Serological studies of infectious bovine rhinotracheitis, parainfluenza 3, bovine viral diarrhea, and bovine respiratory syncytial viruses in calves following entry to a bull test station

Peter J.K. Durham, Lori E. Hassard, Joyce Van Donkersgoed

Bovine respiratory disease continues to be a major problem in feedlot calves. The disease is of complex etiology (1–3), involving several viruses that predispose to invasion by bacteria such as *Pasteurella* and *Haemophilus* spp. Agents that have been incriminated include parainfluenza 3 (PI3) virus, bovine respiratory syncytial (BRS) virus, and infectious bovine rhinotracheitis (IBR) virus (1,2,4,5), although bovine viral diarrhea (BVD) virus (3,6) and adenoviruses (4) have also been associated with respiratory disease. It is believed that overcrowding, transport stress, dietary stress, dehydration, and mixing of stock from different properties may predispose to primary damage by the viruses (1,2,5,7).

Although several reports have associated IBR, PI3, BRS, or BVD virus infections with outbreaks of respiratory disease in cattle (3–6) in eastern Canada, few studies have been carried out in western Canada.

The present study was undertaken in 1987 to investigate the changes in antibody titers to the IBR, PI3, BRS, and BVD viruses in bull calves following entry into the Record of Performance (ROP) Bull Test Station at Saskatoon, Saskatchewan.

The animals studied were 283 purebred bull calves from 88 Saskatchewan owners. The calves were of various breeds, and were six and nine months old at entry to the station. On arrival, the calves were weighed, eartagged, given ivermectin (Ivomec, MSD Agvet, Kirkland, Quebec), and immunized with a combined modified live virus IBR-PI3 vaccine and *Haemophilus somnus* bacterin (IBR-PI3-Somnugen, Boehringer Ingelheim Animal Health, Burlington, Ontario) and with an 8-way clostridial bacterin (Tasvax 8, Coopers Agropharm Inc., Willowdale, Ontario).

As part of a BRSV vaccination study, the bulls were randomly divided into two groups, half the bulls being immunized with a modified live virus BRS vaccine (BRSV Vac, Pioneer Hi-Bred Ltd., Chatham, Ontario), and revaccinated two weeks later. The remaining bulls served as controls, and received a placebo of sterile water on both occasions. The animals were sorted by breed and owner on arrival (as required by the design of the ROP test) and placed in two adjacent rows of six contiguous feeding pens, BRSV vaccinates and controls being housed together.

Blood samples were collected on days 0, 14, 28 and 70 for serological testing. The bulls were weighed every month and placed on a performance test after an adjustment feeding period of 28 days. Bulls were observed daily for sickness. Animals that appeared subjectively different from their pen mates, had a rectal temperature $\geq$ 40°C, and had clinical signs restricted to the respiratory system were considered to have respiratory disease. These animals were taken to a hospital area, treated by a standard protocol, and then returned to their pens.

Pre-entry vaccination histories indicated that IBR and PI3 vaccines were given either as modified live or killed virus; BRSV vaccines were given as modified live virus; and BVD vaccines were given as killed virus. The IBR and PI3 vaccines were given via the intranasal or intramuscular route; the BRSV, BVD, and *H. somnus* vaccines were given via the intramuscular route.

The sera were tested for antibody titers to IBR, PI3, BRS, and BVD viruses using enzyme-linked immunosorbent assay (ELISA), following previously described methods (8–10). All tests were carried out blind, and the results were expressed in ELISA units. Test results were classified as positive if the ELISA reactivity exceeded 10 units. This cut-off was equivalent to serum neutralization test titers of 1/3 for IBR, PI3, and BRS viruses, and 1/2 for BVD virus, based on previous comparative studies. A significant rise in titer between paired sera was defined as an increase in reactivity of 20 units or greater, being approximately equivalent to a fourfold increase in virus neutralization test titer.

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Department of Veterinary Microbiology (Durham, Hassard) and Department of Herd Medicine and Theriogenology (Van Donkersgoed), Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0.

Present address of Dr. P.J.K. Durham: c/o 109 Slacks Road, Palmerston North, New Zealand.

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Table 1. Effect of pre-entry vaccination and initial antibody status on subsequent treatment rates for respiratory disease in calves at a test station

Vaccine	Treatment rate: Unvaccinated	Treatment rate: Vaccinated	Chi-square	Odds[a] ratio	95% CL[b] of OR
IBR/PI3	52/169 (31%)	20/114 (18%)	5.58	0.48	0.27–0.85
BVD	65/236 (28%)	7/47 (15%)	2.66	0.46	0.20–1.06
H. somnus	61/229 (27%)	11/54 (20%)	0.60	0.70	0.34–1.45
BRSV[c]	43/138 (31%)	V8 (13%)	0.52	0.32	0.04–2.69

Type of antibody	Treatment rate: No antibody	Treatment rate: Antibody	Chi-square	Odds[a] ratio	95% CL[b] of OR
IBR	59/226 (26%)	13/57 (23%)	0.12	0.84	0.42–1.66
PI3	18/53 (34%)	54/230 (24%)	1.97	0.60	0.31–1.13
BRSV	50/193 (26%)	22/90 (24%)	0.01	0.93	0.52–1.65
BVD	59/223 (26%)	13/60 (22%)	0.35	0.77	0.39–1.52

[a]An odds ratio of 1 indicates equal treatment rate in vaccinates and nonvaccinates, and in antibody and no antibody; an odds ratio greater than 1 indicates higher treatment rate in vaccinates than nonvaccinates, and in antibody than no antibody; an odds ratio less than 1 indicates lower treatment rate in vaccinates than nonvaccinates, and in antibody than no antibody

[b]Test-based 95% confidence limits of odds ratio. If CL contains the value 1, then the difference in treatment rate between groups is not statistically significant

[c]Nonvaccinated calves on subsequent BRSV trial

Antibody titers to IBR, PI3, BRS, and BVD viruses were present in 20%, 81%, 32% and 21% of the calves, respectively, on arrival at the test station. Animals previously vaccinated with IBR, PI3, and BRSV vaccines showed significantly higher prevalences of antibody ($p \leq 0.05$), though this was not seen with BVD-vaccinated animals (data not shown). The antibody prevalences were similar to those previously recorded in Saskatchewan calves (9). High prevalences of PI3 antibodies also have been noted in beef calves at entry to Ontario feedlots (6).

A total of 72 (25%) of the calves required treatment for respiratory disease during the period of observation, mostly during the first two weeks after entry. This treatment rate is similar to that commonly found in North American feedlots (11), though higher than that reported in a previous study carried out on this property in 1983 (12). The treatment rates were significantly higher ($p \leq 0.05$) in Hereford calves (40%), and lower in Angus (11%) calves, as was also noted in the previous study (12).

Treatment rates were lower in animals that received pre-entry vaccinations and in animals that possessed antibodies to the four viruses at entry (Table 1), but the reduction in treatment rates only reached significance ($p \leq 0.05$) in animals that received pre-entry IBR/PI3 vaccination. In eastern Canada, Martin *et al* (6,13) noted that treatment rates were lower in calves that possessed PI3 and BRSV antibodies at entry to feedlots, and found low IBR antibodies to be associated with increased treatment rates. Key and Derbyshire (4) also found BRSV titers on entry to be beneficial. In contrast, Townsend *et al* (12) found no association between pre-entry vaccination and the incidence of fever, in an earlier study on this property. It is possible that the benefit could also be a reflection of different management practices, because bulls that were vaccinated prior to entry were probably weaned early and therefore under less stress on entry.

Although average daily gains during the first 28 days after entry were slightly higher in animals that received the combined pre-entry IBR-PI3 vaccine and a *Haemophilus* bacterin, and lower in those that received pre-entry BVD vaccine, the differences were not significant (data not shown).

Sixty-nine percent of the calves seroconverted to IBR virus by 14 days postentry, increasing to 85% by 28 days, and to 89% by 70 days. Seroconversions to PI3 virus were also high, reaching 58%, 80% and 82% over the same periods. The high rate of early seroconversion probably reflects the effect of IBR and PI3 vaccination at entry, though field virus challenge is still possible. In contrast, the low BVD seroconversion rates of 3%, 8% and 13% over the same periods showed that there was little BVD viral activity in the calf population. In this study there was no significant association between BVD activity and respiratory disease. Others (6,13), however, have reported an increased risk of respiratory disease with BVD seroconversion.

Calves given BRSV vaccines showed seroconversion rates of 65%, 94% and 96% at 14, 28 and 70 days postentry, the rates in nonvaccinates being 72%, 96% and 99%. There was little difference in the rates of seroconversion between vaccinated and nonvaccinated calves, both populations showing high rates of early seroconversion, indicating strong activity by field or vaccine virus. Full details of the response to vaccination with BRSV vaccine on entry are reported elsewhere (14) as part of a larger study. However, no significant reductions in treatment rate or increases in average daily gains were seen in BRSV-vaccinated animals.

Table 2. Effect of antibody status of calves at entry to the feedlot on subsequent seroconversion rates to BRSV, IBR, and PI3 vaccines, measured over 14 and 28 days postentry

Virus	Time (days)	Seroconversion rates: No antibody	Seroconversion rates: Antibody	Chi-square	Odds[a] ratio	95% CL[b] of OR
BRSV	0–14	68/89 (76%)	21/46 (45%)	11.4	3.9	1.8–8.1
	0–28	88/89 (99%)	40/46 (86%)	6.5	13.2	2.4–73.3
IBR	0–14	165/225 (73%)	30/57 (53%)	8.2	2.5	1.4–4.5
	0–28	206/225 (92%)	40/57 (70%)	16.7	4.6	2.3–7.3
PI3	0–14	42/50 (84%)	118/230 (79%)	16.6	5.0	2.4–10.5
	0–28	49/50 (98%)	182/230 (79%)	8.8	12.9	2.7–62.7

[a]An odds ratio of 1 indicates equal treatment rate in calves with antibody and without antibody; an odds ratio greater than 1 indicates higher treatment rate in calves with antibody than without antibody; an odds ratio less than 1 indicates lower treatment rate in calves with antibody than without antibody

[b]Test-based 95% confidence limits of odds ratio. If the CL contains the value 1, the difference in treatment rate between calves with and without antibody is not statistically significant

Seroconversion rates up to 28 days postentry were significantly lower ($p \leq 0.05$) in calves that possessed antibody to IBR, PI3, and BRS viruses at entry (Table 2). Calves that failed to seroconvert showed no correlation with pre-entry vaccination history, and showed no significant increase in treatment rates (data not shown). Most of these calves eventually seroconverted by 70 days.

No obvious variations in treatment or seroconversion rates between pens were seen, though analyses were made difficult because pen assignment had to be made according to breed type and owner.

Slightly reduced treatment rates were seen when calves were vaccinated prior to entry with a *H. somnus* bacterin (Table 1), but the difference was not statistically significant. The bacterin had no influence on average daily gain. These results suggest that there may be a slight sparing effect of a *H. somnus* bacterin, similar to that previously reported (5,15).

In conclusion, IBR/PI3 vaccination of calves prior to entry to the feedlot was associated with lowered rates of respiratory disease on this property. A BRSV vaccine given at entry failed to yield significant benefits (14). Little BVD activity was seen on the property over the observation period.

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References

1. Potgieter LND. Current concepts on the role of viruses in respiratory tract disease of cattle. Bovine Practitioner 1977; 12: 78–81.
2. Yates WDG. A review of infectious bovine rhinotracheitis, shipping fever pneumonia and viral-bacterial synergism in respiratory disease of cattle. Can J Comp Med 1982; 46: 225–263.
3. Richer L, Marois P, Lamontagne L. Association of bovine viral diarrhea virus with multiple viral infections in bovine respiratory disease outbreaks. Can Vet J 1988; 29: 713–717.
4. Key DW, Derbyshire JB. Serological studies of parainfluenza type 3 virus, bovine adenovirus type 3 and bovine respiratory syncytial virus infection in beef calves. Vet Microbiol 1984; 9: 587–592.
5. Martin SW, Meek AH, Davis DG, *et al.* Factors associated with mortality in feedlot cattle: The Bruce County beef cattle project. Can J Comp Med 1980; 44: 1–10.
6. Martin SW, Bohac JG. The association between serological titers in infectious bovine rhinotracheitis virus, bovine virus diarrhea virus, parainfluenza-3 virus, respiratory syncytial virus and treatment for respiratory disease in Ontario feedlot calves. Can J Vet Res 1986; 50: 351–358.
7. Martin SW, Meek AH, Davis DG, Johnson JA, Curtis RA. Factors associated with morbidity and mortality in feedlot calves: The Bruce County beef project, year two. Can J Comp Med 1981; 45: 103–112.
8. Durham PJK, Sillars HM. Evaluation of an enzyme linked immunosorbent assay (ELISA) for serodiagnosis of infectious bovine rhinotracheitis infection, with results of a preliminary survey. NZ Vet J 1986; 34: 27–30.
9. Durham PJK, Hassard LE. Prevalence of antibodies to infectious bovine rhinotracheitis, parainfluenza 3, bovine respiratory syncytial, and bovine viral diarrhea viruses in cattle in Saskatchewan and Alberta. Can Vet J 1990; 31: 815–820.
10. Durham PJK, Hassard LE. An enzyme linked immunosorbent assay (ELISA) for antibodies to bovine viral diarrhea virus. Vet Microbiol 1990; 22: 1–10.
11. Kelly AP, Janzen ED. A review of morbidity and mortality rates and disease occurrence in North American feedlot cattle. Can Vet J 1986; 27: 496–500.
12. Townsend HGG, Meek AH, Lesnick TG, Janzen ED. Factors associated with average daily gain, fever and lameness in beef bulls at the Saskatchewan central feed test station. Can J Vet Res 1989; 53: 349–354.
13. Martin SW, Bateman KG, Shewen PE, Rosendal S, Bohac JG. The frequency, distribution and effects of antibodies, to seven putative respiratory pathogens, on respiratory disease and weight gain in feedlot calves in Ontario. Can J Vet Res 1989; 53: 355–362.
14. Van Donkersgoed J, Janzen ED, Townsend HG, Durham PJ. Five field trials on the efficacy of a bovine respiratory syncytial virus vaccine. Can Vet J 1990; 31: 93–100.
15. Ribble CS, Jim GK, Janzen ED. Efficiency of immunization of feedlot calves with a commercial *Haemophilus somnus* bacterin. Can J Vet Res 1988; 52: 191–198.