Antibody Responses of Young Calves to Inactivated Viral Vaccines

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Abstract

The ability of maternal antibodies to interfere with active immunization of young animals by vaccination has been realized for many years. The development of vaccines that would overcome this effect could contribute greatly to the prevention of viral diseases of cattle. Major advances have been made in the quality of commercial inactivated virus vaccines to increase their efficacy. Therefore, three of these vaccines were evaluated for immunogenicity in young calves with residual maternal antibodies. Groups of 30 calves were administered each of the vaccines at the start of the experimentation and were administered a second dose 32 days later. Serum was obtained from these calves and 30 calves in a nonvaccinated control group prior to vaccination and at 32, 61, 97 and 125 days thereafter. The sera were tested for antibody levels with virus neutralization tests. Antibody responses to viruses included in two of the vaccines were extremely limited and restricted to animals with low maternal antibody titers. The third vaccine overcame suppression by maternal antibodies and elicited responses clearly differentiated from antibody levels in the control group of calves. Mean antibody titers were significantly higher in this vaccinated group of calves when compared to unvaccinated calves or animals in the other two vaccinated groups at 61, 97 and 125 days.

Introduction

A number of viruses including bovine viral diarrhea (BVD), infectious bovine rhinotracheitis (IBR), parainfluenza type 3 (PI-3), and bovine respiratory syncytial (BRS) viruses are ubiquitous in our cattle population. Consequently, cows in most herds possess antibodies to these viruses either as a result of natural infection or vaccination. These antibodies are transferred to a newborn calf by ingestion of colostrum and may protect the calf from infection during early life.

While these maternal antibodies may be protective, they may also interfere with the induction of acquired immunity by vaccination.[1] The interference can be elicited against both inactivated and modified live virus vaccines. Studies by Brar *et al*[2] and Menanteau-Horta *et al*[3] indicated that the degree of interference can be related to antibody levels in the animals at the time of vaccination and the viral agent under consideration. Further, there was evidence that modified live virus might prime the immune system in the absence of a detectable humoral response. However, a report by Stott *et al* suggested that the response to respiratory syncytial virus can be completely blocked by maternal antibodies.[4]

An individual vaccine can probably induce an immune response at some minimal level of maternal antibodies. However, in practice, the recipient animals are the complicating factor. In any group of calves, one can expect extremely variant levels of maternal antibodies to each of the viral entities. This is due to variant levels of antibodies in the dam, degree of transfer to the newborn calf, and the age of the calf. Consequently, the age of the calf at the time of vaccination has been a major determinant for successful vaccination.[5]

Materials and Methods

One hundred twenty calves in the Rhodes Research Farm beef herd were selected and randomly assigned to one of four groups of 30 animals each. These calves were of mixed breeding, born in the Spring of 1995, and ranged in age from 28 to 69 days at the time of primary vaccination.

At the start of the experimentation the calves were bled for serum, and calves in treatment groups were administered a commercial vaccine. All vaccines con-

tained inactivated IBR, BVD, PI-3 and BRS viruses and were purchased from Midwest Veterinary Supply, Des Moines, Iowa. The 5 ml dose of each vaccine was injected into two sites, 2.5 ml intramuscularly in each thigh. Groups and vaccine administered were as follows:

Group A — Controls, no vaccination
Group B — ELITE 4, Boerhinger Ingelheim Animal Health, Inc., St. Joseph, Missouri
Group C — Triangle 4, Ft. Dodge Laboratories, Inc., Fort Dodge, Iowa
Group D — Vira Shield 5, Grand Laboratories, Inc., Larchwood, Iowa

Calves were bled and administered a second dose of the vaccine 32 days later. They were bled again on days 61, 97 and 125 of the experimentation.

Serum was harvested and stored at -20°C until tested for antibodies to the various viruses. Antibody titers were determined by standard microtiter virus neutralization tests conducted with two-fold dilutions of serum. Duplicate tests with two strains each of BVD type 1 and type 2 viruses were conducted and results reported as the mean of the determinations.

Statistical analysis of the data was conducted with the SAS system[a] and the general linear models procedure. Determination of differences between groups was with Duncan's multiple range test with an alpha value of 0.05.

Table 1. Serum antibody titers to various viruses for all 120 calves at the time of primary vaccination.

	IBR	BVD-1*	BVD-2**	PI-3	BRS
Mean Titer	14.7	76.60	45.9	85.6	40.8
Range of Titers	<2-128	20-1920	7.5-1280	2-480	<2-480

*Genotype 1
**Genotype 2

Results

At the start of the experimentation almost all the calves had detectable antibodies against each of the viruses, but titers were quite variable among the animals (Table 1). The mean level of residual maternal antibodies was highest to PI-3 virus and lowest to IBR virus. The presence of detectable antibodies in the serum of most of the calves at this time is an important consideration because there was potential for interference with the vaccines.

[a] SAS Institute, Cary, N.C.

Mean antibody responses to IBR virus, BVD virus type 1, BVD virus type 2, and PI-3 virus in the four groups of calves are presented in Figures 1, 2, 3 and 4, respectively. As expected, antibody titers to each of the viruses declined in the control calves during the period of experimentation. This supports clinical observations of no respiratory disease in these animals during the experiment and absence of natural infection with any of the viruses. Thirty-two days following primary vaccination mean antibody titers to all viruses had declined in all groups of calves indicating minimal, if any, humoral response to the viruses in the vaccines. Statistical analysis indicated no difference in mean antibody titers of the groups of calves to each of the viruses at this time. By 61 days post-vaccination, antibody responses to individual viruses were apparent in certain treatment groups.

Responses to the IBR virus component (Figure 1) were somewhat disappointing but Group D calves had significantly higher titers than controls at the 61, 97 and 125 day time period. Some Group C calves also responded since their antibody levels were higher than controls at 61 days although they failed to sustain the response thereafter. Group B calves failed to generate a humoral response to IBR virus.

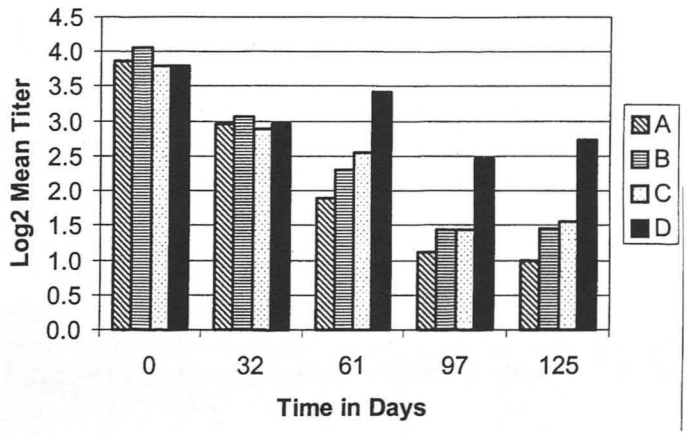

Figure 1. Mean antibody titers to IBR virus in four groups of calves. Calves were left as unvaccinated controls (A) or were vaccinated with one of three commercial inactivated virus vaccines (B, C, D) on days 0 and 32.

Residual maternal antibody titers to BVD virus were moderate at the time of primary vaccination and probably influenced the response to the vaccines. As compared with Group A controls, little if any response was elicited in Group B calves (Figures 2 and 3). Antibody titers of Group C calves to BVD type 1 virus were significantly higher than controls at the 97 and 125 day bleedings. However, this did not extend to type 2 virus where titers at all bleedings were equivalent to the con-

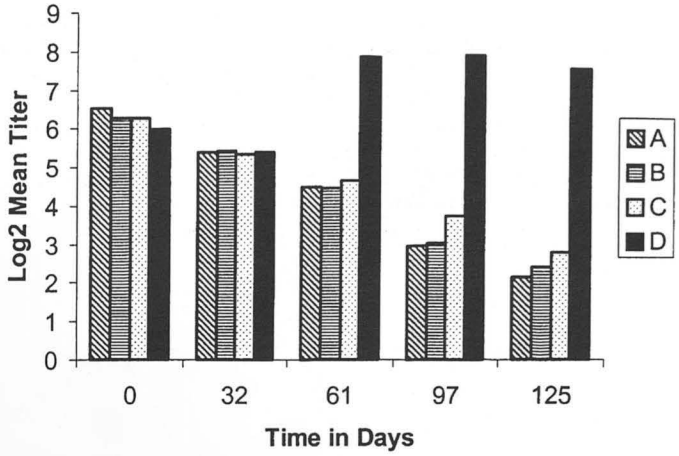

Figure 2. Mean antibody titers to BVD type 1 virus in four groups of calves. Calves were left as unvaccinated controls (A) or were vaccinated with one of three commercial inactivated virus vaccines (B, C, D) on days 0 and 32.

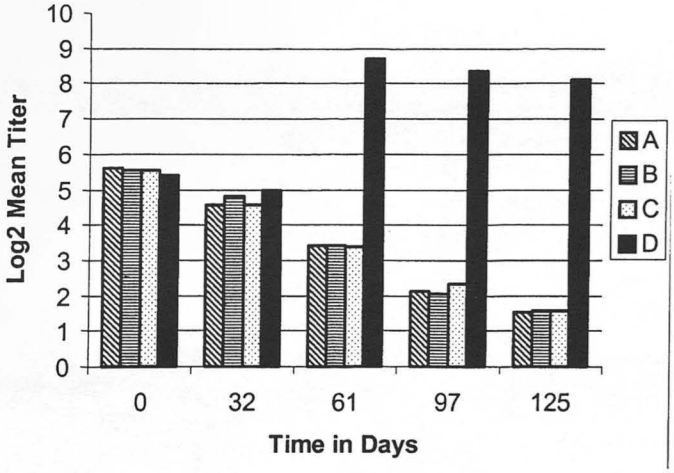

Figure 3. Mean antibody titers to BVD type 2 virus in four groups of calves. Calves were left as unvaccinated controls (A) or were vaccinated with one of three commercial inactivated virus vaccines (B, C, D) on days 0 and 32.

trols. Enhanced levels of BVD virus antibodies were present in Group D calves at 61 days and remained at high levels throughout the experimental period. These enhanced titers related to both types of virus.

Maternal antibody levels to PI-3 virus were quite high at the beginning of the experiment but two of the vaccines did induce active humoral responses (Figure 4). Group B calves had significantly higher titers than controls at the 61 and 97 day bleedings but levels failed to persist to 125 days. On the other hand, Group D calves had significantly higher antibody titers to PI-3 virus at 61 days and through day 125.

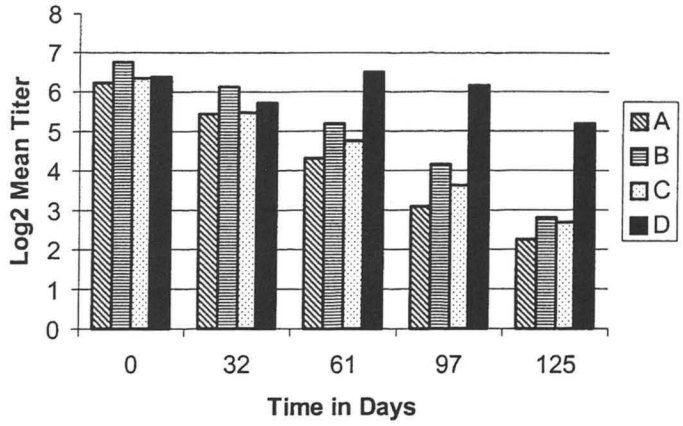

Figure 4. Mean antibody titers to PI-3 Virus in four groups of calves. Calves were left as unvaccinated controls (A) or were vaccinated with one of three commercial inactivated virus vaccines (B, C, D) on days 0 and 32.

Discussion and Implications

This experimentation demonstrated that appropriately formulated inactivated virus vaccines do have the potential to overcome suppression by maternal antibodies and induce acquired humoral immunity in young calves. In particular, the Vira Shield 5 vaccine produced by Grand Laboratories induced clearly differentiated antibody responses two months following primary immunization. The responses persisted through the following 60 days of the experimentation. The antibody responses in these calves indicated that the vast majority of calves in Group D responded to the vaccine irrespective of the maternal antibody titers. This contrasted with the rather minimal responses of Groups B and C calves where responses appeared to be restricted to calves with low maternal antibody titers at the start of the experiment. This observation is consistent with those of Schultz[1] and Anderson[5] who reported that only a certain percentage of young calves of a particular age will respond to vaccination with a BVD virus vaccine.

The findings of this experimentation which demonstrated that a commercial inactivated virus vaccine can induce significant humoral responses in calves with appreciable levels of maternal antibodies is particularly important. This should permit immunization of young calves against several viruses even though the calves are variable in age and residual maternal antibody levels. The question arises as to whether the antibodies induced by inactivated viral vaccines are protective. Reported observations on BVD virus vaccines[6,7] and a BRS virus vaccine[4] would indicate that they can be efficacious.

References

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