to mask the tuberculous lesion. But you should always be suspicious of such a case if the signs are on one side only. One point which you may note is that the sonorous rhonchus frequently ends with a prolonged expiration. If you hear that, you may take it as pathognomonic of phthisis. With regard to enlarged bronchial glands, there is not much trouble, because they never cause *râles* at the apex, and generally speaking the sounds due to bronchial glands are found in other regions.

The Diagnosis from Mediastinal Tumours.

The question of mediastinal tumours I need not go into fully here. The symptoms of these tumours are so very different from those of tuberculosis, and the same may be said of aneurysm. I have seen cases in which aneurysm has been overlooked, and I have seen cases of supposed aneurysm in which the signs were produced by consolidation, which had been overlooked.

The Diagnosis from Typhoid Fever.

The question of typhoid fever from a diagnostic point of view has more bearing on acute tuberculosis than ordinary pulmonary phthisis. The history of such cases does not tell you very much, but when you watch the temperature charts in the two conditions you will find them very different. The typhoid-fever chart shows a higher and more continuous temperature. As a rule, the consumptive chart shows a low temperature in the morning, rising towards mid-day and up to 2 or 5 o'clock, or it may rise to as late as 8 o'clock, and then falling rapidly from then till the next morning. That is the general run of temperature in a phthisical patient. Of course the temperature varies according to the amount of suppuration present, the pyæmic chart being mingled with the tuberculous. Anaemia is the last condition which it is necessary to bear in mind; here the absence of wasting and the presence of physical signs will settle matters.

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THE NATURE OF THE INFECTIVITY OF PHTHISIS: A STUDY OF THE VIEWS OF KOCH, FLÜGGE, AND OTHERS.

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ALTHOUGH views as to the infectivity of phthisis attained no scientific measure of accuracy until within quite recent years, there are historical records of such views being held long before the bacteriological period of pathology. For instance, in the eighteenth century, principally owing to the teaching of Morgagni, both in Italy and Spain, phthisis was recognized as an infectious disease, against which most stringent precautions were taken.

INHALATION OF TUBERCLE BACILLI.

Klencke and Villemain¹ both demonstrated the inoculability of tuberculosis, but to Robert Koch is due the crowning honour of having in 1882 isolated the tubercle bacillus. The results of the experiments which led to this discovery are set forth at length in the masterly essay entitled *The Etiology of Tuberculosis*.² These researches are too well known to need recapitulation; but as having a special bearing on the subject of this paper I will briefly call attention to what the essay has to say on inhalation experiments. Experiment 26 is thus described:

A very roomy box, having on one side an opening for the orifice of the spray apparatus, was placed in a garden at a good distance from any habitation. The spray apparatus was placed outside the box, with its orifice projecting into the interior. The apparatus was connected by means of elastic tubing and a suitable length of lead pipe, which passed through the woodwork of a closed window, with the india-rubber bellows, and so could be worked from the room beyond the region of the spray.

Pure culture from a phthisical lung in the human subject, No. 1 (carried through twenty-three generations in fifteen months), rubbed up with distilled water, and the fluid diluted to such an extent that it looked almost clear. Any visible fragments present in the fluid subsided after standing a short time; the upper layer, which showed hardly any opacity, was poured off and used for inhalation. Fifty c.c.m. were dis-

persed in the course of half an hour on three successive days, and inhaled by the animals in the box as follows: 8 rabbits, 10 guinea-pigs, 4 rats, and 4 mice. After the inhalation the animals were kept in separate roomy cages and well looked after. In some of the animals dyspnoea appeared after ten days, and 3 rabbits and 4 guinea-pigs died in the course of four to twenty-five days. All the remaining animals were killed twenty-eight days after the last inhalation. All the rabbits and guinea-pigs had numerous tubercles in the lungs, the size of the tubercles being proportionate to the length of time the animals had lived after inhalation.

A more convincing proof of the highly-infectious character of sprayed tubercle bacilli could scarcely be asked for. But at this still early stage of research Koch was not led to draw any strong distinction between the effect of the inhalation of sprayed tubercle bacilli and the inhalation of tuberculous dust. Nevertheless, Professor Koch's comment on the results obtained by Experiment 26 call for note and consideration here. Thus he says:

There can likewise be no doubt as to the manner in which the tuberculous virus is carried from phthisical to healthy subjects. By the force of the patient's cough particles of tenacious sputum are dislodged, discharged into the air, and so scattered to some extent. Now numerous experiments have shown that the inhalation of scattered particles of phthisical sputum causes tuberculosis with absolute certainty, not only in animals easily susceptible to the disease, but in those also which have much more power of resisting it. It is not to be supposed that man would be an exception to this rule, but, on the contrary, we may surmise that any healthy person brought into immediate contact with a phthisical patient, and inhaling the fragments of fresh sputum discharged into the air, may be thereby infected. But probably infection will not often take place in this way, because the particles of sputum are not small enough to remain suspended in the air for any length of time. Dried sputum, on the contrary, is much more likely to cause infection, as, owing to the negligence with which the expectoration of phthisical patients is treated, it must evidently enter the atmosphere in considerable quantity. The sputum is not only ejected directly on the floor, there to dry up, to be pulverized and to rise again in the form of dust, but a good deal of it dries on bedlinen, articles of clothing, and especially pocket handkerchiefs—which even the cleanliest of patients cannot help soiling with the dangerous infective material when wiping the mouth after expectoration—and also is subsequently scattered as dust.

From this it will be seen that while Koch from the outset recognized the possibility of infection occurring both from bacilli coughed out by the consumptive and from the dried pulverized expectoration, he regarded dried sputum as the most fruitful source of infection.

The view with regard to the danger of pulverized sputa here enunciated has in one form or another been adopted by a series of writers down to the time of Flügge.

Tappeiner, Thaon, Cornet, and Straus have all supported this view. At this stage it is interesting to note that we now have on record two unintentional but nevertheless crucial experiments on man. The one showing the danger of inhaling artificially sprayed tuberculous sputum; the other showing the deadly character, when inhaled, of powdered tuberculous material.

In the one case Tappeiner lost a servant, who, after carelessly handling the apparatus for spraying tuberculous sputum, was attacked with an acute onset of pulmonary tuberculosis and died. In the other case, Nocard³ relates that Thaon, while experimenting on the effect of tuberculous dust upon animals, himself fell a victim to it, and was seized with an attack of tuberculous broncho-pneumonia, which proved rapidly fatal.

Space will not allow of my dealing with all the experiments made. Many of them are described at great length in Straus's⁴ large work, and I will refer to a few as illustrating this point. Thus Tappeiner used the spray experiments in 1877, in Buhl's laboratory at Munich, and was followed in this form of experiment by Weichselbaum⁵ and Veraguth,⁶ who all obtained positive results.

In 1883⁷ Dr. Arthur Ransome stated that he had discovered by microscopic examination the presence of tubercle bacilli in the expired air of advanced phthisical cases, the vapour of which had been condensed by a freezing mixture. Dr. Theodore Williams⁸ also detected a certain number of tubercle bacilli in the air of the wards of Brompton Hospital.

I now pass on to a series of experiments conducted in the years 1897 and 1898 by a group of observers, the results of whose work are dealt with by Flügge. In 1899 Flügge⁹ published a summary of a series of experiments on the infectivity of phthisis (a) through the inhalation of powdered desiccated tuberculous sputa; (b) through the inhalation of the minute drops sprayed by the coughing, speaking, or similar breath movements of a consumptive patient. In these experiments Flügge was assisted by Sticker, Heymann, Laschtschenko, and Beninde, who worked in his laboratory at Breslau under his directions.

Sticker, after failing in several instances to secure infection by inhalation of tuberculous dust, at length succeeded in animals, almost without exception, when he rubbed fully-dried sputum on a rag or a board and blew with powerful puffs, producing an air current of 1 m. or more per second, and forced the air visibly dust-laden into a confined inhalation space. On the other hand, if he lowered the speed of the current of air to from 10 cm. to 30 cm. per second, although thereby producing an appreciable draught, he did not succeed in any case in creating tuberculosis by inhalation in the animals experimented on.

Cornet¹⁰ also produced tuberculosis by inhalation of dry sputum dust by blowing the infected dust with a pair of bellows into the mouths of some of the animals experimented on, and also by holding others in clouds of dust raised by the sweeping of a carpet covered with dried sputum. The infection of guinea-pigs by inhalation of pulverized phthical sputum, when certain conditions are observed, is now indisputable. But Flügge maintains that

These conditions differ widely from those obtaining in human dwellings. The sputum is scientifically dried; the mass of sputum is relatively large; the pulverization of the dust is effected by exaggerated artificial operations; and very strong artificial currents of air, which are by no means present in living-rooms, transport the dust through a short course into the animals experimented on.

Sticker laid great emphasis on the absolute dryness necessary, and Beninde confirmed this by showing that handkerchiefs soiled with sputum and carried in the pocket for twenty-four hours after use, were not dry enough to yield bacilli when rubbed and exposed to strong currents of air.

On the other hand, it is certain that on dusty floors of insanitary dwellings, offices, and workshops dried sputum dust can be formed, though Flügge urges that this condition does not often obtain to a sufficient extent in dwellings. On this point, Cornet wrote in his first work:

Any one who has himself tried to rub the well-dried sputum into atoms and to pulverize it very finely will agree with me that it is no easy task to produce a really fine powder which remains suspended in the air for some time. The strong statements that have been made up to now—that one has only to rub with the foot on the dried sputum to raise immediately a cloud of dust of infectious germs—are absolutely false.

Experiments with Sprayed Sputum.

Turning now to the experiments with sprayed sputum the results are very different. Numerous experiments by Koch, Gebhard, Preeys, and others were carried out so that the artificially sprayed sputum was introduced into the breathing space of the animals experimented upon—generally guinea-pigs. Infection took place in this way with great certainty, and even with very much thinned sputum. It is interesting here again to recall that Koch, (original essay on the Etiology of Tuberculosis) obtained, in his inhalation experiment with sprayed tubercle bacilli (Experiment 26), tuberculosis in every animal out of 8 rabbits, 10 guinea-pigs, 4 rats, and 4 mice exposed to an infected spray for a period of half-an-hour on three successive days. This deadly effect upon animals of an artificial spray carrying tubercle bacilli has been confirmed by many other observers since.

The next set of experiments deal directly with drop infection. Laschtschenko held a solution containing *B. prodigiosus* in his mouth, and found that by speaking, coughing, and sneezing, these germs were sprayed out and deposited on agar plates which he had placed in front of him at various distances. Laschtschenko then got phthical patients to cough over object glasses on which, in some cases, tubercle bacilli were deposited.

Similar results were obtained in leprosy by Schäffer. Heymann experimented with object glasses on 35 phthical patients, and out of that number 14 (or 40 per cent.) deposited on the object glasses placed half a metre from the coughing patient drops containing tubercle bacilli. The size of some of these bacilli-laden drops was as low as 30 μ in diameter. By several other experiments it was then shown that these drops contained virulent infective tubercle bacilli; and, finally, the "direct infection of experimental animals, through the coughs of a phthical subject" was attempted. Flügge felt the difficulties of this experiment to be so great that he anticipated a negative result. Thus, he points out that

The breath volume of the guinea-pig is at least 100 times less than that of man; if, therefore, here is one infectious bacillus in the quantum of air that a man breathes in the time unit, I shall only have a prospect of attaining with the same air the infection of a guinea-pig when I let 100 guinea-pigs breathe that air.

In spite of this and other objections, positive results were obtained. Out of 25 guinea-pigs, coughed at in a repeatedly

disinfected room by phthical patients, whose clothes were previously disinfected, at distances from 20 to 25 cm., for three hours every other day, 6 died showing symptoms of inhalation tuberculosis. Of these, 2 died in four weeks, 2 in seven weeks, 1 in two months, and 1 in four months.

In conclusion, while admitting the danger of infection from tuberculous dust, Flügge states that infection will occur

Through living together with coughing and drop-disseminating phthical subjects, if frequent proximity to the cougher up to less than 1 metre occur.

In 1901,¹¹ Flügge published a second paper entitled *Further Contributions on the Dissemination and Combating of Phthisis*. In this he states that since his previous publication further experiments had been made by Fränkel, Weissmayr, Engelmann, Möller, and others, confirming the fact that minute drops containing tubercle bacilli are sprayed by consumptives while coughing. Möller also succeeded in infecting guinea-pigs by exposing them to the coughs of tuberculous patients. On these grounds, together with those already referred to, Flügge states that, in his opinion, the minute drops sprayed forth by the cough of consumptive patients have been shown, as fully as demonstration without actual experiment on man can be carried, to be a most fruitful source of the infection of phthisis. He also attributes to the inhalation of dried tuberculous dust a certain amount of infection.

On both drop and dust infection, further experiments by Heymann, Nenninger, and Steinitz, acting under the directions of Flügge in his laboratory, have been made. Heymann¹¹ made a series of experiments to ascertain how the drops sprayed in coughing are distributed in a room. Thus he found that virulent tubercle bacilli were deposited on object glasses up to as far as 140 cm., in front of the mouth of the patient. Occasionally microbe-bearing drops were also found deposited on plates behind the patient.

Heymann next endeavoured to ascertain how long the minute sprayed drops were capable of remaining suspended in the air. This he did by placing a coughing phthical subject into a glass case. In this glass case he put twelve small shallow glass bowls filled with sterile bouillon, they were closed with lead-covered glass tops, lightly sealed with plaster. To these tops strings from outside were attached and the bouillon vessels exposed at different intervals after the patient had left the case. The patient remained in the case, coughing at intervals from an hour and a half to two hours. In two of the bowls opened thirty minutes after the patient had left the case, and which remained exposed for several hours, the proof of the presence of tubercle bacilli was demonstrated by intraperitoneal injections into guinea pigs. This result is the more noteworthy in that the area of bouillon exposed was small.

Heymann next tried to ascertain how long these minute drops remained suspended in moving currents of air. The mouth of an aspirator was inserted into the case, and the air of the case was drawn out and passed through bottles containing sterilized water in a vacuum. The micro-organisms deposited in the water were either examined microscopically, cultivated, or injected into guinea-pigs. The speed of the air current used was 3 m. per second. The aspirator used was furnished with three funnels of entrance, all opening into the case. These funnels by a mechanical contrivance were opened from outside, only one being opened at a time. Through the first air was drawn for an hour while the patient was seated inside, one cubic metre of air being removed from the case in the course of the hour. The result was that out of seven experiments with four patients, virulent tubercle bacilli were twice found in the water. Through the second funnel air was drawn for an hour from the case, the aspiration beginning ten minutes after the patient had left the case. This also was tried on seven occasions. With the third funnel the same experiment was made on four occasions. In neither of the last instances were tubercle bacilli found.

These aspiration experiments, which undoubtedly deserve repetition, still further confirm the fact that tubercle bacilli are to be found in the atmosphere immediately surrounding a coughing tuberculous patient, but as far as they go they do not appear to suggest that a considerable number of the minute drops containing tubercle bacilli remain suspended in the air for an appreciable length of time. As against this, however, we must set the result obtained in the former experiments referred to, which at any rate show that some suspension of these drops occurs.

The next set of experiments were addressed to ascertaining how long the bacilli retain their vitality in (a) artificially

sprayed drops; (b) in the naturally-sprayed drops of tuberculous patients.

In the artificially-sprayed drops, the bacilli retained their vitality in bright light for two days, and in darkness for seven days. In the naturally-sprayed drops the bacilli retained their vitality in bright light for three days and in darkness up to eighteen days. From these experiments, Heymann concludes that, under ordinary circumstances, the bacilli in naturally-sprayed drops do not usually retain their virulence for more than four or five days.

Experiments with Dried Sputum and Dust.

A second group of experiments made by Heymann deals with the genesis and the air-floating properties of pulverized particles of dried tuberculous sputum. Inside the glass case already referred to, Heymann placed carpets soiled with tuberculous sputum and dried. These were beaten and rubbed with a stick, inserted through a cambric screen let into the glass case. Two small cups of bouillon placed in the case were opened while the rubbing was going on, two ten minutes afterwards, the others at intervals of 30, 45, 60, 90, and 120 minutes after the rubbing was finished. The two cups of bouillon opened during the beating gave positive results. All the others were negative.

Similar experiments made with sputum-soiled and dried pocket-handkerchiefs, however, gave positive results with bouillon exposed as late as 60 minutes after the rubbing had ceased—the reason, in Heymann's opinion, being that the particles from handkerchiefs were small and light enough to continue floating in the atmosphere for some time.

A set of aspiration experiments on dust, conducted on the lines already described for the spray, gave the following results: Dust particles beaten up from carpets and boards rapidly fall to the ground, and after ten minutes, with one exception, in thirteen experiments negative results were obtained. With sputum-soiled and dried pocket-handkerchiefs on the other hand, positive results were obtained half an hour after the rubbing had ceased in one out of two experiments made.

From these experiments it would appear that soiled fibres of such materials as cotton or linen are among the most readily floating and dangerous forms of dust. As a matter of fact this experiment fully confirms the statement made by Koch² in his original essay on tuberculosis.

Dust of Rooms and Wards Occupied by Phthisical Patients.

The third group of experiments deals with the presence of tubercle bacilli in the dust of rooms and hospital wards occupied by phthisical patients. Dust was collected with a camel-hair brush from the contact area, that is, the area within reach of the patient, and from beyond that area. For practical purposes the contact area may also be taken as approximately that of the cough infection area. Dust was also collected from these two areas by a wet sponge, which was the method employed in experiments by Cornet. The use of the camel-hair brush ensured the removal of only the lightest and most minute dust particles, while the wet sponge gathered coarser and also adherent particles.

The result of these experiments taken from fifteen different private rooms was that in the case of dust removed with the brush five out of fifty-nine tests gave positive results. Of these two were within the contact area and three outside. From sixteen different hospital wards out of sixty-one tests with the brush five were positive. Of these two were within the contact area and three outside. In the foregoing cases a spittoon was in use in all the hospital cases and in the great majority of the private cases, only one out of the five positive results from the private cases referred to being from a room where no spittoon was used.

In the next set of experiments, where sponges for collecting bacilli were used, many more positive results were obtained, but, as Flüge points out, this is hardly a fair way of estimating the infectious quality of dust, as only dust capable of floating can infect by inhalation, and the sponge removes both coarse and adherent particles. Flüge points out further, though perhaps it is hardly necessary to do so, that the danger in individual cases from tuberculous dust must vary with individual conditions, such as the use or non-use of spittoons, the expectoration on to a dusty workshop floor, and other similar factors.

One practical lesson which the foregoing experiments with tuberculous dust teach is of considerable importance. The experiments in the glass case show that it is only the lightest

and finest dust particles which remain suspended and are capable of inhalation, and such particles as these are formed very largely from the minute traces of tuberculous sputum left on a patient's mouth, beard, handkerchief, bed linen, or clothes, which dry perfectly and readily, thus keeping up some danger of dust infection even where the spittoon is carefully used.

INFECTION IN HUMAN TUBERCULOSIS.

Turning now from this summary of researches and experiments, let us see how the latest views of Flüge, with which Professor Koch personally assured me he was quite in accord, bear upon actual statistics of phthisical cases. For this purpose I have been unable to find any more valuable records than those compiled by different medical officers of health in this country. It is impossible to deal with more than one or two such reports, and for the purpose of this paper I have selected the splendid body of evidence afforded by Dr. Niven's Manchester Report for 1901. In Dr. Niven's work he had the co-operation of four medical assistants—Drs. Coates, M'Leary, Beatty, and Cowie, and from the evidence contained in the Report of the Health of the City of Manchester for 1901, I take the following extract:

The investigations tabulated by the medical assistants on forms which were drawn up as the result of previous investigations show that, corresponding to the scientific facts, there is abundant evidence of exposure to an adequate amount of infection in the case of a large proportion of the consumptives, both at home and in the workshops.

From the report made by Dr. Beatty to the Medical Officer of Health for Manchester (February 2nd, 1902), it appears that out of 1,455 cases visited by the assistant medical officers, there were 1,006 cases in which there was some information available.

A source of infection was detected in 652 out of these 1,006 cases, that is, in 64.8 per cent. Of these 652 sources 467 may be described as probable sources, that is, 46.4 per cent. of the 1,006; and 185, or 18.4 per cent., were more doubtful sources, but still with some degree of probability attached to them.

Among these 1,006 cases, 123 were cases where neither the patient nor a close relative nor an intimate friend was seen, and the information obtained was altogether inadequate to explain the occurrence of the disease; these being deducted leave a total of 883 in which a cause might be found. A source was found in 73.8 per cent. of these 883 or 88 per cent., having a probable source and 21 per cent. a more doubtful source.

There remain 281 cases in which no source of infection could be detected. In many of these cases the patient himself was seen, so that all the information required was obtainable, but in others the patient was not seen, and the relative or intimate friend interviewed could not give the requisite particulars as to the patient's workplace or workmates, and thus an important possible source of infection was left without investigation.

Sources of Infection.

The most common source of infection is a consumptive relative. The cases where this was the presumed source numbered 303. As a rule the patient lived in the same house as the relative mentioned, but examples are given where patient and relative lived in different houses. In most cases the probabilities are decidedly in favour of this being the source of infection, but in others this cannot be said.

Then follow a long list of cases from which I have made an illustrative selection:

Patient Probably Infected by Living in the same House as a Consumptive who was not a Relative.

Case 392.—F., 43. Ill six months. (Investigated, April 16th, 1901). Patient spent a good deal of time sitting with a consumptive patient (case 291, 1899), in this house, who died on November 13th, 1899. (Coates).

Patients who have been intimately associated with Consumptive Relatives though not actually living in the same house.

Case 552.—F., 5. Ill six months. Two aunts have phthisis at present, living in different houses. Patient is constantly visiting one or other aunt. (Coates).

Case 782.—F., 30. Ill six to seven years. Sister-in-law died two years ago after a prolonged illness. She had had cough for many years. Patient often visited her. (B.).

Patients who had been intimately associated with Consumptives who were not Relatives.

Case 231.—F., 56. Ill ten months. A friend died of phthisis a few months ago; she had been ill two years. Patient and she often visited each other. (McCleary).

Case 307.—M., 33. Ill nine months. Patient frequented race meetings. While away from home at these meetings he slept with a man who died of phthisis nine or ten months ago. (Coates).

Immediate Neighbours.

Certain cases appear to have been infected by living next door to a consumptive. As mentioned in the annual report for 1899, this may be due to the fact that "in the processes of removing dust, shaking carpets, and so on, from an infected house, probably the air becomes sufficiently

impregnated with tuberculous dust to infect persons in an adjacent dwelling." It would appear that in New York, which especially suffers from this mode of infection, it is customary to put the bedclothes on the open window to air them. In this group there are 23 cases.

Case 851.—M., 39. Ill four years. Case lives next door, ill eight years. There has been no intercourse between the families, this patient not even knowing of the existence of the other one. (B.)

In all the foregoing cases, with the exception of the last group, of which only 23 instances are given, it will be seen that frequent and actual contact with some one suffering from phthisis was a condition common to them all—in other words, whatever part pulverized sputum may have actually played in the spreading of the infection, there is a history in all but the last 23 cases referred to of the actual respiration of an atmosphere sprayed into in the actual presence of the case by the cough and speech of a phthisical subject. The views held by Professors Koch and Flügge—that infection by "Tropfen-infektion" is a more potent factor in spreading the disease than the infection which arises from desiccated and pulverized sputa—is supported to a considerable extent by this record of Manchester cases.

For instance, let us turn to what Dr. Beatty has to say about house infection. Surely if pulverized, desiccated sputum were the main factor—no one doubts that it is a factor in spreading infection—the record of house infection among these 1,006 cases would be somewhat higher than the following:

House Infection.

In 12 cases patients may have contracted the disease by living in houses which had been infected by previous consumptive tenants. It is rarely that anything is known by the patient or his relatives of the previous occupants of a house in which they have lived. Hence the infrequency with which the disease can be attributed to this cause. A special report on an investigation into the subject was made by Dr. Beatty to the medical officer of health during the year, but this report had no reference—save in one case—to the cases quoted here.

In reference to even these cases it is right to observe that in some there is also the history of contact with a phthisical subject to be noted.

Such then are some of these striking Manchester cases compiled by a body of impartial medical men. They stand like the record of a long series of experiments, and, read with impartiality, in the light of the latest researches, how striking is their testimony. In the laboratory it is true we may set the conditions of experiment, but science should also teach us how accurately to estimate the conditions set by human life and its environment.

CONCLUSIONS.

I will now state briefly my own view of the evidence adduced in this paper.

I hold it conclusively established that both dried tuberculous sputum dust and the minute drops coughed out by the consumptive are capable of conveying infection. The precise proportion which each factor plays in this infection it is difficult to estimate, but there are two points in connexion with the cough infection which, I think, are of special importance.

In the first place, the minute cough-sprayed drop which contains a tubercle bacillus probably in the majority of instances contains that bacillus in a condition of a high degree of virulence. The bacillus contained in the minute sprayed drop comes straight from its natural soil, and is probably more potent as an agent of infection than that contained in the dust particle which had been exposed to desiccation, and in the majority of instances to some degree of light.

Secondly those sprayed drops which fall to the ground, or are deposited elsewhere, although they may not carry with them a large number of bacilli, nevertheless deposit such bacilli as they do carry, under conditions which ensure their rapid desiccation and formation into the smallest particles of dust. These minute drops thus add their quota of bacilli to that quantity of minute dust which alone is capable of inhalation.

With reference to the extent of the infectivity of phthisis, while I hold it to be an infective disease, I do not consider that the degree of this infectivity is a high one. But as against this we must set the fact that phthisis is a chronic disease, and that the chance of conveying the disease often extends over years.

Of those exposed to infection for brief periods only a very small minority are infected. Of those exposed for days, weeks, even months in a small confined atmosphere many escape. Why many escape and others do not escape, has not yet been scientifically demonstrated. But this we know, that the causes of apparent immunity what they may, no

person can develop tuberculosis who is not exposed to the possibility of invasion by the tubercle bacillus.

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HUMAN AND BOVINE TUBERCULOSIS:

THE POSSIBILITY OF HUMAN INFECTION FROM CATTLE.

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DURING the last few years I have had under observation over 2,000 cases of phthisis pulmonalis, and I have been particularly impressed with the fact that the tuberculous process is nearly always confined strictly to the lungs. I have only seen the glands and the joints affected in six cases, and in the late stages one sees the intestine and peritoneum involved. Phthisis pulmonalis is essentially a disease of young adult life. On the other hand, strumous or tuberculous joints, enlarged glands, spinal disease, and abdominal tuberculosis with *tabes mesenterica*, are essentially diseases of infancy and childhood, and are only rarely seen in adult life. It is very rare to see a patient with enlarged glands, strumous joints, or spinal disease develop true phthisis pulmonalis.

Again, I have had the opportunity of seeing over 500 necropsies on cases of tuberculosis, and I have noticed that even the lungs are attacked by two distinct varieties of tuberculosis—one of a slow and insidious nature, the other rapid and acute and generally associated with tubercle in other parts of the body. If one compares the appearances seen in cattle dying with tuberculosis with those of children dying of *tabes mesenterica* and abdominal tubercle the almost exact counterpart is seen; in fact, as Creighton observes, there is an exact mimicry of disease.

From these general clinical and pathological observations I am inclined to think that primary intestinal tuberculosis, *tabes mesenterica*, and other tuberculous affections of the serous membranes in children are probably bovine tuberculosis conveyed by milk, and are not related to human tuberculosis, although the bacillus of Koch is found in them all, and is indistinguishable.

Tabes Mesenterica.

Infants and children suffer from tuberculosis of the intestines and glands, but it is perhaps more common before the age of 1 year than afterwards. In 103 consecutive necropsies of children dying of tuberculosis at the Manchester Children's Hospital, there was tuberculous ulceration of the intestine in 62, cheesy mesenteric glands in 71, and both ulcers and cheesy glands in 55. Ashby states that in at least 70 per cent. of children dying of tuberculosis, disease of the mesenteric glands was present, and in rather more than 55 per cent. tuberculous ulceration was associated with it, and, as he says, primary tuberculosis of the intestine is suggestive of infection by means of tubercle bacilli taken in milk from a tuberculous cow. At the Great Ormond Street Children's Hospital, London, of 254 tuberculous children examined *post mortem*, 151, or 59 per cent., showed cheesy mesenteric glands, and Dr. Still found that in 29 per cent. of cases of tuberculosis in children, primary infection had taken place through the intestine. Woodhead records 127 cases of fatal tuberculosis in children with involvement of the mesenteric glands in 100.

I grant it is extremely difficult to exactly diagnose the onset of *tabes mesenterica*, and it is not to be assumed that a great many of the cases of diarrhoea, wasting, and general marasmus in children are tuberculous, as they certainly are