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Bovine Brucellosis

IN THE UNITED STATES

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BOVINE BRUCELLOSIS IN THE UNITED STATES-- RESEARCH, CONTROL, AND ERADICATION

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Bovine brucellosis has caused serious economic losses to the cattle industry in the United States. While the disease is most prevalent in the predominantly dairy sections of the country, it exists from coast to coast and from northern to southern borders. Moreover, there is probably no disease of animals at the present time that constitutes a more serious threat to public health than brucellosis. It is because of the combined economic and public health aspects of bovine brucellosis that eradication efforts have received widespread support in the United States.

Control and eradication of bovine brucellosis, like most infectious diseases of animals, must be based on the detection and elimination of infected cattle, the prevention of exposure, and protection by artificially induced immunity. Over the years, research has developed the tools that have been used to successfully combat this disease.

RESEARCH

One of the outstanding contributions of research toward successful control of brucellosis has been standardization of diagnostic procedures. The blood serum agglutination test has proved to be the most practical and reliable method of diagnosing bovine brucellosis. Beginning in 1938, major emphasis was placed on standardizing antigens, procedures, equipment, and interpretations. These studies included selection of a highly antigenic strain of Brucella abortus, development of procedures for the selection and maintenance of smooth colony forms, production of adequate quantities of the organism, and development of standard methods and equipment for preparing antigens with a constant sensitivity.

In 1940, the first standard Brucella tube and plate antigens were made available for the diagnosis of brucellosis in live-stock. This was followed by adoption of standard equipment in all State-Federal testing laboratories. Procedures were then inaugurated to standardize the interpretation of the tests. Reference serum samples, along with standard tube and plate antigens, were and still are submitted annually or semiannually to each official testing laboratory in this country. Results of tests in each laboratory are returned to the antigen control laboratory at Beltsville, Md., for compilation and evaluation. From 1948 to 1955, 91.88 percent of the tube-test and 91.07 percent of the plate-test interpretations agreed with the standard interpretation. Furthermore, there has been 99.12 percent agreement between the tube and the plate tests.

Recent results of research have brought about the official adoption of a new interpretation of the tube and plate sero-agglutination tests for brucellosis in officially calf-vaccinated cattle 30 months of age or older. The new interpretation allows the diagnostic titer to be one dilution higher in officially calf-vaccinated than in nonvaccinated cattle. By more accurately determining the brucellosis status of 637 calf-vaccinated animals examined, this interpretation reduced the number of reactors by 70 percent and the number of suspects by 40 percent, and increased the number classified as negative by 400 percent.

Comparisons of interpretations of the seroagglutinin tests for brucellosis in nonvaccinated and calf-vaccinated cattle are presented below:

For nonvaccinated cattle			For calf-vaccinated cattle				
Dilutions			Diagnosis	Dilutions			Diagnosis
1:50	1:100	1:200		1:50	1:100	1:200	
-*	-	-	Negative	+ *	-	-	Negative
I	-	-	Suspect	+	I	-	Suspect
+	-	-	Suspect	+	+	-	Suspect
+	I	-	Suspect	+	+	I	Suspect
+	+ **	-	Reactor	+	+	+ **	Reactor

-: Negative

+: Complete agglutination

*: or less

** : or higher

I: Incomplete agglutination

The milk-ring test is the latest of the diagnostic procedures to be adopted for the brucellosis control program. The antigen control laboratory at Beltsville, Md., started producing and distributing milk-ring antigen for official testing in 1949. Considerable progress has been made since 1949 in developing a standard antigen, procedures for collection and preservation of milk and cream samples, standard test procedures, and uniform interpretation of results. The principal purpose of the milk-ring test is to locate brucellosis-infected herds. This provides for concentration of effort on eliminating infected animals, and amounts to tremendous

savings in manpower, time, and materials; particularly in dairy sections of the country.

There are no diagnostic tests capable of accurately differentiating between serum agglutinin titers caused by virulent Brucella abortus and those caused by Strain 19 vaccine. Considerable progress has been made recently, however, in differentiating between specific agglutinins (those produced by Brucella) and nonspecific agglutinins (those produced by causes other than Brucella) found in the blood and milk of cattle. When accurate tests are developed, they will be of considerable aid in correctly classifying animals that show questionable agglutinin reactions.

Much of the research effort, during the last 3 decades, has been toward the development of an effective immunizing agent against bovine brucellosis. When the various kinds of experimental vaccines were evaluated, Strain 19 showed the best combined qualities of safety, immunogenicity, and stability. Consequently, vaccination with Strain 19 was adopted as an integral part of the control program in 1941 and the vaccine has been the only official one in this country since that time.

Strain 19 is a member of the species Brucella abortus and has the unique properties of low pathogenicity and relatively high immunogenicity, which have remained stable since 1930. All of the available evidence shows that immunity follows the rapid, complete recovery of cattle from a low-grade infection produced by Strain 19. Furthermore, the disease is not transmitted from vaccinated to susceptible nonvaccinated animals by contact. The desirable characteristics of Strain 19 are maintained by careful selection of specific colony forms.

Newly selected seed cultures of Strain 19 are supplied to all biological companies producing vaccine in this country and to approximately 25 foreign countries every 3 to 4 months. Each lot of vaccine produced in this country is tested in the vaccine control laboratory for viability, purity, and colonial characteristics.

Strain 19 vaccine is available either as a liquid or a dried product. The dried product is more stable than the liquid one under average environmental conditions. However, it should always be kept in mind that improper handling of the dried vaccine can render it useless by causing death of the Strain 19 organisms.

Immunity produced with Strain 19 vaccine against brucellosis in cattle is usually relative and seldom absolute. The degree of immunity induced is directly related to the response of the individual animal to viable organisms and this may vary considerably among animals. Furthermore, it has been repeatedly demonstrated that as the exposure dose of virulent Brucella abortus increased, the percentage of vaccinated animals with demonstrable protection decreased. The large majority of evidence indicates that immunity produced by calf vaccination with Strain 19 does not decrease

with an increase in age of the animal. Experimental results also show that any increase in immunity resulting from revaccination is temporary and does not persist sufficiently long to be of any practical value.

Accumulated evidence supports 6 to 8 months as the most desirable age for vaccinating heifer calves with Strain 19. Cattle vaccinated at that age develop an immunity equal to that produced in cattle vaccinated at older ages. Furthermore, their vaccinal titers recede faster and to a lower level than those in cattle vaccinated at a later age.

The minimum vaccinal dose of viable Strain 19 organisms required to produce a serviceable immunity in cattle is unknown. Controlled experiments to determine the degree and duration of immunity in cattle vaccinated when between 6 and 8 months of age have not been done with doses of vaccine smaller than 5 ml. (50 billion viable organisms).

Experimental information shows that the method of injecting vaccine into yearling heifers has little or no influence on the degree of immunity induced when the dosage of vaccine is the same. Similar experiments with calves 6 to 8 months of age have not been reported.

A review of the research on age of vaccination, vaccinal dosage, and method of administration suggests that subcutaneous vaccination of calves between 6 and 8 months of age with the 5-ml. dose of Strain 19 vaccine is preferable. Moreover, loss of viability through improper handling of vaccine further recommends the 5-ml. dose which provides added insurance that animals will receive adequate numbers of viable organisms to produce a serviceable immunity.

Treatment of brucellosis in cattle has not been successful. Practically all of the antibiotics and the newer drugs have been tried, some of which have a tendency to depress the infection temporarily. After treatment is stopped, infection usually returns to its normal course. Many alleged cures have gained considerable prominence by being used in herds when symptoms are normally subsiding.

A considerable part of future research will be concerned with improvement of methods for classifying the species of Brucella, increasing the specificity of diagnostic procedures, and developing new and improving present immunizing agents.

CONTROL AND ERADICATION

The campaign to eradicate brucellosis from cattle in the United States began during the summer of 1934. From the beginning, this program has been developed as a co-operative State-Federal undertaking designed to eliminate, as quickly as possible, the primary exposure sources, namely, infected animals. Although a great deal was accomplished during the early years of the project by the test-and-slaughter method, it soon became apparent that complete eradication by this procedure alone would be difficult to accomplish on a nationwide scale. Regardless

of the procedures employed, it has been repeatedly demonstrated that the progress made in various areas of the country is far more closely related to the thoroughness with which the procedures are applied than with actual methods themselves.

Variations in the types of herds infected with brucellosis, differences in the character of the disease as it affects various herds, and the degree and length of time infection has been present are important factors to be considered in the selection and application of appropriate means of control.

One of the greatest dangers connected with a test-and-slaughter program is the matter of replacements. Owners of herds on a rigid testing program are extremely vulnerable from at least two directions. First, they face the danger of introducing infection through newly purchased stock even when the best precautions are exercised. Secondly, the introduction of highly susceptible animals from herds that have been free of the disease for several years provides fertile ground for perpetuating any residual infection that might remain on the premises.

Approximately 33 million cattle were tested during the first 5 years of the program and the percentage of reactors was reduced from 11.5 in 1935 to 2.5 in 1939. It soon became evident that the most favorable time to eradicate brucellosis from herds is after clinical manifestations have subsided. This, of course, is impractical in nationwide program operations.

Previous experiences with test and elimination of reactors already had emphasized the need for an immunological agent. Consequently, the approval of Strain 19 vaccine in 1941 was an important step in complementing available control and eradication procedures. As might be expected, vaccination was extremely popular in many sections of the country and each year since it became a part of the official program there has been a marked increase in its use. For the 5-year period extending from 1941 through 1945, approximately 2 million calves were vaccinated officially. There is no question, of course, about the value of Strain 19 vaccine when it is used under appropriate conditions. The fact that the protection afforded by this product is usually relative, emphasizes the importance of limiting exposures of vaccinated animals, through the adoption of approved animal husbandry and sanitary practices.

Since adoption of the ring test in 1952, this procedure has proved extremely valuable in screening dairy-type herds for presumptive evidence of Brucella infection. Where moderate to low degrees of infection exist, counties can be ring tested at approximately 10 percent of the cost of blood testing the same areas. Both milk and cream samples can be examined by this method. Insofar as its efficiency is concerned, it has been found that the ring test locates around 90 percent of the herds in which one or more Brucella-

infected animals are in production. There seems to be a psychological aspect associated with ring testing that encourages livestock owners to become actively interested in eradicating brucellosis from their herds.

Progress in the bovine brucellosis eradication efforts during the years before 1947 was greatly handicapped by lack of uniformity in operations in different parts of the country. In order to correct this situation, the former Bureau of Animal Industry took steps to encourage the establishment of uniform control and eradication practices. Sufficient interest was stimulated through discussions with interested groups to result in the adoption of uniform bovine brucellosis eradication procedures at the December 1947 meeting of the United States Livestock Sanitary Association. These recommendations are an integral part of the State-Federal memoranda of understanding relative to the cooperative brucellosis eradication project.

The design of these recommendations was predicated on the importance of providing reasonable flexibility for handling the brucellosis problem under varying herd conditions. Essentially they consist of four separate plans which are as follows:

Plan A - Test-and-slaughter, with or without calf vaccination.

This plan has eradication as its immediate goal and is the method of choice where the incidence of infection is low and herds are self-contained. In the United States, about 7 out of 10 infected herds can be freed of brucellosis by 2 complete herd tests and prompt removal of reacting animals.

Plan B - Test, calf vaccination, temporary retention of reactors.

The plan is designed to enable the owners of heavily infected herds to work out of a difficult brucellosis situation in a gradual manner, thereby avoiding serious economic shock. This procedure permits reactors to be held in quarantined herds for periods not to exceed 3 years. Plan B has been widely used throughout the country and for the most part has worked effectively as a stepping stone toward Plan A and eventual eradication.

Plan C - Calf vaccination without test of any part of the herd.

This plan was developed primarily to encourage the range cattle industry to recognize the brucellosis problem and to initiate some action toward its solution.

Plan C is confined to herds where the movement of animals is allowed only through special permits issued by State Livestock Sanitary Officials.

Plan D - Adult vaccination.

This was included in the procedures to counteract unofficial vaccination of adult cattle. Under present conditions, there is every reason to discourage this practice in the United States. Fortunately it has declined steadily during the past few years. In the presence of so-called "infection storms," a condition usually existing in herds where vaccination is requested, most of the animals already are exposed. Plan D requires the testing of entire herds, with vaccination of adults confined to nonreactor cattle that have been tested within the previous 10 days. This plan is available only on written approval of the State-Federal cooperating agencies.

From July 1934, to June 30, 1955, a total of nearly 12 million herds, representing approximately 142 million cattle, were tested for brucellosis. Over the same period, the indicated animal infection dropped from 11.5 to 2.6 percent. This 2.6 percent animal infection rate represents evidence of the disease in 14.6 percent of the herds tested. During the first 7 years of the program, when yearly testing volumes remained high, there was a decline each year in the percentage of reactors disclosed. With personnel problems developing in 1942, testing declined and the percentage of reactors started to rise, reaching a secondary peak of 5 percent in 1947. From this point on, there again has been a consistent reduction in animal infection rates.

Greatly increased interest in brucellosis eradication is being displayed by various groups, including the livestock industry, the veterinary profession, livestock sanitary officials, and the general public. This interest has been reflected in the growing volume of official work performed. For the 12-month period ending June 30, 1955, more than 14 million cattle were tested for brucellosis in the United States. This represents an increase of 58 percent over the number of tests made in 1954. During the 15-year period (1941-55) a total of 25.7 million calves were officially vaccinated with Strain 19. Since its approval in 1941, the use of Strain 19 has increased each year, reaching an all-time high of over four million calves vaccinated in 1955. In most sections of the country where vaccine has been extensively used, there is a significant increase in the volume of blood testing.

The maintenance of brucellosis-free areas has constituted a rather serious problem. With the advent of the milk and cream ring test, this difficulty has been largely overcome in dairy sections of the country. By conducting semiannual ring tests at milk and cream collecting stations, it is possible to detect centers of infection early enough to limit spread of

the disease. Since it became a part of the official program in 1952, approximately 3 million herds, representing an estimated 58 million cattle, have been ring-tested in 38 States through the fiscal year 1955.

The Congress of the United States has made available additional funds for use in accelerating the brucellosis eradication project during the fiscal years 1955 and 1956. This action could not have been taken at a more appropriate time, as current interest in eradicating the disease has never been greater. It has been possible to expand operations in most sections of the country far more rapidly than was expected. The fact that the new program called for the restoration of former maximum indemnity payments of 25 dollars for grade animals and 50 dollars for purebreds to owners of cattle destroyed because of brucellosis has also been an important contributing factor. Also, the new interpretation of blood agglutination reactions in officially calf-vaccinated animals has further encouraged wider participation.

At the inception of the expanded program, it was realized that the personnel requirements would have to be met through the employment of practicing veterinarians. This being the case, a system was developed for paying cooperating veterinarians on a per-head or per-herd-and-per-head basis. The response of the veterinary profession in the new program has been excellent.

Table 1 shows the increased volume of brucellosis eradication activities for fiscal year 1955 over fiscal year 1954.

TABLE 1.--Comparative Brucellosis Activities Immediately Before and After Inauguration of Expanded Program

Activities	Fiscal Year		Change
	1954	1955	
Blood tests			
Herds.....	<i>Number</i> 696,207	<i>Number</i> 984,541	<i>Percent</i> 41 +
Cattle	9,002,109	14,186,241	58 +
Ring tests			
Herds.....	932,003	1,200,898	29 +
Cattle	16,633,034	20,444,994	23 +
Vaccinations	3,999,101	4,381,397	10 +
Reactors slaughtered.....	¹ 154,990	² 302,812	20 +

¹ 65 percent

² 82.9 percent

The second year of the accelerated program is showing a continued high level of brucellosis operations. From July 1 through December 31, 1955, there was a 13 percent increase in the number of calves vaccinated, a 56 percent increase in the number of cattle tested, and a 33 percent increase in the number of reactors slaughtered, over that recorded for the same period in 1954. It seems highly significant that approximately 96 percent of the reactors disclosed by testing are now being slaughtered immediately.

SUMMARY

Major contributions of research in the development and progress of the control and eradication of bovine brucellosis are as follows:

1. Development of a standard blood serum agglutination test.
2. Development of information leading to the recommendation and adoption of a new interpretation of the blood serum agglutination test for cattle officially vaccinated as calves with Strain 19 vaccine.
3. Standardization of milk ring antigen, testing procedures and interpretation.
4. Development of Strain 19 vaccine, and standardization of methods for its production and administration have been responsible for providing a serviceable immunizing product against bovine brucellosis.

Highly encouraging progress is being made in the campaign to eradicate bovine brucellosis in the United States. The following points are considered important in this regard:

1. Since 1935, the percentage of brucellosis reactors disclosed through blood agglutination testing has been reduced from 11.5 to 2.6. A corresponding reduction has occurred in the percentage of infected herds. For the fiscal year 1935, 36.2 percent of the herds tested were found to be infected. As of December 31, 1955, this figure had been reduced to 13.8.
2. The adoption of Uniform Methods and Rules has been a major factor responsible for the favorable progress made during recent years in the bovine brucellosis eradication campaign.
3. Extensive field experience has shown that an eradication program based upon the intelligent use of a standardized blood serum agglutination test, the milk and cream ring test, and Strain 19 vaccine can be effectively carried out.
4. Full support of the livestock industry, the veterinary profession and the general public is essential to the successful conduct of a brucellosis eradication campaign.

If the current intensified effort can be maintained, it is possible that the incidence of bovine brucellosis throughout the United States can be reduced to 1 percent or less within the next five years.

MOTION PICTURES ON BRUCELLOSIS

The United States Department of Agriculture has released the following motion picture films on Brucellosis. They are available for loan from the Land-Grant College Film Libraries, or you may write the Motion Picture Service, Office of Information, U. S. Department of Agriculture.

1. Battling Brucellosis, 16 mm. color film, 20 minutes, released 1946.
2. The Triple Threat of Brucellosis, 16 mm., color, also black and white, 27 minutes, released 1951.
3. Brucellosis Ring Test, 16 mm., color, 5-3/4 minutes, released 1957.