A Lecture

ON THE

INFECTION OF CONSUMPTION.*

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THERE are few subjects more difficult to deal with than that of the contagion of consumption, and yet there are perhaps none which call for more judicious and temperate handling. It is our duty to do all we can to protect the relations, friends, and attendants of the consumptive from danger, but at the same time we must not unnecessarily vex and harass him by cutting him off from all communication with his fellow beings and reducing him to the miserable condition of the leper of old.

There are many young men and young women in incipient stages of the disease who suffer but little from cough and have no expectoration: these carry out their occupations efficiently, and at the same time, especially if they have been inmates of a hospital or sanatorium for some months, live a hygienic life in their own homes and are gradually advancing to the condition of arrest. They often have been discharged from a sanatorium as fit for work and are probably now not infectious, or if they could carry infection, have been so carefully trained to deal with their secretions that danger from this source is practically eliminated. If, however, alarm is raised in the offices or institutions where they are employed, it might result in loss of occupation to these capable and active workers and their transference to the ranks of the unemployed, which would mean starvation to them. This is a very cruel proceeding, if unnecessary.

I propose in this lecture to examine the various sources of infection in pulmonary tuberculosis and to ascertain to what extent they are elements of causation or spread of the disease.

HUSBAND AND WIFE INFECTION.

Sir Hermann Weber's¹ well-known cases, with those of Musgrave Clay² and of the Collective Investigation Record,³ establish this form of infection beyond all doubt. I would shortly quote Wilson Fox's concise analysis of the evidence on this point, and some of his sensible remarks:

A. One phthisical man married several times, most of his wives becoming phthisical—13 cases.

B. Consumptive man, who died, transmitted to wife, widow infected second husband—3 cases.

C. Man infected wife and died. Widow re-married and also died of phthisis, as did her second husband after he had re-married. His widow lived and also married again, and her next husband died of phthisis.

D. Woman married in succession two phthisical husbands, and became phthisical after the death of the last—2 cases.

E. Wife, consumptive, died, having infected husband, who also infected a second wife—10 cases.

F. Consumptive wife before dying infected her husband, who later infected a second wife. This widow afterwards infected a second husband—1 case.

G. Woman died of consumption. The widower, not stated to be phthisical, married subsequently three other wives: total, four wives, of whom the first, second, and third died of phthisis, but the fourth wife, and apparently the husband, remained free from the disease.

In one out of three cases where consumptives married three wives, one wife survived, and out of nine cases where consumptive husbands married twice, the last wife survived in three instances, giving a total of thirteen husbands to thirty-one wives, of whom twenty-seven died and four lived in apparently good health. It would appear that the infecting husbands were often in an early stage of the disease when infection took place, and some survived their wives by many years.

Of course, in all these cases we must not lose sight of other sources of infection than coition, and must admit the possibility of the people living in insanitary houses containing tubercle bacilli laden dust on walls and floors,

* This lecture was to have been delivered before the International Conference on Tuberculosis at Stockholm in July, but was omitted through the author being prevented by a severe accident from fulfilling his engagement.

due to previous inmates having been consumptive and dirty, and we also know little about the adoption of measures employed to prevent contagion by inhalation or ingestion. In Sir Hermann Weber's cases the husbands appear to have been chronic cases of the disease in a quiescent state, and infection seems only to have taken place if the wives became pregnant, and then the disease assume a very acute form.

INFECTION THROUGH THE AIR PASSAGES BY INHALATION.

This, until recently, was generally accepted as the common method of infection of human beings, but as to the precise material of infection authorities differed, Flügge holding that it is by droplets which the consumptive expels during coughing, sometimes to a considerable distance from his mouth. These contain large numbers of tubercle bacilli, and are carried by inhalation into the smallest bronchia. Flügge⁴ maintains that while infection of the lungs can take place through the ingestion of tubercle bacilli by the stomach, the commonest and most dangerous form is through the air passages. As regards the relative infective powers of pulverized dry sputum and spray, Flügge concluded from his experiments that "infection from pulverized dried sputum is doubtless possible; but it occurs relatively seldom, because particles fine enough to be readily conveyed by air can only be formed from completely dried sputum, and then in very limited quantities." B. Fraenkel's experiments on "droplets" are most interesting, and were carried out with great care.

Heymann carried out a most complete series of experiments to determine the local dispersion and limitation of the sputum drops.

He made consumptives cough on to glass plates, and from 4 patients he obtained abundant tubercle bacilli.

A patient was then placed for one and a half hours in an experimental chamber, in which plates were arranged in different positions to receive droplets. After the patient had left the chamber it was carefully closed and protected from sunlight for some hours. The deposits on the plates were then examined by inoculation experiments.

Where a patient held his handkerchief before his mouth when coughing it was found that out of 36 animals inoculated with material from plates taken out of the chamber, 11, or 30.5 per cent., were infected; and that of 34 animals inoculated from plates taken out of a chamber where the patient did not use a handkerchief, 24, or 70.5 per cent., were infected.

Heymann⁵ found that infected particles are rarely carried more than one metre from the person coughing, so that protection against infection is easy to secure by keeping the patient at arm's length and by the latter using a handkerchief when coughing or sneezing.

The virulence of the tubercle bacilli from the natural spray, if kept in the dark, was lost within eighteen days at the most, but if exposed to the light was lost within three days. Heymann concludes that droplet infection is only operative in circumstances of closest intimacy, as in the intercourse of married people, of mother and child, among attendants on the sick and in factory rooms, workshops and offices. He is of opinion that spray and dust infection are equally important, one form taking precedence over the other according to circumstances.

Cornet,⁶ in 1888, first clearly established that the dust in the vicinity of consumptives, especially dirty ones, frequently contains tubercle bacilli.

In England and among civilized nations more cleanly habits prevail than formerly, but as an instance of what is possible let me quote a letter just received from my friend, Dr. Quevli, of Tacoma:

During my eighteen years' practice in Tacoma, State of Washington, U.S.A., I have had quite a sprinkling of American Indians as patients, and the number of those suffering from tuberculosis was surprising.

My first visit to one of these tuberculous patients convinced me that their present mode of living was to a great extent the cause of it. The Indian to whose home I went was about the most intelligent of this tribe (the Siwash), and the patient was his wife. He, with his wife, two sons, and one daughter, lived in a cabin about 16 by 20 ft., which was their only room. In one corner stood the cooking stove, covered by dirty utensils containing remnants of food, which would be eaten later on. In the middle of the room stood a table covered with dishes, which showed no sign of recent washing. On the floor in one corner lay a mattress covered by a couple of dirty blankets, which served as a bed for the boys, aged 8 and 14, while in

another corner a daughter aged 16 slept in a small wooden bed equally dirty. In a double bed with its head placed in the centre of a wall lay the patient. This bed also served for the husband, and the bedclothes were exceedingly filthy.

The woman had been suffering from tuberculosis for over one year, and she died one month after my first visit. She used no cuspidor, and on each side of the bed were masses of old and fresh sputum, on which swarms of flies feasted. That this patient had not received proper food or care of any kind is a foregone conclusion. I immediately ordered the daughter to scrub the floor; the father and I assisted her. The few extra bedclothes they had were as filthy as those on the beds, so no improvement could be made in that way.

On leaving I gave orders about cleaning and keeping the house in a sanitary condition. I came back in one week, and found that few, if any, of my orders had been followed. On the floor on either side of the bed were masses of sputum, and everything else about the same as before. I made two more visits before she died, but could do very little with them, except to enjoin that they must be careful with the sputum and follow the directions that the doctor usually gives in a tuberculous case.

Within three years the eldest boy and the daughter died of the same disease. I have had very nearly the same experience with most of my other Indian patients, and other doctors have told me that theirs have been about the same.

Tuberculosis is common among the Indians, and still more among the half-breeds of North America.

Most of the Indians, as a rule, besides being filthy, are also very improvident, using their means lavishly as long as they last, and, as a result, often for a long time they must live on poor food. Liquor—when it can be obtained—also plays a big part in ruining their constitutions.

In seven hospitals where consumptives had beds the dust was inoculated by Cornet into 94 animals, and 21.3 per cent. of these became tuberculous. In the dwellings and workplaces of consumptives 62 tests were made on 170 animals, and in 20 per cent. tuberculosis was produced.

Coates⁷ and Delépine found the dust of the dirty houses of consumptives, who used no precautions, capable of inoculating animals with tubercle in 66.6 per cent.

Niven also obtained similar results from the dust of dirty houses in Manchester.

With regard to the above important chain of evidence as to the probability of the infection of human beings through the air passages by inhalation there are two weak points. The proof of infection is based entirely on the inoculation of guinea-pigs, and not on instances of infection of human beings, by the entry of the tubercle bacilli into the air passages, which would be evidence not to be gained. Secondly, we know that tubercle bacilli will enter the nasal cavities of healthy persons, and have been detected there by Strauss, for instance, in students attending the wards of the Charité and Laennec Hospitals in Paris, and among orderlies attending the consumptive wards.

But the tubercle bacilli appear to do no harm to these persons, probably because the constitutional resistance is too great to allow them to settle and multiply, which demonstrates how important a factor in the struggle the resisting power of the constitution or system is, and how much can be accomplished by assisting or supporting the same. When we reflect that the dust in our railway carriages, omnibuses, and trams is found to contain tubercle bacilli,⁸ we must admit that the opportunities of inhaling it are not small.

According to StClair Thomson, in the healthy nose most of the bacteria inhaled are immediately stopped at the nostrils and the penetration of dust into the lungs is opposed in various ways, and is by no means easy. Angles are met with in the nostrils, the nasal cavities, the pharynx, and even in the larynx and bronchi, which oppose the full entry of the dried sputum into the alveoli, but perhaps the greatest protection is to be found in the structure of the trachea and primary bronchi. In the trachea a triple layer of columnar epithelium, the upper one furnished with cilia, promoting a strong outward movement, forms an important defence against intruders. The effect of this is to be seen when a crumb of bread goes the wrong way, or a little dust is inhaled, the reflex irritability is excited, and after a fit of coughing and sneezing the offending particles are speedily expelled.

Many years ago⁹ I made a series of experiments on the introduction of various medicinal substances into the lungs, and I was able to show that it was very difficult to reach the lungs in this way, whereas through swallowing, by the stomach or by hypodermic injection they could be easily reached.

Though it is improbable that inhalation is the principal means of lung infection, there is every likelihood of some infection taking place through the upper air passages, and that the bacilli enter the lymphatics of the mouth and infect the lymphatic glands of this region and the tonsils, which are often the seat of tubercle. The frequent occurrence of strumous submaxillary and cervical glands may be due to this cause.

INFECTION THROUGH THE INTESTINES.

The question of the path of infection in pulmonary tuberculosis, whether by the lungs or the intestines, so ably discussed at the Conference of Tuberculosis at Vienna, has been definitely settled by the epoch-making experiments of Calmette, Guérin, and Breton, extended by Vansteenberghe and Grysez, and confirmed by a most interesting series, carried out on guinea-pigs, by Sir William Whitla and Professor Symmers of Belfast.¹⁰ Finely divided emulsions of living bacilli ground up in an agate mortar with decoction of linseed were injected into guinea-pigs' stomachs, and were absorbed by the intestinal surface, producing extensive tuberculous deposits in the mesenteric glands, in the lungs and other viscera. When the animals lived beyond thirty days, the lungs were invariably found to be studded with caseous tubercle, and the broncho-tracheal glands also suffered. In the guinea-pigs which survived the injections from fifty to sixty days, the deep cervical glands were nearly always found to be decidedly tuberculous.

The involvement of the cervical lymphatics is of the utmost importance, as the usually accepted theory is that when these glands are found to be tuberculous in the human subject, they prove that the bacilli have effected an entrance through the mucous membrane of the mouth, tonsils, or pharynx. A subsequent experiment by Calmette and his fellow workers, of injecting tubercle bacilli through a tube into the stomach of a guinea-pig, and killing the animal in ten days, showed the infection of the whole lymphatic system.

We know now, from the researches of Nicholas and Descos, Ravenel, Römer, von Behring, and others, that the tubercle bacillus can pass through the intestinal mucous membrane without causing any lesion or leaving any local evidence of its point of entrance.

Thus the possibility, and, indeed, probability, of the lungs and lymphatic system being infected through the intestines is proved without doubt, and the converse—that is, the improbability of lung infection by inhalation—is shown by an instructive experiment by Vansteenberghe and Grysez, who submitted rabbits and guinea-pigs to an atmosphere laden with fine carbon particles by keeping them in a glass cage in which a lamp fed by turpentine was burning. The upper air passages were found laden with carbon, some of which had also found its way into the pulmonary alveoli when the experiment was of long duration, but in no case was carbon found in the parenchyma of the lungs, and in the rabbit, which breathes through the nose, the carbon particles were never found to have reached even as far as the trachea. In another experiment with the carbon vapour one bronchus was plugged with cotton-wool and the other left free. The animal was exposed to a prolonged inhalation of carbon dust with one lung shut off from the air and the other exposed to it. The animal was killed and both lungs carefully examined. It was found that the free lung showed carbon deposits in the bronchi and in the external portions of the alveoli, whilst the lung isolated from the carboniferous atmosphere manifested intraparenchymatous deposits, the alveoli and bronchi being free.

These observers were therefore justified in their conclusion that physiological anthracosis is due in such cases to intestinal absorption of particles arrested in the nasal and pharyngeal passages and afterwards swallowed with the saliva and nasal mucus, to be carried to the pulmonary parenchyma by the blood stream.

The most important item in this form of infection is that of milk and meat, and after the conclusive evidence of the British Royal Commissioners, confirmed by numerous other authorities, there can be no longer any doubt as to the danger to the human body, and especially to children, from bovine tubercle bacilli contained in milk. The danger of infection from the meat is not so great.

INFECTION THROUGH THE SKIN AND MUCOUS MEMBRANES
BY WOUNDS.

This is not a common method of infection, but sundry cases are on record which prove its possibility and indicate the undoubted danger from that source. A well-known instance was that of a nurse who accidentally cut her hand when she broke a spittoon containing tuberculous sputum, and was infected therefrom, and died eventually of phthisis.

At all the consumption hospitals certain porters are told off to destroy the sputum and sterilize the vessels containing it. In spite of every precaution being taken to prevent infection, these men occasionally get infected, generally through neglect of the proper precautions. At the Brompton Hospital there have been several cases, of which Mr. Stanley Boyd has published some examples;¹¹ later on I will give some cases.

HOSPITAL INFECTION.

In August, 1882, shortly after the discovery of the tubercle bacillus by Koch, I read a paper at a meeting of the British Medical Association at Worcester on the "Contagion of Phthisis," which was¹² afterwards reprinted and had a large circulation. It was also translated into various languages. The paper contained the experience of the Brompton Hospital staff as regards the infection of phthisis for the first thirty-six years of the hospital's existence, the statistics being prepared by the late Dr. Cotton, Mr. Virtue Edwards, and myself, and related to several hundreds of individuals. This paper was very well received at the Worcester meeting, and at a later date was quoted by Dr. Wilson Fox, Professor von Hirsch, and Dr. Bulstrode as sound evidence on the subject.

Dr. James Andrew gave similar evidence with reference to the staff of the Victoria Park Hospital, and Dr. Robertson as regards the Ventnor Hospital, Isle of Wight. I was under the impression that the evidence of these great institutions, the largest in England, carefully collected by skilled observers, and all coinciding in the same conclusions, had settled the question of the rarity of infection to the resident staffs of hospitals from consumptive patients, but Dr. Arthur Newsholme, in a recent work,¹³ has thrown doubt on these statistics as proofs of the rarity of infection in hospitals, and describes them "as examples of investigation in which the data are, possibly owing to insuperable difficulties, incomplete, and insufficient to justify any dogmatic statement."

I will now deal with that phase of Dr. Newsholme's objections which calls in question the after-histories of the Brompton Hospital staff. He says: "It is not certain how thoroughly the subsequent history of workers in those hospitals was traced. It is likely that such workers as had died were less completely traced than those still alive."

My paper states: "Of the four resident medical officers who have held office from 1846, when the hospital was founded, to 1882, all are alive and tolerably well. Mr. Virtue Edwards held the post for twenty-five years without any symptoms of lung disease, and still enjoys good health. Of the others, two showed at some period of their residence signs of hospitalism but none of consumption."

As regards the clinical assistants, or, as they are now called, "house-physicians," I state that of 150, 8 became consumptive at some time or another of their lives, and 5 died. The histories of the first 75 were traced by Mr. Virtue Edwards, who knew most of them during his long term of office, and kept them in view afterwards, and are as follows: Of the first 16, 1 became consumptive, of the next 59, 4 became so, but none of them, according to Mr. Virtue Edwards, showed any sign or symptoms of the disease during their residence of six months in the hospital. The history of the last 75 was investigated by myself, and I traced them all but 3. Of these 72, 1 had died from other causes than tuberculosis, 2 had died of consumption; the first of these had hæmoptysis previous to residence, and in the other case the disease came on one, if not two, years after leaving the hospital, the clinical assistant being quite well during his term of office. Another, who was overworked, became consumptive while in the hospital, but has since recovered. "The remaining 69 (including the last mentioned) are all

well, and actively engaged in practice, many of them holding distinguished positions in the medical profession."

I do not propose to go into all the categories of those serving the hospital, but I think enough has been stated to prove that the evidence at my disposal was sufficient, and that the after-history of all these members of the resident medical staff was, with few exceptions, carefully and successfully traced.

It is quite possible that some of the 8 cases of consumption among the 150 house-physicians were due to hospital infection which developed at a later date, but what is that number in proportion to the total?

It would have been impossible to have investigated the after-history of many of the resident staff, if the hospital had not had the advantage of Mr. and Mrs. Virtue Edwards's valuable assistance, the former having been resident medical officer for twenty-five years, and the latter matron for twenty-four years, both keeping records of almost all the members of the staff and household.

Professor Cornet¹⁴ also objected that the numbers of our statistics were too small, and that in the second place the persons constituting the material were kept under observation for far too brief a period. I cannot admit that 377 is a small number of persons to be exposed to infection, most of them for years, and the critics seem to have overlooked the fact that all the medical officers held office for at least six months and many much longer, and that we gave a complete history of the majority up to date.

I propose now to give some statistics of the Brompton Hospital medical staff resident since 1882, the date of my previous paper.

The hospital has largely increased its number of beds, and instead of 240 beds, to which my last statistics related, it numbers 318, while the Frimley Sanatorium has added another 140 beds, making a total of 458 beds. This increase in the patients has necessitated augmentation in the resident medical staff at the hospital and of new appointments at the sanatorium.

It is impossible to give complete statistics of the nurses and servants on account of their short periods of service and the frequent changes. There are, however, a number of nurses, and especially of sisters, who have been in the hospital for many years, some twenty-five, some twenty years, and the occurrence of infection of phthisis among them is almost unknown, but the newcomers do not remain long and are difficult to trace. I do not, therefore, intend to include the nurses, but to speak chiefly of the medical officers.

Resident Medical Officers.

Since 1882 there have been eleven whose period of office has varied from one to five years. Two have died, one from brain disease during residence, and one from pneumonia several years after leaving. The rest are well and actively engaged in different departments of practice, never having shown any symptoms of consumption either during their term of office or subsequently.

Assistant Resident Medical Officers.

Omitting those who only held office as substitutes or for quite short periods, there have been fourteen since 1882. The duties of this officer are to assist, and if needs be to act as substitute for, the resident medical officer, to assist in *post-mortem* examinations, and to draw up the hospital medical reports.

The assistant resident medical officer is generally selected from former house-physicians. None of the fourteen died during their residence in the hospital, which varied from three months to five years, but one contracted phthisis from a *post-mortem* wound during his term of office, and recovered completely under sanatorium treatment.

Five at a later date became resident medical officers, and of these two died (not of tuberculosis), but their deaths are included in the statistics of resident medical officers. The rest are all living, and busily engaged in the practice of their profession.

House-Physicians and Clinical Assistants.

Since 1882 there have been 181 of these officers, who are young qualified medical men residing in the hospital for six months, and during that time engaged in the treatment of patients and in recording cases.

I have succeeded in tracing 176 out of 181, and so will confine my statistics to this number.

None of these house-physicians died or showed symptoms of consumption during their residence, but in some instances they became consumptive later. Twelve have died since quitting the hospital—1 of apoplexy, 1 of appendicitis, 2 from enteric fever, 1 from pneumonia, 1 from pleurisy and pulmonary oedema, 1 from septic poisoning after a dissecting wound, 1 from an overdose of morphine, 1 from causes not tuberculous. One became resident medical officer and died from an acute non-tuberculous brain attack. Two became medical officers of a Poor Law infirmary and of a hospital respectively, and both died of phthisis some months after leaving the Brompton Hospital. It is possible the disease may have been contracted at Brompton, or else in the hospital and infirmary in which they died, in both of which institutions cases of advanced consumption were admitted. One house-physician became consumptive fourteen years after residence, and has quite recovered. Another became consumptive four years after leaving the hospital, and has recovered.

At the Frimley Sanatorium, opened five years ago, there has been one medical superintendent and four assistants in succession, all of whom enjoy good health. They have held office on an average for one year.

Porters.

There have been 57 resident porters and 79 non-resident since 1882, and of this number 6 have become affected with consumption and 3 of these have died. Three porters are told off to assist in the sterilization of the linen and in the destruction of the sputum, and are called sterilizing porters, and the three deaths include two of these, of whom I will give a typical case later. The other porters are employed in various occupations, but whether resident or non-resident, they all have to go into the wards from time to time to carry food, medicines, parcels, and at times patients. One porter acts as storekeeper, and of these storekeepers two in succession have been attacked with consumption and one died. The present storekeeper has been affected, but has recovered and has returned to duty.

Pathologist's Assistants.

These assist the pathologist in performing autopsies and making preparations for the museum. There have been four since 1882, of whom one has been affected with consumption, whose case is given below.

Physicians and Assistant Physicians.

There has been no case of consumption among the physicians since 1882; among the assistant physicians one has died of consumption. His lungs were affected before he was appointed, and he was only a few months in office.

Dispensers.

There have been twenty-three dispensers since 1882. These have to supply medicines to the out-patients through a hatch wall, and have nothing to do with the in-patients, as the medicines are conveyed to the wards by nurses and porters. None of these have been infected.

I will now give details of the two cases of infection alluded to before.

CASE I.

Alfred B., aged 41. No consumption in family.

History.

For twelve years served in the navy, and during the last seven years has been indoor porter at the Brompton Hospital, and enjoyed good health till February, 1908. His duties lay principally in the sputum and sterilizing departments, which he entered in April, 1906, and these duties were (1) to carry the mattresses of patients who had died of phthisis and the sheets and bedding of bad cases from the wards to the disinfectant, all these being conveyed in bags, passed through the sterilizer, and returned to the wards in bags. Here the only possible period of infection was when these articles were removed from the bags and passed by hand into the sterilizer. The trays for the sputum cups were also placed in the sterilizer. (2) On Sundays (that is, on two out of every three) he had to remove the sputum

cups from the galleries and convey them by lift and trolley to the sputum room. There the sputum was emptied from the cups into the steam boiler, and the cups having been washed with soda and water, were all sterilized by steam. For the handling of the cups india-rubber gloves are provided, and B. maintains that he always used the same.

In February, 1908, he complained of pains in his back, and was treated by the resident medical officer, Dr. Shrubbsall, for lumbago, which subsided under appropriate treatment. He remained at work till June, when Dr. Shrubbsall saw him again, and, examining his chest, detected slight signs of tuberculous disease. He was ordered to bed in the hospital, though he had no cough, and after two months' treatment he greatly improved, and gained 5 lb. in weight. In August he was sent to Frimley Sanatorium, where he remained four months, and, being put on walks and graduated labour, rose to the third standard of the latter, and was discharged as fit to return to work. At the end of November, 1908, he resumed his duties at the sterilizer and in the sputum room, and remained at this occupation till February, 1909, keeping well, but was then transferred to the lighter and more wholesome occupation of cleaning windows and sweeping the garden walks. Cough commenced during his stay at Frimley, and has continued ever since.

Present Condition.

He is much emaciated, especially over the thoracic walls. The chest is narrow and poorly developed. There are hectic spots on the cheeks, though the mouth temperature is subnormal, 97.1° F. Appetite good. Weight, 9 st. 2 lb. Pulse 96. Deficiency of movement over the front chest. On the right side of the chest crepitation is heard to the fourth rib, also above the scapula; dullness and bronchophony are detected to third rib. On the left side there are some wheezing sounds, but no dullness. Crepitation under the left clavicle can be detected.

This is a remarkable case of infection, because there is no proof, in spite of his occupation, of any wound in his hands through which the system might become infected. Infection must therefore have taken place through the lungs or stomach, by inhalation or swallowing the dried sputum. After the experiments of Ernest Oberworth and Lydia Rabinowitsch¹⁵ on sucking-pigs, which show that tubercle bacilli pass directly from the intestines into the lungs, it is more probable that infection followed the swallowing of dried and powdered sputum rather than inhalation of the same, but we must not lose sight of the possibility of infection by the skin in a case where the hands come into play.

CASE II.

J. M., aged 71, formerly in the Indian Army Medical Service and for twenty-one years assistant to the pathologist of the Brompton Hospital. Here his duties consisted of performing autopsies, and specially of opening and sewing up the bodies of consumptives and others who had died in the hospital, and also of staining specimens of sputum and cutting lung sections. In the examination of the tuberculous sputum one day, to quote Mr. Stanley Boyd's excellent account of the case,¹⁶ "he employed a steel pen to spread it upon a covering glass, and left it projecting beyond the edge of the table and brought his hand forcibly against its point. The nib was driven into the proximal end of the flexor sheath of the ring finger. This occurred in the middle of June, 1900. He immediately tried to introduce fuming nitric acid into the wound caused by the pen, and possibly disinfected the surface by this means but not the depths. A hard lump gradually formed in the palm and extended down the ring finger, which became flexed, stiff, and painful. He was treated by means of a palmar splint, and was sent to Brighton for some weeks." He did not improve and returned to London.

In August Mr. Stanley Boyd found the finger contracted, and that the middle and little fingers also were being drawn down into the palm. "A long, low, tense swelling occupied the whole length of the flexor sheath of the ring finger. The diagnosis was tuberculous teno-synovitis." Mr. Boyd split the tendon sheath almost completely open and cut down on to a quantity of granulation tissue, which showed no cheesy degeneration and was not vascular. The whole of this was removed and pure carbolic acid applied to the surface of tendon and sheath. He also removed a superficial gland. The result was absolutely satisfactory. Six months after the operation he was quite well, and although extension of the finger was somewhat limited by the long longitudinal scar on its palmar aspect, he enjoyed fair use of his fingers, and there had been no recurrence of the disease. A section of the granulation tissue removed showed several giant-cell systems in great perfection.

In April, 1904—or nearly four years from the date of the infection—cough and expectoration came on, attended by general malaise though not by fever, and he was admitted into the Brompton Hospital in May, when the sputum was found to contain tubercle bacilli. He had wasted very much. He improved considerably, gained flesh and strength, and after ten months' residence was discharged free from cough. The sputum had been examined several times, with negative result.

May 18th, 1909. I examined M. and found him fairly well. He had retired on a pension from the hospital, and seldom had

cough or expectoration; the last specimen, examined some months ago, gave negative results. His weight was 10 st. 8 lb. The left chest gave a smaller measurement than the right by $\frac{1}{2}$ in. at the level of the third rib, and of 1 in. at the level of the fifth rib. There was marked dullness in the first interspace on the left side and bronchophony from the clavicle to the third rib. The palmar cicatrix was quite healthy.

There is but little doubt that this man was inoculated by the pen containing sputum, and that he suffered afterwards from tuberculous teno-synovitis, for the tissue removed by Mr. Boyd was of a distinctly tuberculous character—witness the giant cells found therein—but the curious feature of the case was that nearly four years elapsed before the lungs showed any symptoms of being attacked. We are driven to one of two conclusions: Either that the infecting material—that is, the tubercle bacillus—had been carried to the lungs through the lymphatics, and had remained dormant for years, until a depressed condition of the patient determined its manifestation, or that there was altogether a fresh infection.

Either of these is possible. In favour of the first there are many instances of caseous lymphatic glands being found in autopsies, which have given rise to no symptoms during life, and whose existence was unsuspected, and we know that the connexion of various parts of the body with the lungs through the lymphatic system is intimate and extensive. In favour of the second, it must be admitted, a pathological assistant at a hospital for consumption has abundant opportunities of fresh infection unless he scrupulously observes every precaution. The use of india-rubber gloves, which are indispensable, is not always carried out, and operators, when they want a firm grip of certain parts of the cadaver, sometimes for a while dispense with them, thus exposing themselves to grave danger. There are many instances of infection of the tendons of the hands with tuberculosis where a servant has broken the sputum receiver of a consumptive and got some of the sputum into her hand, and I would refer you to Mr. Stanley Boyd's paper for the same.

But to return to the Brompton statistics for the last eighteen years. Among the resident medical officers there were no cases of consumption; among the assistant resident medical officers one (from inoculation), and among the house-physicians none were affected during residence. Two subsequently died of acute phthisis, when holding resident appointments in hospitals where cases of consumption are admitted, and one was attacked with consumption fourteen years after he left the hospital, and recovered.

The figures do not testify to much danger of infection to those who have the care of consumptives, but show that with proper precautions such service is quite safe. At the same time occurrence of tuberculosis among the porters, especially among those who handle the sputum, demonstrates where the true danger lies, and inculcates the importance of dealing effectually with this element of danger.

These statistics are even more favourable than those of the Brompton Hospital published by me in 1882, and this might be expected under the circumstances, as the hospital has greatly improved its accommodation and built a fine sanatorium for early cases.

Saugman¹⁷ gives some valuable statistics as regards infection of medical men engaged in sanatorium work, and he notes that in answer to inquiries he found very few medical men wore masks or took special precautions during the throat and lung examinations of their patients. Saugman applied to 112 institutions, and received answers from 65 sanatoriums in Germany, France, Austria, Hungary, Switzerland, Norway, Sweden, Holland, and Finland. Saugman only included doctors who had resided in the sanatorium and treated patients for at least three months, and he excluded six who were exclusively engaged in bacteriology. Out of 289 from whom he could obtain information, 107 had been previously tuberculous and 182 regarded themselves as healthy. Saugman excluded from his figures any doctor who had been tuberculous before entering the sanatorium, if the disease had shown a fresh outbreak in the sanatorium. Of these 107 old cases of tuberculosis 1 died of cancer of the sternum, 16 died of tuberculosis, 9 still show signs of tuberculosis, and 73 are healthy. The average period of duty of these doctors in an institution was three and a half years, and the average period under

observation till death, or up to 1902, the date of the report, was six and a half years. Among these old cases of tuberculosis was one in which fresh symptoms appeared while in the sanatorium, which were found to be due to the presence of the Timothy bacillus, not of the tubercle bacillus. There was one instance of fresh infection in a second medical officer, who had laboured nine to ten hours a day for two and a quarter months among very bad cases. Of 174 healthy doctors who had spent an average of three years in a sanatorium and whose after-history was traced for three and a half years, 2 or 3 were attacked with tubercle but quite recovered, and not one had died of tuberculosis; 5 died of other diseases, and 166 remain quite healthy. Saugman also gives statistics of 66 throat specialists from eight clinics, from which he had obtained facts. One previously tuberculous is, after seventeen years of great activity in laryngeal practice, in excellent health. The rest have been for a period of four years engaged in laryngeal work, and have never suffered from tuberculosis.

The result of these statistics showed that two or at most three of the 174 sanatorium doctors were affected with tuberculosis—that is, 1.78 per cent.—and none of the sixty-four laryngologists suffered at all.

I have reviewed the principal methods of infection in consumption and endeavoured to assign to each its proper value as an etiological factor, but when this is accomplished, it will be found that there is something behind all these factors, in the individual strength of constitution, on which mainly depends the question of infection or non-infection. The healthy individual can defy the tubercle bacillus, the same person depressed by want, impure air, or recovering from acute disease cannot, and falls a victim to his attack. But under improved conditions his constitution may rally, and after a long struggle overcome and expel the invader.

Concerning the sources of infection, ingestion of tuberculous material by the intestines is the commonest, inhalation by the air passages comparatively rare, except that which occurs in the upper air passages, affecting the lungs through the lymphatics. Infection through wounds of the skin and mucous membrane is not common, but occurs among those who handle sputum and other tuberculous material where proper precautions are omitted.

Infection by coition, though it occurs occasionally, is rare.

Finally, all infection from consumptive patients can be avoided if the well recognized precautionary measures are adopted and carried out thoroughly.

I must thank several former resident medical officers, Drs. Waugh, Felkin, Paterson, and the present resident medical officer, Dr. McNalty, with the secretary, Mr. Frederick Wood, for much assistance in the preparation of the recent Brompton Hospital statistics.

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NEXT year a Japan-British Exhibition will be held at the White City, Shepherd's Bush, and an appeal, signed by Prince Arthur of Connaught, Honorary President, and the Duke of Norfolk, President, has been issued to British manufacturers and art owners to help in making the exhibition representative.

AMONG certain new regulations issued by the Board of Health in Boston, U.S.A., relative to the conduct of the milk trade, is one which provides that on and after January 1st, 1910, all milk sold elsewhere than in hotels and restaurants shall be delivered in tightly-capped receptacles of a pattern approved by the board. Another regulation, which comes into operation immediately, forbids the sale of milk in the same room in which it is bottled, and prohibits any mixture of milk with skim milk or condensed milk, or water, for the purposes of sale, except in the preparation of modified milk.