for ten minutes, and is also more difficult to carry out, as it is easy with simple domestic apparatus such as Aymard's, or other double saucepan, or Soxhlet's, or Hawksley's bottle-holding tins to keep the milk in a bath of boiling water for ten minutes.

In times of epidemic summer diarrhoea the heating should be prolonged for at least half an hour, and the milk drunk within a few hours, or subjected again to the process, as the spores of the bacillus sporogenes enteritidis are very resistant. Under all circumstances milk, whether raw or "sterilised" should be drunk as fresh as possible, and then the liability to gastro-enteritis and nutritional diseases will be diminished; but it is my emphatic opinion that infants who live wholly or mainly on milk as at present supplied to us should never be exposed to the dangers lurking in the raw fluid.

Lastly, let me say that nothing in this paper is intended to detract first from the paramount importance of children being suckled by their mothers for the first seven or eight months of their life; and, secondly, from the equally vital matter of securing a pure milk supply from healthy cows, hygienic stables and dairies, and clean milk cans. Educational and legislative measures to secure such a pure milk supply should have the heartiest support of every medical man.

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REMARKS ON THE RELATIONS OF HUMAN AND BOVINE TUBERCULOSIS.*

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In addition to the danger of inhaling the infection of tuberculosis it has until lately been believed that human beings may also be infected through the digestive passages by the consumption of meat or milk derived from tuberculous animals; but Professor Koch has startled the Congress recently held in London and the world by declaring that the risk of this occurrence is extremely slight and that in his opinion no measures to prevent it are necessary.

What, then, are our reasons for believing in the identity of human and bovine tuberculosis, and that the disease can be transmitted from one species to the other?

1. The bacilli found in each case are extremely alike both in their form, their staining reactions, and their mode of growth under artificial cultivation.

2. These bacilli, whether of bovine or human origin, produce typical tuberculosis when injected into rabbits and guinea-pigs.

3. Tuberculin prepared from human tubercle bacilli produces a characteristic reaction when injected into tuberculous cattle just as it does when injected into tuberculous man.

Objections can be urged against each of these statements. The similarity of the bacilli, it is said, does amount to identity of form. The bovine bacillus is not beaded like the human one, and is also shorter and thicker. In pure culture there are some differences in the mode of growth, and the bovine bacillus will not grow on glycerine-agar while the human will.

COMMUNICABILITY OF HUMAN TUBERCULOSIS TO BOVINES.

A fact, admitted by all observers, is that while both bacilli are pathogenic for animals, the bovine bacillus is much more virulent than the human. This fact, however, may eventually turn out unfavourable to Koch's views. His argument is based on the results of experiments in which he found calves very susceptible to bovine tuberculous material, whereas these animals were not susceptible to infection by human material, and swine but very slightly. But it is a matter of experience that man is as a rule liable to the diseases which are common to the domestic animals, and if bovine tubercle is virulent for a large number of different animals it

strengthens the probability that it is virulent for man also. With regard to the tuberculin reaction Koch explains that, although the bacilli are different, they belong to the same group, the members of which give a common reaction with toxins. In support of this statement he points out that typhoid serum agglutinates cultures not only of typhoid bacilli, but also of paratyphoid [a form of colon bacilli]. As regards pathological and experimental evidence, the conclusion seems to be justified that the differences between human and bovine bacilli are those of variety rather than of species, such variation being due to the soil on which the organism grows.

Other observers, however, have not met with such uniformly negative results after attempts to communicate human tubercle to cattle. Ravenal of Philadelphia¹ inoculated intraperitoneally four calves with human sputum; three of these became tuberculous, two showing extensive lesions of true *Perlesucht* character. Contrary to Koch's experience, he found swine very susceptible to infection by human sputum. Lately Professor Delépine² has succeeded in giving human tubercle to the calf. Dr. Sidney Martin fed calves on bovine and human material. Those fed with bovine material were easily infected. The experiments with human material, while not being entirely negative, failed to communicate tubercle in two cases out of six, while in the other four there were lesions of limited extent in Peyer's patches and the mesenteric glands. Accidental infection of cattle, pigs, and even fowls, by means of the sputum of phthical attendants, has been thought possible, and cases in support have been cited, but, as we are not told that all other sources of infection were excluded, the evidence is not very convincing.

COMMUNICABILITY OF BOVINE TUBERCULOSIS TO MAN.

We may now turn from the possibility of communicating tuberculosis from man to cattle to the far more important consideration whether transmission of the disease from cattle to man can take place, and whether the danger of contracting tuberculosis from meat and milk is real and substantial. I have nothing to say about the danger from meat, because meat inspection is practised by our authorities; and even if tuberculous meat escapes the inspector, the risk is so much diminished by cooking, that the transmission of tuberculosis by this means is so rare as hardly to constitute a substantial danger. Indeed, Dr. Sidney Martin³ tells us that meat itself very rarely contains tubercle bacilli, and that danger consists only in its being contaminated by knives, cloths, etc., which have been in contact with tuberculous organs. Nocard⁴ was unable to infect animals by feeding with raw flesh from highly tuberculous beasts, and even inoculation with juice from the same generally failed. The case is different as regards milk, because it is much more frequently taken uncooked, and the general opinion is that it is a fertile source of the tuberculosis of childhood. This belief is supported by the findings of the Royal Commission in 1895. We are told that something like 30 per cent. of milch cows—kept as is usual in confinement—are tuberculous, but that only the milk of cows with tuberculosis of the udder is infective. Udder disease is said to exist in 2 per cent. of cows; but this estimate may be too high, for Mr. Lloyd,⁵ veterinary surgeon to the Manchester Corporation, after examining 9,576 animals, found this affection in 0.5 per cent., and appears to consider this a fair average for the whole country. Tuberculous milk is dangerous in proportion to the number of bacilli contained in it, and it is easy to exaggerate the infectiveness of milk, unless we remember that the infection is very much diluted by the mixing of milk. Tuberculous milk has been amply shown to be infective for animals. Knowing this, we find in the bodies of children lesions in the intestine, glands, or peritoneum, and we argue thus: All children drink milk, some milk is infective, therefore some children die of infection by milk. This conclusion may be correct, but in forming it there is something we have not taken into account.

Koch⁶ has said: "It is just as likely these cases of intestinal tuberculosis were caused by the widely-propagated bacilli of human tuberculosis." In breathing a germ-laden atmosphere tubercle bacilli may be deposited in the mouth or nose and afterwards swallowed mixed with mucus, or even after being inhaled they may be expectorated and swallowed.

* Extracts from a paper read before the Nottingham Medico-Chirurgical Society.

It is not only milk that goes into the mouths of children; they grub about on all-fours, plastering their fingers with the tuberculous dust hidden away in inaccessible corners, and then put their fingers in their mouths; they play with the spittoons and handkerchiefs of phthisical relatives; jellies, blanchmanges, and other food are left for hours, if not days, besides a coughing patient, and these, as well as all other infection lying about, are finally eaten by the children.

ABDOMINAL TUBERCULOSIS IN CHILDREN.

There is a pretty general belief among the medical profession that tuberculosis in young children usually affects the abdominal organs primarily, and this belief is fostered by the reports of the Registrar-General, which show during the first five years of life a heavy mortality from *tabes mesenterica*. This disease—true mesenteric tuberculosis—can hardly be diagnosed clinically, the term being apparently used to signify a disease characterized by diarrhoea, wasting and tumid belly, the so-called “consumption of the bowels” of the laity. Sir Richard Thorne-Thorne in his 1898 lectures uses these very fallacious statistics to prove his point that infantile tuberculosis is due to milk. He points out that while the death-rate for phthisis, owing to improved hygienic conditions, has declined during the last fifty years as much as 50 per cent., that for *tabes mesenterica* for children under 5 has remained practically stationary, and has even increased as much as 27 per cent. for children under 1 year. Children, he says, have had the benefit equally with adults of improved sanitation, therefore some other cause, not affecting the phthisis death-rate, has been operative in causing the increased tuberculous death-rate in children, and this cause is probably infective milk. There are observers, however, as fully convinced as Sir R. Thorne-Thorne of the dangers of milk who do not accept the figures on which he bases his conclusion. Dr. J. McFadyean, who defended the milk theory against Professor Koch at the Congress, says: “The Registrar-General’s returns do not afford much trustworthy information with regard to the number of cases of primary intestinal tuberculosis, and are absolutely worthless as an indication of the extent to which human beings are infected by milk.”

The only reliable statistics open to us are those based on necropsies. The results thus obtained are very striking, and do not lend much support to the doctrine that abdominal tuberculosis is relatively common during the milk-drinking period. The records of several large Children’s Hospitals for a number of years back have been analysed by independent observers—Dr. Shennan of Edinburgh, Drs. Still, Carr, Colman, Guthrie, and others, in London. The investigations concern over 2,000 necropsies, and the results in each case are strikingly similar.

It is shown in the case of children under 12 years of age dying in hospital, first, that nearly one-third of the deaths are due to tuberculosis, thus supporting the general opinion that the disease is common in childhood; but secondly, it is also shown that at all the age periods up to five years tuberculosis primarily affecting the lungs or thoracic glands is at least twice as common as the same affection of the intestine or abdominal glands.

After five years of age tuberculosis is much less common, and primary infection in the two cavities is more nearly equal. The most fatal period of tuberculosis is the second year of life, and this is the very period when we ought to find most evidence of primary infection through the intestine. At this age Dr. Still⁸ found 38 cases of primary thoracic infection and 15 of primary abdominal; Dr. Shennan’s figures are 57 and 22.⁹ These figures show a preponderance of chest tuberculosis in the proportion of nearly 3 to 1, at an age when milk is largely drunk.

Putting together the figures of these two observers, and taking all cases up to 6 years of age, we get 281 primarily thoracic and 91 primarily abdominal. And if we look at the earliest period of life, under one year, we find the figures, instead of confirming the impression given by the Registrar-General’s reports that abdominal tuberculosis is especially fatal at that time of life, absolutely contradict it; for Dr. Still found primary chest disease in 18, abdominal in 5; Dr. Shennan, chest 21, abdominal 4. Here the figures are 4 to 1 in favour of the chest. Dr. Carr examined into the cause of

330 deaths in children, 30 per cent. of which were due to tuberculosis, and concludes:¹⁰ “Tuberculous disease starts much more frequently in the thorax than in the abdomen, and certainly far more often in the thoracic than in the mesenteric glands.” His figures are 65.8 per cent. starting in the thorax as against 16.7 per cent. in the abdomen. Dr. Colman says:¹¹ “While not doubting the infection by milk in some cases, I am led to attach more importance to the condition of the thoracic glands, as the process was more advanced in them as a rule than in the mesenteric glands.” There are two other sites beside the chest and abdomen in which tuberculosis may have its primary seat, and which conceivably may be infected either by inhalation or ingestion. One of these is the middle ear, which Dr. Still¹² found affected fifteen times, and suggests this is really an inhalation tuberculosis, as the Eustachian tube is more closely related with the respiratory than the alimentary passages. The other site is the glands of the neck, which probably become tuberculous by infection through the tonsils or other parts of the fauces. Dr. Shennan claims this mode of infection as due to food, but it is, in my opinion, just as probably aerial in origin, and, anyway, cannot prove very much in favour of milk infection, being probably more common in later than in earlier childhood. In 43 of Dr. Still’s cases healed tuberculous lesions were found, the patient having died of some other disease. In these healed lesions the proportion of thoracic to abdominal disease was fairly well maintained, being 26 of the former to 16 of the latter. So far as the evidence goes we may say that the tendency of tubercle to become obsolescent is not decidedly more marked in the one situation than in the other.

From what has been said it must not be concluded that cases of tuberculosis in childhood can always be ascertained clinically to be of pulmonary or intestinal type respectively. Nearly half the total number appear clinically as meningitis, the primary lesion, whether thoracic or abdominal, being often latent. What is shown by the figures—and I think conclusively—is that primary infection takes place far more often by the respiratory than by the alimentary passages. And just as primary chest infection is commoner than primary abdominal, so also a larger proportion of secondary meningeal infection comes from a thoracic than from an abdominal source. Therefore clinically, and excluding meningitis, we ought to find pulmonary phthisis more common than abdominal, and this, I think, is what we do find. During my last six months practice in the out-patient room I have not seen a single case in which there were reasonable grounds for a diagnosis of abdominal tuberculosis, while I have met with a considerable number of children with local and constitutional signs of the pulmonary form, one of these, aged 2 years, being probably infected by a phthisical mother. Experience in the wards points in the same direction, and I think in private practice also, if anyone kept careful note of his cases, he would find at the end of a twelvemonth he had seen more cases of pulmonary phthisis in children than abdominal.

CONCLUSIONS.

What follows from this line of argument? Well, we cannot as yet deny the possibility of infection by milk; still enough has been said to show that the assumption that the frequency of tuberculosis in early life is chiefly due to tuberculous milk is in one direction too narrow and in another erroneous. An exclusive milk theory, while it ignores the greater incidence of tuberculosis on the lungs than on the bowels in young children, fails also to take account of other sources of infection. There can be no doubt that certain infantile diseases—measles, whooping-cough, bronchitis, broncho-pneumonia—serve as powerful predisposing causes to tuberculosis mortality. They leave behind them constitutional weakness, catarrh of the respiratory passages, and often of the intestinal as well. Under these conditions the widely disseminated bacilli of human tuberculosis gain a footing, attaching themselves to the most susceptible organs—in a majority of cases the lungs or their related glands, in other cases to the intestine, ear, or neck glands. Milk may be responsible for some cases, but the fact that thoracic tuberculosis is so common at an early age suggests the conclusion that the human bacillus (in the one case inhaled, in the other swallowed) mixed with

the bodily secretions or with food, is the cause of chest trouble in one case and of abdominal in another.

Koch has told us that while secondary infection of the intestine is admittedly very common, primary infection of that tube with tuberculosis is exceedingly rare. This conclusion, however, is not in accordance with British experience as regards disease in children.

In 66 cases of Dr. Shennan's, 45 were found with ulceration of the intestine prior to infection of the glands of the mesentery; but in a minority the glands were affected with little or no lesion of the bowel, thus tending to support the view that bacilli may sometimes find their way through a mucous surface without leaving traces there of primary inoculation. It is said¹³ that in Germany the use of boiled milk is very common, if not the rule, while with us it is the exception; and this difference of treatment would, therefore, if milk be the cause of the disease, explain the greater frequency of primary intestinal ulceration among us.

The following case has been often quoted in support of the belief that tuberculosis can be acquired from milk. At a school for girls in France there occurred within three months 11 cases of tuberculosis of which 5 were fatal. In several of the cases the site of the infection appeared to be intestinal. The milk used during the period was obtained from a cow affected with tubercle of the udder and internal organs. There is other evidence of at any rate the occasional innocuousness of tuberculous milk. The following occurrence was communicated to me by Professor Clifford Allbutt, with his permission to publish the facts: Some years ago when living at Meanwood, near Leeds, he used to keep a small herd of Guernseys, among which was a prize cow he had purchased for a high price. This cow had been coughing for many weeks without any particular attention being paid to the fact, when at last it was noticed that her milk did not look right. On examination disease of the udder was found, no doubt at an advanced stage, seeing that the milk was noticeably altered in appearance. The milk contained swarms of tubercle bacilli, and had been consumed mixed with that of the other cows for a long period by over twenty persons, ten of these being children. This disclosure naturally gave Dr. Allbutt considerable anxiety for a time. But he says, "No one was one penny the worse, except myself for the loss of my pedigree cow."

From instances like the foregoing it is difficult to draw any general conclusion as to the danger of drinking tuberculous milk. The evidence, however, tends to show that such milk is not highly infective when diluted with the milk of healthy cows, and that some persons are likely to show a much higher degree of susceptibility than others. Nocard, an eminent French authority, quotes several cases of tuberculosis of the intestines in young persons traced with a high degree of probability to milk, but he also says, "Ingestion only succeeds in giving tuberculosis when the ingested material is very rich in bacilli."¹⁴

As regards the spread of tuberculosis we seem to be going through much the same change of thought as we have gone through with regard to the spread of typhoid fever. In this disease we used to say that case-to-case infection was very rare, and that infection from a common source was the rule. We now believe that the disease often arises from case-to-case infection. In the same way we have slowly come round to the idea that tuberculosis in adults arises directly or indirectly from case-to-case infection. During the last few years the belief has become general that the tuberculosis of childhood is due mainly or entirely to a common source of infection, namely, milk. Are we not now in process of recognising that here again tuberculosis is mainly caused by infection derived directly or indirectly from a person affected by the disease?

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GENERAL HOSPITALS AND PULMONARY CONSUMPTION.

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ONE of the most important problems that have arisen in connexion with the national efforts to check the ravages of phthisis pulmonalis is how to deal with advanced cases among the artisan and generally less wealthy classes—those socially a little above the pauper grade. The sense of self-respect of the sufferers will not, as a rule, permit them to enter the parochial hospitals; and, indeed, at least in Scotland, they would have no legal claim to become inmates of these institutions. What happens with a large proportion of the cases of that kind in Glasgow, and presumably also over the kingdom, is that they seek admission into our infirmaries and general hospitals, and—I do not put it too strongly—are turned away from their doors. It is done in this way: A consumptive, with cavities in the lungs, having obtained a subscriber's line and a medical certificate of his illness, comes or is brought by his friends to the reception room of the infirmary. He is there examined by one of the resident medical officers, and also, in the event of a refusal, by a dispensary or chief physician. The decision having been arrived at that the disease has advanced to the condition described, the patient is told that his case is unsuitable for admission. Very clearly, the shock to the sufferer and his friends must often be great on hearing this statement, and, it need scarcely be said, the duty of declining him is a painful one to the physicians.

OBJECTIONS TO ADMISSION OF ADVANCED CASES TO GENERAL HOSPITALS.

In such cases, whatever their feelings, there is nothing for it but to go back to their homes. These are too often in densely populated districts where overcrowding is common. There they remain for the weeks or months that intervene before death closes the scene. More frequently than otherwise husbands or wives, brothers and sisters, as the case may be, are meanwhile exposed to the infection from the sputa that are usually so abundantly expectorated in the terminal period of consumption. During all this time they are centres for the diffusion of tubercle both in the home circle and around it. Who can doubt that this is one—indeed, probably, the chief—source from which continues to spring the various forms of tuberculosis, and more particularly phthisis pulmonalis?

The question arises, Ought the physicians who refuse to receive consumptives in the advanced stage into their respective hospitals to act otherwise? Certainly not, in view of the absence of special arrangements for the care of these cases. The physician's duty is, as far as practicable, to protect those under his charge from possible infection, and to admit in considerable numbers patients in advanced consumption into the general wards would be blameworthy. It would endanger those recovering from pneumonia, certain forms of bronchitis, and, generally, cases in which the vital powers are low, especially when there is likewise an hereditary disposition to tuberculous disease. It will doubtless occur to many, why restrict the objection only to the admission of considerable numbers, as, if there be risk, why not exclude all cases of that kind from the ordinary wards of hospitals? Complete exclusion of them I believe to be the only sound and satisfactory position to take up in relation to the question. And yet there are physicians of eminence who contend that in the large, well-ventilated wards of modern hospitals, with abundance of air space and disinfection of the sputa, the presence of, say, two consumptives with vomices in their lungs and abundant expectoration in a general ward does not really expose the other patients to danger of infection. They point to the absence of evidence that either patients or nurses in such hospitals have actually become phthisical. To this the reply may justly be made that the danger, though not great, unquestionably exists. Patients in the stage referred to, when they become weak and when the mind is not very clear, sometimes carelessly or inadvertently, especially at night, soil their nightdresses and bedclothes with the sputa. This, it must be obvious, is a clear source of risk to others.