Effects of Passive Immunity On Immune Response In Calves Following Vaccination for Blackleg

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Based on blackleg vaccination results it would appear that 1) the optimum age to vaccinate nursing calves and immune dams for blackleg would be after four months of age, 2) that a second or booster vaccination will extensively enhance the immune status of nursing calves indicating that initial vaccination of calves six weeks older or younger will not interfere with booster vaccine administration, 3) that the immunological response of the six-week-old or younger calf to the *Cl. chauvoei* bacterin is variable indicating that maternal interference is not always exhibited or may even stimulate antibody production.

It is well established that either antigen or antibody may interfere with immunological responses in a "normal" young animal.[14,24,25] Natural passive immunity (antibody interference) has received attention in the livestock industry as a possible explanation for disease outbreaks even though animals received a correctly administered specific vaccine when they were young.[2,4,5,12,17,18]

Several hypotheses have been offered in relation to the cause of immunosuppression by passive immunity.[6,7,23,25,29] The most frequently offered explanation is the interaction of antibody and antigen.[7,25]

Investigations by others have demonstrated that mothers immune to blackleg will pass immunity to their offspring through the colostrum. The nursing calf or lamb will have demonstrable protection up to four weeks.[1,4,19] It has also been demonstrated that active protection will be provided for up to seven months following vaccination with a blackleg bacterin.[21,28] It has been shown that there are at least several strains of blackleg organisms and that the greatest protection is afforded through vaccination when the strains in the vaccine are homologous to those present in the livestock environment.[3,6,13,22] Investigations have also indicated that the addition of aluminum hydroxide or other adjuvants in the vaccine will increase the response of vaccinated animals.[8,9]

This investigation was initiated to determine the degree of immunosuppression following vaccination of young animals with blackleg bacterins.

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MATERIALS AND METHODS

Experimental Animals

All animals used were of Holstein breeding. All animals were obtained as pregnant adult animals and vaccinated at least twice before parturition with *Clostridium chauvoei* (BL) bacterins. A total of 40 calves were utilized from these cows.

Blood and Milk Samples

All cows were bled and colostrum was collected from all lactating quarters before nursing occured. All calves were bled before initial nursing, at 24-36 hours post-nursing, at one week of age and at monthly intervals thereafter up to 36 weeks post-partum and at pre-vaccination and 4 weeks post-vaccination intervals after 36 weeks post-partum. Blood serum and milk whey were obtained by centrifugation. All evaluations were made within 36 hours of sample collection. Surplus blood serums and milk whey were frozen at a -20^{o} and stored until assayed.

Antibody Determination

All serum and whey titers to blackleg were determined by agglutination tests utilizing a specially prepared *Cl. chauvoei* antigen.[16] The antigen was provided for this investigation through the courtesy of Doctor M.E. Macheak, chief of veterinary bacteriology and field operations, Veterinary Biologics, USDA, APHS, Ames Iowa. Serum and whey titers are expressed as a reciprocal of the greatest twofold serological dilution in which agglutination could be determined.

Vaccines

Three commercially prepared *Cl. chauvoei* bacterins were each intermittently utilized according to the manufacturer's instructions throughout this investigation.

Results

The 19 cows involved in this investigation were vaccinated at least twice with a *Cl. chauvoei* (Blackleg) bacterin. This resulted in a colostral titer higher than that of the blood serum to *Cl. chauvoei* (Table 1).

Nineteen calves of the above cows all had demonstrable blood titers within 12 hours following consumption of colostrum and had a mean maximum titer of 1:27 at approximately 24 hours post-birth. It is assumed that blood titer of 1:16 will provide protection against blackleg infection. There was no demonstrable pre-nursing titers to *Cl. chauvoei*.

Group 1 consisted of ten calves from immune dams that were vaccinated at one to six weeks of age. Blood titers to *Cl. chauvoei* were made three weeks following vaccination. From Table 1 it is obvious that vaccination had little effect in increasing passive titers in these young calves. The titer was unchanged in 70% of the vaccinated animals.

Group 2 consisted of nine calves of immune cows that were vaccinated with *Cl. chauvoei* bacterin between the ages of four and twelve months. Blood titers were determined not less than three weeks or more than five weeks post-vaccination. A greater response to vaccination was detected to this group of older calves than in Group 1 calves as demonstrated in Table 1.

Fifteen calves (Groups I and II) were vaccinated a second time - booster vaccination. All calves received a booster vaccination at least one month following initial vaccination. Blood titers were determined not less than three weeks post-vaccination. This group of animals had a greater response to vaccination than either Groups I and II with 93.3% of the calves exhibiting an increased titer to *Cl. chauvoei*.

Discussion

The results of this investigation would indicate that the young animals (1-6 weeks of age) will not as readily respond to *Cl. chauvoei* bacterin as older calves (4-12 months). This deficiency in response may be due to passive maternal antibodies or individual immunoincompetence. The aspect of maternal antibody interference may be debatable in that it has been demonstrated that maternal antibodies are essential to active antibody stimulation in the very young animal.[3,10,11,15,24,26,27]

A second administration of bacterin in calves 18 to 24 months of age indicated that previous vaccination had no adverse effects on the immunological response following the second administration, hence it would be feasible to vaccinate young calves to provide the maximum obtainable immunity in early life and to follow with a booster vaccination to provide maximum protection later.

It should be emphasized that the results obtained in this investigation are for a specific antigen (*Cl. chauvoei* (Blackleg) bacterin) and that a different result would likely be obtained with other *Cl. chauvoei* strains, other bacterins, and or viral vaccines.[20]

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Table 1. Average Mean Blood Serum Titers for BL of Calves of BL Immune Dams

Postvaccination Titer	Dams (19)		Age of Calves at Vaccination		
	Serum	Colostrum	1-6 Wks (10)	4-12 Mo (9)	Second Vaccination 18-24 Mo (15)
High	512	1024	32	256	52
Mean	140	188	17	87	173
Low	8	8	0	16	32
Titer Change (%)					
Increased			20	66.7	93.3
No change			70	33.3	6.7
Decreased			10	0	0

(10) = No. of animals in each investigation

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