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TUBERCULOUS INFECTION THROUGH THE ALIMENTARY CANAL.

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When a truth, whether scientific or other, goes against the interests of a large and powerful class of the community, it is generally ignored or resisted till a more powerful class enforces its recognition. For the last 30 years farmers and butchers have been roughly disturbed by mere scientists, medical observers, and veterinary surgeons, who have come to the conclusion that it is not safe for man or beast to feed on tuberculous products.

At first the observations of Villemin, Chauveau, Gerlach, Günther and Harms, Toussaint, Peuch, Bollinger, Jöhne, etc., though conclusive enough, were not accepted as quite convincing by a number of authorities, because there was no easy criterion by which tuberculous lesions could be recognised.

Even after Koch's demonstration of the presence of a tubercle bacillus, not only in human tuberculous lesions, but also in those of the lower animals, many who considered themselves experts tried to evade the logical consequences of this discovery.

At the present time opinions are still divided, and thereby the work of the Medical Officer of Health is rendered so difficult that he may at times be hindered from serving the public interests which he has to protect. I was much struck with this in connection with a case which occurred in Blackpool quite recently.*

Seventeen pieces of meat having been seized by the Inspector of Nuisances as unfit for food, Dr. Anderson, the Medical Officer of Health for the town, found that the meat not only showed general evidences of advanced disease, but that some of the lymphatic ganglia were enlarged, and presented areas of congestion and of suppuration or softening. In these glands Dr. Molloy demonstrated the presence of tubercle bacilli. There were other evidences of disease, but those just mentioned will suffice for the present purpose. On these grounds the meat was condemned. The butcher, however, chose to contest the validity of this judgment, urging that there had been an error, that the meat was fit for food, and that it was not set, simply on account of the weather.

The chief difficulty experienced by the prosecution was due to the possibility of it being said on behalf of the defence that the

* *The Blackpool Herald and Fylde Advertiser*, Tuesday, April 9, 1895.

flesh of a tuberculous animal was not dangerous to eat. It was thought better to obtain confirmation of the magistrates' order, on the ground that the meat presented all the characters of unsound meat, than to bring in the question of tuberculosis. The meat was bad, and had all the characters of bad meat, and if meat inspection was to be of any use, this should be enough to justify the action of the meat inspector, the Medical Officer of Health, and the magistrate who originally condemned the meat. The fact that there was tuberculosis showed what was the actual nature of the danger that would be run by persons, and especially children, partaking of it, but the defence might have taken advantage of the difference existing between experts to obscure the main question. This putting aside of the question of tuberculosis led the experts for the defence to make statements which, in the light of the more complete knowledge in possession of the prosecution, showed the danger of disputing the necessity of condemning bad meat. Notwithstanding that the meat in question was pale, soft, not set, moist, that fat was almost entirely absent or replaced by a soft gelatinous, sodden tissue of bad colour, that the synovial membrane attached to articular ends of bones was swollen and exuded a purulent looking fluid on pressure, that the lymphatic glands were enlarged, some deeply congested, others softened, apparently suppurating ; it was asserted for the defence that such meat would not be harmful, would in fact be wholesome, could be condemned only on account of its being of low nutritive value, and that selling such meat as good meat would be taking money under false pretence.

Now had the experts called by the defence been acquainted with the fact that the animal, the carcase of which had been condemned, was suffering from advanced tuberculosis, and that lymphatic ganglia deeply situated among the muscles had been found much enlarged and altered by tubercular lesions, in which tubercle bacilli had been demonstrated, they could not have spoken of the state of meat as indicating a harmless condition, or if they had done so they would have had to prove that tuberculosis is not communicable by the consumption of tuberculous food. The latter view has been held by some eminent men, but it becomes more and more untenable.

The evidence which has been adduced to prove that the flesh of tuberculous animals was not capable of causing tuberculosis, though very interesting, cannot shake in the least the observations on which the opposite view is based. It is with the object of showing the bearings of the arguments brought forward by both sides that I will now attempt to give a short account of the present state of this question. The following remarks, with the exception of those relating to the recent publication of Nocard, were originally communi-

cated three years ago in the shape of an address to the Medico-Ethical Society of Manchester.

It will be taken for granted that the infectiousness of tuberculosis has been fully demonstrated by the work of Villemin, of Koch, and of their followers. Tuberculosis of the lower animals is due to the same micro-organism as in man, and it can be communicated from man to the lower animals and from the lower animals to man. The well-known cases recorded by Tscherning and by Pfeiffer prove clearly that bovine tuberculosis is communicable by inoculation from cattle to man.

Numerous experiments, since the time of Villemin (1865), have abundantly shown that human tuberculous products of any kind were capable of producing tuberculosis in a large number of animals, when inoculated under the skin, into the blood vessels, into a serous cavity—in fact, into any part of the body. Professor Burdon Sanderson* has justly said that the identity of bovine and human tuberculosis is a thing to be accepted as a fundamental proposition. This statement is not affected by the fact that there are certain differences in the morphology of the bacillus and in the character and mode of extension of the lesions in the two cases.

We need not either discuss the question of heredity as a causal factor in tuberculosis. It can be safely admitted that an exceedingly small number of children are affected at birth, and the same may equally truly be said of the young of the lower animals. The few cases of fatal tuberculosis recorded by Hiller, Shleuss and Grothaus, Jöhne, Landouzy and Martin, etc., though they show that it is possible for a fœtus to be infected in utero, are of little importance when compared with the statistics given by Boltz,† for instance, in his "Inaugural Dissertation." Out of 2,576 children whose bodies were submitted to a post-mortem examination in Kiel, between 1873 and 1889, there were 424 cases of tuberculosis, or 16·4 per cent. The following table shows the percentage at different ages :—

Still-born children	0·0 per cent.
Up to 4 weeks old	0·0 „
5 to 10 months old	0·9 „
3 to 5 months	8·6 „
6 to 12 months	18·3 „
1 to 2 years	26·8 „
2 to 3 „	33·0 „
3 to 4 „	29·6 „
4 to 5 „	31·8 „
5 to 10 „	34·3 „
10 to 15 „	30·1 „

* Burdon Sanderson. "Transactions of the International Congress of Hygiene and Demography." London, 1891. Vol. II., p. 185.

† Boltz. *Journal of Comparative Pathology*, 1890, p. 370. *Thiermedicinische Rundschau*, Dec., 1890.

Woodhead* has given on a smaller scale results, equally significant, of 127 cases of tuberculosis :—

In children under 1 year					.....	4 cases.
„	„	from 1 to 2½		years	33	„
„	„	„ 3	„ 5½	„	29	„
„	„	„ 6	„ 7½	„	12	„
„	„	„ 8	„ 10	„	13	„
„	„	„ 11	„ 15	„	 9	„

Such statistics, and others not mentioned here, indicate clearly that tuberculosis usually begins after birth, and that it is a rare disease in the early months of life. There is ample evidence to prove that among the channels of infection the air passages are most important; a large number of children must, however, become infected through their alimentary canal, as seems to be proved by the following observations recorded by Woodhead :—Out of the above 127 cases of tuberculous children examined post mortem, 43 presented tubercular lesions of the intestine; 100 (*i.e.*, 79 per cent,) tubercular lesions of the mesenteric glands; 14 tubercular lesions of the mesenteric glands only. Of the 43 cases with intestinal lesions, 24 were found in children between 1 and 5½ years. Of the 100 cases with intestinal lesions 62 were found in children 1 to 5½ years old. Of the 14 cases with mesenteric lesions, 9 were found in children 1 to 5½ years old.

In a series of over 100 experiments made by myself, I have found that tuberculosis of the mesenteric glands occurs very late, if at all, in guinea-pigs infected through other channels than the alimentary canal or the peritoneal cavity, and when the mesenteric glands are affected in such cases all the other organs are in a state of advanced tuberculosis, but where the seat of inoculation is in the abdominal cavity, the mesenteric glands are, on the contrary, the first organs affected. In fact, it is generally possible, by carefully dissecting out the lymphatic ganglia, to find the part through which the animal has been infected.

To give only a practical instance of the results obtained, it will be enough to mention here that I have found a single prick of the tongue, of the lips, or of the fauces with a needle loaded with tubercle bacilli to be followed by marked tuberculosis of the cervical ganglia, the lesions in such a case resembling closely those observed in the neck of scrofulous children.

In presence of such observations, it is only right to assume that when the mesenteric glands are the only organs affected with tuberculosis, or when they are much more affected than other organs, the channel of infection must have been the alimentary canal.

* "Laboratory Reports," Royal College of Physicians, Edinburgh, 1889. Vol. I., p. 181.

Judging from the statistics recorded above, it is evident that this occurrence is far from unfrequent in children. In corroboration of this fact we have seen that children begin to be liable to tuberculosis after they have reached the age of six months (*i.e.*, after most of them have begun to be fed on cow's milk, or foods other than the maternal milk).

There is, however, more than circumstantial evidence to show the danger of tuberculous food. Chauveau, Gerlach, Harmz and Günther, Jöhne, Nocard, Peuch, Viseur, etc., etc., have shown that tuberculous organs and flesh when given to various kinds of animals were capable of causing tuberculosis beginning in the abdomen. Gerlach, Klebs, Jöhne, Bollinger, Baumgarten, Peuch, Bang, etc., have proved the existence of the same danger in connection with the milk from tuberculous cows. By putting together the statistics given by Harmz and Günther, Gerlach, Jöhne and Peuch, we get a total of 87 experiments in which various animals were fed with flesh from tuberculous animals; out of these animals, 18 became tuberculous, *i.e.*, about 20 per cent. In these experiments the flesh had been obtained from tuberculous cows and oxen, and apparently taken without any special precaution. Nocard has pointed out that when cats are fed with muscle free from tuberculous glands, and not accidentally contaminated with tuberculous products coming from other organs, tuberculosis is never obtained. This is true even when young kittens are used, though these animals are easily rendered tuberculous by the ingestion of small quantities of tuberculous lungs, liver, and lymphatic ganglia.

In support of Nocard's contentions, we have the experiments of Peuch, Galtier, and Perroncito, showing that muscular tissue taken from tuberculous animals, but free from tubercular lesions, is practically incapable of producing tuberculosis by ingestion.

I will now only briefly allude to inoculation experiments, because it has been urged that subcutaneous or intraperitoneal inoculations are not a fair test of virulence, because it is much easier to transmit tuberculosis by inoculation than by ingestion.

It is interesting, however, to find that inoculation experiments give results resembling closely those which have been obtained in feeding experiments.

Thus, putting together the experiments made by Villemin, Gosselin, Toussaint, Galtier, Jeannel, we find that out of 56 experiments made to test the virulence of the blood of tuberculous animals, 28 yielded positive results; on the other hand, in 26 experiments performed by Bang, Nocard, and MacFadyean* we find that the blood was capable of causing tuberculosis in two cases only. It must be admitted that

* MacFadyean. *Journal of Comparative Pathology*, 1892, p. 28.

in many of the first series of experiments the blood had been collected without sufficient precaution to prevent the admixture of tuberculous products present in various parts of the body. For several other reasons many of these experiments may be objected to.*

Inoculations made with meat juice give equally ambiguous results. Out of 52 experiments by Gratia and Liénaux, Peuch, Galtier, Veyssière and Humbert, Arloing, and Nocard, 14 yielded positive results. To these should be added the experiments of Bollinger and Steinheil,† and also those of Dreschfeld, which have given positive results. On the other hand, we have another series of 27 experiments by Bollinger and Kastner and by MacFadyean, with nothing but negative results.‡ To these should be added experiments of Nocard and others, which have also yielded a very large proportion of negative results.

The differences between results obtained by inoculation and ingestion are not, on the whole, so great as has been alleged by some writers.

From what precedes it is evident that there is no doubt as to the danger of eating tuberculous food, but there is a divergence of opinion among authorities as to the parts of an animal which are infectious.

Toussaint was of opinion that tuberculosis was a disease "totius substantiæ corporis" (from which it would follow that any part of the body was capable of producing tuberculosis by inoculation or ingestion). This view cannot be accepted as true, except in cases of very advanced general tuberculosis.

Various attempts have been made to prove that though this is not always true, the blood can, at times, contain enough tubercle bacilli to render any part of the body infectious. This, however, has been shown by Bang, Nocard, and Macfadyean to be an extremely rare occurrence.

The only thing which has been clearly proved is that whenever an organ shows distinct tuberculous lesions, this organ is capable of transmitting tuberculosis by inoculation or ingestion.

It is, therefore, interesting to find what is the prevalence of tuberculosis in the various organs of bovidæ, which of all the animals used for food, are those liable to tuberculosis. According to Nocard§ the organs of oxen and cows are affected in the following order of frequency: Lungs and pleura, 40 per cent; lungs alone, 20 to 25 per cent; pleura and peritoneum alone, 15 to 20 per cent; lymphatic glands, genital organs, mammæ, bones, articulations, 15 to 25 per cent.

Nocard insists upon the fact that it is not very unusual to find lymphatic ganglia affected without there being any trace of tuberculosis

* *Journal of Comparative Pathology*, 1890, p. 77.

† *Deutsche Zeitschrift für Thiermedicin*, Dec., 1889.

‡ *Journal of Comparative Pathology*, 1892, p. 29.

§ Nocard (Ed.). "Les tuberculoses animales." Paris, 1895, p. 13.

in the viscera through which, he assumes, the tubercle bacilli have penetrated into the organism. This is not only true of the thoracic and abdominal ganglia, but also of those which are outside the cavities, notably the cervical and pharyngeal ganglia.

A slight knowledge of the distribution of lymphatic ganglia in the body will make it evident that there is hardly any joint of meat, as cut by the butcher, which does not contain one or more lymphatic glands. These ganglia have often been found to be diseased not only in the neighbourhood of the great serous cavities, but also in the extremities. This may even be the case without the meat showing any evidence of the existence of a wasting disease; in fact, tuberculous glands have been found in meat apparently of prime quality. Such an invasion of the peripheral lymphatics is, of course, generally most extensive in advanced cases in which wasting has taken place; the appearance of the meat in such instances easily betrays its unsoundness, as in the Blackpool case.

If this invasion of the lymphatics is taken in consideration, the careful experiments by which several observers have tried to prove that the flesh of tuberculous animals is not infectious, by carefully separating the muscular from the surrounding tissues, are not of much practical value, notwithstanding their great scientific interest.

But it is not only through the presence of tuberculous glands in their midst that meat from tuberculous animals is rendered dangerous. Butchers, when they dress a carcase, do not, like the careful experimentor, sterilise their fingers and knives at each step of the dissection, they do not sterilise the walls, tables, hooks, etc., which they use after those have come in contact with tuberculous carcases or offals. On the contrary, the meat constantly runs the risk of being contaminated with discharges or products coming from the tuberculous organs, which, no doubt, are condemned and destroyed, but leave traces behind them.

What is, therefore, the practical use in experiments on the infectiousness of flesh from tuberculous animals, to use muscles or blood, removed or collected under conditions which cannot be observed in the abattoir?

Nocard says that experiments in which precautions are not taken to avoid the contamination to which I have just alluded are not good experiments. This is perfectly true when one wishes to discover how infection is brought about; but, this being settled, it is still more important to know how the flesh of tuberculous animals, dressed in the usual way, will affect those who partake of it. Arloing has justly set aside Nocard's criticism, and maintained that it is impossible to pass over experiments proving the infectiousness of meat obtained without special antiseptic precautions.

It seems to me that whenever it has been proved that in the midst of a piece of meat there was a tuberculous gland, this piece of meat, and the whole carcase from which it has been taken, should be condemned. Not only when the meat looks unsound, but also when it seems in good condition.

Some might feel inclined to think that there is no reason for troubling much about the question, because, after all, tuberculosis of cattle is not frequent enough to cause serious danger. It has been found, however, that tuberculosis is far more frequent in the bovidæ than was suspected before tuberculin was used for diagnostic purposes.

Nocard says that, according to districts, 10, 15, 25, or more per cent of the cattle are affected with tuberculosis. He further states* that in stables where tuberculosis has existed for some years the proportion of tuberculous animals is always considerable, 50, 60 or even 80 per cent of the total number of animals may be affected. He gives several instances of the extraordinary prevalence of tuberculosis in certain forms. I will only quote one. In 1892 he tested by tuberculin 105 heads of cattle, and found that 55 of them were tuberculous, yet all these animals were on a large and well-kept estate in the North of France.

In Germany, Lydtin† has shown that out of 80 oxen and cows certified by competent veterinary surgeons to be healthy and fit for food, 17 were found after death to have tuberculous lesions (*i.e.*, 21 per cent). This shows the great necessity of careful meat inspection, or the use of tuberculin during life, for the 17 animals just referred to were found to give the reaction of tuberculosis with Koch's tuberculin. It is not necessary to quote a larger number of figures to prove a fact which is accepted by the majority of observers. Veterinary surgeons in England generally recognise that tuberculosis is a very common disease of cattle. It must be admitted that we are more often exposed to tuberculous infection through our food than we have been led to suppose till lately.

It is fortunate for us that it is only when the tubercle bacilli are pretty abundant that that they are capable of causing disease in a healthy adult person. But in weak or young individuals the danger is much greater, and there is always the possibility that some bone or hard particle infected with tuberculous matter may wound the mucous membrane of the mouth, fauces, or some other part of the alimentary canal, and bring about tuberculosis just as in my experiments with the tuberculous needle.

* Nocard. *Loc. cit.*, p. 103.

† Lydtin. "Thierarzliche Mittheilungen." 1891.

It is not easy to prove the actuality of the danger by quoting cases in which tuberculosis has been undoubtedly the result of the ingestion of tuberculous meat.

The statistics quoted above to prove the frequency of abdominal tuberculosis in children appeal only to those who have made a large number of experiments and observations.

Even in those cases in which meat might be suspected to be the cause of tuberculosis it would be difficult to trace clearly the piece of meat which should be incriminated, and afterwards to establish clearly its history; and if this could be done, it is evident that the carcase from which the joint had been obtained would have long been beyond the reach of scientific investigation when tuberculosis had made sufficient progress in the victim to be evident.

With regard to infection by milk, however, it is sometimes possible to find a case showing clearly that infection has been due to the milk.

Demme* mentions four cases occurring in children of healthy parents. Those children were clearly proved to have been fed on uncooked milk from tuberculous cows.

Demme says that out of 2,000 tuberculous children treated by him these are the only four in whom he could surely eliminate all other sources of tuberculosis. This, of course, does not show that these four cases were the only ones attributable to the consumption of milk, but that, in order to eliminate all possible sources of error, he was obliged to put aside a large number of cases possibly due to the ingestion of tuberculous food.

Ollivier and Boutet, quoted by Arloing,† record an outbreak of tuberculosis in a boarding-school. Cows were kept in that establishment. One of the cows supplying milk during a certain period was tuberculous, and during that time six of the children became tuberculous.

Stang‡ gives details of another case. A boy, aged five years, born of healthy parents, died from advanced tuberculosis of the mesenteric ganglia and miliary tuberculosis of the lungs. It was ascertained that he had been in the habit of drinking warm uncooked milk from a cow suffering from tuberculosis, as was proved by examination of the viscera after the animal had been slaughtered.

A still more telling instance is recorded by Dr. Gosse, of Geneva.§ His daughter was, at the age of 16, a strong and healthy girl, and there was no trace of tuberculosis in the family. About 10 months before

* Demme. Twentieth Yearly Report. Jenner's Children's Hospital, Berne, 1883.

† Arloing. "Leçons sur la Tuberculose," 1892, p. 349.

‡ Stang. *Comptes rendus du Quatrième Congrès internationale Veterinaire de Bruxelles*, 1883, p. 188.

§ *Journal de Genève*, October 31, 1893.

her death she began to manifest signs of some mysterious illness, which caused gradual wasting, and ultimately the patient died at the age of 17. At the autopsy it was found that the poor girl had suffered from intestinal and mesenteric tuberculosis. It was then remembered that she used, when spending the Sundays on a small estate where cows were kept, to drink warm milk almost straight from the cows. These cows were, in consequence of this, examined; four out of the five were found tuberculous, and of these two had tuberculous udders.

Such instances of infection, though few, are sufficiently clear to establish the risks attending the use of tuberculous food.

It may be argued that meat is usually cooked before being eaten, and that the virulence of the tubercle bacillus is in this way destroyed; but it must be remembered that a large proportion of the meat used for food is either roasted or grilled, and that the internal parts of chops, beef-steaks, or roasted joints are seldom sufficiently cooked to kill bacilli. Chauveau and Arloing have shown that unless a tuberculous piece of meat has been kept all through at a temperature of 70° C. for about half an hour, it is still capable to infect animals. Now, whenever the inside of a joint is still red, it can be safely said that the temperature of the red parts has not even reached 70° C.

Toussaint has stated that three-quarters of the animals inoculated with the central parts of an imperfectly cooked tuberculous joint became tuberculous.

Jöhne, in 62 experiments, has found that tuberculous organs and flesh kept for ten to fifteen minutes in boiling water were still capable of infecting 35·5 per cent of the animals fed on them.

In parallel experiments made with the same tuberculous material uncooked, 65·5 per cent of the animals became tuberculous. If cooking is to be relied upon to destroy the virulence of tubercle bacilli, it is necessary that this cooking should be thorough, and that all the parts of the tuberculous joint should be exposed to a sufficient temperature.

Bang has shown that after milk had been kept at a temperature of 85° C. for five minutes, any tubercle bacilli which it might contain is killed. To obtain such a temperature in the centre of an ordinary joint, much more prolonged cooking than is generally desired should be allowed.

Such are the main facts and arguments which may be relied upon to prove the danger connected with the consumption of tuberculous meat. Many more observations and experiments might have been quoted, but it has been thought that they could hardly be more convincing than those alluded to in the text. Only few bibliographical references are given, because most of the information wanted will be easily found in

works such as those of Aloing* and Nocard,* and also in papers by Woodhead and MacFadyean.*

Special notice has been taken of Nocard's views, because he is one of the strongest advocates of mild measures, and any admission coming from him has double value on that account.

It is hoped that the facts brought together in this short *exposé* will be enough to convince the reader of the seriousness of the matter at issue, and of the *real risk which is incurred if tuberculous meat is allowed to pass as fit for human food by meat inspectors.*

[The report of the Royal Commission on Tuberculosis not being available yet to the public, I regret not to be able to take advantage of it in support of my contention, but it may be said in a general way to establish the views here advanced.]

Loc. cit. and others.

John Heywood, Excelsior Printing and Bookbinding Works, Manchester. [P 2,330.]