Active and Passive Immunity to Bovine Viral Respiratory Diseases in Beef Calves After Shipment

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ABSTRACT

Fifteen steers were vaccinated after shipment with a modified live virus vaccine containing infectious bovine rhinotracheitis (IBR), bovine virus diarrhea (BVD), and bovine myxovirus parainfluenza-3 (PI3), and 16 unvaccinated steers were kept as controls. Geometric mean titers one month after vaccination were highest to BVD, followed by PI3 and IBR. Weight gains were higher during 30 days after vaccination in the controls. One case of acute respiratory disease developed in one vaccinated calf. Revaccination 79 days after the first dose increased antibody to PI3 and BVD virus but not IBR. In a second trial, no clinical respiratory disease developed after shipment of 13 heifers that received an antibacterial-antiviral antiserum or in the 12 controls. Weight gains 30 days after shipment were identical in both groups.

RÉSUMÉ

Après leur transport, on administra à 15 bouvillons un vaccin attenué contenant le virus de la rhino-trachéite infectieuse bovine (RIB), celui de la diarrhée à virus bovine (DVB), ainsi que le myxovirus bovin para-influenza-3 (PI3); on utilisa 16 bouvillons non-vaccinés, comme témoins. Un mois après la vaccination, la teneur en anticorps du sérum des sujets vaccinés, par ordre décroissant, était la suivante: DVB, PI3 et RIB. Durant les 30 jours qui suivirent la vaccination, les gains de poids s'avérèrent plus élevés chez les témoins. On décela un cas de maladie respiratoire aiguë chez un des bouvillons vaccinés. Une seconde vaccination, effectuée 79 jours après la première, provoqua une augmentation des anticorps contre les virus PI3 et DVB, mais non contre celui de la RIB. Dans une deuxième expérience, on n'observa pas de maladie respiratoire clinique, après le transport de 13 taures qui reçurent un immun-sérum antibactérien-antiviral, ni chez les 12 sujets témoins. Trente jours après le transport, les gains de poids s'avérèrent identiques chez les deux groupes d'animaux.

INTRODUCTION

The prevalence of antibodies to infectious bovine rhinotracheitis (IBR), bovine virus diarrhea (BVD), and bovine myxovirus parainfluenza-3 (PI3) in beef cow herds in Southern Illinois justifies use of a live virus vaccine and/or antiserum in calves as an aid in prevention of acute post-weaning respiratory disease (12). The following report describes the use of a modified live virus vaccine containing BVD, IBR, and PI3 in steers compared with a nonvaccinated group and the use of antibody concentrate against the three viruses in heifers compared with a control group.

MATERIALS AND METHODS

Calves from three of four East Central Illinois beef herds were found to be free of antibodies to bovine virus diarrhea (BVD), infectious bovine rhinotracheitis (IBR), and bovine myxovirus parainflu-

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TABLE 1. Results of Microbiological Examination of Nasal Secretions and Geometric Mean Serum Titers for IBR, BVD and PI3 at Indicated Times

Vaccinates[c]							Controls					
Serological Titers				Microbial Findings			Serological Titers			Microbial Findings		
No in Group	Date	IBR[a]	PI3[a]	BVD[a]	Pasteurella sp	Mycoplasma sp	No in Group	IBR[a]	PI3[a]	BVD[a]	Pasteurella sp	Mycoplasma sp
15	12-18-68	0	0	0	not done	not done	16	0	1.6	0	not done	not done
15	1-28-69 (First vaccination)	0	2	0	1[b]	5[b]	16	0	5.4	0	1[b]	1[b]
15	2-24-69	1.1	1.7	11.6	0[b]	8[b]	16	0	2.6	0	0[b]	6[b]
13	4-15-69 (revaccinated)	0	2.7	7	not done	not done	11	0	1.5	0	not done	not done
13	6-24-69	0	17.7	9	not done	not done	11	0	2.2	1.3	not done	not done

[a]Geometric Mean Titers
[b]No positive
[c]Vaccinated with Mucovax 3 — Modified live virus vaccine containing tissue culture origin IBR, BVD, and PI3, Dow Chemical Co., Midland, Michigan

enza-3 (PI3). Calves from one herd had low titers to BVD and PI3 viruses. At the time of weaning, blood samples were collected from all calves and tested for antibodies against BVD, PI3, and IBR as previously described (12). All calves were vaccinated against blackleg, malignant edema, and *Leptospira pomona*. Three weeks later, 31 steers were transported 250 miles to the experimental pen, weighed, bled, rectal temperatures recorded, and 15 were vaccinated with a modified live virus vaccine containing BVD, IBR, and PI3[1]. Vaccinated and unvaccinated calves were mixed in the same pen. WBC and rectal temperatures were determined at the time of vaccination and bi-weekly for four weeks. Nasal secretions were collected from all steers at the time of vaccination and 30 days later for microbiological examination using methods previously described (9, 11). At the end of the period, all steers were weighed and blood samples collected for antibody determination.

The calves in the vaccinated group were revaccinated two and one half months after their first injection. Both groups were still maintained together. Blood samples were collected from the vaccinates and conweeks later for determination of antibody titers to IBR, PI3, and BVD viruses.

In March 1969 another group of 25 heifers from herds, 1, 2, and 3 were transported 250 miles to a feedlot. Thirteen were given a preventive dose of antibacterial-antiviral antiserum[2] and 12 did not receive antiserum. Serum samples were collected at the start of the observation and weekly for four weeks. The group receiving the antiserum was also bled 24 hours after receiving the biologic. WBC counts were made weekly. Weights were recorded at the start and finish of the observation. Nasal secretions were collected for microbiological examination at the beginning of the observation and four weeks later. The serological and microbiological procedures have been described (10, 12).

[1]Mucovax-3. Bio. No. 649, bovine rhinotracheitis, virus diarrhea-parainfluenza-3 vaccine. Dow Chemical Co. Midland, Michigan.

[2]Serogen, L.A., Diamond Laboratories, Des Moines, Iowa A dose of 7 ml per 100 lb body weight was given Prepared from cattle hyperimmunized with Corynebacterium pyogenes, Pasteurella multocida types 1, 2, and 3, and viral fluids containing IBR, BVD, and PI3.

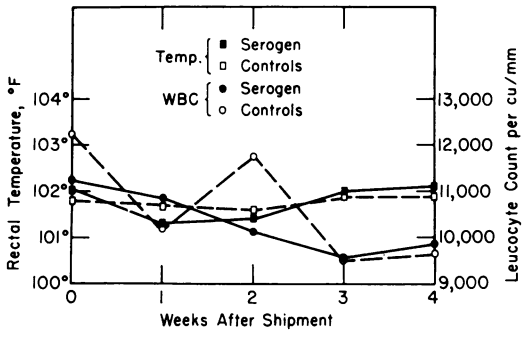

Fig. 1. Mean WBC counts and rectal temperatures in 13 calves receiving antiserum compared with 12 controls.

RESULTS

VACCINE STUDY

One case of acute respiratory disease developed in a vaccinated calf with a rectal temperature of 104.5°F. It was treated nine days after vaccination. Clinical signs also included depression, occular and nasal discharge, and increased respiratory rate. Mean rectal temperature of the vaccinates were only fractionally higher than the controls during the 30 day observation period. Mean WBC counts in the vaccinates rose steadily for three weeks after vaccination. The mean WBC counts in the controls decreased on the 12th day, followed by a rise to near that of the vaccinates during the next two weeks.

Pasteurella multocida was isolated from nasal secretions of one vaccinated steer at the time of vaccination, but none was isolated 27 days later. *Mycoplasma* sp. were isolated from five steers at the time of vaccination and from eight animals 27 days later. *Pasteurella multocida* was isolated from one control at the start of the study, but none were isolated 27 days later. *Mycoplasma* sp. was isolated from one control at the start and from six at the end of the 27 day observation.

No antibody to IBR or BVD was detectable in two prevaccination samplings of vaccinates and controls, but two steers in each group had low titers to PI3 virus. Twenty-seven days after vaccination, geometric mean titers in the vaccinates were highest against BVD, lower to PI3, and only two steers developed detectable (1:2) antibody to IBR. Titers to PI3 virus increased during the interval before the study started in the unvaccinated group, but did not increase during the 27 day observation period. No detectable antibody to IBR or BVD developed in the controls.

No cytopathic agents were recovered from nasal secretions collected at the start of the study or 27 days later. Weight gains in the control group were 0.8% greater during the observation period than in the vaccinates. The difference in weight gains was statistically significant at the 5% level of probability when tested by the chi square method. These results are summarized in Table II. Revaccination of 13 steers 79 days after the first injection resulted in higher geometric mean titers to PI3 virus, a small increase in BVD antibody titer, and no detectable increase to IBR. The microbiological and serological results are summarized in Table I.

ANTISERUM STUDY IN HEIFERS

No clinical respiratory disease developed in either group. Mean rectal temperatures in each group were practically identical, but the mean WBC counts of the controls fell more sharply the second week than in the group receiving the antiserum. By the second week, the WBC counts of the control group were higher than the group receiving serum. The mean WBC counts of the group receiving antiserum continued to decline to the third week. These results are

TABLE II. Comparison of Weight Gains in Vaccinated and Control Calves at Indicated Times

Group	No	Starting Weight 1-28-69	Final Weight 2-24-69	Total Pounds Gained
Vaccinated[a]	15	7,109 lbs	7,510 lbs	401 lbs
Control	16	7,849 lbs	8,355 lbs	506 lbs

[a]Vaccinated 1-28-69 wtih Mucovax-3. Bovine rhinotracheitis, virus diarrhea and bovine parainfluenza-3, modified live virus, tissue culture origin. Dow Chemical Co., Midland, Michigan

TABLE III. Results of Microbiological Examination of Nasal Secretions and Geometric Mean Serum Titers for IBR, BVD and PI3

Antiserum Group[c] Serological Titers					Microbial Findings		Controls Serological Titers				Microbial Findings		
No in Group	Date	IBR[a]	PI3[a]	BVD[a]	Pasteurella sp	Mycoplasma sp	No in Group	IBR[a]	PI3[a]	BVD[a]	Pasteurella sp	Mycoplasma sp
13	3-6-69	0	0	1.33	0[b]	0[b]	12	0	0	0	0[b]	0[b]
13	4-6-69	0	0	1.33	0[b]	4[b]	12	0	0	0	0[b]	7[b]

[a]Geometric Mean Titers
[b]No positive
[c]Serogen, LA, Diamond Laboratories, Des Moines, Iowa

summarized in Fig. 1. No *Pasteurella* sp. were isolated from either group. *Mycoplasma* sp. were not detected in either group at the start of the study, but were isolated four weeks later from heifers that had received antiserum and from seven controls. Serological tests to IBR, BVD, and PI3 were negative throughout the study except for the fact that one heifer in the antiserum group was positive at the 1:40 dilution to BVD in all samplings.

The serological and microbiological results are summarized in Table III. The weight gains during the 30 day observation period were practically identical in both groups.

DISCUSSION

This study compares two methods of prevention of post-shipment respiratory disease. The fact that steers from three of the four herds did not have detectable antibodies to any of the three viruses was fortuitous but very helpful in evaluating serological response to a commercially available vaccine. In the fourth herd, antibodies were detectable to only PI3. However, on the basis of serological tests, there may have been spread to other animals before the study started even though no clinical illness resulted. The most effective antigenic component of the vaccine seemed to be the BVD fraction, followed by the PI3 and IBR components as determined by the measured serological responses. The low antigenicity from the IBR component is surprising, since other studies showed good post-vaccinal response (4). However, in this case, even revaccination did not elicit a high level of detectable antibody using the serological test employed. Revaccination, however, did increase HI antibody to PI3 virus.

Intercurrent infections and exposure to other infected animals was not a significant factor in this study since the calves were shipped direct from the farms of origin to the feedlot. Had they been shipped to a sales barn and then to the feedlot, the results would probably have been significantly different (12). An evaluation of the low level of serological response to the

viruses used in the vaccine may be questioned since a degree of immunity may have resulted but is not measurable with the methods employed. The vaccine manufacturer indicated that a 90 to 95% immune response in vaccinates could be expected. Other evaluation of the vaccine indicated good results in preventing clinical illness (13). Clinical and experimental findings on the BVD-IBR components have been more extensive (1, 5, 11). No clinical illness after vaccination developed similar to that described by Peter *et al* (7).

The minimum antigenic dose for the three viruses used is not known. However, it has been reported by Kahrs that the 95% antigenic dose for one BVD vaccine was 630 $TCID_{50}$ (3). The potency testing of the triple virus vaccines require a minimum SN titer of 2 or greater for IBR, SN of 10 or greater for BVD, and SN of 4 or greater for live PI3 virus vaccines or HI of 80 or greater for inactivated PI3 virus vaccine according to Peacock (6, 8). The importance of the so-called antibody "crowding out" effect concerning combined vaccines has been discounted by York (13). The temperature rise following use of the triple virus vaccine used has been ascribed to primarily the IBR component according to Bittle and York (1).

The clinical importance of the increased prevalence of *Mycoplasma* sp. in both vaccinates and controls is not known. It is known that many species have been isolated from cattle and that they complicate respiratory infections (2).

These vaccine trials indicate that vaccination of calves free of antibody to BVD, IBR, and PI3 after shipment was a sufficient stressor to reduce weight gains compared to controls. Under average feedlot conditions of mixing feeder calves from many sources, use of such a vaccine after shipment would have to be evaluated according to the need for active immunity versus maximum feedlot performance.

Use of antiserum compared with controls

The use of the commerically available antiserum did not result in any detectable level of antibody to the three viruses 24 hours after injection. However, undetectable levels of antibody may have been present which would have had value in protecting an exposed calf. Since no clinical or subclinical respiratory disease developed in either group, it can only be stated that the serum produced no sparing effect of stress that reflected itself in increased weight gains compared to the controls.

Since the heifers remained free of detectable antibody to IBR, BVD, and PI3, they were saved for breeding purposes with the goal of establishing a herd free of infection with the three viruses.

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REFERENCES

1. **BITTLE, J. and C. YORK.** Combination vaccines for control of bovine respiratory diseases. J. Am. vet. med. Ass. **152**: 889-893. 1968.
2. **HAMDY, A.** Role of **Mycoplasma** in bovine respiratory infection. J. Am. vet. med. Ass. **152**: 829-832. 1968.
3. **KAHRS, R.** Discussion of bovine viral diarrhea mucosal disease. J. Am. vet. med. Ass. **152**: 870. 1968.
4. **LARSON, K. and K. SCHELL.** Toxicity and antigenicity of shipping fever vaccines in calves. J. Am. vet. med. Ass. **155**: 495-499. 1969.
5. **MacLEAN, G.** Comments on feedlot operations. J. Am. vet. med. Ass. **152**: 724-726. 1968.
6. **PEACOCK, G.** Test requirements for biologics used against bovine respiratory diseases. J. Am. vet. med. Ass. **152**: 833-836. 1968.
7. **PETER, C., D. TYLER, and F. RAMSEY.** Characteristics of a condition following vaccination with bovine virus diarrhea vaccine. J. Am. vet. med. Ass. **150**: 46-52. 1967.
8. **PHILLIPS, C.** Progress toward improved modified live-virus vaccines. J. Am. vet. med. Ass. **157**: 1864-1866. 1970.
9. **PILLAI, C., G. WOODS, H. RHOADES and J. SIMON.** Results of exposure of colostrum-deprived pigs to a strain of **Mycoplasma** sp. isolated from a swine lung. Illinois Vet. **10**: 12-14. 1967.
10. **WOODS, G., J. THURMON and L. HANSON.** Serologic response of beef steers given bovine virus diarrhea and infectious bovine rhinotracheitis vaccines after shipment. SWest. Vet. **22**: 111-113. 1969.
11. **WOODS, G., M. MANSFIELD and J. KRONE.** A controlled field study using live virus vaccines and an antiserum in a preconditioning program. Can. J. comp. med. **36**: 12-16. 1972.
12. **WOODS, G., M. MANSFIELD and R. MEYER.** Benefits of preconditioning. Mod. vet. Pract. **51**: 46-48. 1970.
13. **YORK, C.** Comments on license requirements for vaccines for bovine respiratory diseases. J. Am. vet. med. Ass. **152**: 840-841. 1968.