

IS THE VACCINATION OF CATTLE AGAINST TUBERCULOSIS A PRACTICAL POSSIBILITY?

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To be permanently effective a program for the eradication of bovine tuberculosis must include more than the recognition and elimination of tuberculous cattle. There must be some insurance that the disease, once eliminated, will not return in as serious or more serious form.

Admitting, as we must, that the plan of tuberculosis eradication approved by our municipal, state and federal authorities is the only practical method available for meeting the present day problem of tuberculosis in cattle, we must, nevertheless, recognize that if not supplemented by provision for certain definite future problems, the plan itself predisposes to danger.

Briefly, the chief danger is a reduction in the degree of racial immunity in cattle. I am sure this is no fantasy. The approved method calls for the removal of all dairy cattle reacting positively to the tuberculin test, that is, of all cattle bearing any trace of active tuberculosis, followed by the replacement of these cattle by cows which have never had any experience with tuberculosis and are therefore tuberculin-negative. In ordinary practice these replacing cattle are in no way selected with a view to their resistance to tuberculosis. The result may well be the formation of large herds with far less native resistance to tuberculosis than the original stocks in which a certain percentage of tuberculosis was always present.

The danger which I shall point out may seem hypothetical, but I can perhaps bring out my point by recalling for you the well recognized situation in man. Almost all human adults in congested communities react to tuberculin. They react because they have been infected with tuberculosis. Necropsy observations furnish abundant confirmation of the results of the tuberculin test. In spite of this enormous extent of infection less than 10 per cent die of the disease. This very fact is sufficient

evidence that the human race, as it exists today in well-populated centers, has a high resistance to tuberculosis.

But this has not always been the case. Whereas the death rate from tuberculosis today is less than 100 in 100,000 population in this country, it is not many generations since it was three or more times as high. Admitting immediately that many factors have combined to produce this extraordinary decline, and that education and improvement in living conditions constitute the chief ones, we must nevertheless accord an important place to the well known biological phenomenon of the survival of the fittest.

Variability is one of the recognized attributes of animal life. Resistance to tuberculosis is a complex of many factors, certain of which are under hereditary control. These factors vary from individual to individual. In the age-long contest between man and tuberculosis those individuals well equipped with these hereditary factors have lived longer and reproduced more of their kind than those poorly equipped.

Civilized man has come through a long period of this slow process of survival of the fittest. The results of the process are readily apparent, however, if we compare the tuberculosis of the white man of our congested communities with the type of disease which occurred when the Indians, Esquimaux and South Sea Islanders made their first acquaintance with tuberculosis. In the one case the disease is usually chronic, and first infections, if not too large, have a notable tendency to become encapsulated and latent. Less than ten per cent of all infections in this group progress to fatality.

In primitive peoples, on the other hand, with no long period of survival of the fittest as respects tuberculosis behind them, in spite of magnificent physical development, the course of the disease was violent from the start, not unlike the tuberculosis we see in guinea pigs on experimental infection. An enormous mortality occurred. Whole communities were wiped out in six months' time. Admittedly, poor hygienic and living conditions played a part in this frightful severity of the disease. Nevertheless a tuberculosis which is chronic

occurs in peoples living under hygienic conditions fully as bad, but with a history of centuries of slow racial immunization behind them. On the whole it is hard to escape the impression that the susceptibility of primitive peoples is largely the result of a lack of that racial resistance to tuberculosis which is fostered by the process of survival of the fittest to which I have referred. In support of this belief is the fact attested by numerous competent observers, that tuberculosis among recently primitive peoples is showing a distinct tendency now to take on the chronic character seen in the white man with long historic contact with the disease.

The relation of this matter of racial immunity in man to our cattle problem is easily seen. By eliminating all cattle reacting positively to tuberculin, whether they give any evidence of putting up a good fight against the disease or not, are we not working against the operation of the principle of the survival of the fittest, which has produced, not a perfect, but a high degree racial resistance in man? If we eliminate cattle on the basis of mere accidental acquisition of infection, which is all the tuberculin test shows, rather than on the basis of successful resistance to the disease, are we doing anything for the improvement of racial resistance to the disease? We are doing it only if we consciously select for replacement breeds of cattle of known good native resistance to tuberculosis. Such stocks are available. Insofar as this is compatible with the selection of good dairy cattle this seems to me to be an indispensable part of a tuberculosis eradication problem.

Otherwise every tuberculosis-free herd will be constantly exposed to the menace of a sudden invasion of tuberculosis which will sweep through the herd at a far more violent rate than ever would occur when a certain proportion of the cattle were immune to some degree as a result of mild tuberculous infections which they had spontaneously brought to the condition of latency. If absolutely all cattle tuberculosis could be wiped out, with perfect abolishment of all chance for infection, it would make no difference whether our cattle had any degree of immunity to the disease or not, but I am sure this per-

fect freedom from tuberculosis is for many generations to come an unattainable condition.

Lest my position be misunderstood let me say here that I am fully aware of the dangers inherent in the use for dairy purposes of cattle reacting to tuberculin, and am in hearty support of the measures recommended by our governmental authorities. The situation in cattle, as I see it, is quite different in many respects from that obtaining in human beings. The majority of human adults react to tuberculin. Only a small fraction are spreaders of the disease. The figures available for cattle indicate that tubercle bacilli are found at some time or other in the milk of about 25 per cent of the cattle reacting to tuberculin. This high proportion comes about as a result of a number of easily understood factors. In the first place anatomical proximity of parts is such that the cow's udder is frequently contaminated with her droppings, and the latter are almost sure to contain tubercle bacilli if there are ulcerative lesions in the respiratory or alimentary tracts.

Secondly the cow is notoriously more subject to tuberculosis of the mammary gland than is the human mother. Various investigators have found that in tuberculous cattle the udder is grossly infected in 2 to 10 per cent of cases.

Finally there is much evidence that bacilli may be excreted in the milk without actual disease of the udder. Calmette, for one, is inclined to consider the milk ducts one of the routes of natural elimination of bacilli, excreted there from the blood stream, just as bacteria are excreted in certain infections in man through the kidneys without gross anatomical change.

Nevertheless, to be fair we must admit that of one hundred cattle reacting to the tuberculin test, seventy-five are probably no menace as regards the milk supply. The positive reaction is due frequently to a single well encapsulated, almost healed tubercle in a lymph gland, or to a difficultly recognizable focus of skin tuberculosis. Again, lest I be misunderstood in my position, let me say that it is usually impossible to tell either from the tuberculin reaction, or physical examination, or both to-

gether, whether a reacting cow belongs to the dangerous 25 per cent or the 75 per cent which do not appear to shed bacilli in the milk. The 75 per cent are at least to be considered potential spreaders, while non-reacting cattle, or at least non-tuberculous cattle, cannot possibly spread the disease. With our present knowledge there is only one sure way of keeping tubercle bacilli out of the milk. To be certain of removing the dangerous 25 per cent the whole 100 per cent of reactors must be eliminated.

Nevertheless, as I have tried to bring out, thoughtless destruction of cattle without careful selection of the cattle used for replacement on the basis of resistance to tuberculosis, is a short-sighted policy. It will never do to fill up our herds with stocks of low resistance which will succumb rapidly before epidemic invasions of the disease, comparable to the terrible invasions which scourged the Indians, Esquimaux and South Sea Islanders. It will be many generations before it is possible to eliminate all centers of infection from which such invasion might start. With stocks of cattle of low resistance to tuberculosis forming the bulk of our dairy herds, prone to rapidly progressive disease, semi-annual tuberculin testing will not begin to be frequent enough to detect early cases and remove spreaders of disease from the herd.

I have mentioned careful selection of the replacing stock as an indispensable measure against this danger. I have also referred to the fact that some protection against tuberculosis is afforded by the presence within the body of a mild tuberculous lesion which has become latent. This at once suggests the matter of vaccination. The immunizing effect of a latent infection is well established clinically in man, and there has been abundant experimental demonstration of the fact in animals. Vaccination should, therefore, be possible in cattle. If cattle may accidentally acquire a tuberculous infection and overcome it to the extent that it becomes latent while at the same time conferring some degree of immunity, it should be possible deliberately to cause a small controlled infection accomplishing the same result.

Theoretically this should be possible, but as I am sure most of this audience is aware, attempts in this direction in the past have for the most part resulted in admitted failure. Between 1900 and 1910, under the direction of distinguished scientists in several countries, many thousands of cattle were "vaccinated" with living tubercle bacilli of the human type, which is of low virulence for cattle. For a time high hope was entertained that vaccination was the solution of the cattle tuberculosis problem. By 1910, however, most observers were satisfied of two discouraging facts, first, that the protection afforded cattle by vaccination with living human type tubercle bacilli was transient, seldom lasting more than a year, and, second, that a distinct element of danger existed in the tendency of the tubercle bacilli injected for vaccination, to localize and set up tuberculous lesions in the milk glands, thereby creating the most dangerous form of tuberculosis, rather than preventing it.

On the whole, after thousands of cattle had been subjected to vaccination experimentation in Germany, France, England, the United States, Italy, Hungary, Denmark and other countries, the results were profoundly discouraging, and most competent authorities came to the conclusion that it was safer not to vaccinate cattle.

Nevertheless several notable attempts to vaccinate cattle are still in progress. The best known and empirically most impressive of these is that of Calmette in France. This investigator has reduced the virulence of a strain of tubercle bacilli by years of growth on a medium containing bile, so that now this bacillus, even on injection in quantities of several centigrams, is said to be absolutely harmless. However, according to Calmette, the bacillus has preserved its capacity to stimulate specific resistance to tuberculosis. So sure is Calmette of both its non-virulence and its immunity promoting quality, that he has sponsored the vaccination of thousands of new-born infants in France and the French colonies in recent months. At least a thousand cattle have been vaccinated also. The results reported so far, as respects resistance to natural infection in the vaccinated cattle and children, are very encouraging.

However, we must not forget that the best sounding methods must meet success in the hands of more than one individual before their merit can be recognized for certainty. This statement applies to the Calmette as well as other methods. And it is much to be hoped that the Calmette method will soon have the extensive trial in this country which the distinguished character of its originator warrants.

In principle the Calmette method has much to recommend it. It is like the methods which proved so fruitful in the hands of Pasteur in the field of protective inoculation, where attenuation of microbes rendered the procedure safe. Only elaborate trial, however, can ever prove the safety and simultaneous effectiveness of any procedure of this character.

This means that much scientific research on the problem is desirable. We are making a great mistake if we recognize the fact that mild infection confers some immunity and fail to carry on research directed toward safe but efficient protective immunization based on this principle.

One per cent of the enormous sums appropriated annually as indemnification for slaughtered cattle would adequately finance an able investigation of the problem. The vaccination of cattle with living tubercle bacilli of reduced virulence will probably some day be found practical, but this situation will be reached only by exhaustive research. Killed tubercle bacilli certainly are not effective for the purpose. The ideal situation toward which effort should be directed, is vaccination of herds of cattle, which must be quite free from tuberculosis to begin with, with living organisms producing a localized, non-progressing tubercle. It will not prove easy to limit the vaccinating tuberculosis to precisely this extent, but it will probably ultimately prove possible. The achievement would be of such enormous value that its quest is well worth the hazard of a good deal of money for research.