ON THE APPLICATION OF THE TUBERCULIN TEST TO THE OX.*

BY

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It has occurred to me that it would be useful at this time to run over together some of the points in the application of tuberculin to oxen as a test of their infection with tuberculosis.

It was in August, 1890, you will remember, that Koch announced the discovery of his "lymph," or "material," as he called it at first; and in a second communication made in the same year he pointed out that injection of his lymph into tuberculous animals was attended with a notable rise of temperature, which occurred within a few hours, while no such effect was produced in animals not so suffering.

This attracted the attention of all who were interested in the prevention of tuberculosis in the ox. For, of course, it was already known that this disease could make considerable progress in that animal before it betrayed itself by clinical signs; that the disease was communicable from beast to beast; that the means of reducing its prevalence among oxen must lie in separating the sick from the healthy; and, consequently, that to separate the visibly sick alone might still leave in the herd a number of cattle capable of communicating their disease—a number not unsuspected, indeed, but down to that date undiscoverable. In 1891, Guttman of Dorpat had already published an account of the extent to which Koch's statement held good for oxen. This, I believe, was the first published account, at all events, it was the first which gave good ground for believing that Koch had placed in the hands of breeders a trustworthy and most important aid to them in their fight against tuberculosis. Thus we have had command of this weapon only for about six years at the most. And yet we cannot call it new any longer. Age is not always to be measured by lapse of time alone; and in this case the very wide experience gained and recorded during those six years has established this test in an impregnable position. It is now a part of the common knowledge of all whose interests require them to be acquainted with advances in pathology, and time is wanted merely to diffuse that knowledge more and more widely, until it is common also amongst the least of those whose interests require a knowledge in them, of the economics of the breeding, and of the dairy-farm.

A tuberculous animal injected with tuberculin, then, suffers a rise of temperature, which is usually apparent at the ninth hour, or at a time between the ninth and the twelfth. Hereupon it should be noted that this general statement requires some qualification. An animal which has but a small tuberculous focus—it may be but two or three small glands affected—will show this reaction with certainty, and most often in marked degree, but one which is far advanced in the disease may not show it, or may not show it with the intensity which is necessary to establish the diagnosis. From this two practical rules follow: First, an animal in which tuberculosis can be diagnosed by the ordinary clinical methods with tolerable certainty should not be submitted to this test; and secondly, when an animal which has reacted, nevertheless appears after slaughter to be healthy, a very careful search should be made—such a search as requires a good deal of anatomical, though not necessarily of professional or scientific anatomical knowledge—before the carcass is pronounced healthy, and before it is noted that in that case the test seemed to have failed. These, I venture to say, are very important points to remember and to make widely known in relation to a proceeding which will be much used by persons not possessed either of special knowledge or even of much experience.

Next, what is the rise of temperature as measured by the thermometer which may be relied upon to indicate infection? The temperature of adult man is very uniform and very stable, and is not disturbed by trifling external or internal influences. It is far otherwise with bovine animals. It is easy to state their average temperature; it is not so easy to find it in individual beasts. The average for adult oxen in health is taken at F. 101°·5, and for calves at about a degree higher or F. 102°·3 or 102°·4. Variations of external temperature which have so slight an effect on man, have an appreciable effect on them; by exertion or by worry their temperature is easily raised by one, two, and even more degrees; it is easily and markedly raised by trifling ailments, and especially by slight disturbances of digestion. Besides this it may, and not very infrequently is, found to be subnormal by a degree or more, or, it should rather be said, below the average, for animals having that lowered temperature have no appreciable ailment to account for it; and, again, drinking will lower the temperature in the rectum by a degree for an hour or more afterwards. Now, Professor Nocard so early as January, 1892, laid down the rule, deduced from experience, that a reaction of less than F. 2°·5 could not be safely accepted as evidence of tuberculosis; but he added that a reaction of F. 1°·4 had no significance at all, thus leaving it to be inferred that the full rise of F. 2°·5 need not always be strictly adhered to. After consideration it will be apparent, I think, that a less rise than

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F. $2^{\circ}5$ may sometimes be accepted by a skilled and experienced observer in accordance with other considerations which weigh in the balance of his judgment as a proficient; but that if a rule is required to guide all alike, others as well as proficients, then it must be said that a rise of less than F. $2^{\circ}5$ cannot be depended upon. Accordingly, in the directions which are now before you, you will observe that I have said that a less rise than F. $2^{\circ}5$ is not to be accepted as decisive of tuberculosis, and that the word "decisive" is emphasised by being printed in large type.

But, since the temperature of bovine animals varies by a degree and a half, or more, even, when they are in health, from what step on the scale shall the rise be reckoned? No arbitrary datum can be named. The normal temperature of each animal must be ascertained before testing, or, at least, that temperature which is apparently normal for it at the time of observation. We are content, for reasons to be mentioned immediately, to take it three times during the day preceding the application of the test. These temperatures will be found to differ between themselves. They do not by themselves yield any other guide than this: they serve to show that the animal's temperature lies within the rather wide limits of the normal, and therefore they do not, apparently, furnish the required datum, but two or three different temperatures between which a choice has to be made. The way out of this difficulty is simple. The reaction temperature, or rise after injection, must be measured from the highest of the three normal temperatures observed beforehand.

At what hours of the day should the preliminary temperature be observed? A common recommendation is to take it three times a day, or even oftener, for several days before injecting. That is desirable, no doubt; and as long as this method was under investigation it was indispensable. It is still desirable when accuracy is sought; but practical work has to be carried on under limitations, and as a matter of fact it is in this country very difficult to devote much more than twenty-four hours to the application of this test to any particular herd of small size, at all events under presently existing conditions. This being the case, and the number of preliminary observations being consequently limited to three or four, it appeared that the times of observation should include those at which the temperature was considered to be normally highest, so as to avoid the error which might sometimes arise if hours of lowest natural temperature were inadvertently chosen; for the temperature of bovine animals fluctuates with the hour of the day as well as with other conditions, some of which I have already mentioned. Nine a.m. and 5 p.m. are considered to be hours of maximum normal temperature for the ox; and accordingly I fixed upon these, recommending also

that one observation should be recorded at mid-day, or three hours after the first.

We now come to consider how the temperature should be taken. It is customary to take it either in rectum or vagina; but there is usually a difference of three or four tenths of a degree between the two, that of the vagina being the lower, except during oestrus. As long as the temperature is taken at successive observations in the same cavity in the same animal, probably it does not matter which is chosen as regards that single case. But in order that a series of observations on different animals may be comparable, it is necessary that all should be taken in the same way; and for this reason it is better for the present purpose, to direct that all temperatures should be taken in the rectum. There is another point of a similar kind, but of greater importance. This is that the temperature recorded will be higher when the thermometer is fully inserted than when it is only partly inserted, and the difference, as has been shown by Mr. Frederick Hobday, M.R.C.V.S., may be as much as one degree. As this difference of temperature corresponds to a difference in depth of insertion of only two inches, it is essential that some method for securing insertion to the same depth always, both in the same and different animals, should be adopted. The best instruction is to insert the instrument until its extremity is but just visible; but, unfortunately, thermometers differ somewhat in length.

The reaction temperature may be observed sometimes at the sixth or seven hour; usually it does not occur until the ninth hour; and in every case it always lasts over that hour. There is no object, therefore, in attempting to observe it earlier. Strictly, observations of the reaction temperature should be continued every three hours until the twenty-fourth; it is desirable to follow it until, at about that time, it has disappeared; but, as with the preliminary temperatures, it is not very often possible to do this. The working rule, therefore, is to begin to observe the temperature at the ninth hour after injection, and to continue every three hours until a rise of F. $2^{\circ}5$ above the highest preliminary temperature has been recorded. By this plan the least time possible will be occupied. But occasionally the reaction is delayed to the eighteenth hour, so that if the expected standard rise is not observed earlier, it must not be hastily concluded that the beast is healthy.

When the reaction temperature has been marked, but yet short of the standard, the result may be considered as doubtful. A fresh injection must be made, and a larger dose than that given at first should be employed. But a second injection must not be given until a week has gone by. The reason is that the first dose apparently protects the animal for that short time, so that a second given within it sometimes produces little or no effect. The dose

is increased partly in case the average dose given at first should have produced only a doubtful effect because of some idiosyncrasy of the animal; because the animal was one which required a larger than the average dose, without any reference to its state as to disease.

Of the way in which this injection is made I need scarcely say much on this occasion. Any syringe made for serum-therapy which holds ten centicubes will do. The needle should be stouter than is used for man. It is a good precaution to interpose a short length of india-rubber tubing between the syringe and the needle, about an inch is enough; there is then less risk of getting the needle broken should the animal move unexpectedly during the little operation. The injection may be made under the skin of any part of the body, behind the shoulder being a favourite spot; and sometimes it is customary to incise the skin before thrusting the needle in, but if a stout and sharp needle be used this is seldom necessary.

There are three brands of tuberculin which are more or less freely available in Sydney; they differ somewhat in appearance, but much more in price than in any other respect. Koch's tuberculin, prepared under direction of Dr. Libbertz, costs only 3s. 6d. in bottles holding five centicubes; and as .4 cc. is a good dose for an adult, the cost of the tuberculin used at each observation is about 3½d. Marcker's lymph, prepared in a government laboratory at Copenhagen, also sent in bottles containing five centicubes, costs twenty shillings; the dose being the same, the cost of the tuberculin used at each observation is about 1s. 8d. The tuberculin for veterinary use supplied by the British Institute of Preventive Medicine is found in small wide-necked bottles holding three centicubes each; the cost is 1s., and as one centicube is a dose for an adult, the cost of the tuberculin used at each observation is 4d. These are remarkable differences of price; and I can only tell you that we have for two or three years past been in the habit of using Koch's, and, of course, with perfectly satisfactory results. The others have been tried, and with the same satisfactory results. But the difference in price is important in relation to a material which ought to be used, and in course of time will be used, in several thousand cases every year.

The direction given with the German and with the Danish lymphs is to dilute them before use each portion of 5 centicubes is to be made up to 50 or to 100 centicubes with 45 or with 95 centicubes of boiled water in which half a part of phenol has been dissolved; no such direction is given with the product of the British Institute. Doubtless the object is to render the loss of a few drops of the mixture of less consequence, should any be spilt in making the injection, and, as a general rule, dilution should be recommended.

But, as a matter of fact, the Chief Veterinary Inspector of the Board of Health was for long in the habit of injecting the tuberculin undiluted, and with an ordinary hypodermic syringe; and in careful hands I believe there is no objection to this plan. Still it is convenient and safer to use the india-rubber joint which I mentioned above, and then, of course, a diluted solution must be employed, since some of it will remain in the rather large cavity of the tubing as well as in the barrel of the stout needle.

The form of record now in your hands has been devised to secure as much uniformity as possible in the method of applying this test; it does not include any other instructions than seem necessary for that purpose. The object is to accumulate a body of trustworthy evidence touching the use of the test in this country such as will appeal to breeders here more forcibly than similar evidence adduced from other parts of the world. I have also taken steps to record separately the results reported by veterinary surgeons and medical men, and those reported by gentlemen who are not known to be possessed of technical skill and of pathological knowledge. And I will take this opportunity of pointing out that members of our profession have it in their power to render a great service to this country by diffusing the knowledge they have of the means of preventing tuberculosis among stock among those of their neighbours who are actually engaged in breeding stock. I hasten to add that in making this remark I do not intend either to trench on the domain of the veterinary surgeon, or in any way to disparage his knowledge. The hard fact is that while the veterinary art is practised by all and sundry, veterinary science is but sparsely represented in Australia, and, I fear, too little appreciated. The consequence is, that the opportunities of informal teaching enjoyed by veterinary surgeons are but small, for there are very few places indeed where they practice in the country. But there are medical men in almost every part; and I am sure they might, without the least trouble to themselves, do a very considerable service to the State if they would take steps to interest themselves in some departments of knowledge which bear upon the pastoral industry. You know that there was a time when it was supposed to be beneath the dignity of the physician to consider the diseases of animals. Perhaps it has not altogether passed away, though rapidly passing. The pathology of the animal body is the same in man and beast; and now we know that the diseases which afflict us are in many cases common to both, so that we can no longer afford to regard them with contempt.

I will conclude by pointing out a little more particularly what the service is which, I think, the medical men so widely scattered over the country might well and easily render in this connection. Our interest in the prevention of

tuberculosis among oxen is two-fold. We share the commercial interest which prevention of that disease has for this pastoral country. Tuberculosis is a disease which, in those districts where it is prevalent, inflicts very great losses on the breeder. I do not know that any attempt has been made to estimate the amount of that loss here, but you need not search far in order to find individual breeders who will tell you that their losses from this cause have seriously discounted their otherwise prosperous business.

Secondly, we know that tuberculosis in man is a too prevalent disease, or, to put it in another way, we know that tuberculosis in man is a preventable disease which yet is far from being effectually prevented. We feel that the fight to prevent it entirely must in the nature of the case be long and difficult, and consequently we feel also the most urgent need to neglect no advantage which knowledge has given us, nor any advantage which we have some hope or reason to believe we may thus seize. Now, while it is demonstrable, and while it has been abundantly demonstrated, that tuberculosis can be communicated from animal to animal by feeding on milk and meat derived from tuberculous animals, we do not know how much of the tuberculosis in man is communicated to him through one or other of those channels. But we are certain that what can happen, sometimes actually does happen; there is no doubt at all that it is so. Here, then, we have some hold over a powerful enemy. It may be small, we do not know exactly whether it is small or very small, but there it is; and in a prolonged and arduous struggle even the smallest advantage is not to be despised or neglected, and therefore the sale of the meat and milk of tuberculous animals must be strenuously resisted by all who have the prevention of tuberculosis in man at heart. Our struggle to effect this is greatly and happily facilitated by circumstances, for as soon as we begin to consider how we should proceed we perceive at once that though inspection of slaughterhouses and dairies is useful and must not be abandoned, the direct method is to prevent the disease at the breeding station. Thus we find ourselves once more within the domain of commercial interest which I mentioned just now; the prevention of tuberculosis among cattle which interests us as guardians of the public health, also interests the breeder as a matter of prudent commercial management. Very often the public health and commercial interests appear superficially to be opposed; seldom can they be convincingly demonstrated to jump together as in this case they can, and it is this consideration which encouraged me to point out the opportunity for beneficent action which lies open to those members of the profession who are in contact, all over the country, with pastoralists and breeders.

BOARD OF HEALTH, NEW SOUTH WALES.

TUBERCULIN TEST RECORD.

Year.	District.
Owner's Name.	Address.
DESCRIPTION OF BEAST.	
Kind.	Description (Colour, &c.)
Brands.	Class (Dairy, Store, Working, &c.)
Sex.	Age. Distinguish young animals (the age up to which bovines are to be reckoned as <i>Calves</i> is one year—when younger, age to be stated in months.)
OBSERVER'S NAME.	
THERMOMETER NUMBER. (With reference to Correction Certificate.)	
NATURAL TEMPERATURES.	Date.
9 a.m. } Hours of reputed	Noon.
5 p.m. } maxima.	
INJECTION.	Date. Hour.
TUBERCULIN.	Brand. Quantity used.
REACTION TEMPERATURE at hours after Injection. (Not to be taken before 9th hour).	
9th, 12th, 15th, 18th, 21st, 24th.	
DIFFERENCE between highest <i>natural</i> temperature, and highest <i>reaction</i> temperature.	
SIGNS OF TUBERCULOSIS DURING LIFE. } In milch or breeding cows, note state of udder especially.	
ORGANS FOUND TUBERCULOUS AFTER DEATH. }	
ANY OTHER DISEASE DETECTED AFTER DEATH.	
REMARKS (always mention total in herd, total inspected, and total found tuberculous).	

BOARD OF HEALTH, NEW SOUTH WALES.

RULES TO BE OBSERVED IN APPLYING THE TUBERCULIN TEST.

NOTE.—Although this form is designed primarily for use by the Veterinary Inspectors of the Board of Health, it is desired that it may be employed by all who apply the tuberculin test to animals. The following directions, which it is very important to follow carefully, are therefore printed here. Forms will be supplied gratis on application to the Secretary, on condition that a copy of the record made is subsequently forwarded to the Health Department.

1. Animals should be confined during testing, and the natural temperature should not be taken until they have become cool and quiet after being first confined.

2. Animals under test should be allowed to drink only immediately after taking their temperature, and not within one hour at least before taking it.

3. The temperature must be taken in the rectum; a string should be attached to the thermometer, and held; the thermometer being about six inches long, should be introduced until its extremity is only just visible; it should remain in for five minutes by the watch; it should be withdrawn horizontally, and read while still in that position; the reading should be written down at the same time; lastly, the thermometer should be cleaned, and the mercury shaken down until it stands below 98°, before replacing it in its case.

4. The natural temperature of the animal to be tested must be taken during the daytime before the injection is