%) were removed from the pen, whereas 19 of 85 (22%) of calves vaccinated in the neck were removed from the pen for health reasons.

Discussion

In the study reported here, we did not detect a significant difference between calves vaccinated in the base of the ear and those vaccinated in the neck for MDG on day 57 (or 62) or MDG for the entire feeding period. Power of a study should be evaluated when differences are not detected between treatment groups. Power calculations indicated that the experimental design provided the ability to detect a difference of 10% (0.14 kg) in MDG on 57 (or 62) and a difference of 8% (0.13 kg) in MDG for the entire feeding period. Analysis of our results suggests that when a clostridial bacterin-toxoid vaccine is used, location of administration does not affect growth performance of calves.

Some injection-site reactions of calves vaccinated in the base of the ear were quite large (5 × 5 cm). These large injection-site reactions did not substantially alter the ear or head carriage of those calves to an extent that feedlot personnel could visually classify those calves as abnormal and remove them from their pen for further evaluation. Using the baseline morbidity rate of calves vaccinated in the neck (22%), the morbidity rate would have to be increased to 37% to conclude there was a significant difference in BRDC removal status.

It was determined that the additional vaccination against 7 clostridial species administered in the neck of the second group of calves was inconsequential on the basis of the lower rate of neck injection-site lesions in the neck of those calves. Compared with calves vaccinated in the neck, calves vaccinated in the base of the ear were 2.89 and 4.16 times more likely to have an injection-site reaction at 57 (or 62) days and at time of slaughter, respectively. Subcutaneous administration of vaccine in the base of the ear is a relatively new technique. Unfamiliarity with vaccinating calves in the base of the ear may have contributed to vaccinates in that group having a larger relative risk of developing injection-site reactions than the calves vaccinated in the neck. Differences in the ease of palpating injection-site reactions also may have resulted in a greater number of the calves vaccinated in the base of the ear having a detectable injection-site reaction. Differences also may be a result of location differences that affect develop-

ment or resolution or lesions such as skin tightness, local lymph circulation, or local blood flow.

Four fewer injection-site reactions were detected in calves vaccinated in the base of the ear during palpation at slaughter than during palpation on day 57 (or 62). Mean value for the largest dimension of injection-site lesions in calves vaccinated in the base of the ear was 8.59 and 6.89 cm at day 57 (or 62) and at slaughter, respectively. A decrease in the number and size of injection-site reactions with time suggests that these lesions were resolving. For calves vaccinated in the neck, there were 5 fewer injection-site reactions detected during palpation at slaughter than on day 57 (or 62). Mean value for the largest dimension of injection-site lesions in calves vaccinated in the neck was 8.36 and 10.89 cm at day 57 (or 62) and at slaughter. An increase in size of injection-site reactions suggests that these reactions were not resolving. However, the decreased number of reactions suggests some lesions were resolving. Disparity in size of injection-site reactions may also be attributable to the fact that measurements were made by 2 investigators (1 investigator on day 57 [or 62] and a second investigator at slaughter).

It is believed that injection-site reactions in the subcutaneous tissues are removed with the hide. In our study, 9 injection-site reactions were recorded during palpation of the hide in calves vaccinated in the neck. However, after removal of the hides in those calves, only 1 injection-site reaction was detected on the carcasses. Our results indicated that 89% of the subcutaneous injection-site reactions were removed by use of a mechanical hide remover. The small sample size resulted in a large 95% confidence interval for this estimate.

Analysis of these results suggests there is not a detrimental effect of SC administration of multivalent bacterin-toxoid vaccines against 7 clostridial species in the base of the ear on frequency or duration of eating or duration of drinking. Mean frequency of drinking 11 to 27, 27, and 57 days after arrival were significantly less for calves vaccinated in the neck, compared with values for calves vaccinated in the base of the ear. Calves vaccinated in the neck had a lower frequency for drinking (0.50 fewer visits/d). It is the opinion of the authors that, although the lower frequency for drinking differed significantly, it was not clinically relevant.

Data used for outcomes for eating and drinking were corrected for any situation that resulted in a period of ≥ 2 hours during which a calf was not available for those behaviors. This allowed the data to be corrected for calves that were missing from their pen as a result of treatment, chronic sickness, straying, or death; it also accounted for system failures. Data used to calculate rate of injection-site lesions, growth performance, and health performance did not include calves that died.

Analysis of results of the study reported here revealed that location of administration of a bacterin-toxoid vaccine against 7 clostridial species did not have an effect on growth performance, health performance, or behaviors involving eating. Frequency of drinking may be altered by location of administration of a bacterin-toxoid vaccine against 7 clostridial species; however, this alteration did not appear to be clinically relevant.

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[a]GrowSafe System, Airdrie, AB, Canada.
[b]Tandem 3KL, Rhone Merieux, Athens, Ga.
[c]TSV-2, Pfizer, Exton, Pa.
[d]One Shot, Pfizer, Exton, Pa.
[e]Alpha-7, Bio-Ceutic Division, Boehringer Ingelheim Animal Health, St Joseph, Mo.
[f]Micotil 300 Injection, Elanco Animal Health, Indianapolis, Ind.
[g]Dectomax, Pfizer, Exton, Pa.
[h]Anipro, Anipro, Greeley, Colo.
[i]Synovex H, Fort Dodge Animal Health, Overland Park, Kan.
[j]Heritage 1, Bayer Corp, Shawnee Mission, Kan.
[k]Vision 7 with Spur, Bayer Corp, Shawnee Mission, Kan.
[l]Ralgro, Schering-Plough Animal Health Corp, Union, NJ.
[m]SAS/STAT Software, Version 6.12, SAS Institute Inc, Cary, NC.
[n]EpiInfoVersion 6, Centers for Disease Control and Prevention, Atlanta, Ga.

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