Field Use and Evaluation of a Vaccine for Bovine Staphylococcic Mastitis

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Abstract

A commercial staphylococcic vaccine was evaluated for the treatment and prevention of Staphylococcus aureus mastitis. There was no significant therapeutic effect upon the udder infections or the clinical incidence of mastitis in 13 cows with chronic mastitis. Prophylactic vaccination in two dairy herds resulted in an insignificant decrease in the clinical incidence of mastitis of both herds and a significant decrease in the rise of infected quarters in one herd. Vaccination was of limited value for controlling S. aureus mastitis.

Bovine mastitis costs the dairymen of the United States $386 million yearly, or an average loss of $19.53 per cow (15). Of the many organisms capable of producing mastitis, Staphylococcus aureus is the most significant (2, 21). The incidence of staphylococcal organisms in milk samples varies from 50.9 to 71.0% (11, 17, 20).

The annual cost of mastitis antibiotic medicants is more than $31 million (15); however, these drugs have not only failed to reduce the S. aureus infection rate of bovine mammary glands, but have probably increased it by hindering other mammary gland organisms while staphylococci have developed drug resistance (32). Loss of milk production is another major portion of the total cost involving mastitis. Subclinical infections cause three times the milk loss resulting from clinical mastitis. To significantly reduce losses from S. aureus, mastitis protection rather than treatment must be considered.

Observations made on the effectiveness of vaccination against bovine staphylococcic mastitis have resulted in conflicting conclusions. Varying experimental design and circumstances deviating from those seen in the field may be partially responsible.

Intramammary or intramuscular injections of toxoid failed to reduce or eliminate the staphylococcic organisms from infected mammary glands (8, 12, 13, 18, 26-28). Other workers reported recovery from clinical cases of bovine staphylococcic mastitis and the reduction or elimination of staphylococcic organisms from the mammary gland (6, 14, 23-25). Parenteral vaccination failed to prevent clinical cases of staphylococcic mastitis in cattle (3, 8, 10, 22, 26, 27). However, effective protection following vaccination has also been documented (2, 12, 23, 28, 29, 31).

Increased resistance to bovine S. aureus mastitis following parenteral vaccination was noted as a reduced severity of the disease (10, 22, 28, 30). The procedure was more effective in cattle with little udder pathology and in those animals in which infections were not well established (10, 28, 31). Udders with mixed infections did not respond well. Infections homologous with those in the vaccine were more responsive than those caused by heterologous strains of staphylococci (2, 5, 7-9, 25). Mastitis vaccines have been recommended for dairy herd health programs (1, 4, 12, 16).

The purpose of this study was to evaluate a commercially available staphylococcic vaccine for the treatment and prevention of S. aureus in infected mammary glands in two commercial dairy herds.

I. Therapeutic Effects of Vaccination

Materials and Methods

Thirteen cows were selected from a herd of 34 cattle in which S. aureus was the most common udder pathogen. These cows had repeated attacks of mastitis and had S. aureus infected quarters. The vaccine used was a purified concentrate of whole cultures of S. aureus inactivated with beta-propiolactone. Cellular antigens and standardized quantities of beta and alpha toxoids were present."
At weekly intervals the 13 cows received single administrations of vaccine in the semimembranosus, semitendinosus, and biceps femoris muscles; 10 ml the first week, 15 ml the second week, and 20 ml the third week. The other animals in the herd served as controls and were injected with identical amounts of a placebo prepared by the manufacturer. No change was made in the milking procedure. Clinical cases of mastitis were recorded as they occurred, indicating the date, and the cow and quarter affected.

Quarter milk samples were aseptically collected monthly in individual sterile tubes. One to 5 ml of the first milk available was used and the tubes identified. Samples were placed under refrigeration until cultured. Each sample was streaked on sheep blood agar media. All four quarter samples from one cow were cultured on separate portions in the same petri plate and incubated in an inverted position at 37 C. Plates were examined at 24 hr and organisms present were identified. Colonies suspected of being S. aureus were tested for coagulase activity. Negative plates were reincubated for an additional 24 hr.

The test period (after vaccine treatment) lasted ten months and was compared with a base period (before vaccine treatment) of the previous ten months. Five days elapsed after the first injection of vaccine before mastitis cases were included in the test period. The milk sampling following the initial dose of vaccine was the first included in the test period.

The test and base periods were compared in the 13 vaccine-treated cows on the basis of the number of cow-months required for each clinical attack of mastitis and the average number of infected quarters per cow. One cow in the experiment for one month equaled one cow-month. The same values were determined for the 21 placebo-treated cows. Only quarters infected with S. aureus were considered. Side effects were carefully watched for.

Results and Discussion

Effect of vaccination on the clinical incidence of mastitis. During the base period, the vaccine-treated groups had 54 clinical attacks of mastitis during 136 cow-months (2.5 cow-months per attack) and 11 attacks during the test period of 100.5 cow-months (9.1 cow-months per attack). This compared with 15 attacks during 208.5 cow-months in the control group during the base period (13.9 cow-months per attack) and 13 attacks during 178.5 cow-months in the test-period (13.7 cow-months per attack).

Comparison of the two groups during the respective periods is presented in Fig. 1.

A decreased frequency of mastitis, that is, more cow-months required for a mastitis attack, was seen in the treated group. The difference, however, was not statistically significant (P > .05).

Effect of vaccination on the incidence of infected quarters. The changes in the average number of infected quarters per cow in the treated and control groups are presented in Fig. 2. The number of infected quarters per cow in the vaccine-treated animals increased from an average of 1.47 in the base period to 1.99 in the test period. The average increased from 0.93 to 1.23 infected quarters per cow in the control group during the same period. There was no significant difference between the two groups in the rate of increase over the two periods.

Side effects of the vaccination procedure. A mild irritant action was seen during injection of the vaccine. A post-administration swelling was seen in one of the 13 animals. It subsided in three days and no lameness resulted. Shock or allergic responses were not observed.
Conclusions

The treatment of cows chronically infected with mastitis, using large doses of staphylococci vaccine, caused a nonsignificant decrease in the cases of clinical mastitis. The procedure had no effect on the incidence of infected quarters. Minor local irritation resulted from the large quantities of vaccine injected.

II. Prophylactic Effects of Vaccination

Materials and Methods

Two dairy herds were chosen in which S. aureus was the common pathogen found in pre-experiment milk samples. Herd A consisted of 38 cows and Herd B had 113 cows in the experiment. The vaccine used to vaccinate Herds A and B was the same as in Part I. No changes were made to improve the management or milking procedure of either herd.

Since Herd A contained a small number of cows, monthly milk samples collected during a seven-month base period (before vaccination) were used as the control against which to evaluate the effects of vaccination. All cows were then vaccinated by aseptically injecting 5 ml of vaccine into the gluteal muscles. The procedure was repeated after six weeks. All cows were given 5-ml booster injections at six-month intervals during the 13-month test period (after vaccination).

Herd B consisted of 113 cows with well-documented histories. Before vaccination, two milk samples were collected from each animal one month apart. The herd was separated into two groups, dividing the cows equally as to age, history of mastitis, previous milk production, and number of infected quarters. Animals in one group were vaccinated according to the procedure for Herd A. The other group was injected identically, using a placebo prepared by the vaccine manufacturer. Heifers coming into the milking herd during the 13-month test period were alternately assigned to the vaccinated or control group. Only one pre-vaccination milk sample was taken from the newly introduced animals.

Clinical cases of mastitis were recorded as in Part I. Milk samples were collected from both herds monthly. The collection and culturing of quarter milk samples were carried out as in Part I.

Milk samples were collected from Herd A for 20 months, 13 of which were during the test period. Herd B was surveyed for 14 months, of which 13 were during the test period.

The effect of vaccination in Herd A was evaluated by comparing herd values for the base period with those obtained for the same animals following vaccination. In Herd B the vaccinated and control groups were compared. Both herds were studied for the effects of vaccination on the clinical incidence of mastitis and the number of infected quarters. Adverse reactions due to the vaccination were watched for.

Results and Discussion

Effect of vaccination on the clinical incidence of mastitis. The clinical incidence of mastitis was computed on the number of attacks per cow-month. One cow-month was the equivalent of one cow in the experiment for one month.

Seventeen of the 38 cows in Herd A had attacks of mastitis during the base period; 19 cows were clinically affected in the test period. Eleven had clinical mastitis during both periods. A total of 41 attacks occurred during the 212 cow-months of the base period (5.2 cow-months per attack). Following vaccination, 54 mastitis attacks occurred during 444 cow-months (8.2 cow-months per attack). The incidence of mastitis in Herd A during the base and test periods is presented in Fig. 3. Though the incidence of mastitis decreased, that is, the number of cow-months required per attack of mastitis increased, this difference was not statistically significant (P > .05).
Fig. 3. Clinical incidence of mastitis attacks in the cows of Herd A before vaccination (base period) and after vaccination (test period).

Comparison of the vaccinated and control groups of Herd B during the one-month base period and 13-month test period revealed the vaccinated cattle had 11 attacks of mastitis in the 48 cow-months of the base period (4.4 cow-months per attack) and 53 cases of mastitis in 363 cow-months during the test period (6.8 cow-months per attack). The control group had ten cases of clinical mastitis during 54 cow-months of the base period (5.4 cow-months per attack) and 55 cases of mastitis in 328 cow-months in the test period (6.0 cow-months per attack). The clinical incidence of mastitis in Herd B is presented in Fig. 4.

An increase in the number of cow-months required for an attack of mastitis was seen in both groups. A greater time interval between mastitis attacks occurred in the vaccinated group, but the difference was not statistically significant (P > .05).

Effect of vaccination on the incidence of infected quarters. Evaluation was based upon the average number of infected quarters per cow. Only those quarters yielding milk containing S. aureus were considered infected.

Herd culture results obtained during the base period and test period were compared in Herd A. These results are presented in Fig. 5. There was a gradual rise in the average number of infected quarters per cow during both periods.

The culture results in Herd B were compared in vaccinated and control groups during the base and test periods and are reported in Fig. 6. Both the vaccinated and control groups had an increase in the average number of infected quarters per cow during the course of the experiment. Although no statistically significant difference was present at the start, the variation between the two groups at the end of the test period was significant (P < .005; Chi square = 10.428 with 1 d.o.f.).

Side effects of the vaccination procedure.

No serious effects were noted when vaccinating 151 cattle with recommended dosages at prescribed intervals. Tissue irritation during administration occurred infrequently. Twelve cows had swellings at the injection site, but the reaction subsided in three to five days in all cases.

Two cattle developed swellings in the gluteal region one month and two months, respectively, after the booster vaccination. One hundred milliliters of a thick yellow material was removed from each swelling and healing was satisfactory. Infection induced at the time of vaccination was a possible cause. However, no swellings developed in the animals given the placebo.

Fig. 4. Clinical incidence of mastitis attacks in the vaccinated cows and the control cows of Herd B before vaccination (base period) and after vaccination (test period).
The vaccine may have been deposited into or through the sacrosciatic ligament, or the inactivating agent used in vaccine preparation could have produced tissue necrosis. Bacteriologic examination of the lesions was not performed.

**Conclusions**

The vaccination of dairy cattle with a staphylococcic toxoid had no statistically significant effect on the clinical incidence of mastitis. It did not reduce the incidence of infected quarters. A significantly smaller increase in the number of infected quarters in the vaccinated cattle of one herd suggested a reduction in the rate of infection spread.

No serious side effects resulted from the administration of recommended quantities of the vaccine.

*Staphylococcus toxoid* was of limited value in the control of mastitis.

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