Bovine tuberculosis has been combated for more than 50 years. The disease has been brought to a low level in the United States through the cooperative efforts of the state and federal animal health officials. Changes in program emphasis have been necessary to prevent the eradication effort from degenerating into a static control program. National program statistics and studies of current outbreaks have shown the need for better surveillance and condemnation of all exposed cattle in herds with spreading infection. Detailed epidemiological investigations are essential to finding and eliminating the remaining foci of disease.

Sharpening the Attack on Bovine Tuberculosis

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In the minds of most medical personnel, bovine tuberculosis is a rare and unimportant disease. In the minds of most cattle owners, it is a disease of only historic importance, and it is an unknown disease to the average citizen. Yet 54 years ago when the Cooperative State-Federal Bovine Tuberculosis Eradication Program was begun, one cow in every twenty was infected[1] and perhaps one-fourth of the tuberculosis cases in children were caused by *Mycobacterium bovis*.[2] Of the 9.3 million cattle carcasses inspected by federal meat inspectors in 1917, 50,000 were "condemned" or "passed for cooking only" because of extensive bovine tuberculosis.

Today, approximately one bovine in 20,000 is infected. Bovine tuberculosis is rarely reported in man in the United States and less than 300 cattle carcasses per year out of 35 million are "condemned" or "passed for cooking only" because of this disease. It is estimated that between 200 and 500 cattle herds in the United States contain at least one infected animal.[3] The location of 67 of these infected herds was known or discovered during fiscal year 1971, and 22 of them were completely depopulated with payment of state and federal indemnity to help absorb some of the owners' financial losses.[1] In the twenties, this many infected herds could be found in a single township in some parts of the Northeast.

In 1940, the last areas of the country achieved Modified Accredited status signifying that the prevalence of the disease was less than one-half of one per cent. Yet 31 years later, the disease was confirmed in cattle herds in 16 States and Puerto Rico.[1] Why?

The answer to this question is not simple. The efforts and studies made in attempts to answer the question have revealed a great deal about the epidemiology of bovine tuberculosis and, perhaps more important, much information on the comprehensive measures necessary to eradicate a chronic communicable disease.

The first question that must be answered is whether or not an eradication program is feasible or economically sound when compared with a control program. A Program Planning and Budgeting Model[3] was developed in 1969 to evaluate the present bovine tuberculosis program and compare it to several alternatives. Even this late in the program, the results showed that over the next 40 years, a benefit/cost ratio of 3.6 to 1 in favor of the present program would result when the program was compared with a decentralized control program. The projections indicated that after 40 years, the annual costs and losses under a control program would be 20 times greater than the annual costs and losses now.

A number of people have felt that program progress has slowed greatly since 1940. Study of meat inspection records, however, indicate that the prevalence of bovine tuberculosis has been declining steadily at an average rate of 17 per cent per year since 1935. At this rate, as projected by the Model, complete eradication in cattle can be expected in 1995.

The Model showed further that by increasing the rate of discovery of infected herds and by destroying most of the known exposed cattle, eradication could be achieved as early as 1980 with an additional savings of $168 million.

One key to bovine tuberculosis eradication is the detection of infected herds before spread to other herds can occur. As in human tuberculosis, an infected cow may carry tuberculosis for long periods of time before the organisms are shed in sufficient number to infect other animals. Once an open case occurs in the herd, spread may be very rapid or may occur slowly depending on the type of confinement of the animals, the herd management, and sanitary practices.

The intradermal tuberculin test has been the primary tool used for screening, diagnosis, and removal of infected animals from infected herds. During the years when the greatest reduction in the number of infected cattle

occurred, this test was used to screen a large segment of the cattle population each year. For example, in 1935 when the cattle population numbered about 68 million head, 25 million tuberculin tests resulted in the location of 377,000 reactors. Postmortem examination revealed lesions which resembled tuberculosis grossly in 82 per cent of the reactors killed that year.[1] The practice of tuberculin testing a large segment of the population was easy to justify when the prevalence of the disease was high. If the tuberculin test had been perfect—that is, 100 per cent sensitive and 100 per cent specific—eradication would have undoubtedly been achieved very rapidly. However, as the prevalence of tuberculosis declined, the percentage of the population tested declined as did the percentage of lesion cases among the reactors destroyed. The failure to complete the eradication of bovine tuberculosis in cattle quickly can be attributed to three main factors:

- Screening coverage—Testing of the population decreased as the disease prevalence decreased.[1]
- Test Sensitivity—Infected animals which failed to respond to tuberculin or which gave only slight responses remained in herds to perpetuate tuberculosis after quarantine release.[3,4]
- Test Specificity—As tuberculosis was eliminated from most herds in the country, the problem of false positive tuberculin responses became very important in relation to the amount of tuberculosis left. In many areas, this problem undermined the testing veterinarian's confidence in the tuberculin test.[5-8]

In population screening or disease surveillance, if the probability of finding disease is to be kept from decreasing as the prevalence of the disease decreases, the coverage of the population must increase. A high level of surveillance must be maintained, not only to find the remaining foci of the disease, but to continually show whether or not the segments of the population free of the disease remain free. To deal with only the cases of tuberculosis that come to light without actively seeking the newly infected herds will insure the survival of the disease.[9] To cope with this problem in the bovine tuberculosis program, screening emphasis was changed from routine tuberculin testing to slaughter inspection. Cattle move to slaughter from most of the herds in the country each year. The percentage of the cattle slaughter covered by meat inspection has been increasing steadily, and because of the enactment of the Wholesome Meat Act, this coverage will soon approach 100 per cent.

In order to insure that the tuberculous cattle that go to slaughter are identified as being tuberculous, meat inspectors are asked to collect and submit for laboratory examination samples of lesions suspicious of tuberculosis and samples of all granulomatous lesions found in the thoracic cavity. This is a difficult and expensive task to accomplish, but it is far less expensive than tuberculin testing 110 million cattle every 3 to 6 years.

When a tuberculous carcass is located at slaughter, the herd in which the animal was infected must then be found. A program of identifying cattle in transit to their herd of origin has been under development for a number of years. Although it is not perfect today, it is quite effective for mature cattle and is being improved each year. The great advantage of the system is that it can be used for a wide variety of animal and human health problems involving beef and is not limited to a single disease program.

Another important aspect in the discovery of infected herds is tracing cattle movements to and from the newly discovered infected herd. A great deal of effort is spent on finding out where the disease came from and where it may have gone. Records of livestock movements are the key tool. Many of these investigations span several years, and the discovery of one infected herd often leads to the tuberculin testing of many herds and the discovery of several other infected herds.[10]

Tuberculosis surveillance at slaughter provides a practical adjunct to the problem of screening the cattle population. It also minimizes the problem of false positive tuberculin test. Since more of the tuberculin testing is concentrated in herds which have a greater risk of being infected, less testing is done in low-risk herds. Many cattle are not tested that would demonstrate cross-sensitivity to tuberculin.

Thus, in fiscal year 1971 about 3.8 million cattle were tuberculin tested. Of these, 94 per cent were routine tests, and these accounted for 23 per cent of the reactors destroyed and one-third of the newly discovered infected herds. On the other hand, only 3.4 per cent of the tests were conducted in herds of higher risk found through tracing. These tests accounted for 27 per cent of the reactors destroyed and two-thirds of the newly discovered infected herds.[8] The remaining tests and reactors were in known tuberculous herds under quarantine. At this point in time, it is imperative that both methods of surveillance are continued in order to locate sources of infection quickly.

The problem of tuberculin test sensitivity or false negative test results is, for the most part, easier to deal with. Depopulation of all exposed cattle and swine and careful examination of other exposed animals, as well as exposed people, have proved to be very effective in cutting off further spread of the disease. It was found that during the early and mid-sixties, among the *M. bovis* infected herds which received adequate followup and were not depopulated, one-third of them were found to have additional infection sometime after release of the quarantine. Because of the low prevalence, it can be assumed that the infection was carried over from the previous outbreak. During the same period in herds where all the exposed animals were destroyed, infection in the cattle used to restock the premises occurred in less than one per cent of these herds.[3]

Cattle in the United States are managed much differently today than they were 30 years ago. Herds are fewer and larger and the turnover of cattle is faster. Cattle move more often and greater distances and are kept in closer confinement. The opportunity for disease spread is greater, and thus, the potential for extensive losses from contagious disease is greatly increased.

Last year, two tuberculosis-affected dairy herds were depopulated in one of our southern states. Each of these herds contained over 1,500 cattle. The state and federal indemnity paid for these two herds exceeded $500,000. However, tuberculin testing over a period of 6 years in one of these herds and 10 years in the other had failed to eliminate the disease.

In an adjacent state, a single thoracic granuloma submitted to the laboratory resulted in the discovery of a

badly infected dairy herd. The ensuing investigation involved tuberculin testing of over 140 herds of cattle and the discovery of at least three additional infected herds.

The primary problem we face in tuberculosis eradication is a people problem. The interest that veterinarians have in combating the disease is, for the most part, directly proportional to the prevalence of the disease; the degree of their expertise and the care with which their work is done are directly related to their interest.

The result is that in the animal health field, we have a few people that have considerable interest in seeing the bovine tuberculosis program completed; and many, many people who care little about this work. The people problem transcends all of the technical problems.

In an attempt to see program progress continue and improve in spite of widespread apathy, the Animal and Plant Health Inspection Service has attempted to maintain a small group of veterinarians scattered across the country who are well-trained tuberculosis epidemiologists. These specialists have been very successful in seeing that program problems are brought to light and that these problems receive proper attention. They have also been successful in interesting other people in tuberculosis eradication. We believe that the highly trained tuberculosis epidemiologist can play a vital role in solving the apathy problem, provided he is given freedom to go where the problems are and has sufficient influence to bring about solutions to those problems. The work of these epidemiologists is varied and includes conducting special comparative tuberculin tests in problem herds, ferreting out tracing information, consulting on laboratory procedures, as well as conducting training courses and speaking at National and International meetings.

Finally, tuberculosis does not respect specific host or program lines. Bovine tuberculosis can and does infect a wide variety of animals including man.[9,12,13] Recently, sixty people were tested because of exposure to infected cattle in one outbreak; six of them reacted, two responses were the size of lemons. The fact that chest plates showed no tuberculosis is not very reassuring, especially where the bovine organism is involved. In another small infected dairy herd, it was learned that a dozen families used the milk raw. Several years ago, the deer in a roadside zoo were found to be badly infected.[13] We have example after example of the interspecies relationship of the several types of tuberculosis. If we are to eradicate all tuberculosis, the effort will have to be a coordinated effort, and our interagency relationships will have to undergo a great deal of change.[9]

In summary, through the bovine tuberculosis eradication program, we are learning that eradication is not only a practical approach to chronic contagious disease, but it is a great deal more economical than control. The final stages of such a program are the most difficult and the most important. Effective screening of the population is necessary for success. The specificity and sensitivity of testing procedures become critical as the disease prevalence approaches zero. Apathy is the greatest roadblock to eradication and the most difficult to overcome. Careful attention to all details of the program is imperative in the last stages. A few well-trained and interested specialists can have a great effect near the end of such a program.

We would like to leave you with the thought that life and disease form a continuous spectrum in nature; unless the health sciences can work across discipline lines, we will not succeed easily. Veterinarians, especially the public health veterinarians, are in an excellent position to break down some of the health-profession barriers and help to create a continuous spectrum of health science.

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