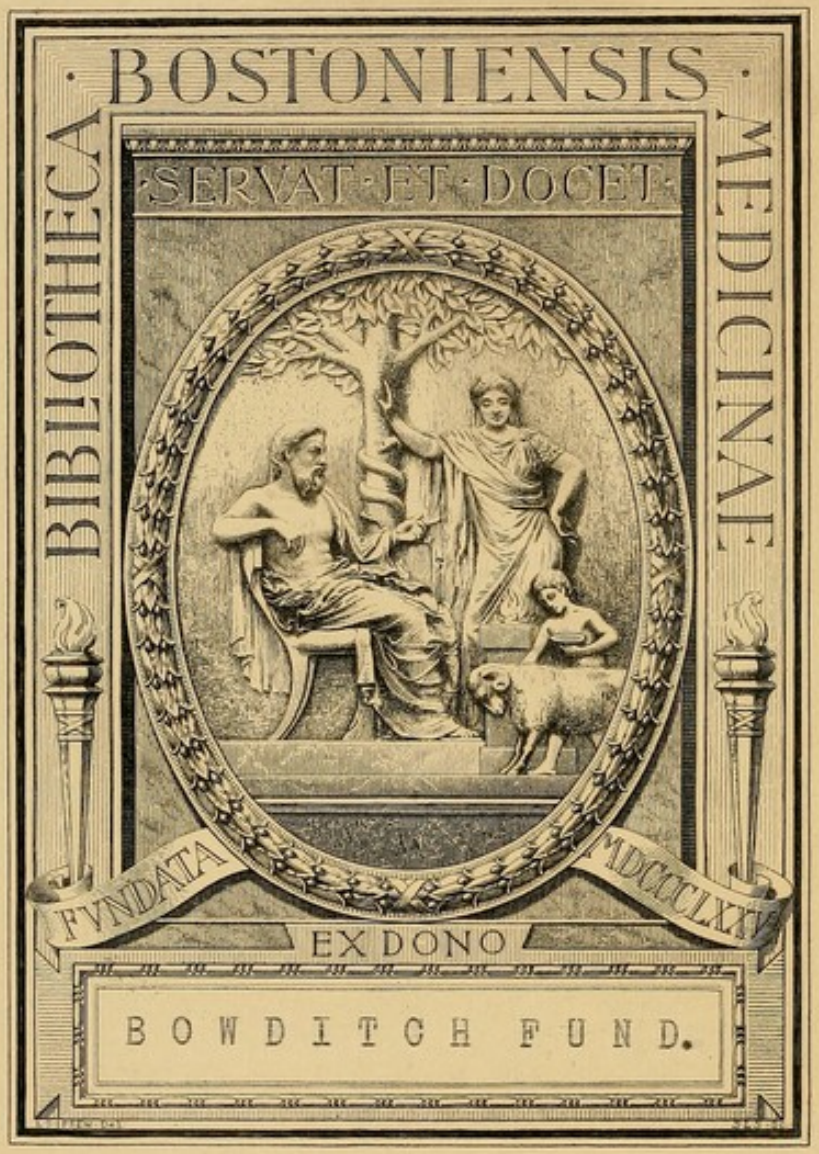
The channels of infection in tuberculosis : together with the conditions, original or acquired, which render the different tissues vulnerable / by Hugh Walsham.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THE CHANNELS OF INFECTION IN TUBERCULOSIS

Together with the conditions, original or acquired, which render the different tissues vulnerable

BEING

THE WEBER-PARKES' PRIZE ESSAY

1903

BY

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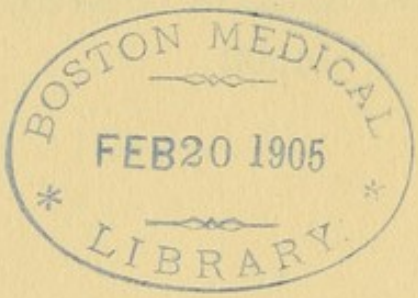


TO

EUSTACE SMITH, ESQUIRE, M.D., F.R.C.P.

PHYSICIAN TO HIS MAJESTY THE

KING OF THE BELGIANS

AND CHEVALIER OF THE ORDER OF LEOPOLD;

CONSULTING PHYSICIAN TO THE CITY OF LONDON

HOSPITAL FOR DISEASES OF THE CHEST;

SENIOR PHYSICIAN TO THE EAST LONDON HOSPITAL

FOR CHILDREN;

THIS ESSAY IS DEDICATED

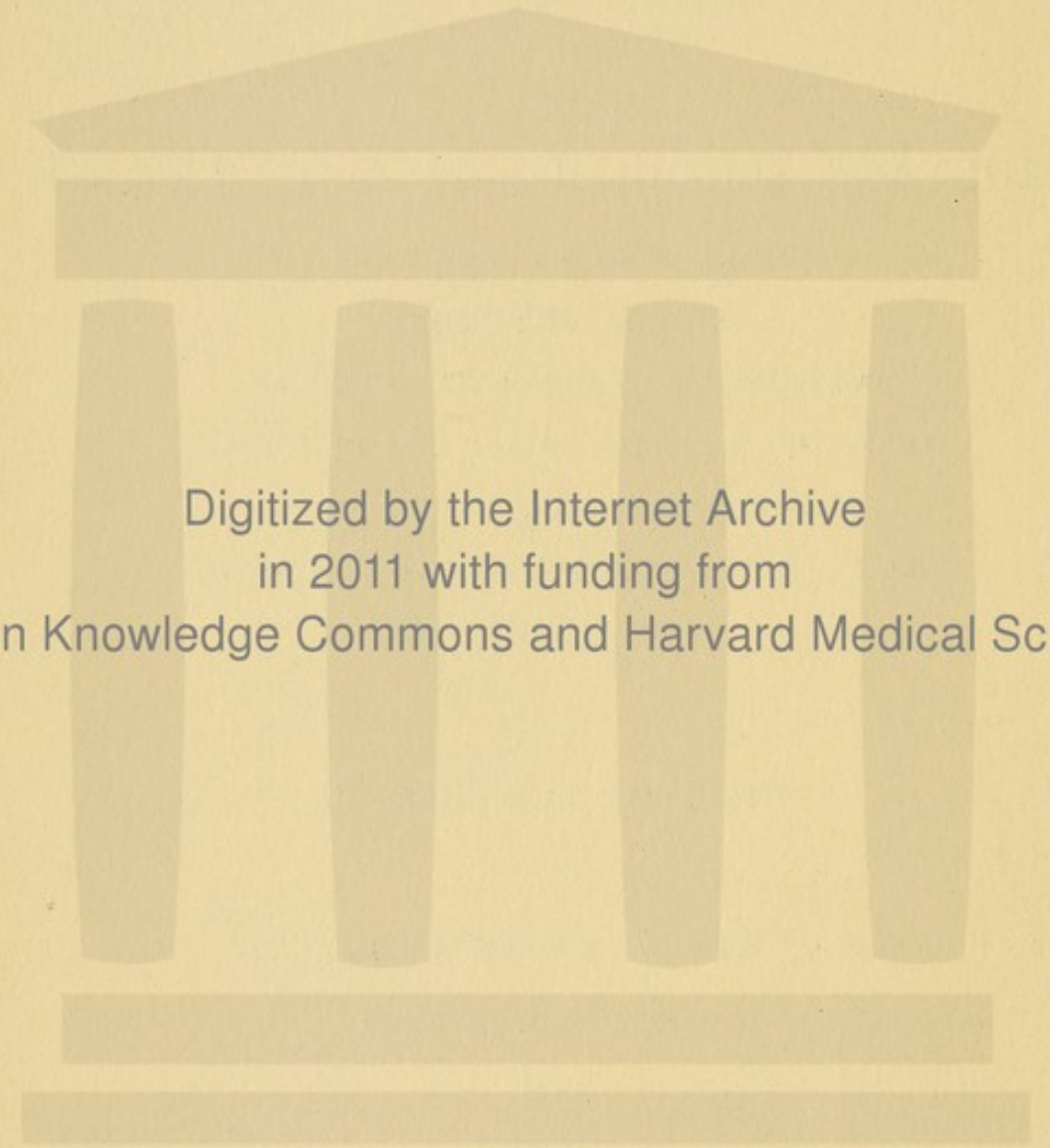
IN

GRATEFUL REMEMBRANCE

OF MANY ACTS OF KINDNESS

TO ITS

AUTHOR.



INTRODUCTION.

THE regulations for the Weber-Parkes' prize, issued by the Royal College of Physicians of London, state :— That the prize will be awarded triennially to the writer of the best essay upon some subject connected with the etiology, prevention, pathology or treatment of tuberculosis, *especially with reference to pulmonary consumption in man.* That the competition be open to members of the medical profession in all countries; that the essays be type-written, and in English, or if written in a foreign language, be accompanied by a translation into English; that the next award under this foundation will be made in 1903, and that the adjudicators have selected as the subject of the essay for this occasion :—

"The Channels of Infection in Tuberculosis, together with the conditions, original or acquired, which render the different tissues vulnerable."

It is further stated :—That in making the award the College will have regard to careful collection of facts and original research. That in the case of original work, anatomical or pathological preparations made in illustration of the subject should accompany the essay.* That each essay bear a motto, selected by the writer, who shall insert his name within a sealed envelope

* The Essay was illustrated by 280 microscopical preparations.

having the motto on the cover, the envelope being transmitted with the essay to the Registrar, who shall return the unsuccessful essays to their authors.

It may be assumed, I think, that in this essay the results of the observation of the essayist himself are what are chiefly required. I shall, therefore, mainly dwell upon what I have myself carried out, but without wishing to attribute to it any undue importance.

The subject naturally falls into two parts :—

First, the Channels of Infection.

Secondly, the Conditions, original or acquired, which render the tissues vulnerable.

PART I.

THE CHANNELS OF INFECTION.

THE

CHANNELS OF INFECTION IN TUBERCULOSIS.

PART I.

THE CHANNELS OF INFECTION.

It was always my earnest endeavour, while holding the office of pathologist to a Consumption Hospital, to trace out, as far as possible, the channels of infection in every case of tuberculosis that came under my observation for *post-mortem* examination. The number of *post-mortem* examinations available for this purpose are 200, not a large number certainly, but sufficient perhaps to enable me to draw some conclusions as to the channels of infection in some of these autopsies.

Before Koch's discovery of the specific organism of tuberculosis—the tubercle bacillus—any attempt to trace successfully the channels of infection in the human organism would have been impossible.

Even now, in the light of recent discovery, it is often very difficult, and in certain cases absolutely impossible, to trace out the infecting channel. In the

more chronic cases of tuberculosis, so many organs are affected, and in such varying degree, that the portal of entry and the channel of spread is completely lost. There still remains much to be worked out. We know not, for instance, why the bacillus selects certain tissues of the body to grow upon, while others remain almost immune ; why, in some cases, the bacillus remains localised in some one focus, such as a particular set of glands or a joint, while in others it spreads diffusely. The portal by which it gains entrance to the body in tuberculosis of deep-lying parts, is, in many cases, hard to ascertain. Before making any attempt, however, to trace out the channels of infection it will be well, I think, to consider a few facts in connection with the tubercle bacillus itself. This organism is too well known to require any description here, but we must remember that recent research has shown that there are many more acid-fast bacilli other than the tubercle bacillus. Only one of these need detain us — the Timothy grass bacillus. This will grow at the same temperature and produce the same lesions as the tubercle bacillus, but Moeller, its discoverer, finds, by virulence and culture character, that it is not the tubercle bacillus, nor is it convertible. These pseudo-tubercle bacilli have frequently been found by Dr. Moeller not only in sputum from the lungs, but also in mucus from the nose and pharynx and in secretion from the tonsils. The other acid-fast bacilli, morphologically resembling the tubercle bacillus, require only to be mentioned, such as the bacillus lepræ, bacillus smegmatis, important in the differential diagnosis of genito-urinary tubercle, and those from milk, butter and manure. The existence of these forms makes us cautious in giving a positive diagnosis of tubercle

bacillus from microscopical examination only. But for human tubercle, especially phthisis in man, the existence of these pseudo-forms does not affect the microscopic methods of diagnosis. There are three other conditions of the organism requiring notice which have a bearing on the channel of infection, viz. :—

(1) The tubercle bacillus is immobile.

(2) It is of very slow growth.

(3) It produces very varied tissue-changes in those places where it locates itself.

(1) The immobility of the tubercle bacillus would appear, at first sight, to make it easy for us to trace out its spread through the body. We might suppose that its propagation by wandering cells would be a perfectly passive one in the blood or lymph streams. But there are facts which go to prove that the bacillus may and does, in the lymph paths at any rate, and perhaps also in the walls of the smaller blood vessels, extend itself against the blood and lymph streams. Again, renal tuberculosis may apparently originate from a tuberculosis of the lower genito-urinary organs by the bacillus making its way up the ureter—that is, in a direction opposed to the flow of urine—just as in septic disease. It is obvious that the propagation of the bacillus in a direction against the blood or lymph streams must greatly complicate the task of tracing out the infecting channel. I shall return, however, to this question later in my essay.

(2) The tubercle bacillus is of very slow growth. This fact no doubt accounts for the slowness of its spread from its original focus in some cases of the disease, and is of very great importance in the differential diagnosis from the pseudo-tubercle bacilli above mentioned.

(3) The tubercle bacillus produces very varied

tissue changes in those organs in which it locates itself. The presence of the tubercle bacillus or of its involution products in an affected part, and more especially its inoculability upon a fresh host, are the great criteria by which we are enabled to pronounce upon the tuberculous nature of a given tissue or organ. Of these the inoculation method is far the best, because we frequently find morbid products in the tissues and organs of the body which, from their histological features or degenerative changes, we should pronounce to be tuberculous (such as some miliary granulations in the lung and peritoneum, in lupus and in certain cases of bone disease), yet in which it is impossible to demonstrate the specific bacillus with the microscope, though they, nevertheless, respond to the inoculation test. It is maintained by Watson Cheyne and others that, in bone lesions at any rate, the tubercle bacillus passes into a state in which it fails to re-act to staining re-agents, but yet is in a sufficiently virulent condition to produce a tuberculous eruption when introduced into the body of a suitable host. Klein and, still more recently, Marmorek have shown that quite young tubercle bacilli are non-resistant to acid and alcohol.

Now, obviously, it is absolutely essential to come to a clear understanding as to what changes in a tissue or organ are to be considered tuberculous or not before we can hope to be able to trace out with any degree of precision the channels of infection.

Strange as it may seem, doubts appear still to exist as to the identity of the so-called scrofulous gland and tubercle. Professor Clifford Allbutt writes thus: "Whether scrofula is always due to this bacillus (that is, the bacillus of tubercle) or always associated with it, is not yet decided. Almost up to this moment the penetration of the microbe into the tonsil and its implan-

tation thence into the cervical glands has been a matter of doubt. It seems probable that scrofula may arise by the agency of microbes other than tubercle, again originating independently of tubercle, on it tubercle may afterwards supervene, and once more that scrofula may be due to tubercle primarily or exclusively."

Again, doubts have existed, and still exist, as to the identity of that condition of the lymphatic glands known as large-celled hyperplasia and tubercle, and also as to the relation of lymphadenoma to tubercle.

So, at the outset, it appeared to me to be absolutely necessary to try and clear up some of these doubts before attempting to trace the channels of infection.

The questions I proposed to myself to answer were the following :—

(1) Is the tubercle bacillus or its involution forms (Schrön's capsules, Cornet's spores, *Keimungsproduckte*) always found in scrofulous glands?

(2) What phases do the bacilli pass through in the glands?

(3) What are the histological changes produced by the tubercle bacillus in the glands?

I have examined the cervical and bronchial glands in twenty-seven consecutive cases of pulmonary tuberculosis, *post mortem.* I chose this method advisedly, in preference to examining the cervical glands removed by the knife of the surgeon, in order to obtain them in an earlier stage of pathological change, and in order to be able to trace the change from gland to gland. The cervical glands, when removed by the surgeon, are frequently in a suppurating condition, and are therefore not so well suited for a bacteriological and histological examination. I wished to obtain the glands in a much earlier stage than this, in order to discover which of the

various microbes found in the lymphatic glands were responsible for the initial change. There can be no doubt that suppuration in the glands is determined by microbes other than the tubercle bacillus. As in the lung, so in the lymphatic glands, the condition is generally one of mixed infection. I therefore decided to make a systematic examination of the cervical and bronchial glands removed from the dead subject. But, first, I should like to say a word on the frequency of tuberculous changes in the cervical and bronchial glands in pulmonary tubercle, as this has an important bearing on the infecting channels. As said above, 27 cases were examined in reference to this point with the remarkable result that the cervical and bronchial glands (and in one instance the axillary glands likewise) were found tuberculous in all with one exception, and that was a case of fibroid disease of the lung.

Batten, in 100 cases of tuberculosis in children, examined by him at the Children's Hospital, Great Ormond Street, found the cervical glands tuberculous in only 14. But this was from naked-eye observation only. I venture to think, that had Dr. Batten examined the cervical glands in his cases with the microscope and inoculation test, the proportion would have been greatly increased. In 125 autopsies at the Foundling Hospital, New York, the bronchial glands were tuberculous in every one. Loomis found 8 of 30 cases in which there were no signs of old or recent tuberculous lesions, and yet the bronchial glands were infective to rabbits. In the earlier stages of tuberculosis of the lymphatic glands it is absolutely impossible from naked-eye observation only to say whether a given lymphatic gland is tuberculous or not. Indeed, even on microscopic examination, it is sometimes anything but easy, in the absence of the

specific bacillus, to say whether the histological change is tuberculous or not. If we are to limit our ideas of tubercle by the histological term, tubercle, we shall miss at least one quarter of the glands so affected. I take to be tuberculous any histological change found in the lymphatic glands, always provided that the tubercle bacillus or its involution forms be present, or that it responds to inoculation test. The term tubercle is merely an anatomical one, and if not so well established by long usage would be better discarded altogether. The condition of gland, for instance, formerly known as large-cell hyperplasia, referred to above, is undoubtedly a tuberculous condition, as I have found the tubercle bacillus in glands so affected, although tubercle in its histological sense was absent. We must remember, however, that the lymphatic glands in lymphadenoma may closely resemble this form of tubercle. I shall, however, return to this change when I discuss the third question. The occurrence of histological change in the lymphatic glands with tubercle bacilli, but with no definite tubercle present, is not confined to them. The same change is found in the lung. Frequently, in this organ, we find tracts of pneumonic consolidation, the air sacs being filled with catarrhal products, with tubercle bacilli lying amongst the caseating epithelial cells, but with no definite tubercles, although these may be found scattered in other parts of the organ. I take it that this pneumonic consolidation of the lung is equally tuberculous. (See plate 16, figs. 1 and 2.)

But to return to the first question. Is the tubercle bacillus or its involution products (Schrön's capsules) always found in the so-called scrofulous glands? Before 1882, when Koch made the discovery of

the specific micro-organism, the question as to whether the so-called scrofulous gland and the caseating tuberculous gland were one and the same was impossible to answer. Schuppel in his classical work, published in 1871, went as far as it was possible to go, in the absence of the tubercle bacillus, to prove their identity. But just one small connecting link (the bacillus) was wanting in the chain of evidence to completely establish their identity. Koch supplied this missing link.

In all cases of caseation of the cervical and bronchial glands, when the proper gland substance has become completely converted into a caseous mass, a typical scrofulous gland in fact, I have always, on patient examination, found the tubercle bacillus or its products; or they have responded to the inoculation test. I will now give the cases.

(1) *Post mortem.*—B. R., aged 33, labourer. Chronic pulmonary tuberculosis; tuberculous pericarditis; cavities in both lungs; bronchial glands enlarged, not caseous.

Microscopical examination.—The cervical glands are tuberculous; bacilli in the giant cells; the giant cells contain vacuoles; a few bacilli outside giant cells; bronchial glands are in a condition of large-celled hyperplasia with scattered tubercles; bacilli in process of disintegration; early caseation.

(2) *Post mortem.*—H. J., aged 35, colour printer. Chronic pulmonary tuberculosis; pericarditis; right lung practically solid from caseous broncho-pneumonia; large cavity at apex of left lung; bronchial glands enlarged, not caseous.

Microscopical examination.—Cervical glands contain no definite giant-cell systems; bacilli very numerous, caseation beginning; bronchial glands tuberculous;

bacilli in giant cells; large-celled hyperplasia; caseation beginning.

(3) *Post mortem.*—A. G., aged 5. Caseous bronchial and mesenteric glands; general miliary tuberculosis; broncho-pneumonic patches with grey tubercle in each lung; the right bronchial glands formed a large caseous mass; the glands in front of the lower part of the trachea were similarly affected; the left bronchial glands were enlarged but were not caseous.

Microscopical examination.—Cervical glands contain large caseous masses with many giant cell systems. The giant cells contained bacilli and very beautiful vacuoles, as many as three in some of the cells. The bronchial glands contained large caseous foci, with giant cells at the periphery; numerous bacilli; the glands were typically those of *scrofula.*

(4) *Post mortem.*—D. B., aged 39, clerk. Chronic pulmonary tuberculosis. The whole apex of the right lung was converted into a cavity, the greater part of the rest of the lung was solid with grey and caseous tubercle; the left lung was in much the same condition, but without cavitation; bronchial glands enlarged, one or two caseous.

Microscopical examination.—Cervical glands caseous throughout. Numerous bacilli at the periphery of the caseous mass; numerous Schrön's capsules; bronchial glands contained large encapsuled caseous masses, with caseous tubercles scattered around; the giant cells contained bacilli; a few small Schrön's capsules; there was also some lardaceous change; the glands were typically *scrofulous.*

(5) *Post mortem.* — R. E., aged 51, tea porter. Chronic pulmonary tuberculosis; lobar pneumonia; mitral incompetence; cavity just below apex of right

lung ; cavity in upper lobe of left lung, lower lobe solid, in pneumonic condition (grey hepatisation), showing for the most part no tubercles ; bronchial glands enlarged considerably, not caseous.

Microscopical examination.—Cervical glands were in a condition of large-celled hyperplasia. In parts definite tubercle bacilli present but staining bluish, recognised by beaded appearance ; many other organisms present ; marked pigmentation ; few well-stained tubercle bacilli in giant cells ; bronchial glands contained a few round caseous masses ; tubercle bacilli present.

(6) *Post mortem.* — J. D., aged 49, carpenter. Chronic pulmonary tuberculosis. Small cavity at the extreme apex of right lung ; scattered clusters of grey tubercle throughout upper and middle lobes ; cavity at the apex of left ; bronchial glands enlarged, not caseous.

Microscopical examination. — Cervical glands enlarged ; large-celled hyperplasia, one or two tubercles in each section ; no tubercle bacilli seen ; bronchial glands ; the adenoid tissue completely destroyed ; large fibroid masses of tubercle with much pigmentation.

(7) *Post mortem.*—J. R., aged 31, harness-maker. Chronic pulmonary tuberculosis ; old cavity at the left apex, very fibrous, grey tubercle throughout ; two small recent cavities in right lung ; bronchial glands enlarged, not caseous.

Microscopical examination.—Cervical glands contain a few tubercles ; bacilli broken up in giant cells. Bronchial glands ; large-celled hyperplasia ; almost complete conversion ; no tubercle bacilli found.

(8) *Post mortem.*—L. M., aged 25, house work. Acute pulmonary tuberculosis ; small recent cavities in

left lung ; the upper lobe of the right lung was converted into a solid mass (pneumonia), in places breaking down into pus ; bronchial glands enlarged, not caseous.

Microscopical examination.—Cervical glands contain encapsuled caseous masses ; scattered tubercle around, some lardaceous change ; there were a few scattered tubercles in the bronchial glands ; tubercle bacilli present.

(9) *Post mortem.*—D. C., aged 26, servant. Chronic pulmonary tuberculosis ; more than half of the left lung is converted into a great cavity, the rest of the lung being non-crepitant and solid ; small cavity in right lung, the rest of the lung being solid with grey and caseous tubercle ; bronchial glands enlarged, not caseous, cortical tubercle in left kidney.

Microscopical examination.—The cervical glands were caseous throughout ; numerous bacilli were scattered around the periphery of the caseous masses ; numerous Schrön's capsules in peripheral lymph sinuses ; the bronchial glands were caseous throughout, the periphery of the caseous masses being stuffed with tubercle bacilli ; in the surrounding lymphatics were seen many Schrön's capsules scattered in groups ; both the cervical and bronchial glands were typically *scrofulous.*

(10) *Post mortem.*—J. P., aged 16, servant. Chronic pulmonary tuberculosis ; cavities in both lungs ; bronchial glands enlarged, not caseous.

Microscopical examination.—Cervical glands contained a few scattered tubercles ; bacilli present ; the bronchial glands also contained tubercles and bacilli, few in number.

(11) *Post mortem.*—F. D., aged 49, hawker. Chronic pulmonary tuberculosis ; calcareous patches in right pleura ; cavity in right lung ; few scattered nodules of

tubercle in left; anterior mediastinal and bronchial glands much enlarged.

Microscopical examination.—Cervical glands contained numerous giant cell systems; bacilli in fair number in giant cells; bronchial glands much congested; numerous foci of tubercle throughout; bacilli present.

(12) *Post mortem.*—C. D., aged 21, laundress. Pulmonary tuberculosis; left upper lobe riddled with small cavities; scattered tubercles all over right lung, no cavitation; *bronchial glands much enlarged, no tubercles; cervical glands healthy!*

Microscopical examination. Cervical and bronchial glands are scattered throughout with tubercle; bacilli present.

(13) *Post mortem.*—C. F., aged 24, painter. Chronic pulmonary tuberculosis; laryngeal tubercle; cavity in right upper lobe; much caseous tubercle in both lungs; spleen lardaceous; *cervical and bronchial glands not enlarged, no tubercles!*

Microscopical examination. — Numerous tubercles throughout; caseation beginning in parts; giant cells well marked; bacilli numerous; the bronchial glands contain large tracts of caseous tubercle; bacilli present.

(14) *Post mortem.* — H. T., aged 37, labourer. Chronic pulmonary tuberculosis; cavities in both lungs; much grey and caseous tubercle throughout both; bronchial glands enlarged, not caseous; lardaceous change in liver and spleen; no lardaceous change in kidneys, but they contained tubercle in the cortex, one or two in the medulla (excretion tubercle) the size of a millet seed. In one place in the medulla a chain of yellow tubercles was seen extending to the pelvis of the organ (epithelial spread).

Microscopical examination. — The cervical glands

presented a most beautiful example of miliary tuberculosis, caseous in parts; numerous bacilli; the bronchial glands were also a beautiful example of large spindle and round-celled hyperplasia; bacilli present.

(15) *Post mortem.*—H. H., aged 27. Acute pulmonary tuberculosis; recent cavities in both lungs, which were thickly scattered with tubercle; much pigmentation; bronchial glands were not caseous; tubercle in liver and kidney, mostly in the cortex of the latter, but one or two in the medulla (epithelial spread).

Microscopical examination.—The cervical and bronchial glands were practically in the same condition, both showed tracts of large-celled hyperplasia with scattered tubercle; numerous tubercle bacilli present in both.

(16) *Post mortem.*—A. S., aged 20. Chronic pulmonary tuberculosis; ruptured aneurism of the pulmonary artery in basic cavity of right lung; cavity at apex of left lung; bronchial glands enlarged, not caseous; caseous tubercle in cortex of left kidney.

Microscopical examination.—Both cervical and bronchial glands contained tubercle, but no bacilli were found after a careful search.

(17) *Post mortem.*—C. H., aged 21, tobacco worker. Diabetes; acute pulmonary tuberculosis; large irregular recent cavity at the apex of right lung, surrounded by caseous pneumonia; middle and lower lobes congested with a few scattered tubercles; large recent cavity, size of an orange, at the apex of the left lung; bronchial glands enlarged, not caseous; pancreas very small. On microscopical examination there appeared to be very little healthy pancreas tissue left; hæmorrhages in places.

Microscopical examination.—Cervical glands greatly congested; tubercle scattered on periphery of gland, some caseation; *tubercle bacilli present;* bronchial glands enlarged; tubercle scattered throughout; beginning to caseate.

(18) *Post mortem.*—S. J., aged 45, warehouseman. Chronic pulmonary tuberculosis; ruptured pulmonary aneurism; cavities in both lungs. In a cavity at the base of left lung the aneurism had ruptured; bronchial glands enlarged, not caseous.

Microscopical examination.—Cervical glands were almost free from tubercle, only found in one section; bronchial glands contained large indurated masses of tubercle; no bacilli found.

(19) *Post mortem.*—J. P., aged 47, porter. Chronic pulmonary tuberculosis; left pleural effusion; small cavities at the apex of left lung; grey tubercle scattered thickly throughout right; much pigmentation; bronchial and cervical glands markedly enlarged, not caseous.

Microscopical examination.—Cervical glands, congested with scattered miliary tubercle; bronchial glands, scattered tubercle throughout; bacilli present in both.

(20) *Post mortem.*—W. Q., aged 27, 'bus conductor. Acute caseous pulmonary tuberculosis; left pyo-pneumothorax; apex of right lung riddled with cavities; bronchial glands enlarged, not caseous.

Microscopical examination.—Cervical glands much enlarged, some enormously so; large tracts of caseous tubercle throughout; bacilli very numerous; bronchial glands caseous in parts, but less so than the cervical; numerous foci of lardaceous change; numerous bacilli; typical examples of *scrofulous glands.*

(21) *Post mortem.*—M. S., aged 41. Chronic pulmonary tuberculosis ; cavities in both lungs ; much pigmentation ; much fibroid tubercle in both ; bronchial glands enlarged, not caseous ; caseous tubercles in the medulla of kidney (excretion tubercle).

Microscopical examination. — Few scattered tubercles in both ; no bacilli found after a prolonged search.

(22) *Post mortem.*—G. J. P., aged 24, 'bus conductor. Chronic pulmonary tuberculosis ; cavities in both lungs, with grey and caseous tubercle ; bronchial glands enlarged, not caseous.

Microscopical examination. — The upper cervical glands were only slightly affected, containing a few scattered tubercles. The lower were typically scrofulous in character, large caseous masses throughout. The bronchial glands were only slightly affected with tubercle ; *the lower cervical glands being thus the most affected* (upward extension). Numerous bacilli in all the glands. A few Schrön's capsules present in the bronchial glands; both cervical and bronchial glands were greatly enlarged ; typically *scrofulous.*

(23) *Post mortem.* — W. P., aged 47, coachman. Chronic pulmonary tuberculosis ; some fibrosis in both lungs ; grey and caseous tubercle ; cavities in both ; bronchial glands enlarged, not caseous for the most part.

Microscopical examination.—Both cervical and bronchial glands were beautiful examples of large-celled hyperplasia, with tubercle bacilli scattered throughout the large-celled tissue.

(24) *Post mortem.* — G. W., aged 57, labourer. Chronic pulmonary tuberculosis. The apex of the right lung was in a state of grey hepatisation, with a

few clusters of grey tubercle, some becoming caseous. Two old irregular cavities at the apex of the left lung; the rest of the lung was solid with grey and miliary tubercle ; bronchial glands not caseous.

Microscopical examination.—Cervical glands contain many tubercles, some beginning to caseate; bacilli present ; bronchial glands contain old fibrous masses of tubercle, with fresh tubercle scattered at the periphery ; bacilli present.

(25) *Post mortem.*—C. T. H., aged 53, clerk. Chronic pulmonary tuberculosis ; much fibrosis in both lungs ; cavitation ; scattered tubercle in both.

Microscopical examination.—Very few tubercles in both cervical and bronchial glands; no bacilli found; much large cell conversion.

(26) *Post mortem.*—A. B., aged 14. Fibro-tuberculous ; empyema; gangrene ; large quantity of pus in left pleura ; obvious fibrosis of left lower lobe ; large cavity at base, in gangrenous condition ; caseous tubercle at extreme apex of right lung ; bronchial glands enlarged, not caseous.

Microscopical examination.—No tubercle or bacilli discovered in either cervical or bronchial glands after a prolonged search.

The glands in five of the above cases were typical examples of the so-called "scrofulous gland" (see plate 1, fig. 3, and plate 2, fig. 3), namely *post mortems* 3, 4, 9, 20, and 22. The microscopical change varied from hyperplasia, with scattered caseous foci (see plate 1, fig. 5), up to complete caseation of the whole gland. In all the cases tubercle bacilli or Schrön's capsules were found. In the centre of the caseous masses bacilli were very rarely present, but on careful and patient examination they were in every case found to be present at the

PLATE 1.

FIG. 1.—Section through the peripheral part of a cervical gland from a case of mixed infection. Numerous Schrön's capsules and tubercle bacilli are seen. A number of cocci and bacilli are also present. Leitz, $\frac{1}{12}$ oil imm.; Zeiss, Oc. 4. Draw-tube at 18 mm.

(*a*) Schrön's capsules; (*b*) cocci; (*c*) bacilli other than tubercle; (*d*) tubercle bacilli.

FIG. 2.—Shows the various varieties of tubercle bacilli found in the cervical and bronchial glands. Leitz, $\frac{1}{12}$ oil imm., Oc. 4. Draw-tube at 16 mm.

(*a*) Bacilli in bundles, short variety; (*b*) bacilli that have taken the staining reagent badly, probably bacilli in stage of disintegration; (*d*) Schrön's capsules.

FIG. 3.—Portion of the same gland as fig. 3, plate 2, more highly magnified. Numerous tubercle bacilli (*a. d.*) are seen at the periphery of the caseous mass and also in the lymph sinus. Zeiss, Obj. D., Oc. 2.

FIG. 4.—Schrön's capsules (round variety) and tubercle bacilli at the periphery of a cervical gland. Leitz, $\frac{1}{12}$; Zeiss, Oc. 4. Draw-tube at 20 mm.

(*a*) Schrön's capsules; (*b*) tubercle bacilli.

FIG. 5.—Section through cervical gland. The tuberculous process is less advanced than in the preceding figure. Numerous foci of tubercle (*a*) are seen scattered through the gland. Zeiss, A., Oc. 2.

Fig. 1

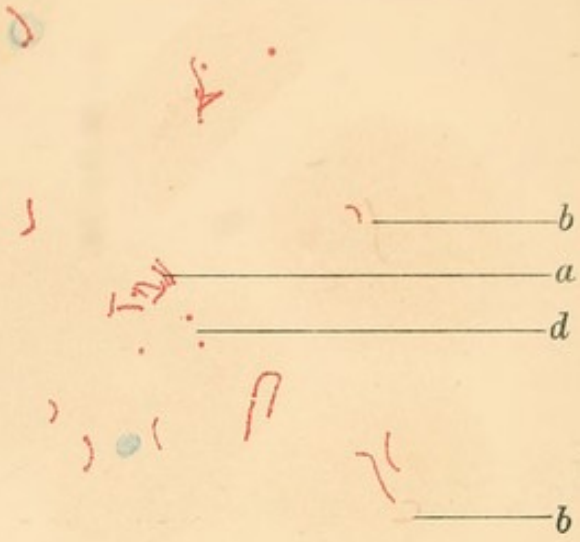


Fig. 2

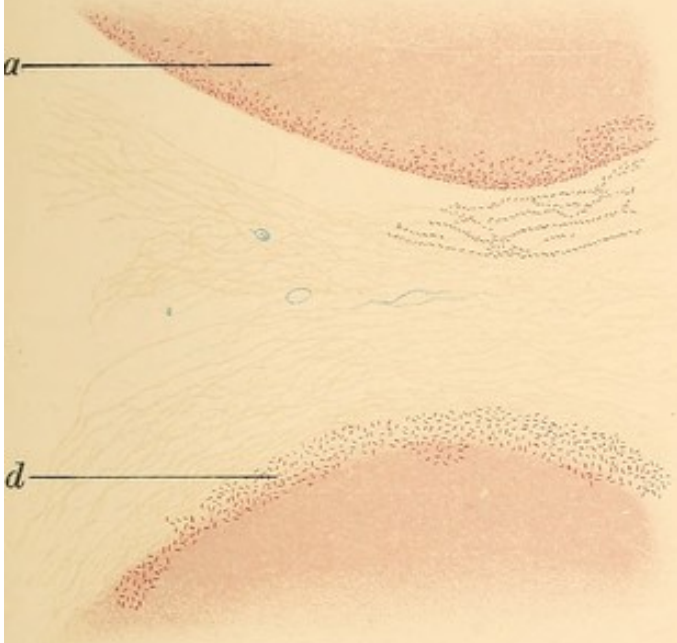


Fig. 3

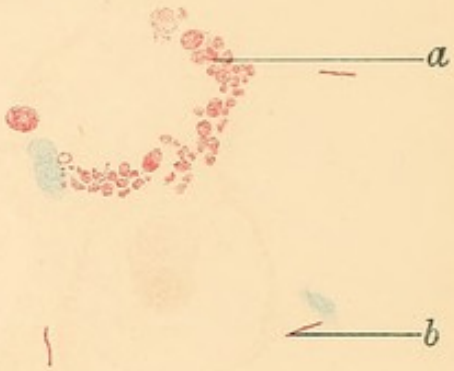


Fig. 4

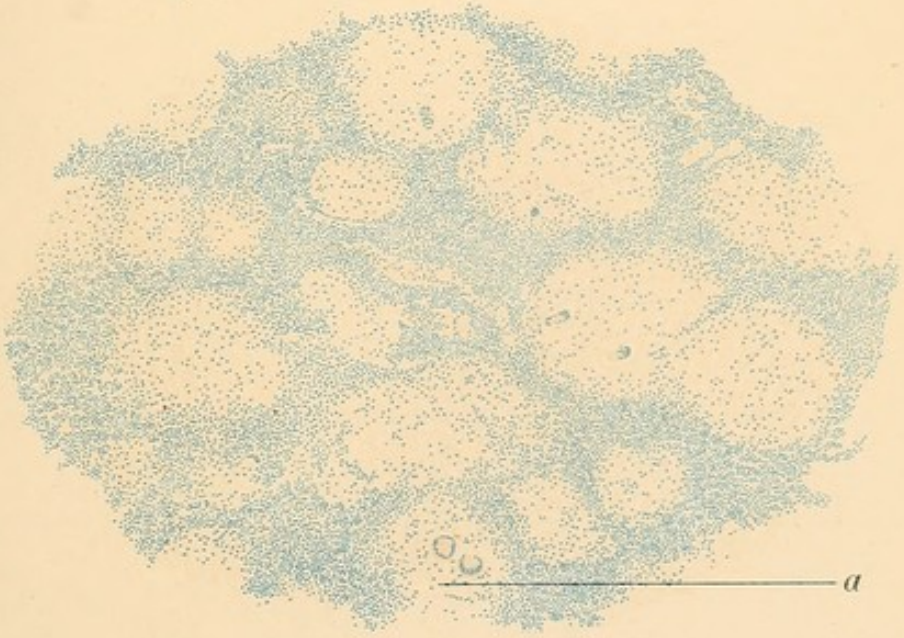


Fig. 5

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periphery of the caseous masses (plate 1, fig. 3). Schrön's capsules were found almost exclusively in glands in an advanced stage of caseation. Most of the bacilli and capsules were found in the lymph spaces at the periphery of the gland. I have in one case, however, found the capsules in the centre of a young tubercle.

From the examination of the glands of these cases, there can be, I think, no reasonable doubt that the so-called scrofulous gland is in reality a tuberculous one.

The next question to settle, if possible, is whether the change is produced by the tubercle bacillus, or by any of the other numerous organisms that are occasionally found in the lymph sinus. (See plate 1, fig. 1). That many cocci and bacilli, other than those of tubercle, are frequently found in the lymphatic glands there can be no question, but these organisms are mostly found in the peripheral lymph sinuses, and but seldom in the substance of the gland. Tubercle bacilli, on the other hand, are frequently found in the gland substance, where they produce the typical so-called tubercle, or give rise to large-celled hyperplasia in the neighbourhood. I think if the figures be carefully examined, no doubt will remain in the mind of the observer that the tubercle bacillus is alone responsible for the scrofulous change, although, as said above, it is not responsible for the production of suppuration in the gland. It must be remembered, however, that nearly all my cases had advanced to cavitation, and were therefore examples of mixed infection.

I will now pass on to the second question. What changes do the bacilli undergo in the glands? (Plate 1, figs. 2 and 4). We find the following forms: *Bacilli*, some very long and thin, generally isolated, usually having a very beaded appearance resembling streptococci.

Bacilli in bundles, generally of the short variety. Bacilli with buds, generally situated at one end, though occasionally two or three are found in the length of the bacillus. Bacilli bent at a right angle, the two limbs of which are always unequal; this is a very common form. Bacilli with small offshoots from the side, mostly nearer one end than the other—a rare form. Bacilli that take the staining reagent very badly, only coming out with a light pinkish tinge, being probably bacilli in a very early stage of disintegration, or too young to be acid-fast.

*Schrön's capsules.** — Mostly small oval or round bodies, requiring a $\frac{1}{12}$ oil immersion lens for their detection. Generally only found in the lymphatics at the periphery of the gland. They occasionally stain differently, the round variety generally taking only a light pink colour (see plate 1, fig. 4) with carbol-fuchsin, while the oval variety takes a much deeper colour with the same staining reagent (see plate 1, fig. 1). This involution form of the tubercle bacillus has been found by Schrön, Metchnikoff, and Roux, in cultures of tubercle bacilli, and in the walls of tuberculous cavities in the lungs. What the special pathological significance of these various forms may be it is impossible to say.

I will now consider the third and final question. What histological change does the tubercle bacillus or its excretion products produce in the lymphatic glands? The first and earliest change consists of *a simple hyperæmia* with consequent swelling. This change is always well marked in the earlier stages, even when the gland is only very slightly affected with tubercle (see plate 2, fig. 1). Hyperæmia is found in all stages, from simple engorgement of the vessels up to the actual extravasation into the gland.

* See Appendix.

PLATE 2.

FIG. 1.—Section through cervical gland very slightly affected with tubercle. It shows the initial hyperæmia. Zeiss, D., Oc. 4.

(*a*) Young tubercle, the only one in the gland ; (*b*) engorged vessels.

FIG. 2.—Section through a bronchial gland. It shows well the proliferation of the adenoid reticulum, most of the lymph cells having disappeared. Numerous tubercle bacilli are seen scattered through the gland. Leitz, $\frac{1}{12}$; Zeiss, Oc. 2.

FIG. 3.—Section through upper cervical lymphatic gland. The gland is seen to be caseous throughout. A typical "scrofulous" gland. Zeiss, Obj. A. Oc. 2.

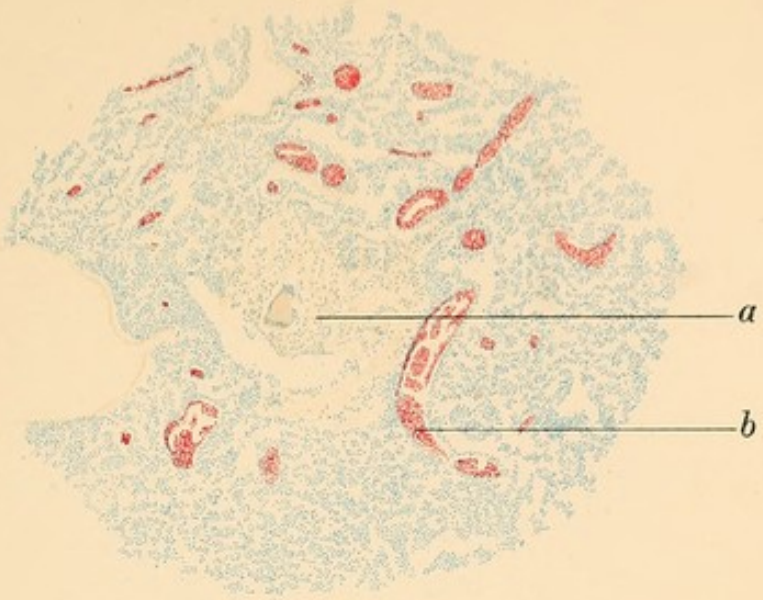

Fig. 1

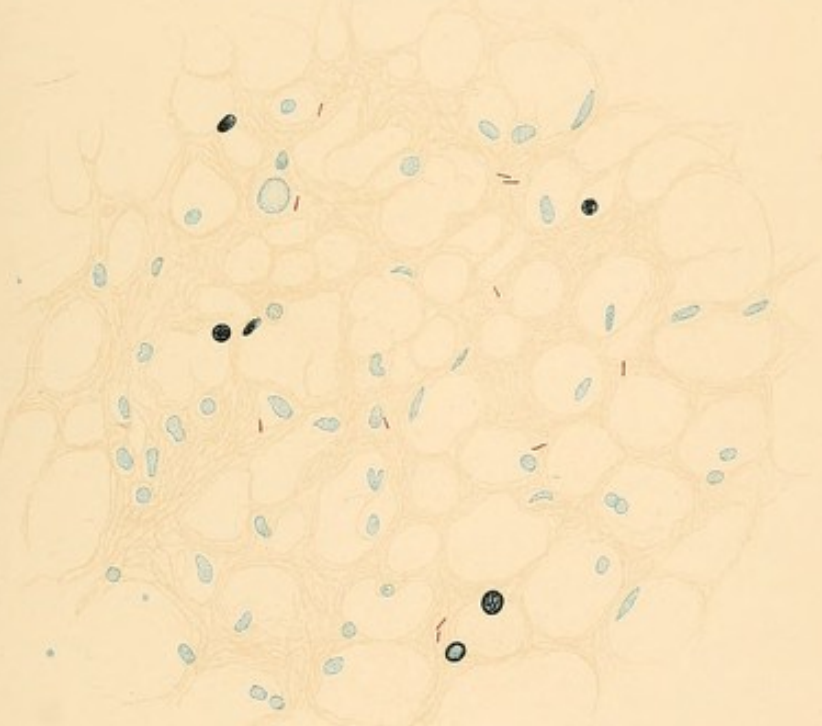

Fig. 2

Fig. 3

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Pigmentation of the glands, both cervical and bronchial, I shall merely mention, as of course this is not a tuberculous change, although it has its interest as bearing on the question. I have noticed that the cervical glands are frequently pigmented in tuberculosis, proving conclusively that particulate matter may be absorbed by the lymphatics from the adenoid rings surrounding the entrance to the respiratory and digestive tracts.

Lardaceous change was observed in a few cases, but this again can hardly be called a tuberculous condition of the gland, and was only found in conjunction with widespread lardaceous substitution in other organs, such as the spleen, liver, and kidneys.

I will now turn to the changes in the substance of the gland proper. As the result of numerous histological observations, there can be no doubt that the earliest change in the gland substance proper, consequent on the presence of the bacillus or its products, consists in a proliferation of the adenoid reticulum, with a destruction or conversion, or, at any rate, a disappearance of the lymphoid cells. Many of the specimens show this change well (see plate 2, fig. 2).

But the presence of the bacilli or their products in the gland may produce a histological change quite different from the above—why this should be it is hard to say. Possibly it may be due to some change in the malignancy of the organism, but the fact remains. In certain cases the only change found in the cervical and bronchial glands is one of hyperplasia. This large-celled hyperplasia of the lymphatic glands is distinguished by the transformation of the normal gland tissue into large-celled tissue, having none of the characteristics of the original structure. This large-celled tissue consists partly of rounded and polygonal cells

(see plate 3, figs. 2 and 3) and partly of spindle cells. If the proper lymphadenoid tissue has not altogether disappeared the remaining portions of it form reticulated bands pervading the large cells. The microscopical structure of a gland that has undergone this change is well shown in plate 3, fig. 1. The normal lymphoid tissue stains more deeply than the large-celled tissue, thus coming out in sharp contrast under the microscope. Ziegler separates the large-celled hyperplasias from tuberculous affections of the lymphatic glands, but he goes on to say: "That it is not unlikely that tuberculosis may assume this type, and that some of the so-called scrofulous inflammations of the lymphatic glands, in which no typical tubercles can be found, are really due to the invasion of the tuberculous virus." In many glands so affected I have discovered the specific bacillus, leaving no doubt that the change is a tuberculous one.

The accompanying plates show well this large-cell conversion, tubercle bacilli being present in all. See *post mortems*, Nos. 1, 14, 15, 19 and 25. Compare fig. 3, plate 3, with plate in *Pathological Transactions*, by Dr. Andrewes, on Relation of Lymphadenoid to Tubercle.

Of course the question naturally arises, How do the bacilli reach the lymphatic glands? That the microbe may and very frequently does penetrate into the tonsil, the cervical glands becoming secondarily affected, there can be no doubt, and I think the so-called scrofulous gland receives the virus in this way; the cervical glands stand, as it were, on outpost duty, to arrest the invading bacilli. It is still an open question whether or not the lung can be infected by the gradual extension of the bacilli downwards with the lymph stream. I think in

PLATE 3.

FIG. 1.—Section through a bronchial gland in a condition of large-celled hyperplasia. The large cells take the staining badly, thus standing out in sharp contrast to the lymph cells under the microscope. Zeiss, Obj. A., Oc. 2.

(*a*) Lymph cells ; (*b*) large-celled tissue.

FIG. 2.—Large-celled indurative hyperplasia of a bronchial gland (spindle-celled variety). This plate represents a highly magnified portion of fig. 1. Tubercle bacilli are seen scattered amongst the spindle cells. Leitz, $\frac{1}{12}$; Zeiss, Oc. 4. Draw-tube at 17 mm.

(*a*) Lymph cells ; (*b*) large spindle-cell conversion.

FIG. 3.—Section through a cervical gland in a condition of large-celled hyperplasia. Only a very few lymph cells remain. Tubercle bacilli and pigment granules are scattered through the gland. Leitz, $\frac{1}{12}$; Zeiss, Oc. 4. Draw-tube at 17 mm.

(*a*) Large-cell conversion ; (*b*) lymph cells ; (*c*) fatty degeneration of cell ; (*d*) pigment.

Fig. 1

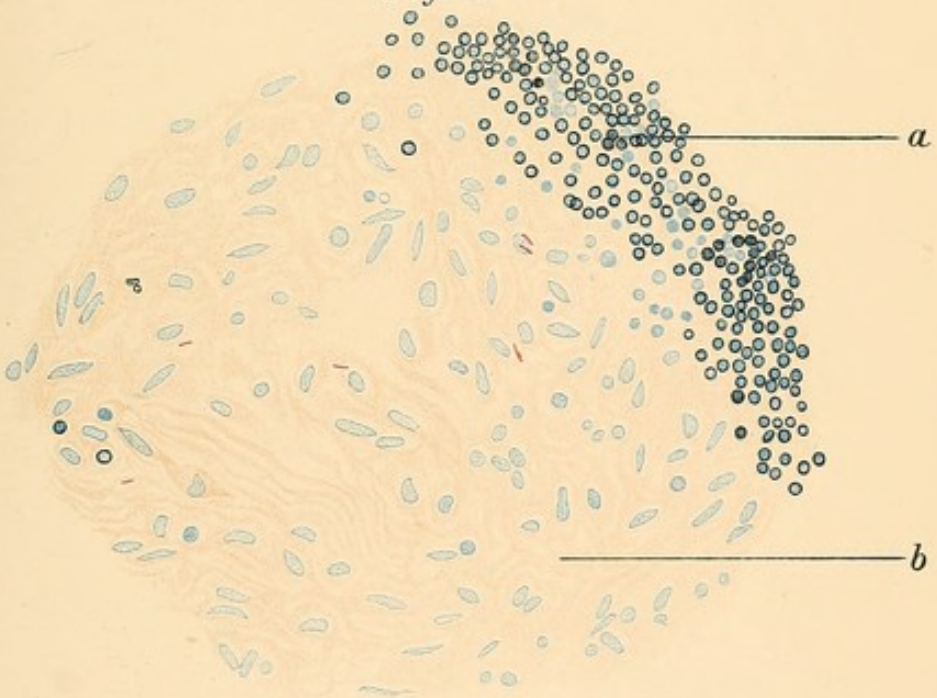

Fig. 2

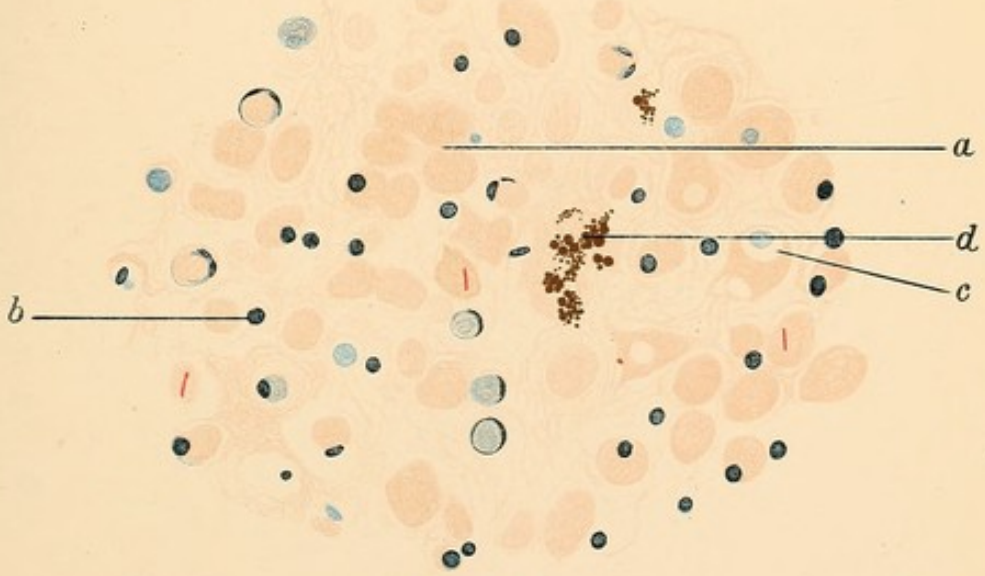

Fig. 3

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those cases where we find the tuberculous change in the cervical glands further advanced than in the bronchial, we may assume that the lung has been infected in this manner. I do not for one minute wish to ignore or detract from the importance of inhalation tuberculosis as being the principal channel of infection, but I think the lymphatic channel should not be overlooked. Of course infection of the lung through the cervical glands is extremely difficult of proof. There are many sources of error. We must remember that tenacious muco-pus, laden with tubercle bacilli, is constantly passing over the fauces and tonsils in the act of expectoration. The tonsils and cervical lymphatics may thus become secondarily affected. This would correspond to the descending gland tuberculosis of Schlenker. But it would also appear that the lower cervical glands may be infected from below upwards, the bacilli being able to work up stream, the ascending gland tuberculosis of Schlenker. Both these sources of error must be taken into consideration before we are justified in concluding that the lung has not been infected by the inhalation of the tubercle bacillus. The brief notes of the above cases were taken from the *post-mortem* records. I alone am responsible for the microscopical examination of the glands. It is impossible, as said above, to form any opinion as to whether a given lymphatic gland is tuberculous or not, from naked-eye observation only, as Cases 12 and 13 well illustrate, the glands in both these cases being, to the naked-eye, healthy.

In all cases serial sections were made.

I shall now proceed to trace the channels of infection. They may be divided into five :—

(1) Hereditary transmission.

(2) The lymphatic vessels.
(3) The blood vessels.
(4) Epithelial channels.
(5) Inoculation into the skin or tissues.

I have not placed these in order of importance. It is probable that as a channel of infection the epithelial paths should stand first. Neither do I wish to convey the impression that in a given case of tuberculosis the channel of infection is by one or other of the above ways to the exclusion of the others. That is not so. The infection in the human organism, at any rate, is conveyed by 2, 3, and 4, but in varying proportion.

(1) Hereditary Transmission.

There are three possible ways for the transmission of the tubercle bacillus in direct inheritance.

(*a*) By the spermatic fluid.
(*b*) Transmission by the ovum.
(*c*) Transmission through the blood by means of the placenta.

There is, as far as I know, no clinical evidence to be adduced in support of the theory that the tubercle bacillus is transmitted with the semen. In order that this might take place it would be necessary for the tubercle bacillus actually to lodge in the individual spermatozoa which fecundates the ovum. The chances of such an occurrence must be extremely rare. We know, however, that tubercle bacilli have been found in the semen, but we must remember that the spermatozoa consist of nuclear material which the tubercle bacillus has never been known to attack.

Experimental work is also opposed to this mode of transmission. Gärtner has shown that the young of healthy female rabbits impregnated by tuberculous males were never found tuberculous even though the females themselves became so.

We must accept, I think, the possibility of transmission by the ovum. Baumgarten has in one instance, at any rate, been able to detect the tubercle bacillus in the ovum of a female rabbit which he had artificially fecundated with tuberculous semen, but what effect such an inoculation would have on the human subject cannot be forecasted.

In congenital tuberculosis, however, the only really likely channel of infection must be the blood stream, the tubercle bacilli gaining entrance by the placenta. Tuberculosis of the placenta has been demonstrated, but actual tuberculosis of the organ itself is probably not necessary. We know that the tubercle bacilli can pass intact mucous membrane and epithelium, and there are undoubted instances in which with a normal placenta tubercle bacilli have been found in the placenta blood and tissues of the fœtus.

The next question to consider is the possibility of the tubercle bacillus remaining latent in the tissues for a longer or shorter period. Can the tubercle bacillus remain latent in an organ or tissue until, for some reason or other, the individual resistance is broken down and tuberculosis results?

Baumgarten strongly supports the view that it can, and there is, I think, both clinical and experimental evidence in support of this view. We know for a fact that tubercle bacilli may remain dormant in an organ or tissue, as the experiments of Loomis, mentioned in an earlier part of this essay, testify. The observations of

Pizzini must be borne in mind in this connection. Pizzini inoculated guinea pigs with the lymphatic glands from the bodies of forty persons who had died of non-tubercular affections and tuberculosis resulted in 42 per cent. of the experiments, the bronchial glands being those which most frequently gave a positive result. Baumgarten bases his belief in the germ transmission of the disease upon two main factors :—

(1) The great frequency of tuberculosis in early life.

(2) The localisation of the lesions in children.

According to Botz, out of 2,576 autopsies made on children 27·8 per cent. died in the first year of tuberculosis. Cnopp's statistics show that out of 298 tuberculous children of from a few days to 12 years of age, no less than 147 had bone or joint tuberculosis, and only eight of these showed evidence of visceral tuberculosis. Baumgarten believes that the accidental conveyance of tubercle bacilli to these parts would not account for such a large proportion of cases, and expresses the view that the bacilli have been present since birth, and have developed when the conditions became favourable. We frequently see after a blow or injury to a joint or bone tuberculosis develop in the part.

The principal experimental evidence in favour of Baumgarten's view is that of Gärtner, who produced tuberculosis in young mice by inoculating the mother with tuberculosis. Mafucci has also shown that after infecting eggs with avian tuberculosis the disease may remain latent in the chick for weeks or months.

Against Baumgarten's theory, however, there are the facts that the percentage of cases of congenital tuberculosis is extremely minute, there being only about twenty examples in medical literature, and that in the great majority of instances the organs of fœtuses born of

tuberculous mothers gave negative results when inoculated into guinea pigs.

(2) By the Lymphatic Vessels.

I will take the lymphatic paths first. Now the organ most commonly affected in human tuberculosis and therefore the most important is the lung.

I shall consider, first the various ways in which the lung may receive the infection, and, secondly, the method of spread in the organ after reception of the specific organism.

The lung may receive the infection directly from the bronchial glands. In support of this method of infection I give the following examples:—

Case 1.—*Post mortem* 170. *Morbus Cordis—Tuberculosis — Infection from Bronchial Glands.* — E. T., female, aged 7 years, died in hospital of morbus cordis, mitral and aortic. The *post-mortem* examination was made twenty-seven hours after death. The body was well nourished. The heart was hypertrophied and dilated and gave evidence of old and recent endocarditis, which was the cause of death. *The larynx, trachea and bronchi were normal.* The pleural cavities contained a small quantity of clear, straw-coloured fluid and showed no adhesions. The bronchial glands were enlarged, and in parts caseous. *At the anterior margin of the middle lobe of the right lung there was a small caseous tuberculous nodule about the size of a small pea;* radiating from this immediately under the pleural surface of the posterior margin of the same lobe were about half a dozen grey granulations; with this exception there was no evidence of tubercle in the body. The left lung

was perfectly free. The tuberculous patch in the right lung was limited to the space of the microscopical section (see plate 4, fig. 3). On making microscopical sections of the bronchial glands (see plate 4, fig. 2) they were found to be typically tuberculous, with large giant cell systems. The microscopical picture of the lung was typically that of grey miliary tubercle. The whole chain of cervical glands was carefully dissected out on the right side and the glands were found to be in a condition of large-celled hyperplasia as described above, but with no typical giant cell systems (see plate 4, fig. 1). The tonsils were very diligently searched for tubercle, but none was found.

The above case is, I think, a very important one for tracing the channel of infection. The patient died from a cause other than tubercle, viz., heart disease. The tuberculous process, at any rate, in the lung had only just started. We see the very beginning of the lung infection, the original focus being in the bronchial glands. The microscopical specimens show well the relation of the tubercle to the vessels.

The three following morbid specimens may also be brought forward in evidence of direct infection of the lung from the bronchial glands.

Case 2.—*Acute Miliary Tuberculosis. Infection from Bronchial Glands.*—A portion of the middle lobe of the lung of an infant, aged 9 months. It showed at the lower angle a few grey miliary tubercles. This portion of the lung surface lay in contact with an inflamed and softened bronchial gland. The tuberculous disease in the lung was confined to the parts in immediate contact with the softened bronchial glands, viz., the middle lobe as above described, and to a portion of the upper lobe lying in contact with the

PLATE 4.

FIG. 1.—Section of one of the upper cervical glands. The gland is in a condition of large-celled hyperplasia. Zeiss, Obj. A., Oc. 4.

FIG. 2.—Section of one of the bronchial glands showing numerous giant cell systems. Zeiss, Obj. D., Oc. 2.

FIG. 3.—Section of a wedge-shaped portion of the anterior margin of the middle lobe of the right lung. The miliary tubercle situated around the vessels is well seen. There are a few discrete miliary tubercles scattered around the primary focus. The section includes all the tubercle found in the lung. Zeiss, Obj. A., Oc. 2.

Fig. 1

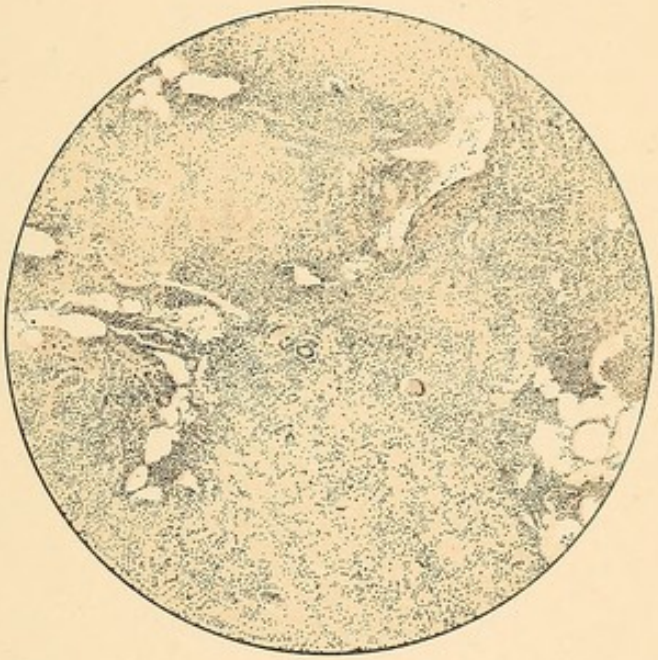

Fig. 2

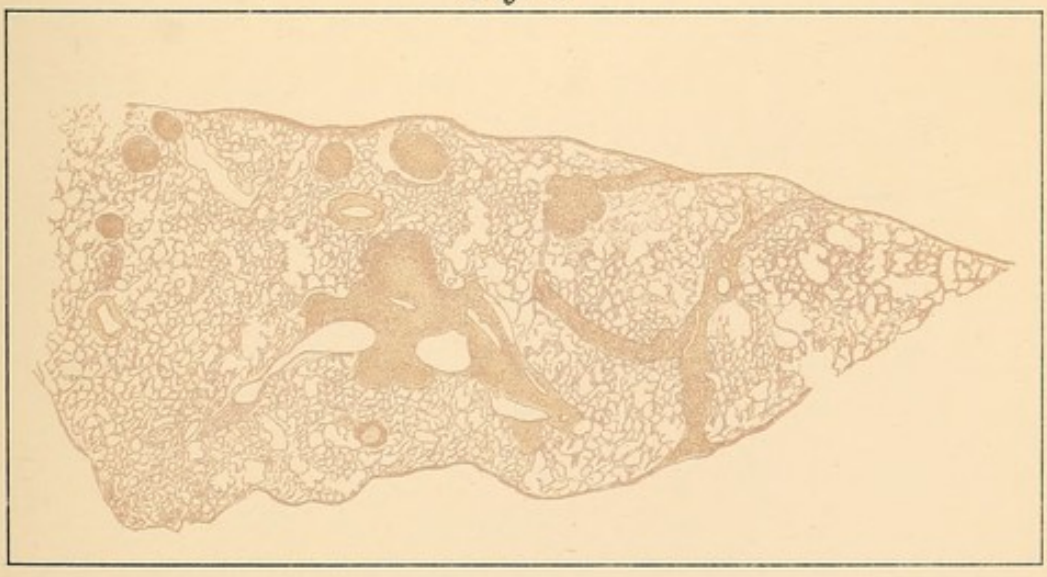

Fig. 3

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caseous gland where a few discrete miliary tubercles were found.

I. C., aged 9 months, admitted for abscess behind ear, found on operation to be due to tuberculous disease of mastoid bone.

CASE 3.—One half of the lung of a child with a row of bronchial glands on its inner edge above the hilus. The glands were enlarged and caseous. The largest situated apparently within the lung substance in reality in relation to the main bronchus had undergone partial softening, and the lung substance immediately adjacent to this softened gland was over a pyramidal area in a state of caseous pneumonia (tuberculous) and presented a pale yellow colour. The lung substance around presented its natural red colour, and was studded with small grey and caseous tuberculous nodules. The pleura was slightly inflamed and covered with flaky lymph.

CASE 4.—*Ulcerative Phthisis (in an infant). Infection from Bronchial Glands.*—Portion of the middle lobe of the lung of an infant, the greater part forming an irregular cavity with inflamed and caseating walls. At the upper angle of the lobe, close to the main bronchus, there was an enlarged caseous and partially softened bronchial gland with intensely inflamed, reddened and thickened capsule. This capsule had ulcerated through at its lower part where it abuts on the lobe, and this probably proved the starting point of the infection of this middle lobe, for the infection was exclusively limited to this lobe. The rest of the lungs was quite free from tubercle with the exception of a limited area of the upper lobe of the same lung, which lay in contact with this same softened gland. This portion of the lung showed a few grey miliary granulations.

The above three specimens are from the Museum

of the Congress on Tuberculosis, held in London in 1901. See also Case 12 under *Tuberculosis of the Tonsil.*

In three out of the above four cases it will be observed that it was the middle lobe of the right lung that first received the infection from the bronchial glands lying in contact with it, and very probably the fourth case started in the same way. These four cases prove, I think, beyond all possibility of doubt, that in certain cases the channel of infection of the lung is derived directly from the bronchial glands. This mode of infection, which must be very common in childhood, explains, I think, the difference of distribution observed clinically in cases of pulmonary tuberculosis in childhood and in the adult, as in the former it is very common to be able to trace a rough localisation of the disease about the roots of the lungs.

But there is another way the lungs may receive the infection from the bronchial glands, the channel in this case being an epithelial one. Many cases have been put on record of an inflamed and softened bronchial gland ulcerating through into the trachea or one or other of the bronchi. In this way tubercle bacilli may be drawn into the lungs by the inspiratory current of air, or extend by the epithelial tract of the bronchi to the lung parenchyma.

Now, what is the channel of infection to the bronchial glands? How does the tubercle bacillus reach them?

The following are possible channels:—

(*a*) The tubercle bacillus is inhaled and thus reaches the bronchial glands.

(*b*) The tubercle bacillus is absorbed at some point in the pharynx, tonsil, or the post-nasal adenoid tissue. From thence it is passed to the cervical glands, medi-

astinal glands, thoracic duct, and so to the right side of heart and lung.

(*c*) Or, thirdly, it is possible there may be an upward spread. The tubercle bacillus may reach the mesenteric glands from the intestine, and so be passed on to the retroperitoneal glands, to the bronchial glands, and so to the lung ; or by thoracic duct to right side of heart and thence to lung.

(*d*) The tubercle bacillus may possibly reach the bronchial glands by the way of the œsophagus.

(*e*) By extension from carious vertebræ (tuberculous).

I will consider these possible modes of infection in order. But before doing so we will stop to enquire if it be possible for the tubercle bacillus to pass through a normal mucous membrane, and so infect the underlying glands or tissues without leaving any trace behind them.

It is almost certain that it can. Professor Benda, at the meeting of the British Congress on Tuberculosis, held in London in 1901, speaks thus :—

" Whether tubercle bacilli gain access through intact mucous membrane is a matter extremely difficult to determine by methods of pathological anatomy. We find a large number of cases of bronchial gland tuberculosis, in which we do not discover a trace of any bronchial lesion, but can we conclude from that that the tubercle bacilli have penetrated through the intact mucous membrane? We have lately heard from Koch, and we know also from personal experience, that tuberculous lesions can undergo perfect healing, and in children we may expect this to take place without cicatrices. Is it not possible that the small lesions which have let the tubercle bacilli pass through are completely healed? I consider this question must be,

in a way, a matter of sentiment and predilection with everyone. I do not think that pathological anatomical observations can lead to any determination. Positive observations are therein more valuable than negative, and I have now and then, after long search, found isolated cicatrices in the intestine, where the intestine was to all appearances free from tuberculosis, and where no primary tuberculosis of the intestine but that of the peritoneum and lymphatic glands appeared to be present. There were here present cicatrices following the lesions which perhaps had been in a position to take up the bacilli."

The occurrence of such infection without surface lesion has been established by Professor Sidney Martin, in the Report of the Royal Commission on Tuberculosis. Four pigs were fed upon bovine tuberculous material (meat and milk) and as a consequence contracted tuberculosis. Martin draws especial attention to the absence of any lesion in the alimentary tract, the disease being first shown in its course from that tract by an infection of the lymph glands in connection with its different parts. The same may be observed in the human organism. The intestine may be apparently quite natural, and yet the mesenteric glands are found to be tuberculous. The experiments of Renshaw may also be quoted.

Renshaw made some experiments on guinea pigs, by which he was able to show that the nasal mucous membrane may be infected by simply introducing tuberculous sputum while leaving the mucous membrane intact. Out of eight animals experimented on seven showed definite tuberculous lesions. It is noteworthy, I think, that from the nose infection of the meninges did not occur, nor was direct infection by the way of the respira-

tory tract found. The channel of invasion was in every case by the lymphatics to the glands and from these to the viscera.

Professor Hamilton, speaking at the same Congress, said :—

"Can the absorbents of mucous membrane seize upon the bacillus and hand it on to the corresponding lymphatics without themselves becoming tuberculous? My own impression is that they can, that the actual point of invasion may from local conditions prove unfavourable to the development of tubercle, and that the bacillus is passed through them to a tissue more favourable to its growth."

From some observations of my own on tonsillar and intestinal tubercle I have come to the same conclusion. I believe the tubercle bacillus can be passed through a normal intact mucous membrane without leaving any trace behind it. But I shall return to this question later in my essay.

One of the channels of infection, then, may be by inhalation. The bacillus passes down the trachea and bronchi and is absorbed through their mucous membrane, and thus reaches the bronchial glands. It will be convenient here before proceeding any further to consider what evidence we have that the tubercle bacillus may also be absorbed by the mucous membrane of the œsophagus, and thus also reach the bronchial glands. Seeing that the tonsil, although not ulcerated, yet must be supposed often to pass the bacillus on to the glands of the neck, the immobile bacillus requires a conveyance ; the salivary corpuscles would suffice to carry the bacillus through the wall of the œsophagus, stopping at the lymphatic glands. The gland most frequently affected in children lies on the œsophagus, in the fork of the

bronchi and trachea. There is some supporting evidence to this theory. Mr. S. G. Shattock last June showed primary tuberculosis of the œsophagus in a python, at the Pathological Society of London. In man tuberculosis of the œsophagus is only known by direct extension and is never primary, but there are no lymphatic structures in the human œsophagus analogous to those of the python, but most remarkable of all was his statement that infection had occurred by invasion between the cells of the epithelium which remained intact without any ulcer.

It is thus very probable, nay, I may say, certain, that the bronchial glands receive the infection through the normal intact epithelium of the trachea, bronchi, or œsophagus. The older theory that the tubercle bacilli are inhaled, passed through the lung and so reach the bronchial glands is improbable. We know for a certainty that the lung may be infected from the bronchial glands, but we do not know that the bacilli can be passed through the lung without affecting the organ.

I will now pass on to the second question : Are the bacilli absorbed at some point in the pharynx such as the tonsil, post-nasal adenoid tissue, adenoid tissue at base of tongue, &c. ?

With regard to the tonsil and pharynx in the dead subject. Professor G. Sims Woodhead, in a paper entitled "The Channels of Infection in Tuberculosis," after reviewing the various ways in which the tubercle bacillus might conceivably gain entrance into the living organism, sums up as follows :—

"I am driven to the conclusion that this method of infection of the glands of the neck through the tonsils must be a comparatively frequent occurrence, especially

in children living under insanitary conditions, and subjected to various devitalising influences."

On a subject so important I determined to make use of my opportunity as pathologist to a consumption hospital to investigate, as far as possible, if this mode of infection of the glands of the neck through the tonsils really took place. I proposed to make a careful histological examination of the tonsils and follicular glands at the base of the tongue of every case of tuberculosis that came before me for *post-mortem* examination, in the hope that such examination might possibly throw some light on this subject.

My investigations, however, were soon directed into a wide channel by a communication of M. Dieulafoy to the Academy of Medicine of Paris, entitled "Latent Tuberculosis of the Three Tonsils." M. Dieulafoy made an experimental investigation to ascertain whether hypertrophy of the tonsils and adenoid vegetations of the pharynx are in any cases of a tuberculous nature, and, if so, in what proportion. He obtained a number of portions of tonsils and adenoid vegetations which had been removed on account of overgrowth.

Hypertrophied tonsils from twenty-one cases were inoculated into guinea pigs, and eight of the animals became tuberculous. Adenoid vegetations from thirty-five cases were inoculated, and seven of the guinea pigs became tuberculous. Thus, one in eight of the cases of apparently simple hypertrophy of the tonsils and one in five of the cases of adenoid vegetation were, according to M. Dieulafoy, tuberculous.

As M. Dieulafoy had made no histological examination of the portions of tonsils so injected, his communication met with much adverse criticism at the hands of his colleagues in the Academy.

It was pointed out that inoculation experiments were open to the objection that virulent tubercle bacilli might be entangled in the mucus of the tonsillar crypts without these organs being necessarily tuberculous, so, in addition to the histological examination of the tonsils removed from the dead subject, I set myself the task of examining histologically portions of tonsils removed from the living patient.

At the outset of the investigation I naturally turned first of all to the classical works of pathology in this country, and here I must admit I met with nothing but disappointment ; in fact, the tonsils seem almost to have escaped the scrutiny of English pathologists.

Drs. Wilks and Moxon, in their well-known work, write as follows : " Occasionally tubercles may be found isolated on the palate, tonsils, and other parts of the mouth, commencing as white spots, and then softening until ulcers are formed."

Dr. Coats, in his text-book of pathology, says, " Tuberculosis of the tonsils occurs chiefly in connection with that of the epiglottis and tongue."

Dr. Osler, in his text-book of medicine, says, " Tuberculosis of the tonsils has been recorded in a few cases."

Professor Hamilton is the only British pathologist who makes any mention of a possible connection between tuberculosis of the tonsils and cervical gland enlargement. He says, " It has even been alleged that tuberculous enlargement of the glands of the neck may be caused by absorption of the tubercle bacillus through the tonsils and analogous structures in the neighbourhood." By analogous structures in the neighbourhood I take Professor Hamilton to mean the follicular glands at the base of the tongue and generally the whole

adenoid ring surrounding the entrance to the respiratory and digestive tracts.

From the text-books of pathology I turned to the *post-mortem* records of the Hospital. On carefully going through the *post-mortem* books from 1854 to the present time, I find no mention of the tonsils being affected with tubercle, and yet, as my investigations will show, how often must these organs have been tuberculous.

Dr. J. Purves Stewart, communicated to the *British Medical Journal* a short paper on the occurrence of giant cells in the tonsils. The case described by Dr. Stewart appeared to be merely one of ordinary chronic enlargement of the tonsils with pharyngeal adenoids associated with post-scarlatinal otorrhœa and enlargement of the cervical glands, in a child aged 10 years. The tonsils were removed. On a naked eye examination they differed in no way in their appearance from ordinary chronically enlarged tonsils. On microscopical examination, however, the following appearances were found. Scattered through the substance of the lymphoid tissues were large numbers of tuberculous giant cell systems, apparently most numerous close beneath the epithelial surface of the tonsil. The giant cells were of the typical multi-nuclear form characteristic of tubercle, surrounded by the usual epitheloid and lymphoid cells. Staining with Neillson and Gram's method failed to demonstrate bacilli in the sections. The pharyngeal adenoids on section were found free from tubercles. Some enlarged cervical glands were subsequently removed from the same patient, and these on microscopical examination showed definite tuberculosis in various stages of advance, from simple enlargement to caseation.

The subject naturally falls into two principal divi-

sions. First, I shall give the results of my examination of the tonsils, cervical glands and follicular glands of the tongue in cases of tuberculosis that came before me for *post-mortem* examination, and, secondly, I shall give the results of my examination of portions of hypertrophied tonsils and adenoid vegetations removed from the living patient.

First, *post-mortem* cases. In all the cases I am about to describe, with two exceptions, there was nothing during the life of the patient to call attention to the tonsils.

In the majority of the patients the tonsils were atrophied; in only one or two was there anything approaching hypertrophy. There was no complaint of pain or difficulty in swallowing. In short, there was nothing to call attention to the organ. Out of thirty-four consecutive *post-mortem* examinations I found the tonsils to be more or less tuberculous in twenty.

I will now give short notes of the cases.

(1) *Post mortem.*—Henry W., aged 32. Chronic pulmonary tuberculosis. Small recent cavity at apex of right upper lobe; a large, much older, cavity at apex of left upper lobe. Larynx and trachea normal. Ulceration of ileum. Cervical and bronchial glands tuberculous.

Tonsils.—Both tonsils somewhat atrophied. The stratified epithelium lining the crypts for the most part desquamated. Miliary tubercle scattered throughout both tonsils. Tubercles very rich in giant cells; some have undergone slight caseous change. Tongue free. Expectoration slight. Tubercle bacilli numerous.

(2) *Post mortem.*—Thomas T., aged 55. Chronic pulmonary tuberculosis, granular kidney. Small recent cavity at apex of right upper lobe. Three small cavities

at upper part of left upper lobe. Larynx and trachea normal. Bronchial glands tubercular. Few scattered tubercles in ileum, with a few small ulcers.

Tonsils.—Slightly atrophied, much fibroid change. The epithelium lining the crypts was desquamated in parts. Old tubercle undergoing fibroid change with the addition of far more recent tubercle scattered throughout. Expectoration copious. Tubercle bacilli numerous.

(3) *Post mortem.*—Sarah B., aged 36. Acute pulmonary tuberculosis, alcoholic neuritis, granular kidney. Small recent cavity, size of a Brazil nut, in the middle of the left upper lobe, apex and lower lobe free from tubercle; there was also a small recent cavity, size of a small walnut, at the apex of the left lower lobe. Small and large intestine ulcerated throughout. Larynx and trachea normal. Cervical glands normal.

Tonsils.—Both tonsils free from tubercle. Expectoration *nil.* No tubercle at base of tongue.

(4) *Post mortem.*—George H., aged 52. Morbus cordis, aortic and mitral, miliary tuberculosis of lungs. Tuberculous ulceration of base of tongue, pharynx and larynx. Both lungs stuffed with grey miliary tubercle from apex to base. Cervical glands enlarged, tuberculous. Extensive ulceration of ileum.

Tonsils.—The left tonsil completely free from any trace of tubercle. The right tonsil was unfortunately lost. Expectoration *nil.* Tubercle bacilli, a few.

(5) *Post mortem.*—William S., aged 38. Acute miliary tuberculosis, caseous suprarenals, no pigmentation. Both lungs stuffed with miliary tubercle from apex to base. Larynx and trachea normal. Cervical glands *nil.* Tubercle in kidney and liver.

Tonsils.—Small deposit of tubercle in one tonsil.

Giant cells ill marked. Expectoration very slight. Few tubercle bacilli.

(6) *Post mortem.*—J. W. B., aged 39. Chronic pulmonary tuberculosis. Both lungs contained numerous cavities throughout. Bronchial and cervical glands tuberculous. Extensive ulceration of larynx. Small and large intestine ulcerated.

Tonsils.—Tonsils hypertrophied, crypts very wide. Epithelium desquamated in parts. Small tuberculous foci in one. Expectoration slight. Few tubercle bacilli.

(7) *Post mortem.*—Thomas R., aged 50. Acute pulmonary tuberculosis. Larynx, trachea, normal. Left lung infiltrated throughout with caseous tubercle, no cavitation. The whole of right upper lobe riddled with small cavities. Bronchial glands caseous. Small intestine ulcerated throughout, four ulcers in ascending colon.

Tonsils.—Atrophied; crypts very wide. Epithelial lining crypts intact. Calcified plates scattered throughout both tonsils. Small deposit of epithelial tubercle in one. Much increase of fibroid tissue throughout both. Expectoration not stated.

(8) *Post mortem.*—Marie D., aged 13. Chronic pulmonary tuberculosis. Larynx, trachea and bronchi normal. Bronchial, cervical, and anterior mediastinal glands tuberculous.

Lungs.—Numerous old cavities in both lungs.

Small tuberculous ulcer on dorsum of tongue. Caseous tubercle scattered through lower ileum. Half a dozen small tuberculous ulcers in ascending colon.

Tonsils.—Normal in size; crypts very wide. Epithelial lining to crypts normal. Epithelial tubercle in both. Giant cells not marked. Expectoration slight. Few tubercle bacilli.

(9) *Post mortem.*—Hadley S., aged 31. Chronic pulmonary tuberculosis, morbus cordis, tricuspid regurgitation, emphysema. Larynx and trachea normal. Bronchial glands deeply pigmented, tuberculous.

Lungs.—Old cavity at apex of right upper lobe; cavity small at apex of right lower lobe. Tubercle scattered sparsely through left lung.

Tonsils.—Both tonsils free from tubercle. Expectoration not examined, as patient died soon after admission. No tubercle in tongue.

(10) *Post mortem.*—Thomas H., aged 44. Pulmonary tuberculosis, tuberculous peritonitis, tuberculous ulceration of pharynx and soft palate. Much superficial ulceration of the epiglottis. Small tuberculous ulcer about one inch from the tip of the tongue. Ulceration of larynx. Bronchial and cervical glands tuberculous.

Lungs.—Small recent cavity about the size of a cob nut at the apex of the right upper lobe. Miliary and caseous tubercle scattered through middle and lower lobes. Left lung, no cavitation; fresh grey tubercle scattered through upper lobe.

Tonsils.—Both tonsils almost completely destroyed by tuberculous ulceration; in fact, there was hardly any of the proper adenoid tissue of the organ left.

The follicular glands at the base of the tongue were tuberculous. Expectoration slight. Tubercle bacilli numerous.

(11) *Post mortem.*—James M., aged 30. Chronic pulmonary tuberculosis. Lardaceous disease of liver, spleen, intestines.

Lungs.—Both riddled with old cavities. Bronchial glands caseous. Laryngeal ulceration. Trachea normal.

Tonsils.—Both tonsils somewhat atrophied, especially

the right. Caseous-looking nodules in right tonsil. Tubercle in both. Slight superficial ulceration in left. Expectoration not stated.

(12) *Post mortem.*—Rose T., aged 15. Caseous and calcareous bronchial glands. Lungs congested, but free from tubercle. Yellowish patch on each tonsil. ? Diphtheritic membrane. A cultivation taken in solid blood serum, streptococci and staphylococci cultivated, but no diphtheria bacilli found. With this exception nothing was found to account for death.

Tonsils.—No tubercle.

(13) *Post mortem.*—William McG., aged 38. Chronic pulmonary tuberculosis, acute nephritis, laryngeal ulceration. Bronchial glands caseous. Three very old cavities in right upper lobe. Small cavity in middle of left upper lobe; apex free, no intestinal ulceration.

Tonsils.—Slightly hypertrophied. Epithelial lining of crypts deficient in places. Few sparsely scattered tubercles in both.

(14) *Post mortem.*—George T., aged 39. Chronic pulmonary tuberculosis. Old fibroid phthisis. Larynx and trachea normal. Right lung a beautiful specimen of tuberculo-fibroid change. Cylindrical bronchiectasis. Old cavity in right upper lobe. General disseminated tubercle throughout left lung. No intestinal ulceration.

Tonsils.—Much fibroid substitution; sparsely scattered tubercle through one.

(15) *Post mortem.*—Benjamin S., aged 39. Acute pulmonary tuberculosis. Epiglottis superficially ulcerated. Pharyngeal ulceration. Extensive ulceration of trachea. Five small cavities in right upper lobe. The left lung infiltrated throughout with tubercle; no cavitation. Few scattered tubercles in cortex of both kidneys. Four or five small ulcers in ileum.

Tonsils.—Atrophy of both tonsils. Crypts contain much broken-down epithelial *débris*. Few tubercles in one.

(16) *Post mortem.*—William J. C., aged 44. Chronic pulmonary tuberculosis. Larynx and trachea normal. Bronchial and cervical glands enlarged, tuberculous. Large cavity at apex of right upper lobe. Three small cavities and general tuberculous infiltration of left upper lobe. *Calcareous mesenteric glands. No ulceration of intestines.*

Tonsils.—Both somewhat atrophied with much fibroid induration. Few tuberculous nodules scattered through one. Much expectoration. Tubercle bacilli few.

(17) *Post mortem.*—Thomas J. M., aged 22. Chronic pulmonary tuberculosis, lardaceous disease. Larynx and trachea normal. Bronchial glands caseous. Cavity size of a walnut at apex of right upper lobe; much larger cavity at apex of left upper lobe

No ulceration of intestines.

Liver, spleen and kidneys lardaceous.

Tonsils.—Normal in size. Epithelium desquamated in places. Both tonsils contained tubercle. Very little fibroid change.

No tubercle in follicular glands of tongue.

(18) *Post mortem.*—Joseph R., aged 46. Morbus cordis. Adherent and calcified pericardium. Empyema, miliary tuberculosis. Larynx, trachea and bronchi normal. At the apex of each lung numerous grey miliary tubercles. Bronchial glands enlarged, not tuberculous.

Tonsils.—No tubercle in either tonsil. No tubercle in follicular glands of tongue.

(19) *Post mortem.*—Fred P., aged 32. Chronic pulmonary tuberculosis. Lardaceous disease. Tricuspid regurgitation. Much œdema of lower extremities. No pigmentation. Old cavity size of a walnut at the

apex of the right upper lobe. Few caseous nodules at apex of the left upper lobe. Larynx and trachea normal. Bronchial glands tuberculous. Cervical glands *nil.* Lardaceous disease of liver, spleen and kidneys. No ulceration of intestines.

Tonsils.—Both tonsils hypertrophied, markedly congested. Epithelium deficient in parts. No tubercle in either. Follicular glands at the base of the tongue very congested, but no tubercle discovered.

(20) *Post mortem.*—Bertha C., aged 19. Chronic pulmonary tuberculosis. Chronic nephritis (large white kidney). Lardaceous disease. Left upper lobe riddled with small cavities. Cavity at apex of left lower lobe. Caseous and calcified bronchial glands. Larynx and trachea normal. Few caseous tubercles in ileum; no ulceration. Spleen and kidneys lardaceous.

Tonsils.—Tubercle in both tonsils. No tubercle in tongue.

(21) *Post mortem.*—Arthur H., aged 27. Chronic pulmonary tuberculosis. Ulceration of larynx. Bronchial glands caseous. Cavities in both upper lobes. No intestinal ulceration.

Tonsils.—Both tonsils atrophied; crypts very wide. Tubercle in both. No tubercles in follicular glands of tongue.

(22) *Post mortem.*—William N., aged 39. Chronic pulmonary tuberculosis. Larynx and trachea normal. Old cavities in both upper lobes. Bronchial and mediastinal glands tuberculous. No ulceration of intestines.

Tonsils.—Atrophied; remarkably wide crypts, some fibroid increase; no tubercle in either tonsil. Tongue free from tubercle. Expectoration much. Tubercle bacilli few.

(23) *Post mortem.*—William B., aged 19. Chronic pulmonary tuberculosis, cirrhosis of the liver.

Larynx healthy. Large old cavities in both lungs. Ulceration of ileum. Few ulcers in ascending colon.

Tonsils.—Both tonsils much congested. Numerous tubercles scattered through both.

(24) *Post mortem.*—Charles W., aged 34. Morbus cordis. Double aortic mitral regurgitation. Infarcts in lungs.

Tonsils.—Both tonsils congested. No tubercle.

(25) *Post mortem.*—Frederick N., aged 17. Morbus cordis. Double aortic and double mitral.

Tonsils.—Deeply congested. No tubercle.

(26) *Post mortem.*—Henry S., aged 8. Gangrene of right lung, pulmonary tuberculosis, pneumonia.

Three small recent cavities at apex of right upper lobe. The apex of the lower lobe gangrenous and breaking down, rest of the lower lobe solid (pneumonic). The left lung—small calcareous patch at the extreme apex of the right upper lobe. No ulceration of intestines. Larynx healthy. Bronchial glands enlarged and caseous.

Tonsils.—Hypertrophied. Very congested. No tubercle in either.

(27) *Post mortem.*—John W., aged 43. Chronic pulmonary tuberculosis.

Perforation of intestine (tuberculous), peritonitis. Both lungs contained much caseous tubercle. Larynx and trachea normal. Ulceration of ileum; one ulcer situated about two inches from ileo-cæcal valve had a large perforation in its floor. Liver tuberculous. Kidneys tuberculous.

Tonsils.—There was some superficial ulceration in the left tonsil. Both the organs, however, were free from any trace of tubercle.

(28) *Post mortem.*—William D., aged 30. Acute miliary tuberculosis.

Old cavity surrounded by dense fibrous tissue at apex of right upper lobe. The rest of the right lung, as also the left lung, simply stuffed with grey miliary tubercle. Larynx, right vocal cord almost completely destroyed by ulceration. Under surface of epiglottis extensively ulcerated. Spleen, kidneys and intestine contained many miliary tubercles.

Tonsils. — Hypertrophied. Tubercle scattered through both.

(29) *Post mortem.*—Richard P., aged 41. Chronic pulmonary tuberculosis.

Small ulcer at base of right vocal cord. Superficial ulceration of the soft palate (tuberculous). Bronchial and cervical glands tuberculous. Huge old cavity excavating the whole of the right upper lobe and part of the middle lobe. Small cavities more recent in left upper lobe. No ulceration in intestine. Kidneys tuberculous.

Tonsils.—Epithelium lining crypts deficient in parts. Numerous tubercles scattered throughout both tonsils. No caseation.

(30) *Post mortem.*—William D., aged 24. Chronic pulmonary tuberculosis, pneumothorax.

Cavities in both lungs. Laryngeal ulceration. Trachea and bronchi thickly set with tubercle. Tuberculous ulceration of both large and small intestines

Tonsils.—Tubercle in both tonsils, some beginning to caseate. Both organs somewhat hypertrophied

(31) *Post mortem.*—John C., aged 29. Chronic pulmonary tuberculosis, suffocative hæmoptysis.

Larynx healthy. Bronchial glands caseous. Large cavity at the apex of the right upper lobe. Small cavity

in the middle of the left upper lobe, communicating with a large branch of the pulmonary artery. Ulceration of ileum.

Tonsils.—Both tonsils hypertrophied. Both simply stuffed with tubercle.

(32) *Post mortem.*—James J., aged 46. Chronic pulmonary tuberculosis, emphysema, suffocative hæmoptysis.

Large old cavity excavating nearly whole of the left upper lobe. Right lung nearly free from tubercle. Bronchial glands caseous. Larynx not examined. Tuberculous ulceration of lower ileum, caseous tubercle in kidneys.

Tonsils.—No tubercle in either tonsil or tongue.

(33) *Post mortem.*—Agnes A., aged 18. Chronic pulmonary tuberculosis.

Small recent cavity at right apex, caseous tubercle at apex of left upper lobe. No intestinal ulceration. Bronchial glands caseous. Larynx healthy.

Tonsils.—Both tonsils free from any trace of tubercle. Both hypertrophied. No tubercle in tongue.

(34) *Post mortem.*—Elizabeth Y., aged 17. Chronic pulmonary tuberculosis.

Tuberculous peritonitis. Perforation of intestine (ileum). Cervical and bronchial glands tuberculous, some calcareous. Larynx and trachea normal. Large cavity excavating left upper lobe. Small cavity at apex of left upper lobe. Extensive ulceration in lower ileum.

Tonsils.—Both tonsils tuberculous. No tubercle in tongue.

I think the results of *post-mortem* examinations are sufficient to disprove what was generally held to be true, that the tonsils are very rarely affected by tubercle.

Now, what is the significance of these miliary tubercles in the tonsils?

Is the tonsil primarily affected? Are we to suppose that the tubercle bacillus may first gain entrance to the human organism by the way of the tonsil, spreading thence to the cervical and mediastinal glands, and so to the thoracic duct, right side of the heart and lung? Or are we to look upon this tonsillar tuberculosis as altogether secondary, and, in short, an auto-infection from the sputum passing over them?

I think both suppositions are true. In support of the first I will take the results of the *post-mortem* examinations of Cases 4 and 10. (See plate 5, figs. 1, 2, and plate 6, fig. 1.)

In the case of George H. the primary cause of death was the aortic and mitral insufficiency. The tuberculosis was altogether secondary. The tuberculous ulcer at the back of the pharynx was very chronic in its course; in fact, there were appearances of healing at some parts. (See plate 15, fig. 2.) Microscopically, also, the sections show the fibroid character of the tubercle. The infection starting thence from the pharynx gradually spread to the cervical glands, which are found *post mortem* to be tuberculous. From here we may conceive that the bacilli may reach the thoracic duct and right side of heart, pulmonary artery, and lungs. Now what do we find? Exactly what one would expect: a general shower of miliary tubercle all over both lungs. My *post-mortem* note on the lungs is as follows: Both lungs are stuffed from apex to base with grey miliary tubercle.

This case is, I think, clear and conclusive. The old tuberculous ulceration in the fauces and the fresh grey miliary tubercle in the cervical glands and lungs leads one irresistibly to the conclusion that the primary source of infection was in the pharynx. There could be no

PLATE 5

FIG. 1.—Vertical section through the tonsil of Case 1, *post mortem* 1. The stratified epithelium lining the tonsillar crypt has completely disappeared Numerous miliary tubercles are scattered through the adenoid tissue of the organ. The giant cells in some of the tubercles are extremely we marked. (Zeiss, Obj. A., Oc. 2.)

FIG. 2.—Vertical section through the tonsil of Case 2, *post mortem* 2. Here also the epithelial lining of the crypts has disappeared. The tubercular foc appear in places to have undergone a fibroid change, but there are many fresh miliary tubercles scattered throughout the organ. (Zeiss, Obj A., Oc. 2.)

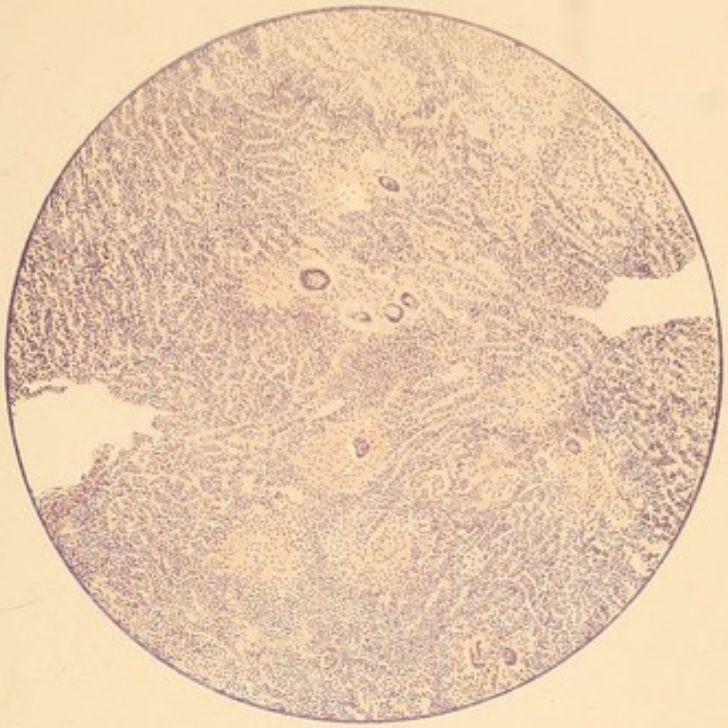

Fig. 1

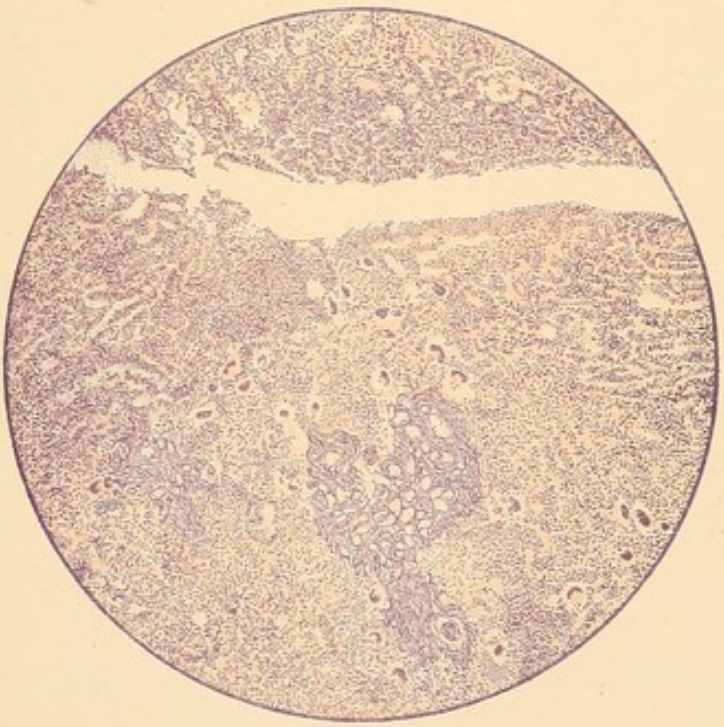

Fig. 2

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question here of the pharynx being infected by the passage over it of sputum laden with bacilli, for, as usually happens in these cases of miliary tuberculosis of the lungs, there was no sputum.

The second case (10) is that of Thomas H. Here we find tuberculous ulceration of the tonsils and soft palate. The follicular glands at the base of the tongue are tuberculous, although no ulceration is present. The cervical and bronchial glands contain tubercle. The condition of the lungs is much the same as in the former case. We find grey miliary tubercle scattered through both lobes of the left lung, a small recent cavity about the size of a small cob-nut at the apex of the right upper lobe, and the middle and lower lobes containing miliary tubercle, some beginning to caseate.

Here, also, I think, the evidence that the tonsil was the primary source of infection is conclusive. The faucial ulceration was much older than the tubercle in the lung. True, we have a small recent cavity at the right apex, and the tubercle in the right upper lobe had begun to caseate, but I do not think this is evidence against the tonsillar origin of the infection.

These are the only two cases in my series in which the tonsil could be regarded as the primary source of infection.

The next of my cases are two of acute miliary tuberculosis, Nos. 5 and 28. Both of these cases contained miliary tubercle in the tonsils.

In the case of William S. (5), both lungs were stuffed with miliary tubercle throughout. The only caseous focus was in the supra-renal capsules.

Here, at first, I was at a complete loss to account for the tonsillar tuberculosis. On reflection, I think it can only be explained by supposing the infection to

have been conveyed to the tonsil, as it is to the other organs, by the blood stream; that is, that the tonsil did not receive the infection from the outside, but from the blood current.

In this case the tubercles were very sparsely scattered in the organ.

Case 28 (that of William D.) is a little different. Here the primary source of infection was, no doubt, the apparently old so-called quiescent cavity at the apex of the right upper lobe.

The history appeared to be this: For some unexplained reason this old cavity gave rise to the general dissemination of grey tubercle to tonsils, spleen, kidneys and intestines, the tonsils being infected, as the other viscera, through the blood stream.

The remaining cases appeared to be instances of auto-infection, from the passage of bacilli-laden sputum passing over the tonsils. The adenoid tissue of the organs becomes affected in the same way as the adenoid tissue of the Peyer's patches in the intestine and the lymphoid accumulations in the larynx and tongue.

Tubercle as it occurs in the tonsil (see plate 5) is generally miliary in character; only very occasionally was there evidence of beginning caseation. In some cases the tubercles were very rich in giant cells, resembling those found in lymphatic glands; in other cases these cells were absent (epitheloid tubercle).

The tubercles vary extremely in number; they may be thickly scattered all through the substance of the tonsil, or one or two may be all that are found after diligent search through many microscopical sections. Bacilli are generally scanty in number, but may be found if diligently searched for.

How do the bacilli gain entrance to the substance of the tonsil? Can they penetrate the normal intact epithelium lining the tonsillar crypts?

In some of my cases the epithelial lining was in parts desquamated. But this does not appear to be necessary for the penetration of the bacillus. If the tonsillar crypts be carefully examined, search being made over hundreds of sections, places will be found where there are conical lymphoid accumulations first described by Stöhr. These lymphoid accumulations completely obscure the epithelium lining the crypts at these points, but the epithelial cells on careful observation are found to be intact.

There is no doubt that the lymphoid corpuscles wander from the deeper adenoid tissue of the tonsil to the surface. The bacilli, perhaps, enter the adenoid tissue of the tonsil at these spots. Here, being destroyed by phagocytes, their life history may abruptly come to an end. But if too numerous, victory may be theirs, and the partially destroyed phagocyte may form the nourishing material on which they may live and propagate.

What is the connection between the so-called strumous cervical glands and the tonsils? Are the tonsils the primary place of infection in these cases? Is it possible for the tubercle bacillus to be absorbed through the tonsils and so reach the lymphatic glands of the neck without leaving a trace behind them in the organ?

I have next to state the result of my examination of the tonsils and adenoid vegetations removed from the living patients

Here my investigations have been entirely negative.

I have examined microscopically many portions of hypertrophied tonsils and adenoid vegetations without finding any trace of tubercle; other observers, however, have been more fortunate. In addition to the observation of Dr. Purves Stewart, referred to above, M. A. Pilliet, in 1892, contributed a short note to the Société Anatomique of Paris upon the presence of giant cells in adenoid vegetations of the pharynx, and a very interesting paper by M. Lermoyez in 1894, communicated to the Société Médicale des Hôpitaux, is entitled "Tuberculous Adenoid Vegetations of the Naso-pharynx." The following case appears to me to be so important that I quote it at length; it is from M. Lermoyez's paper.

A woman, aged 38, married, suffered from chronic nasal obstruction since childhood; she came to the hospital complaining of a purulent discharge from the left ear with deafness; apart from this there was nothing pathological. Husband healthy, three healthy children. She presented a characteristic adenoid facies. Adenoid vegetations were diagnosed and removed. One month after the operation her general condition was found to be very unsatisfactory. She had a cough, night sweats, loss of appetite, and wasting. On examination there was dulness, with prolonged expiration under the right clavicle, and six months later the diagnosis of pulmonary tuberculosis was confirmed. No chest disease was discoverable at the time of the operation.

Now in this case three suppositions are possible :—

(1) The patient may have been infected at the time of the operation.

(2) There was latent tuberculous disease of the right lung at the time of the operation, which developed after.

(3) The adenoids were tuberculous from the first,

the operation letting the bacilli into the general circulation.

Unfortunately no histological examination of the removed adenoids seems to have been made. The first hypothesis in these latter days of aseptic surgery is not, I think, possible. The second is possible but not probable. The third is most likely.

M. Lermoyez gives a second similar case, in a child, aged 6 years. Adenoids were removed. Microscopical examination revealed the presence of giant cells and tubercle bacilli.

A third case has also come under my notice in a young woman, aged 17. No family history of tubercle. Adenoid vegetations were removed one year ago. The chest was carefully examined at that time and no physical sign of disease was discovered. Mother living and healthy, father died of morbus cordis, she was the only child. She never quite recovered after the operation. Cough, wasting and night sweats were marked six months after. On examination the physical signs of a cavity were found at the apex of the right upper lobe.

It is possible, of course, that latent chest disease existed at the time of the operation, but there was no evidence of this. Unfortunately no microscopical or bacteriological examination was made of the adenoid vegetations removed.

The following conclusions, I think, are justifiable :—

(1) That the tonsils, instead of being almost immune from tuberculous disease, are very frequently affected.

(2) That tubercle may be primary in the tonsil.

(3) That the tonsils are very frequently affected secondarily in persons suffering with chronic pulmonary tuberculosis.

(4) That when the tonsils are tuberculous the

cervical glands receiving the lymphatics from these organs are also frequently affected with tubercle.

(5) That the follicular glands at the base of the tongue are occasionally found tuberculous.

(6) That tonsils may be affected from without or through the blood stream in acute miliary tuberculosis

The *post-mortem* examinations were, with one exception, made by myself.

The tonsils on removal were at once placed in absolute alcohol to harden.

When sufficiently hard they were cut with Williams' ether freezing microtome and stained in hæmatoxylin and eosin. In examination for bacilli, carbol-fuchsin and methylene blue were used.

I will now pass on to the pharynx as a portal of entry of the tubercle bacillus. (See plate 15, fig. 2.)

The absolute frequency of tuberculosis of the pharynx, apart from mere extension from the larynx, does not appear to be great, judging from the number of cases that have been put on record. Fraenkel, in the Pathological Institute of Berlin, out of 150 autopsies on cases of tuberculosis only met with a single example. In the Museum of the Congress on tuberculosis there were only two examples of this condition out of all the morbid specimens contained in the various museums in London.

In 200 *post-mortem* examinations of my own I only met with one instance.

Since attention was called to this subject, however, by Dr. Gee in this country, and by M. Bath in France, cases have multiplied. Still, I have only been able to collect 49 cases.

Dr. Gee points out that pharyngeal tuberculosis is always a part of a general tuberculosis, and M. Bath says:—

"Tuberculous angina is rarely primary and isolated, but it almost always occurs as a part of a pulmonary tuberculosis."

Pharyngeal tuberculosis is seen clinically under two forms, either as a more or less chronic ulceration of the pharynx or as a miliary tuberculosis. The latter form is very rare. I have only been able to find a few cases. It occasionally occurs as part and parcel of a general acute miliary tuberculosis. The tonsil may be affected in the same way as described above. Much more frequently, however, it occurs as a tuberculous ulceration and as described above may be the primary focus of the infecting channel, but in the majority of cases is secondary, an example, in fact, of auto-infection from bacilli-laden sputum, in the same manner as the tonsil is so frequently infected in chronic pulmonary tuberculosis.

The etiology of pharyngeal tuberculosis is very obscure. Why does it escape infection in so many cases of pulmonary tuberculosis? M. Bath, writing two years before the discovery of the tubercle bacillus says:

"Quelques auteurs, reprenant la vieille théorie de l'école de Louis sur l'influence irritante des matières expectorées, ont pensé que la tuberculisation du pharynx pouvait être le résultat d'une action directe, d'une véritable auto-infection par les crachats séjournant dans l'arrière-bouche."

He goes on to say that it is impossible to reject this theory completely, and "we must admit that in certain cases the prolonged contact of tuberculous sputum with a mucous membrane already damaged, perhaps bereft of its epithelium, may lead to the development of tubercles *in situ*."

M. Bath continues: " Mais combien de cas sont absolument opposés à cette hypothèse! Souvent la tuberculose pharyngée se développe chez des individus dont les poumons n'offrent aucun signe de ramollissement, et qui, par conséquent, n'éliminent pas encore de matière tuberculeuse ; les cas les plus intenses sont d'ordinaire ceux dans lesquels une granulie aiguë emporte le malade avant la formation des lésions pulmonaires en foyer; enfin, dans les formes chroniques, les seules où l'action des crachats pourrait être incriminée, on voit souvent l'ulceration se localiser en un point circonscrit à la voûte palatine, sur l'amygdale, voire dans la portion nasale du pharynx, tous endroits qui sont rarement en contact avec les matières expectorées."

I think that in cases of tuberculosis of the pharynx we must assume some alteration in the secretions poured into the pharynx by the surrounding glands, or some alteration in the mucous membrane. A mere loss of its epithelial lining is not perhaps necessary for the penetration of the bacillus, because we now know that the bacillus can penetrate normal epithelium. But in this connection a case related by M. Breus is of interest. A man affected with pulmonary tuberculosis swallowed a quantity of caustic potash. The resulting pharyngeal and œsophageal ulcerations became tuberculous.

Dr. Vincent Harris has shown that the salivary glands (the glands examined were the parotid and submaxillary) undergo marked histological changes in tuberculosis. Now although tubercle of the salivary glands is almost unknown, nevertheless in many cases of the disease they undergo a distinct histological change. Dr. Harris says :—

" Having from a number of cases demonstrated the

occasional deficiency in the amount of the diastasic ferment of the saliva (ptyalin) of phthisical patients in a late stage of the disease, I undertook the examination of the salivary glands of such cases obtained from the *post-mortem* room, with the view of finding out whether the condition of the secreting tissue might not account for such deficiency. The examination of a few cases suggested a probable explanation of the abnormal secretion, namely, that fibrosis, sometimes sufficiently marked to be evident to the unaided eye, was not infrequently present."

I have seen this condition of fibrosis also in the tonsils in some cases of pulmonary tubercle.

I think we may sum up by saying that owing to some lesion of the pharyngeal wall or to alteration of the secretions poured into the pharynx, tuberculosis of this part of the alimentary tract may result. Pharyngeal tuberculosis may very rarely be primary, or it may occur in the miliary form as a part of a general miliary tuberculosis, or, lastly, and most frequently, it is a secondary auto-infection from bacilli-laden sputum passing over the pharyngeal wall.

In the miliary form the channel of infection is by the blood current, in the secondary chronic ulcerative form, the channel is an epithelial one.

Thirdly, there may be an upward spread. The bronchial glands may be affected from below upwards, the primary infection coming from the intestines.

There can be no question that the mesenteric glands may be found tuberculous without there being any discoverable lesion in the intestine. (See also Case 16, under Tuberculosis of the Tonsil.)

The channel here is at first an epithelial one

and afterwards a lymphatic one to the mesenteric glands.

(108) *Post mortem.*—J. E. T., aged 45. Milkman. Tuberculous peritonitis. Recent pulmonary tuberculosis.

There were some recent pleural adhesions at apex of the right pleura. No adhesions in left.

There was a small recent cavity about the size of a cob-nut at the apex of the right upper lobe. The rest of the lung was free from tubercle. There were a few scattered tubercles at apex of the left upper lobe. The rest of the lung was free from tubercle. Bronchial glands caseous. There was a small quantity of turbid blood-stained fiuid in the peritoneal cavity. The peritoneum was covered with small tuberculous nodules, especially well-marked on the pelvic peritoneum and posterior surface of the bladder. The coils of small intestine were glued together by lymph, and had lost their polish. On opening up the intestine numerous tuberculous ulcers were found in the ileum.

In this case I think there could be no doubt the primary infection was in the intestine, the tuberculous process spreading upwards to the bronchial glands and lung.

Now, what more evidence have we of this upward infection from the intestine.

The three following *post-mortem* examinations are, I think, strongly suggestive of an upward channel of infection.

(122) *Post mortem.*—G. J., aged 18. Pulmonary tuberculosis; tuberculous peritonitis.

Intestines.—The small intestine was extensively ulcerated, the ulcers were transverse in position and completely surrounded the bowel. They were placed at almost regular intervals all along the small intestine. The ulcers were deep, having penetrated to the serous

coat of the intestine, and in some places had almost perforated the gut. They had set up localised patches of peritonitis, some of the coils of the intestine being glued together by recent adhesions. There was also extensive ulceration of the large intestine. The mesenteric glands were enormous and caseous. The retro-peritoneal glands were much enlarged and caseous.

Lungs.—There were a few caseous tuberculous nodules at the apex of the right upper lobe, no cavitation. The middle and lower lobes were congested, but there is no tubercle. The left lung contained a few scattered tubercles in the upper lobe. The lower lobe was free from tubercle. The bronchial glands were much enlarged and caseous. There could be no doubt that the primary lesion in this case was in the intestine. The tubercle in the lung was much more recent than in the bowel.

(160) *Post mortem.* — A. N., aged 10. Tabes mesenterica.

The mesenteric glands were enormous, some being as large as hen's eggs, in fact, they formed one caseous mass. The spleen was much enlarged, it contained a few scattered tuberculous nodules, and was adherent to the under surface of the diaphragm. The last few feet of the ileum was extensively ulcerated. The retro-peritoneal glands were much enlarged, like the mesenteric glands, and formed one caseous mass at the back of the abdomen. The cervical and bronchial glands were much enlarged and caseous. There was a small cavity at the apex of the left upper lobe. There was also a small cavity at the apex of the lower lobe. The upper and lower lobes were uniformly infiltrated with grey tubercle. The right lung was free from tubercle.

Here, again, the primary lesion was intestinal, the

channel of infection being an upward one to the bronchial glands.

The following morbid specimen is, I think, worthy of record in this connection. It is from the Museum of the Congress on Tuberculosis.

A much enlarged bronchial lymphatic gland situated below the bifurcation of the trachea. It is deeply pigmented by absorbed particles of carbon, and shows many foci of caseation. Microscopically it shows ordinary caseating tubercle. From a man aged 42, who died of *tuberculous peritonitis; the mesenteric and lumbar glands were caseous. No tubercles were found in any of the viscera.*

In this case the lungs being free the bronchial glands could only have been infected by an upward extension from the intestines and peritoneum. The channel of infection to the lungs in the above cases may have been as follows: By upward extension to the bronchial glands and thence to the lungs, or by the thoracic duct, and thence to right side of heart and so to the lung.

That the thoracic duct is frequently affected by tubercle there can be no question. Professor Benda's beautiful preparations in the Museum of the Congress on Tuberculosis puts this beyond doubt. Of the seven specimens shown by Professor Benda one illustrating this upward extension is worthy of record here.

B., aged 60. One isolated tuberculous ulcer of ileum, caseous lymphadenitis mesenterica, and retro-peritonealis, acute general miliary tuberculosis. The thoracic duct was infected through the retro-peritoneal lymphatic roots.

The question of the possibility of the tubercle bacillus reaching the bronchial glands from the œsophagus I have already dealt with.

It thus appears that the lymphatic vessels are important channels of infection. Experience taught us, long before the discovery of the tubercle bacillus, to recognise the region in which we can best study the extension of tubercle by the lymphatics, that is in the intestines and in the chylous vessels. We here see that, starting from a tuberculous ulcer and proceeding through the outer intestinal wall, which need not necessarily be destroyed by the tuberculous process, the tubercle bacilli can pass into the mesenteric vessels and infect the lymphatic glands with the help of the lymphatic vessels and the flow of chyle. The channel is not laid open through the fact of the vessels themselves being diseased. We must accept Koch's explanation that the bacilli are carried by leucocytes. The extension of tubercle bacilli by the channel of the lymph passages for a general infection of the body is not possible, because, according to Weigert's investigations, the lymphatic glands offer a sure means of closure through which the bacilli cannot escape abroad. But, as Baumgarten has shown, when the lymph gland itself is diseased the lymph passage lying close to it is thereby affected. So the bacilli will finally make their way into the thoracic duct and from there out into the circulation of the blood.

There is, however, yet another channel of spread to bronchial glands and lungs—and that is from the vertebral column, as the following *post-mortem* examination well illustrates.

(116) *Post mortem.*—J. J., aged 40.

Tuberculous caries of spine. Psoas abscess. Lardaceous disease. Fistula-in-ano. Recent pulmonary tuberculosis.

There was extensive tuberculous caries of the bodies

of the ninth, tenth, eleventh and twelfth dorsal vertebræ. In the sheath of the right psoas muscle there was a large psoas abscess extending to but not below the brim of the pelvis. The pus in the abscess was very thick and creamy and contained numerous tubercle bacilli. The lumbar glands were much enlarged and caseous, as likewise were the bronchial glands.

The small intestine, as also the liver, spleen and kidneys, were markedly lardaceous. *Both small and large intestines were free from tubercle.*

Both pleural cavities were obliterated by adhesions. The adhesions were remarkably tough, almost cartilaginous. The upper lobe of the right contained numerous small cavities, the middle and lower lobes were infiltrated with caseous tubercle. The upper lobe of the left lung was riddled with cavities. The lower lobe was almost solid with caseous tubercle.

The primary tuberculous focus in this case was in the vertebral column ; the channel of infection appeared to be from this focus to the bronchial glands, pleura and lung, the tuberculous change in the latter organ being much more recent than in the spine.

(3) The Blood Vessels.

The circulation of the blood has always laid claim to a considerable amount of interest in the extension of tuberculosis.

Before considering the blood vessels as channels of infection, however, it will be well to pause for a moment to enquire what happens to the tubercle bacilli when they reach the blood stream ? Can they multiply in the blood or are they destroyed by it ?

Ribbert, who at first asserted that the tubercle

bacilli multiplied in the blood, has step by step, withdrawn that assertion and now believes that in the secondary metastatic tubercle of organs new infection of the blood vessels arise, due to small vessel tubercles.

Professor McFadyean's experiments show that there is no direct relationship between the quantity of bacilli injected into the blood and the number of resulting tubercles. Sometimes the number is large, sometimes small, with the same dose, showing conclusively that many of the bacilli undergo destruction in circulating through the body. No doubt when the tubercle bacilli get into the circulation in large numbers they induce a general miliary tuberculosis, but I think nearly all pathologists will admit that in many cases of primary pulmonary tuberculosis, where it is hard to believe that small numbers of tubercle bacilli are not absorbed from time to time by the blood vessels, the other organs of the body may remain remarkably free from tubercle.

How often do we see on the *post-mortem* table the lungs riddled with cavities, and yet, with the exception of the lymph glands and perhaps of a few tuberculous ulcers of the lower ileum, and perhaps half a dozen tuberculous nodules in the cortex of one or other kidney, the organs are remarkably free from tubercle.

I think we may accept it as a fact that the small blood vessels in and around a tuberculous focus in an organ or tissue are always concurrently affected. Rieder has succeeded in showing that the small blood vessels are always affected. But such tuberculous disease of the small blood vessels will not permit of a general infection because the small vessels become thrombosed and obliterated as the tuberculous process advances and thus prohibit the extension of the bacilli. Tuberculosis of the vessel wall becomes, however, of

great importance when vessels of a certain size become attacked with the disease, that is, vessels which are not completely obliterated by the tuberculous process, and which, therefore, do not exclude the possibility of the bacilli reaching the blood stream. This tuberculous disease of the wall of the great vessels offers the only full and complete explanation of the extension of the tubercle bacilli throughout the whole body. Weigert attributed this to a rupture of a tuberculous focus in the wall of the blood vessel into the blood stream.

Professor Benda has shown, however, that this is not the only explanation. Besides this possibility there is another, namely, that through tuberculous metastases in the intima of the blood vessels an infection of the wall of the vessel may ensue.

According to Professor Benda tuberculosis of the intima may be met with in several varieties.

These metastases may make their appearance primarily in a wholly normal wall; further, they may show themselves as secondary infection in a vessel wall destroyed by other processes of disease. Professor Benda has found tuberculous thrombi in an atheromatous aorta, or proved the presence of tuberculosis on the valves of the heart with verrucose endocarditis; and, lastly, there is the possibility present that thrombi that have been derived from one of the points of rupture assume in other blood vessels the characteristic appearance of tuberculous endangitis. Both these kinds of tuberculosis of the vessel intima have been observed in the heart, arteries, veins and thoracic duct. But even if the tubercle bacillus becomes developed in the vessel wall it does not necessarily follow that an overwhelming dose will be poured into the circulation; it may be shielded against this occurrence by the vessel

tubercle being covered by a fibrin coagulum or completely enveloped by thrombosis.

Professor Benda showed at the Congress on Tuberculosis a preparation of a tuberculous thoracic duct of which a large part was completely enclosed by a perfectly organised and canalised thrombus. In another preparation he showed that in the walls of the pulmonary veins of a child tubercles had developed in a number of places; of these some were covered by a fibrin coagulum, others had been rendered harmless by consolidation, but a number of them had been destroyed by ulceration. Professor Benda also demonstrated tubercle of a heart valve in which an enormous quantity of bacilli were situated on the superficial surface of the vessel wall. If these quantities of bacilli find access to the blood, there exists at once an opportunity for the blood to be surcharged with bacilli and give origin to an acute miliary tuberculosis; but it must be remembered that in cases of vascular tuberculosis, where no large quantity of bacilli find their way into the blood, toxins are diffused into the blood stream, and thereby account for the fever that under the continuance of the vessel tubercle postulates an actual constituent part of the clinical picture of an acute miliary tuberculosis.

(4) The Epithelial Channels of Spread.

One of the best examples of the epithelial channels of spread is found in the kidney, so I will consider the mode of spread in this organ first.

During the last two years I have been making some observations on the position or lie of tubercle bacilli in the medulla of the kidney in cases of disseminated miliary tuberculosis, and as the result of these observa-

tions I have ventured to describe these medullary tubercles as tubercles of excretion.

It will be well, I think, to define as clearly as possible what I mean by the term excretion tuberculosis. Briefly, I mean this—that tubercle bacilli having gained entrance to the urine tubes by a process of excretion through the glomeruli, or otherwise, become arrested at some point in the tube, most often in the medulla of the kidney, and there give rise to secondary tuberculous foci or tubercles of excretion, that is by an epithelial spread in the medulla of the organ.

I have examined thirteen cases of disseminated miliary tuberculosis with reference to this point. The results attained may not seem commensurate to the time taken up with the investigation, but it must be remembered that material had to be waited for, and that a great number of microscopical sections had to be rejected, the absence of bacilli or the advanced stage of caseation of the tubercle making it impossible to draw any conclusion as to their origin. Indeed, as I proceeded with the investigation I found that all tubercles that had advanced to the stage of giant cell formation had to be rejected. The action of the bacilli appears to be weakest in the vicinity of the giant cell, in fact the giant cell is an indication that the tubercle is passing into a chronic condition; moreover, the bacilli found in the neighbourhood of the giant cells are usually scanty in number (excepting those found in various stages of disintegration within the protoplasm of the cell), according to Metschnikoff and Stschastny, on account of the phagocytic action of the giant cell on the bacilli. I shall say no more on the subject of giant cell formation in renal tuberculosis, except that these cells are probably formed from the renal epithelium, as maintained by Arnold.

PLATE 6.

FIG. 1.—Vertical section through the tonsil of Case 34, *post mortem* 34. The epithelium of the crypt is normal. There are a few miliary tubercles in the adenoid tissue of the tonsil. (Zeiss, Obj. A., Oc. 4.)

FIG. 2.—Vertical section through base of tongue between the circumvallate papillæ and the base of epiglottis. Numerous tubercles are seen in the adenoid accumulations. The lining epithelium of the tongue is normal; no ulceration is present. (Zeiss, Obj. A., Oc. 2.)

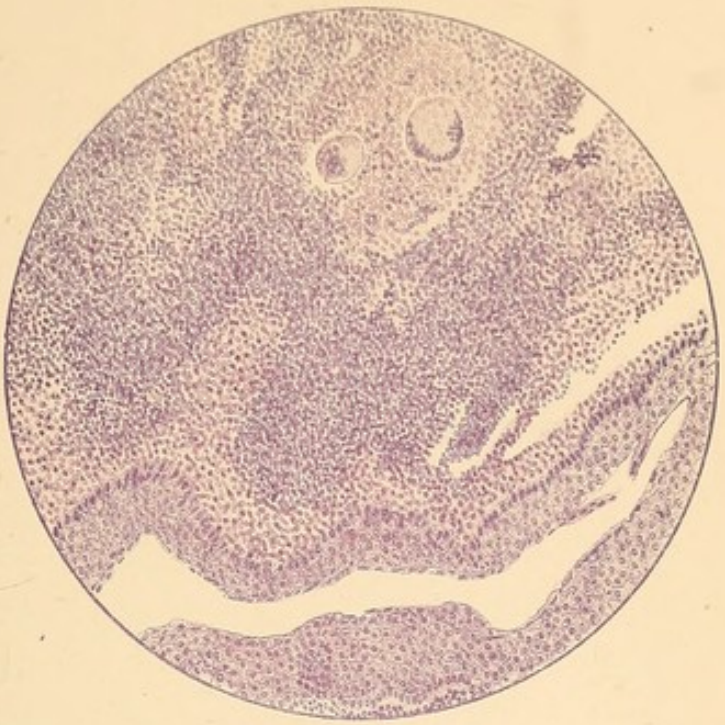

Fig. 1

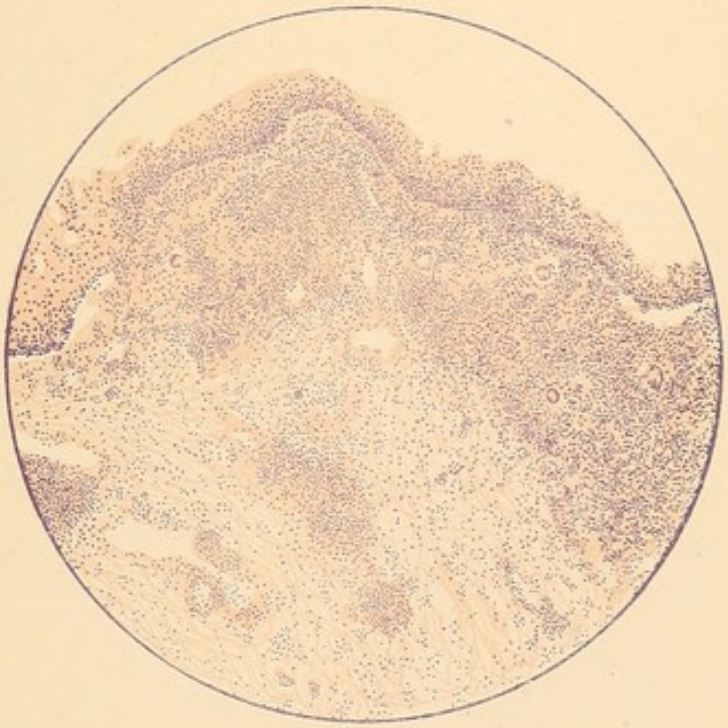

Fig. 2

Bale and Danielsson, Ltd., Del. and Lith.

In all my cases serial sections were made in order to determine the position of the tubercle bacilli as accurately as possible, tracing them section by section. The kidneys were hardened in Müller's fluid and alcohol. The sections were stained in carbol-fuchsin, decolourised in a 25 per cent. solution of sulphuric acid and counter-stained in methylin blue.

If we look in the more modern text-books of pathology we find little or nothing stated as to the exact position occupied by the bacilli in miliary tuberculosis of the kidney. Ziegler, in his handbook (last German edition, 1902), says: "Die Tuberkulose der Nieren entsteht meistens durch hämatogene Infection, doch kann auch eine in den Harn ableitenden Wegen localisirte Tuberkulose auf die Niere übergreifen. Die Miliartuberkulose ist meist Theilerscheinung einer über einen mehr oder minder grossen Theil der Organe verbreiteten Tuberkeleruption. Da, wo die Bacillen hingelangen, erscheinen zunächst kleine, helle, graue verwaschene Flecken. Weiterhin entwickeln sich graue Knötchen, die später weiss werden und häufig von einem rothen Hof umgeben sind. Die grauweisse Verfärbung ist theils durch eine Wucherung des Bindegewebes, theils durch eine trübe Schwellung und Nekrose die Epithels bedingt. Innerhalb der Tuberkel gehen die einzelnen Nierenbestandtheile zu Grunde. Die Zahl der Tuberkel, die in einer Niere sich entwickeln, ist bald bedeutend, bald gering. Zuweilen ist die Eruption auf das Gebiet eines Astes der Nierenarterie beschränkt."

Professor Coats, in the last edition (1900), of his "Manual of Pathology," says:—

"In acute general tuberculosis there are numerous tubercles in the kidneys, mostly in the cortex. They

are usually *elongated in shape* and visible to the naked eye as small pale areas. Under the microscope they are found to be caseous in their central parts while peripherally their cells infiltrate between the tubules."

Professor Hamilton is the only British pathologist who mentions the position occupied by the bacilli. His description is so full and accurate that I have, at the risk of being tedious, quoted it at length. He says :—

"This (acute miliary tubercle of the kidney) is always associated with tubercle in other organs, that is to say, it is part of a general eruption. The nodules vary in size from a millet seed up to a large pea, the most of them being of the former dimension. They are most abundant in the cortex, either immediately adjacent to the boundary zone or at the extreme surface. They are exposed, consequently, on removing the capsule. When of any size they are always yellow in the centre owing to early caseation. They have a very sharp boundary margin, and vary in shape, according to the locality. Thus towards the surface of the cortex they are usually wedge-shaped ; further in they are rounded ; *while in the medulla they are long fusiform bodies* (suggesting an epithelial spread).

" Microscopically they are usually found to be composed of masses of round cells without much reticular network ; giant cells rapidly make their appearance ; and the centre caseates so soon as the nodule becomes a naked-eye object. Tubercle bacilli are usually scanty. When present they are found within the afferent arteries and glomeruli, sometimes in the interstitial tissue, *and occasionally in the tubes.* As the tumour continues to grow, the blood supply is gradually cut off from it, so that in time not a particle of injection can be driven into its interior, even although the vessels of the kidney generally are quite pervious.

PLATE 7.

FIGS. 1 and 2.—The same section of kidney under low and high power. Described in text.

FIG. 1.—Zeiss, Ob. A., Oc. 2.

FIG. 2.—Leitz, oil imm. $\frac{1}{12}$, Oc. 4.

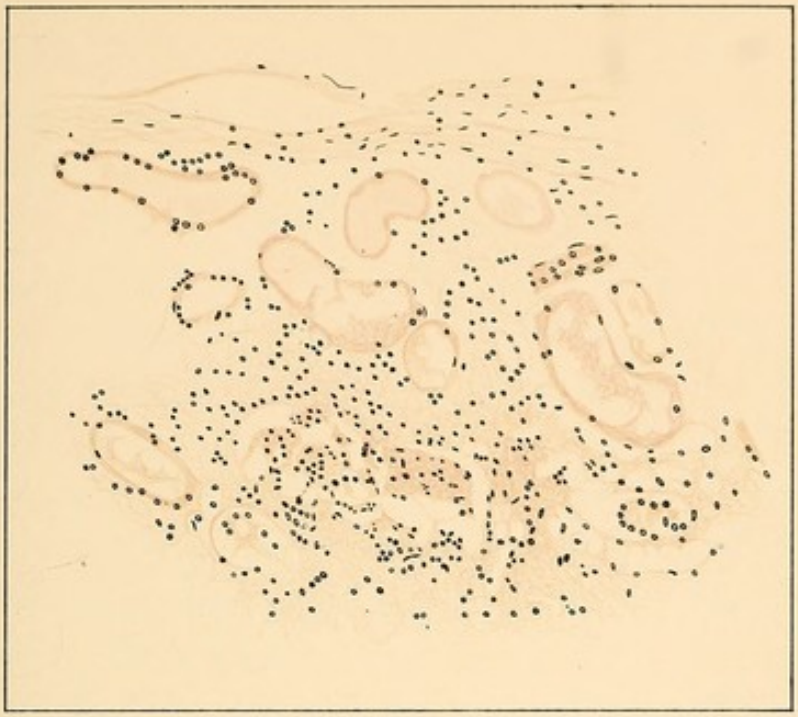

Fig. 1

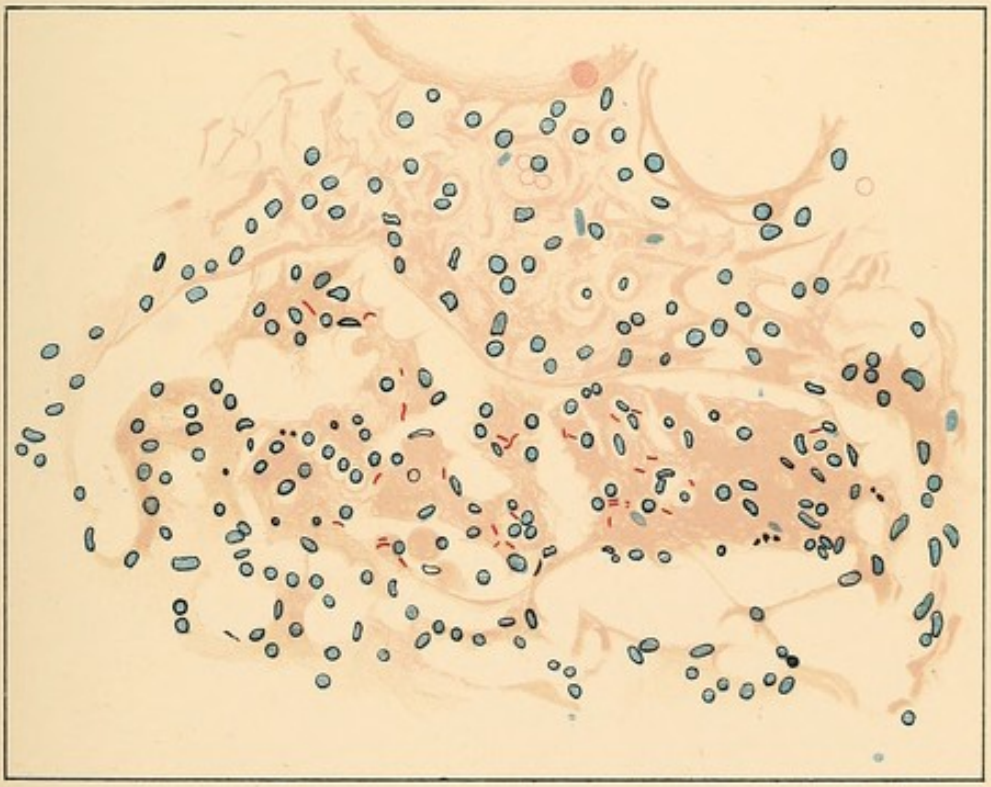

Fig. 2

Base and Danielsson, Ltd., Del. and Lith.

"The nodule appears to rise within a minute blood vessel. This is what might naturally be expected, seeing that the bacillus is conveyed by the blood. The blood vessel is rapidly destroyed, and the cellular accumulation, of which the tubercule at first consists, spreads thence between the tubes, surrounds them and pushes them aside. Those which happen to be engulfed in the cellular mass are strangled and destroyed by it. This variety of tubercle has little inclination to soften; either because the disease proves fatal before time is afforded for this happening, or because the nodules have an inherent tendency to pass into a fibrous state and to contract. When a nodule reaches a large size, a little cavity may be noticed within its substance, but it seems doubtful, to say the least of it, if this variety of tubercle ever terminates in true renal phthisis."

I will now give the cases.

CASE 1.—A man, aged 48, died in hospital of morbus cordis. Numerous miliary tubercles were found scattered in the peritoneum and kidneys. The lungs were emphysematous, but free from tubercle. The tubercles in the kidneys were found scattered in the cortex and medulla, each being surrounded by a zone of congestion.

The kidney was examined by serial sections.

In one of these sections (see plate 7, fig. 1) a small commencing tuberculous nodule was selected at the junction of the cortex and medulla. Under a low power of the microscope the central part of the tubercle is seen to be occupied by a urine tube, the basement membrane of which is intact. The epithelium lining the tube is dull and cloudy, retracted from the basement membrane and partly broken up. Caseation has only just begun. The tube, owing to the alteration of its epithelial lining stands out in sharp contrast to the surrounding norma

urine tubes. Numerous lymphoid cells are seen infiltrating the surrounding tissue.

Under a high power (see plate 7, fig. 2), (Leitz, $\frac{1}{12}$, oil immersion) many tubercle bacilli are seen lying among the broken up and cloudy epithelial cells of the tube, but none are to be discovered among the surrounding lymphoid cells. This tuberculous nodule was traced through eight serial sections, and in all of them the bacilli occupied the same position (varying, of course, in numbers) in the tube, with none in the surrounding tissue.

I next examined a very small commencing tubercle in the medulla of the same section (see plate 8, fig. 1). The urine tubes are in transverse section. Under a low power in the centre of the tubercle is seen a small red spot or ring, surrounded with numerous lymphoid cells. Under a high power (see plate 8, fig. 2), this red spot is seen to consist of masses of tubercle bacilli, lying amongst the broken up epithelium of a urine tube, the urine tubes and interstitial tissue in the neighbourhood being quite free from bacilli but showing evidence of commencing lymphoid infiltration. This tubercle was traced through eight serial sections; the bacilli, as in the former case, being confined to the urine tube, none being present in the interstitial tissue.

The inference from the above case is, I think, conclusive. In each tubercle we have a urine tube as a centre, filled with tubercle bacilli, with surrounding lymphoid cells. It appears to me clear that the bacilli have become arrested in the tube and have there given rise to a tuberculous focus. In fact they are excretion tubercles.

Case 2.—The next case was that of a man aged 28. Miliary tuberculosis of lungs, spleen, kidneys.

PLATE 8.

FIGS. 1 and 2.—The same section of kidney under low and high power. Described in text.

FIG. 1.—Zeiss, Ob. A., Oc. 2.

FIG. 2.—Leitz, oil imm. $\frac{1}{12}$, Oc. 4.

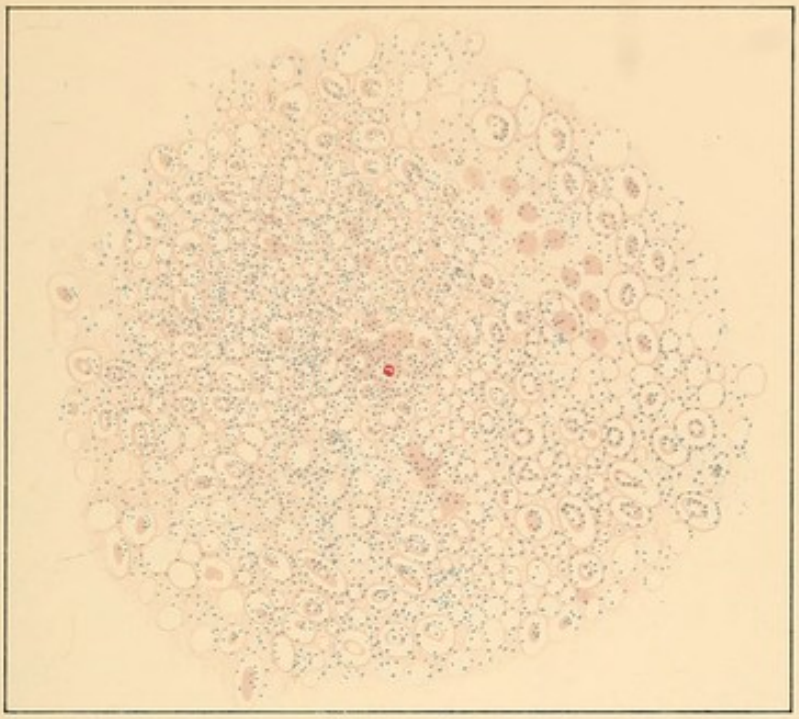

Fig. 1

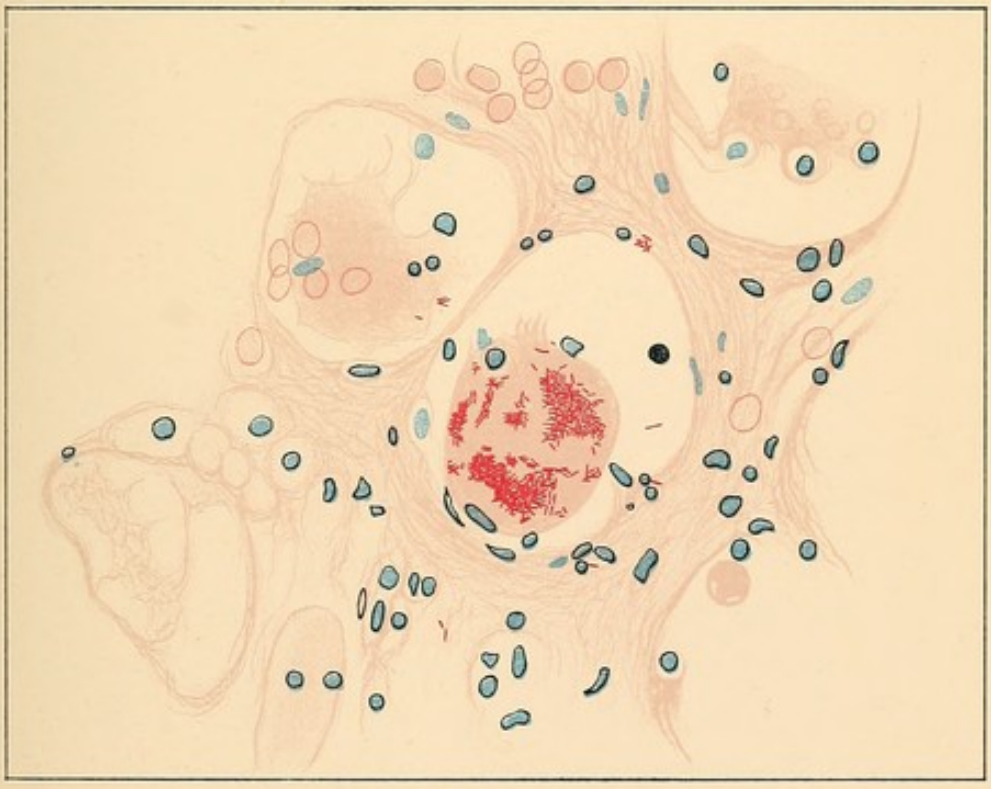

Fig. 2

Bale and Danielsson, Ltd., Del. and Lith.

There were numerous miliary tubercles scattered through cortex and medulla.

The kidney, as in the former case, was examined by serial sections.

A tuberculous nodule was discovered in the lower part of the cortex (see plate 9, fig. 1). The tubercle in this instance was further advanced in caseation than in the former. A urine tube is seen at the periphery of the nodule. The epithelium has stained badly owing to the caseation. The lymphoid accumulation is well seen. The basement membrane of the tube is still to be made out, notwithstanding the caseation of the epithelium. Under a high power (see plate 9, fig. 2) seven tubercle bacilli are seen within the tube, while others are scattered among the broken up and caseous epithelium of the neighbouring urine tubes. The tubercle is an elongated one, as they usually are in the lower cortex and medulla of the organ following closely the epithelial lining of the tube. This tuberculous nodule was traced through twelve serial sections, the bacilli occupying the same position in each.

Case 3.—Disseminated miliary tuberculosis of lungs, spleen, liver and kidney—in a girl aged 16.

In examining the sections of the medulla of this kidney a large collecting tube was discovered (see plate 10, fig. 2) filled with the broken up detritus of its lining epithelium. Scattered in this granular mass were numerous tubercle bacilli; the small tubes in the neighbourhood are quite normal. In this instance the bacilli were in a process of expulsion through the tube. They had not given rise to any tuberculous formation in the surrounding tissue. This tube was traced through thirteen serial sections, all sections containing bacilli. Again, from another part of the same section (see

plate 10, fig. 1) two urine tubes were discovered with the same granular and broken up epithelium, a few tubercle bacilli were scattered in the lower tube but only one was discovered in the upper. The surrounding interstitial tissue was quite free from bacilli or any tuberculous change. In another section of the same kidney (see plate 11, fig. 2) a tube is seen in transverse section of the medulla, the epithelial lining for the most part has been desquamated; six tubercle bacilli are seen in the desquamated epithelium. There is also a large cell whose nuclei are undergoing a process of division, and is no doubt on its way to the formation of a giant cell. Serial sections were made in this case also.

Case 4.—A man, aged 20, died in hospital of acute miliary tuberculosis. Many grey granulations were found scattered through the cortex and medulla of the kidney. A small commencing tubercle was found in the medulla. It was elongated in shape, as tubercles usually are in this position. The basement membrane of the tubules could still be traced through the tuberculous nodule. The epithelium of the tubes was broken up in parts, mingling with the lymphoid cells. Numerous tubercle bacilli were found in the epithelium of the tubules. The tubercle was traced through six serial sections, the tubercle bacilli occupying the same position in each section.

It is not my intention in this essay to enter into the very wide question of the excretion of micro-organisms other than the tubercle bacillus by the kidney, but there can be, I think, no doubt that other pathogenic bacilli and cocci are also excreted by the organ. Dr. Horton Smith, in the Goulstonian Lectures delivered before the Royal College of Physicians of London on the Typhoid Bacillus and Typhoid Fever, in discussing the pathology

PLATE 9.

FIGS. 1 and 2.—Same section of kidney under low and high power. Described in text.

FIG. 1.—Zeiss, Ob. A., Oc. 2.

FIG. 2.—Leitz, oil. imm. $\frac{1}{12}$, Oc. 2.

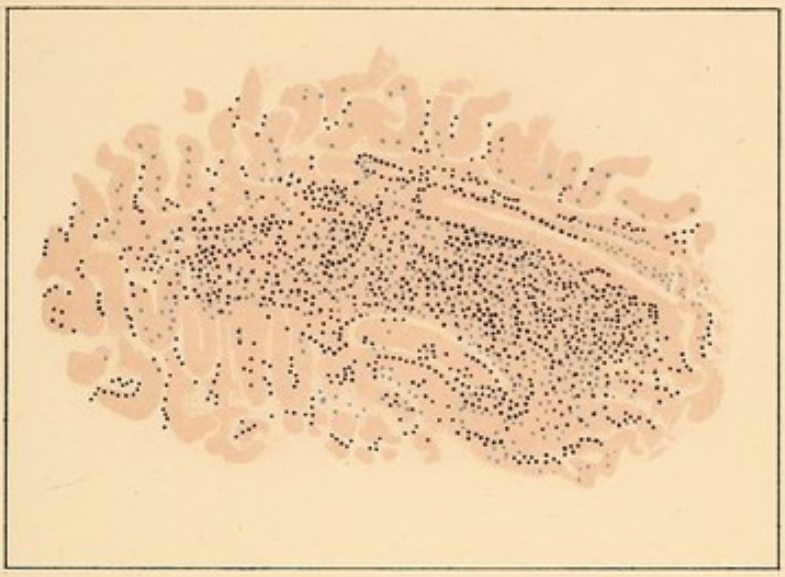

Fig. 1

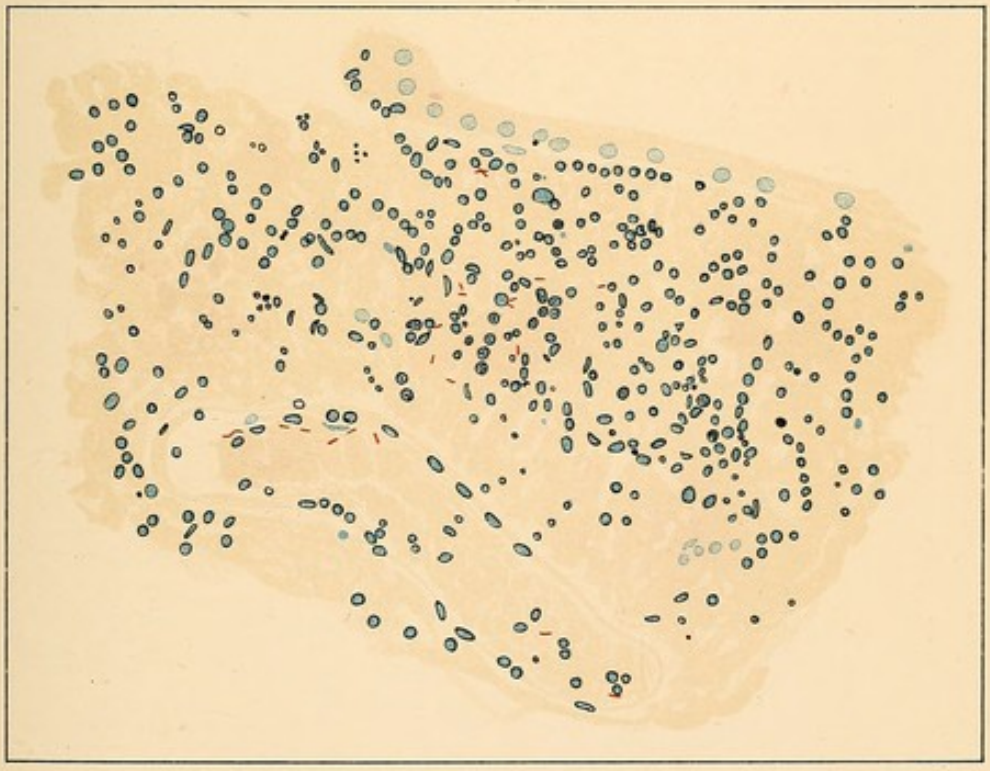

Fig. 2

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of the typhoid bacillus in the urine, writes as follows: "How is the bacilluria produced, and on what does it depend? The simplest explanation which suggests itself, namely, that we have to do with a mere filtration of the bacilli from the blood—may be at once dismissed. The extreme difficulty in finding the bacilli in the blood during life would point to its improbability. Moreover, I have on four occasions examined the blood bacteriologically, at a time when the urine was swarming with bacilli, and on all occasions I failed to find the typhoid bacilli therein. A second suggestion is that the condition arises from suppuration set up in the kidney by the typhoid bacillus, accompanied by the secondary passage of the bacilli and pus into the urine. Such cases do undoubtedly occur, one being recently recorded by Flexner, but they are extremely rare. Thus out of 289 *post mortem* examinations on patients who had died from typhoid fever at St. Bartholomew's Hospital during the last thirty years, in one case only were abscesses found in the kidneys. This rare condition, therefore, could hardly explain the very frequent presence of the bacilluria.

"We are driven, then, to our third possibility to offer an adequate explanation of the condition. According to this view, which I believe to be correct, the whole would depend on a rapid growth in the urine itself within the bladder of the bacillus, a stray micro-organism having found its way there from the blood, doubtless after its passage through the kidney."

Dr. Horton Smith has then to assume that a stray typhoid bacillus has to find its way through the kidney, but how can this take place except by a process of excretion? He says that the extreme difficulty of finding typhoid bacilli in the blood during life would point

to its improbability, but we must remember that the same difficulty is experienced in the discovery in the blood, during life, of tubercle bacilli in cases of disseminated miliary tuberculosis, although after death many miliary tubercles are found in the kidney, proving conclusively that the bacilli must have been present in the blood during life. I do not for one minute dispute Dr. Horton Smith's contention that the typhoid bacilli multiply in the bladder, but I maintain that they must first be excreted by the kidney.

One cannot help regretting that Dr. Horton Smith did not make a histological examination of the kidney in his cases with the intent to discover the presence of the typhoid bacillus in the glomeruli or tubules of the organ. It is interesting to note that Dr. Mayer has found small foci of suppuration in tuberculous kidneys in a case of chronic pulmonary tuberculosis with cavitation, resembling those described by Drs. Horton Smith and Flexner in the typhoid kidney. This is not surprising when we remember that so many cases of so-called chronic pulmonary tuberculosis are in reality cases of mixed infection. I have not met with this condition myself, owing no doubt to my cases being of the miliary variety. As I said above, it is not my intention to discuss in this paper generally the excretion of micro-organisms by the kidney, but I should like to call attention to plate 12, fig. 1, which shows a portion of the cortex of the kidney in a case of septicæmia. Two of the urine tubes will be seen stuffed with micrococci, while the surrounding tissue is free from them, but is infiltrated with pus cells. There can be, I think, no doubt that these cocci were in a process of excretion by the kidney at the time of the death of the patient.

The results obtained by the experimental production

PLATE 10.

FIG. 1.—Section of urine tubules. Described in text. Zeiss, oil imm. $\frac{1}{12}$, Oc. 2.

FIG. 2.—Section of large collecting tube. Described in text. Zeiss, oil imm. $\frac{1}{12}$, Oc. 4.

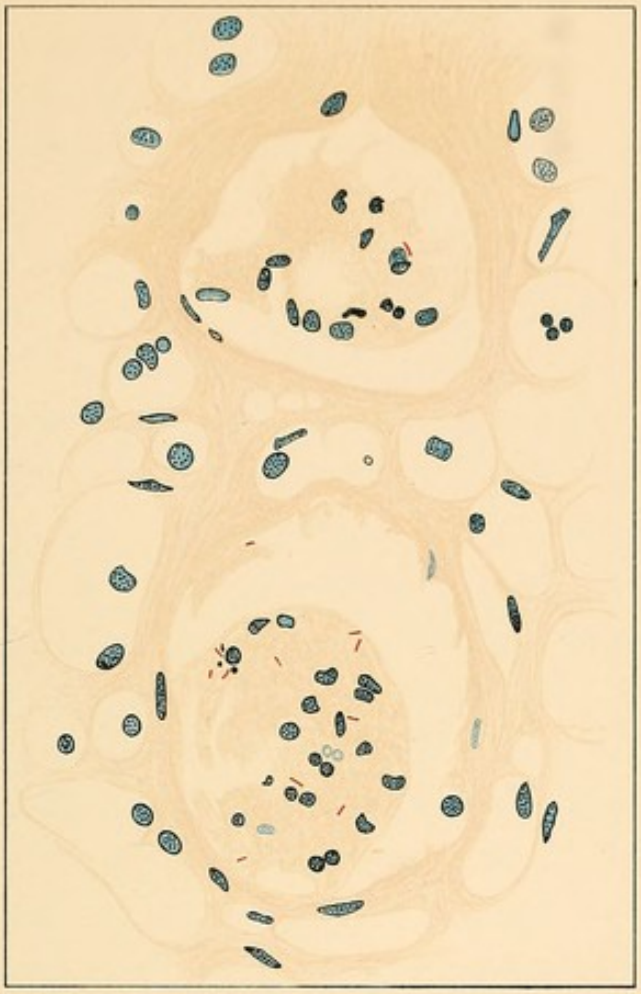

Fig. 1

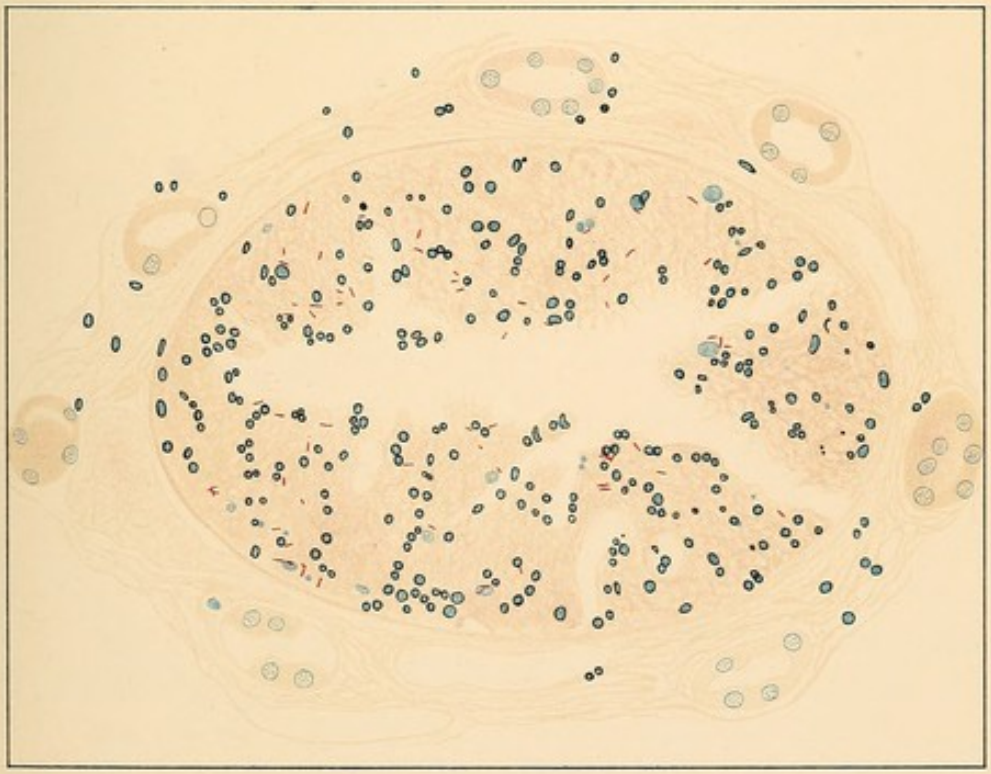

Fig. 2

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of renal tuberculosis are of very great interest as bearing on this question—although experimental observations are not necessarily homogeneous with those of morbid anatomy. Professor Baumgarten was the first observer to produce experimentally, tubercle in the kidney. He says: "Nächst den Lungen sind es die Nieren, welche in unseren Versuchen am frühesten und reichlichsten von metastatischer Tuberkelentwicklung ergriffen werden. Wie bereits oben erwähnt, bleiben die in die Nieren eindringenden Tuberkelbacillen nachweislich zunächst theils in Schlingen der Glomeruli, theils in Epithelien der gewundenen Harncanälchen, in welche letztere sie wahrscheinlich von den anliegenden Capillargefässen aus, möglicherweise auch mittelst des Harnstroms (dem sie Seitens der Glomeruli beigemengt werden können hineingelangen), haften."

The much more recent experimental work of MM. Kostenisch and Volkow does not help us much on account of their method of inoculation. They injected tubercle bacilli directly into the kidney through the lumbar walls. But this method obviously complicates matters unnecessarily by adding to the tuberculous process a process of repair. Of great interest, however, is the experimental work of Borrel, which he communicated to the Eleventh International Congress held in Rome. Borrel first injected tubercle bacilli into the aorta in order to avoid the pulmonary filter, and describes this form of renal tuberculosis as "tuberculose primitive à localisation glomérulaire ou corticale prédominante," and secondly, he obtained on the twentieth day after injection into the venous system a granular tuberculosis. "Tuberculose granulique disséminée dans tout les parties du rein à localisation périvasculaire prédominante." He goes on to say: "*Dans les deux*

cas le processus tuberculeux est toujours interstitiel, les seuls éléments actifs du tubercule sont des éléments lymphatiques que les éléments différenciés de l'organe et l'épithelium en particulier, ne jouent aucune rôle dans la formatiou des tubercules." In the "Tuberculose rénale primitive" he specially lays stress on the "localisation glomérulaire"—"je n'ai jamais constaté la présence de bacilles dans la substance des pyramides." Borrel maintains that his second form "Tuberculose granulique du rein" corresponds to "la granulie aigüe chez l'homme." This form "ne montre par de localisation prédominante dans telle ou telle partie du rein." In the formation of the tubercle "les tubes subissent au véritable processus d'atrophie et ne jouent aucune rôle active." Their late appearance, their position around the vessels, and their relative poorness in bacilli distinguish these granulations from the primary tubercle. According to Borrel in this second form after the primary spread of the bacilli by the blood vessels has taken place there is a secondary spread by the lymphatics of the kidney.

In plate 4, fig. 3, of Borrel's work, he shows in a conduit "qui n'est sûrement pas un tube du rein, mais qui pourrait bien être un conduit lymphatique," cells with bacilli. I think, however, this conduit is in reality a cross section of a urine tube.

Of very great interest also, as bearing on this question, is the work of Wyssokowitsch. He injected various micro-organisms, such as the bacillus pneumoniæ, the bacillus of enteric fever, into the blood of animals, such as rabbits, dogs, guinea pigs, and then after varying intervals of time made plate cultivations of the urine sediment. He came to the conclusion that

PLATE 11.

FIG. 1.—Tubercle bacilli in urine sediment from a case of miliary tuberculosis. Leitz, oil imm. $\frac{1}{12}$, Oc. 2.

FIG. 2.—Section of urine tubule, shows well a giant cell in process of formation. Described in text. Zeiss, oil imm. $\frac{1}{12}$, Oc. 4.

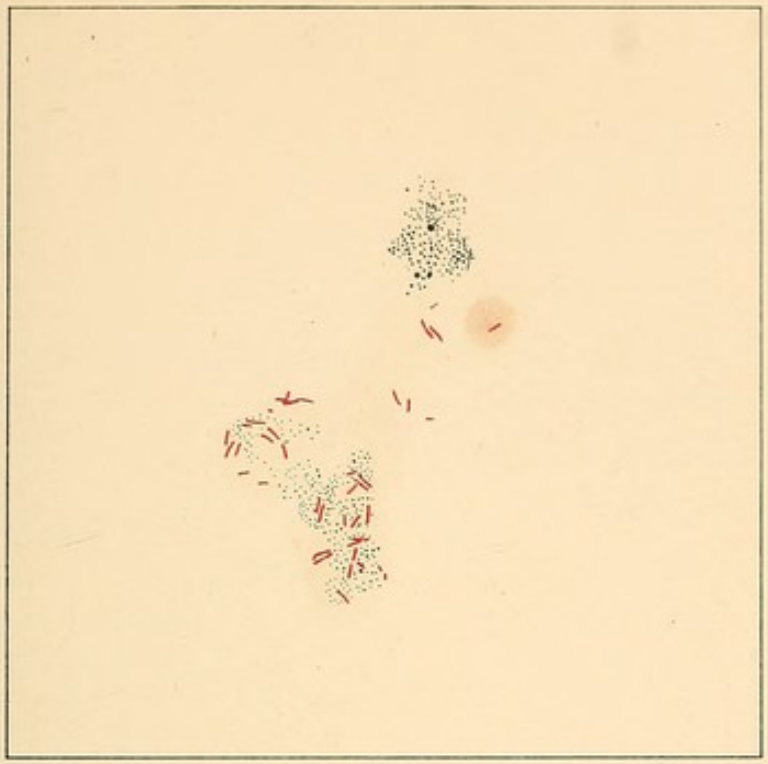

Fig. 1

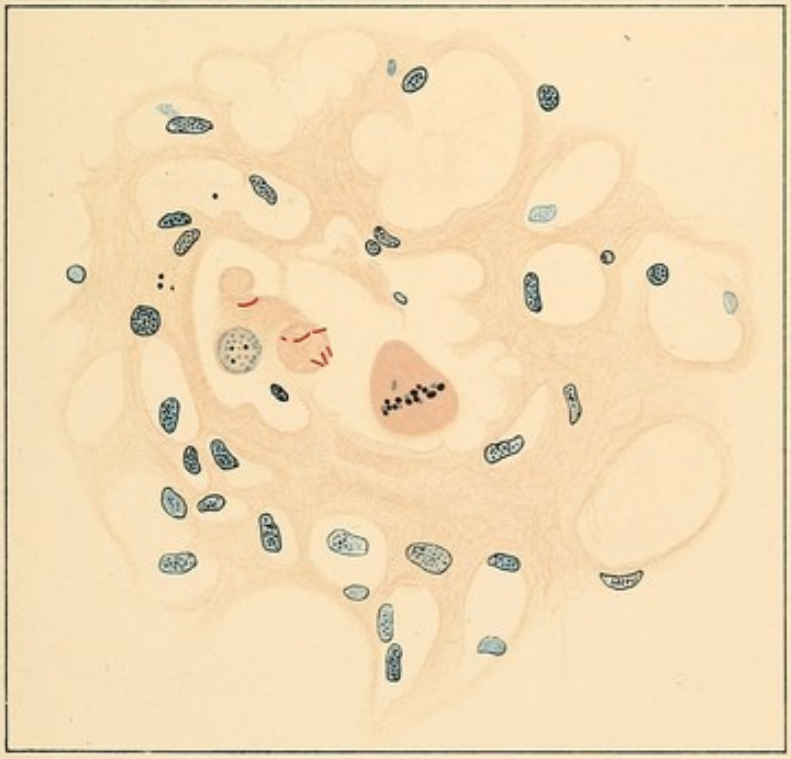

Fig. 2

Hale and Danielsson, Ltd., Del. and Lith.

"Eine grossere Quantität der injicirten Bacterien findet sich nur dann im Harn der Versuchsthiere, wenn makroskopisch wahrnembare Blutextravaste oder Heerde in den Nieren vorhanden sind." Now blood extravasations I have never observed in tuberculous kidneys, so I am unable to say whether tubercle bacilli can be excreted by the kidney without foci of tubercle in the cortex, as all my cases contained tubercle in this region of the kidney. After the injection of the typhoid bacillus into the blood of dogs Wyssokowitsch was unable to find the bacilli in the urine with plate cultivations. Dr. Horton Smith, however, has shown conclusively that they do occur in the urine in this disease in man. Wyssokowitsch does not appear to have made any observations with the bacillus of tubercle.

From the above observations, then, we see that tubercle bacilli are either found in some part of the course of the uriniferous tubules surrounded by lymphoid accumulations, or they are found in the tubules far from any tuberculous focus and without any tuberculous change in the neighbourhood. As they cannot possibly have come from the surrounding tissue, they must primarily have reached the tube either by a process of excretion through the glomeruli, or by rupture of a tuberculous caseous focus into the tube, but this latter method is very difficult of conception. If we look at plate 12, fig. 2, we see a glomerulus of the kidney with numerous bacilli in one half of the capillary tube without any tuberculous change in the surrounding tissue. This is, I think, a glomerulus in the process of excreting the bacilli. Tubercle bacilli arriving by the renal artery become arrested either in the capillaries of the glomeruli or in a small twig of the renal artery (see plate 13, fig. 1), probably in consequence of the slowing of the

circulation at these points. In the majority of cases the bacilli give rise to tuberculous changes at these spots (see plate 13, fig. 2), but in a small number of cases the bacilli would appear to be excreted by the glomeruli into the uriniferous tubes.

But how is it that in some cases (I only found evidence of excretion in four cases out of thirteen examined with reference to this point) excretion of the bacilli takes place but not in others? Microscopically the picture is the same in both. Perhaps large caseous foci of tubercle hinder excretion. A caseous glomerulus is probably unable any longer to excrete, or we may suppose that the glomeruli undergo some alteration, the capillary wall undergoing some change under the influence of the tuberculous virus which allows the passage of the bacilli into the urine tubes. If, on the one hand, as frequently happens, we find large foci of tubercle with wide spread caseation, containing apparently normal urine tubes, which, notwithstanding many tubercle bacilli in the surrounding tissue, contain none, we have a right to assume that the bacilli have been conveyed by the blood or lymph vessels—but if, on the other hand, we find tubercle bacilli in a urine tubule with little surrounding caseation, this condition, I think, points to the conclusion that the bacilli have not found entrance to the tubes from the surrounding tissue, but have produced the tuberculous nodule while in a process of excretion by the kidney.

To sum up. I have shown the presence of tubercle bacilli within the glomeruli of the kidney without any visible change in the vessels of the glomerulus or in the surrounding tissues. Next I have proved the presence of the bacilli in the urine tubes. (Epithelial channel of spread). Then I have shown the bacilli in the tubes

PLATE 12.

FIG. 1.—Section of kidney from a case of septicæmia. Described n text. Leitz, oil imm. $\frac{1}{12}$, Oc. 4.

FIG. 2.—Section of a malphigian capsule and glomerulus. Described in text. Leitz, oil imm. $\frac{1}{12}$, Oc. 2.

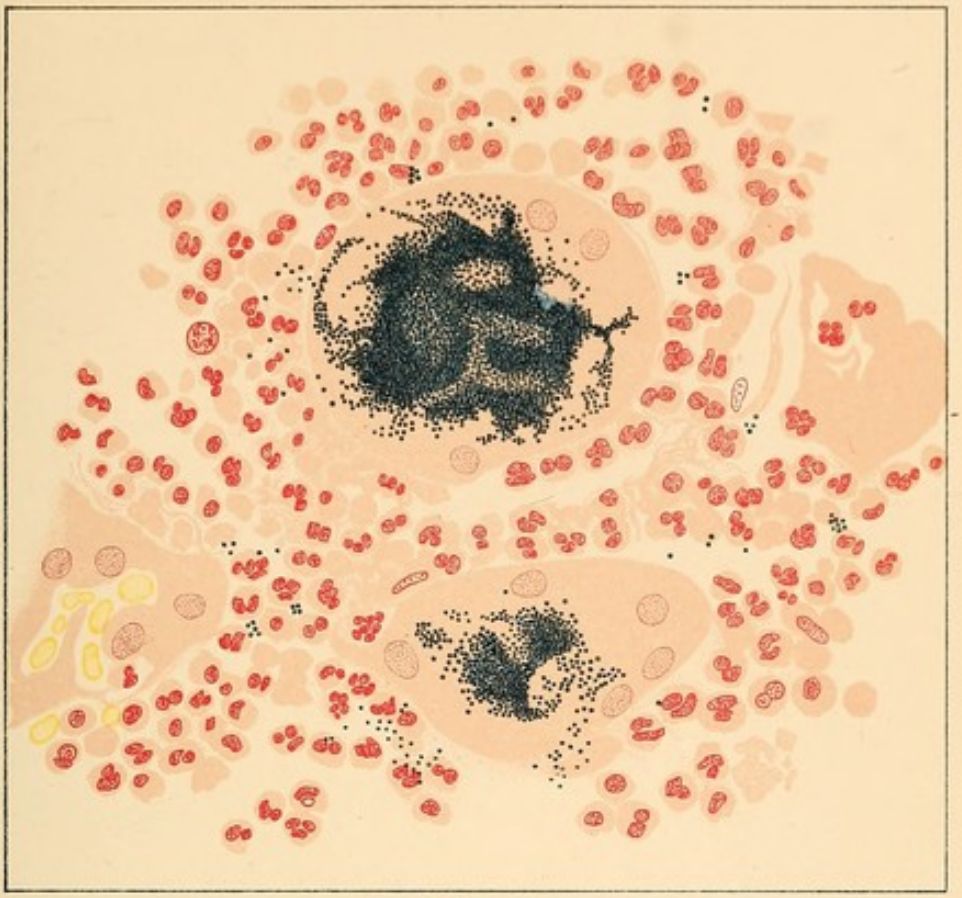

Fig. 1

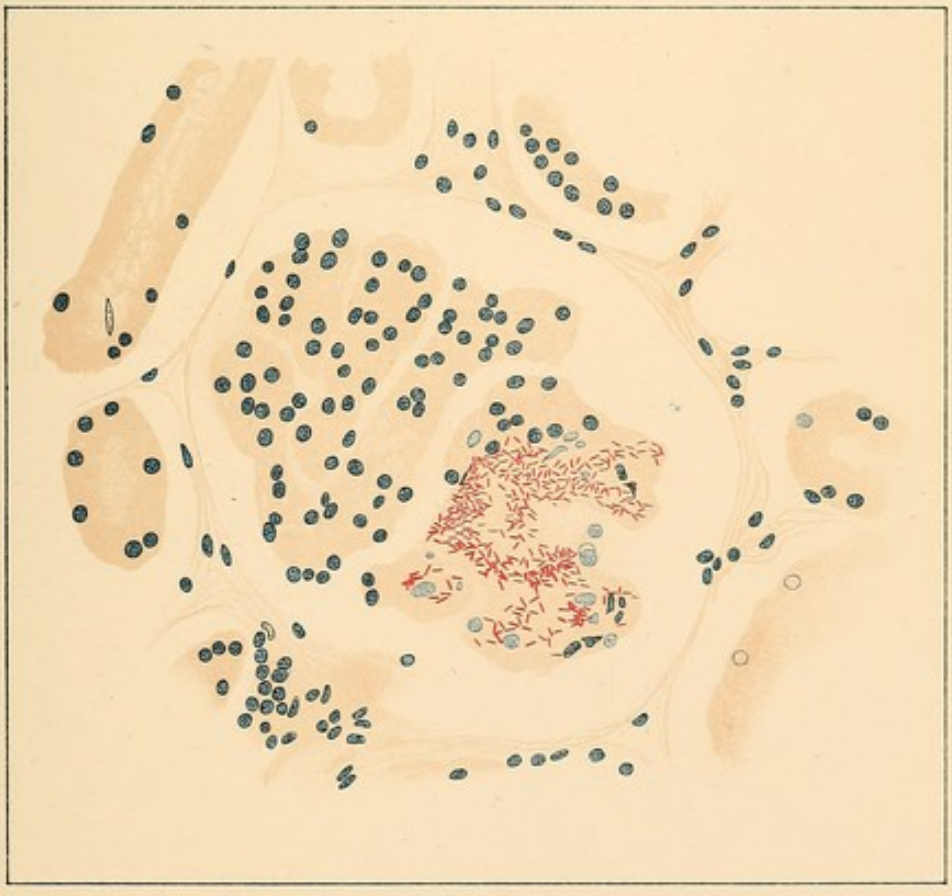

Fig. 2

Bale and Danielsson, Ltd., Del. and Lith.

setting up tuberculous changes in the neighbourhood of tubercles of excretion, and finally the presence of the bacilli in the urine (see plate 11, fig. 1) of a patient who died of acute disseminated miliary tuberculosis.

I am glad to see that Professor Benda agrees with me in the epithelial spread of tubercle bacilli in the kidney. He says :—

"This is what (epithelial spread) exactly obtains in the kidney. I have been making investigations on the kidneys for the past twenty years from immediately after the discovery of the tubercle bacillus, and the result has been to prove that in numerous kinds of tuberculous diseases the urinary tubules have been invaded by the tubercle bacillus and fall into one peculiar diseased state in which bacilli are present, sometimes in enormous numbers. We see in the common tubes and in the straight and convoluted tubes a mass of bacilli, clubbed together partly in cells, partly in cylinders, which show us that the epithelial constituents of the kidneys are infected. In the kidneys it is especially the straight urinary tubules and the common ducts that are to be considered as such localities from which the tubercle bacillus will be able to find a further means of extension outwards, whilst the convoluted tubes become plugged and thus put a stop to further extension. As a consequence tubercles in the cortex have usually no tendency to spread, while the tubercles in the medullary substance increase and constitute the starting point for renal phthisis."

There are three other organs in which the epithelial channel of spread is well exemplified. They are the testis, epididymis and breast. Of course the original channel of infection to these organs, like that of the kidney, is by the blood vessels, but the tubercle bacilli

having once reached the organ immediately begin to infect it by epithelial channels.

We will first consider (see plate 14, fig. 1) a section of a testicle affected with tubercle. Some of the tubercles have coalesced to form large masses and in the midst of these caseous areas are seen the necrotic remains of some of the tubules. One of the tubules in the middle of the field shows caseous degeneration of the epithelial lining with a giant cell at the periphery. In a number of serial sections the tuberculous process is clearly seen spreading through the organ by means of the tubes.

Take again a microscopical section of the epididymis (see plate 14, fig. 2). Here we see well the relation of tubercle to the tubules, most of which in the field are affected, but not all. There are a few normal tubules to the left of the field of view. The tubercle is confined almost entirely to the epithelial lining of the tubules. The epithelium is broken up and contains many giant cells. This change was traced through a number of serial sections. There is also some fibroid change.

In the breast again we find the same method of spread (see plate 15, fig. 1). This section is from a breast showing tuberculous disease of its glandular portion; the acini and ducts are replaced by a mass of cellular tissue containing large numbers of giant cells; the remains of the ducts, greatly dilated and filled with granulating tissue, are seen in some of the nodules.

(5) By Direct Inoculation.

The channel of infection may be by direct inoculation into the tissues.

PLATE 13

FIG. 1.—Embolic tuberculous plug in a small branch of the renal artery. Described in text. Leitz, oi imm. $\frac{1}{12}$, Oc. 2.

FIG. 2.—Section of Malphigian capsule and glomerulus, showing beginning caseation. Described in text. Zeiss, oil imm. $\frac{1}{12}$, Oc. 2.

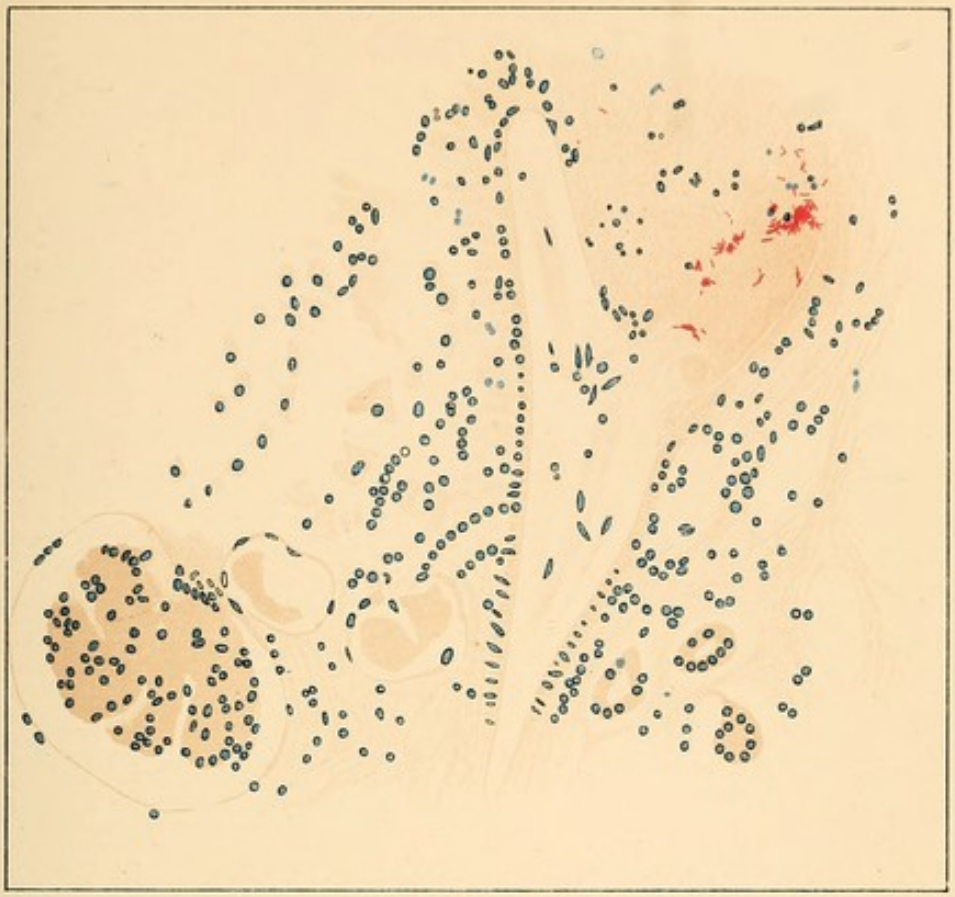

Fig. 1

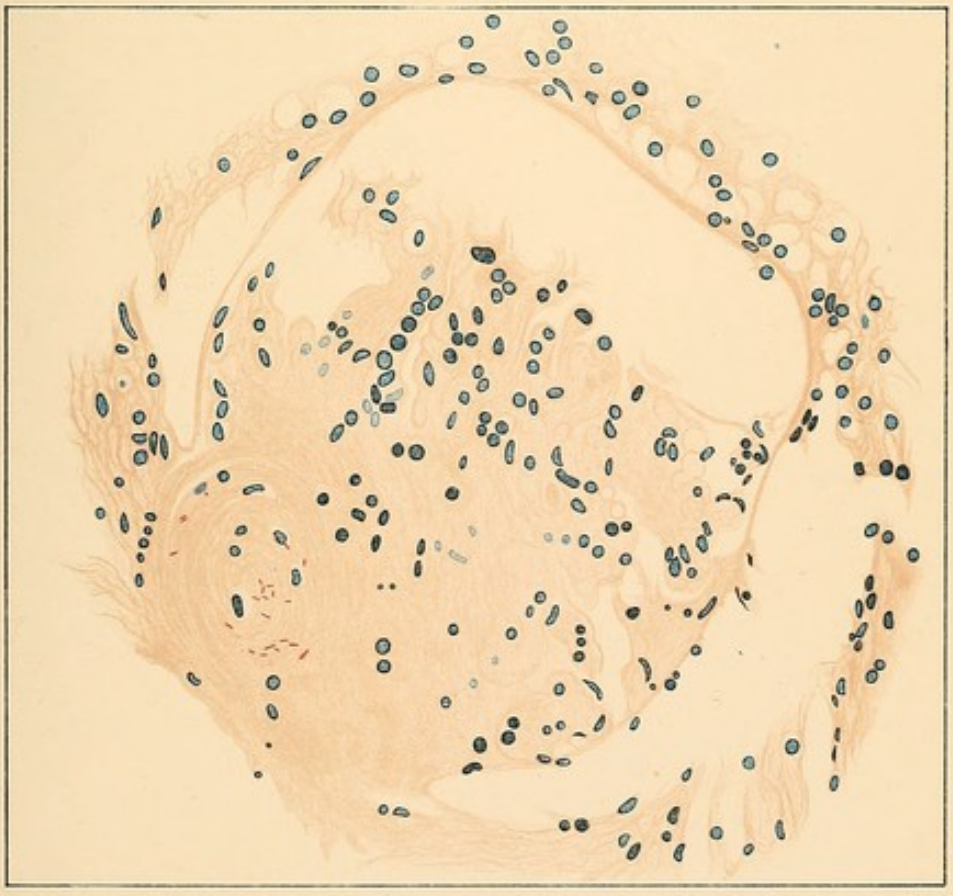

Fig. 2

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Tubercle may undoubtedly be inoculated into the skin either through an abrasion or through a sore, but in this case it is usually arrested at the first lymphatic gland and frequently discharged by suppuration.

Numerous cases of the kind have been put on record.

Tschering, at the Congress on Tuberculosis, held in Paris, 1888, mentions the case of the servant whose finger was cut with a piece of broken spittoon used by a tuberculous patient. In this instance there was a rapid spread of the process, but amputation of the finger and extirpation of the glands in the axilla resulted in saving the life of the patient. Tschering had also another case in which a veterinary surgeon wounded his finger with a scalpel whilst dissecting a cow.

In this case the local symptoms were distinct but the spread of the disease was less rapid than in the case where human sputum had been the inoculating material. The *post mortem* warty growths that are frequently seen on the hands of pathologists are now generally recognised to be tuberculous. These growths nearly always occur on the dorsal surface of the hand or fingers, and are probably produced by inoculation when extracting a lung advanced in tuberculosis from the pleural cavity. These growths, however, have no great tendency to set up secondary deposits. I have known men so affected, but in no case, as far as I know, has there been any secondary deposits.

A very important case of inoculation is related by Dr. Arthur Ransome :—

" A medical man made a *post mortem* examination of a child who was proved to have died of a localised tubercular peritonitis. Immediately afterwards he found that he had a slight abrasion on his left hand over the

carpal, and the metacarpal bone of the thumb. Six days after his temperature rose to 103°, and two patches of congestion were discovered at the base of the left lung. Two days afterwards the left axillary glands became enlarged and painful. A distinguished bacteriologist who saw him at this time regarded the case as one of streptococcic infection. A day or two after the fever subsided somewhat and there was reason to hope that this diagnosis was correct; but at the end of a fortnight from the inoculation the gland in the axilla became more swollen and it became necessary to make a deep exploratory incision into the axilla. Pus was found, and upon microscopic examination was found to contain tubercle bacilli. Some of the pus injected into a guinea-pig produced distinct infection at the end of three weeks."

This was probably a case of mixed infection. Tubercle has also been inoculated into the skin in the operation of tattooing and in the Jewish rite of circumcision. Lupus is, I think, undoubtedly a form of inoculation tuberculosis, following inoculation of the skin with tuberculous material non-virulent in degree.

Gerber reports that, after accidental inoculation in the hand from a case of tuberculosis, he had for months a "Leichen" tubercle, which was excised. Shortly afterwards the lymph glands of the axilla became enlarged and painful, and when removed showed characteristic tuberculous changes with bacilli.

The statement that Laennec contracted phthisis in this way is probably incorrect, since he did not die until twenty years after inoculation and in the interval presented no manifestations of the disease.

Other means of inoculation have been described, as the wearing of ear-rings, washing the clothes of phthisi-

PLATE 14.

FIG. 1.—Section of a testis affected with tubercle Described in text. Zeiss, Ob. D., Oc. 4

FIG. 2.—Section of epididymis affected with tubercle. Described in text. Zeiss, Ob. D., Oc. 4.

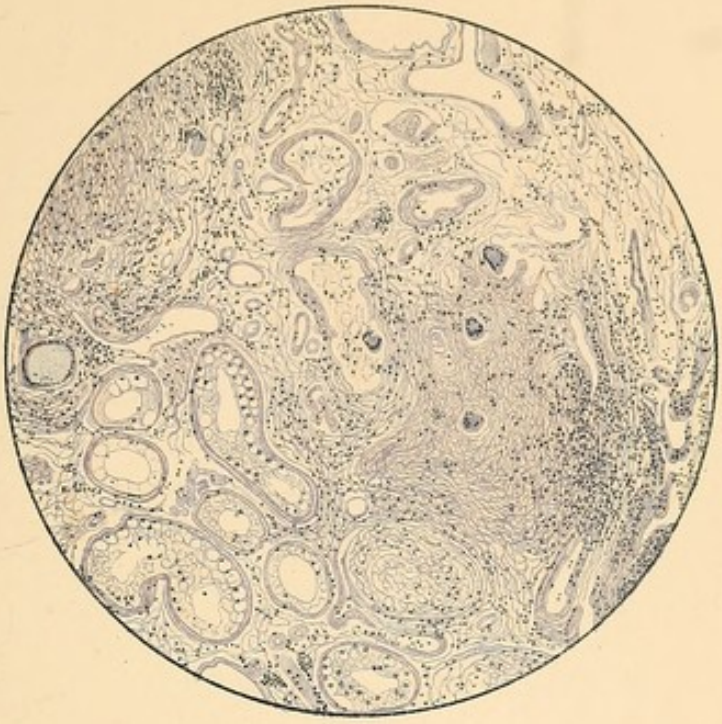

Fig. 1

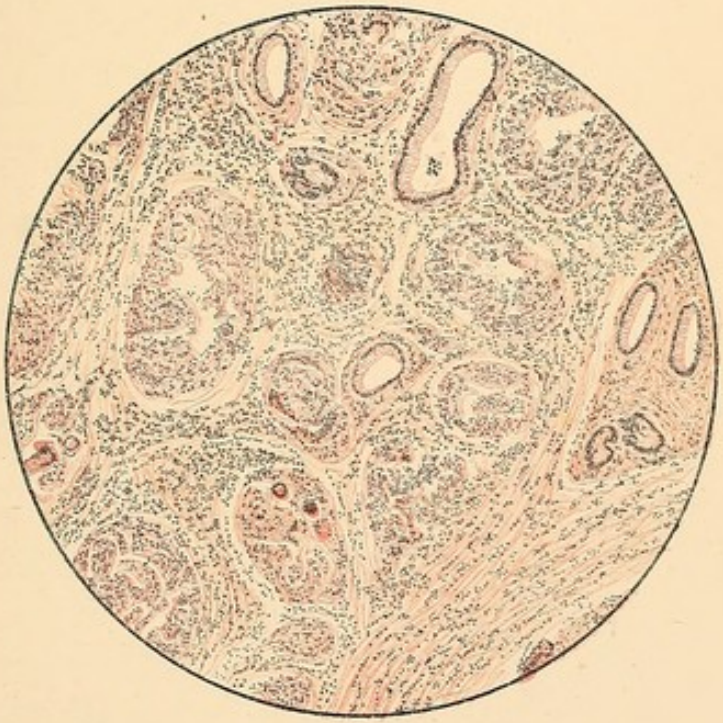

Fig. 2

Bale and Danielsson, Ltd., Del. and Lith.

cal patients, the bite of a tuberculous person, and Czerny has reported two cases of infection by skin grafting.

It has been urged by the opponents of vaccination that tuberculosis may be thus conveyed, but of this there is no evidence. Lupus has undoubtedly originated at the site of vaccination in a few cases; but on the whole it may be said that the channel of infection by the skin plays but a trifling *rôle* in tuberculosis.

The Nose and Larynx as a Channel of Infection.

Although Renshaw's experiments quoted above show clearly that the tubercle bacillus can gain entrance through the normal mucous membrane of the nose (at any rate in guinea pigs) still in the human subject there is no part of the respiratory tract which is so seldom attacked by tuberculosis as the nose.

I have only seen a single instance of primary tuberculosis of the nasal mucous membrane. In my 200 cases of tuberculosis I did not find the nose affected in a single instance. Willink's *post mortem* examinations show the same; out of 1,600 autopsies he only met with one case where the septum nasi was affected with tubercle, although in 450 instances there was evidence of pulmonary tuberculosis. Dr. St. Clair Thomson showed a case of primary tuberculosis of the nose at the Clinical Society in 1900. This case at that date was said to be the only one put on record by a British observer. From the above I think we may take it as certain that the nose as a portal of entry and channel of spread plays a very small part in tuberculosis.

Another curious fact is that when we do meet with a primary tuberculosis of the nose there seems to be no tendency for the disease to spread. It was so at any rate in the case observed by myself.

The channel of infection of the larynx is very obscure.

There can be no doubt that the larynx is more frequently affected than the nose and pharynx, but not nearly so often as the lungs.

Primary tuberculosis of the larynx is not unknown. I have seen a few cases clinically, that is cases with well marked laryngeal tuberculosis, without any discoverable physical signs in the lungs.

Although the larynx is more exposed, one would think, to deleterious agents, such as dust, alcohol, tobacco, syphilis, yet in nearly every case it is infected secondarily to the lung.

It is well known that the posterior part of the larynx is most commonly affected by tuberculosis. This has been attributed to infection of the sputum passing over the inter-arytenoid space to be expectorated or swallowed.

Schröter and others maintain the secondary affection of the larynx is most marked on the side of the body on which the lung is most diseased. With this assertion I cannot agree. Out of 65 consecutive *post mortem* examinations of my own, the larynx was found to be tuberculous in 38. I made special observations as to this point with a negative result in each. I could not find any one-sided distribution of the disease, the channel of infection to the larynx being undoubtedly an epithelial one.

Having endeavoured to trace the channel of infection to the lung by the three modes of convection: (*a*) by the blood; (*b*) by the lymph; (*c*) by the air, I shall pass on to consider how the tubercle bacillus spreads through the organ.

PLATE 15.

FIG. 1.—Section of tuberculous nodule in breast. Described in text. Zeiss, Ob. D., Oc. 4.

FIG. 2.—Section of tuberculous ulcer on posterior wall of pharynx. It shows a large giant cell system, displacing the muscular fibres of the pharynx. Zeiss, Ob. D., Oc. 4.

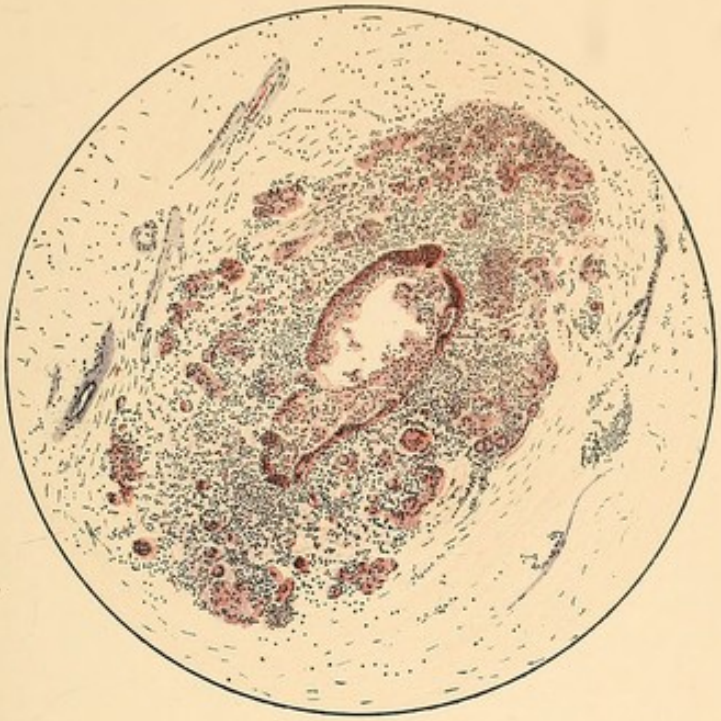

Fig. 1

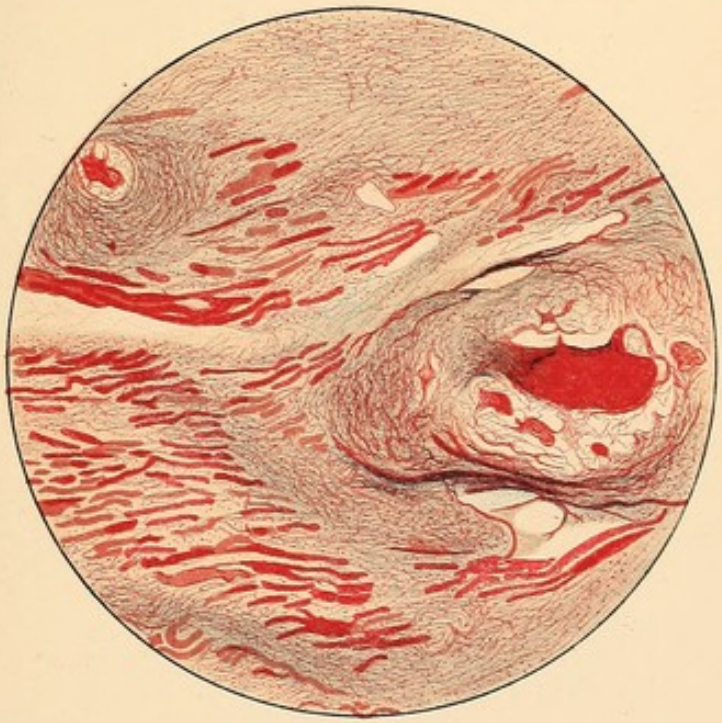

Fig. 2

Bale and Danielsson, Ltd., Del. and Lith.

I think this depends on the original channel of infection.

If by inhalation, the first point of attack in the majority of cases, in adults at any rate, is upon one or other apex. Not the extreme apex, however, but generally about 1½ inches below the posterior apex in the supra-scapular region. Why is this? Various theories have been advanced. Professor Birch-Hirschfeld has pointed out that the apical bronchi in the adult take a very steep direction upwards, so that to pass from the main bronchus to the apical bronchus the air stream must be diverted almost at a right angle, while the course of all the other tubes is either straight or at a very wide angle. Moreover, the apical air passing outwards from the apical bronchi must conflict with the stronger currents from the middle and lower tubes, so that in expiration there will be a dead point in the main apical bronchus near the junction of these streams. Not only so, but on coughing, a backward air current may be forced into these vertical branches whereby tubercle bacilli may be wafted into relatively inactive areas. Professor Birch-Hirschfeld's fusible metal casts of the bronchi show this well.

The relative immunity of the apex of the lung in children has been explained by Professor His by the fact that this disadvantageous position of the apical lobes is less in them, the upper part of the child's lung is relatively short and the apical bifurcation much less steep. With this explanation I cannot agree. I think the difference of the incidence of the disease in the lung in the adult and in the child is due to the infecting channel. In childhood I think the lung receives the infection generally from the bronchial glands, as shown in an earlier part of this essay.

The bacilli having reached the lung alveoli, how do they spread? What is the channel in the majority of cases? It is an epithelial spread from alveolus to alveolus; we see the alveoli filled with catarrhal products producing the so-called pneumonic phthisis. If, on the other hand, the channel of infection is by the blood or lymph, the tubercle is at first interstitial, but in miliary tuberculosis of the lungs, miliary caseous pneumonias are constantly present; that is, in the case of an infection of the lungs from the blood or lymph streams, the bacilli, as our present knowledge of them warrants us to believe, immediately invade the alveoli and infect the parenchyma. We see the same thing in the kidneys, the liver, and in the male organ of generation. In the liver it is the bile ducts, and in the testis and epididymis it is the canals that are attacked by tuberculosis and enhance the extension of the tubercle bacillus (see plate 16, figs. 1 and 2).

The Eye and Ear as Portals of Entry of the Tubercle Bacillus.

In an exhaustive paper on Tuberculosis of the Eye, read before the Congress of Tuberculosis, in 1901, Dr. Allen T. Haight of Chicago, U.S.A., showed conclusively that the eye is an organ that is far more frequently affected by tubercle than is usually supposed. He pointed out that the primary infection may be in the eye. The meninges may be secondarily affected. On reflection it seems strange that the eye is not oftener affected with tubercle than it is, but we must remember that the bacilli are under ordinary circumstances washed away by the lachrymal secretion. In all the cases given by Dr. Haight there was some injury or other to the

organ some time previous to the tuberculous infection. Dr. Haight pointed out that the right eye is more often affected than the left, and considered this is due to inoculation by the right hand. The following case well illustrates this mode of infection.

CASE.—A girl, aged 4 years, met with an injury causing a contused wound of the outer canthus and upper lid of the right eye; recovery was apparently perfect. Fourteen months after she came under observation for lowered vision in the right eye. Upon examination several whitish tumours were seen in the choroid, involving the macular region. Stratified blood clots were found in various parts of the fundus. Tuberculous choroiditis was diagnosed and the eye excised.

The wound healed well, but four months later the child came again under observation with iritis of the left eye, and shortly after died of what proved to be tuberculous meningitis.

The above case is important as showing, I think, conclusively, that the meninges may receive the infection through the eye.

Of course it is a well known fact that the commonest channel of infection to the meninges of the brain is by the way of the ear.

The following *post-mortem* examination well illustrates this mode of infection.

(109) *Post mortem.*—Morbus cordis. Mitral stenosis. Tubercular meningitis.

Horace S., aged 9 years, died in hospital of tuberculous meningitis. Purulent discharge from left ear; fingers clubbed; no œdema. Face puffy, veins over forehead distended. Pleuræ natural. Lungs: lower lobes much congested and œdematous. Pericardium natural; no adhesions. Heart considerably hyper-

trophied and dilated. Mitral orifice much stenosed, button-hole mitral. The liver, spleen and kidneys were typically those of mitral stenosis.

On removal of the skull cap the cerebral convolutions were seen to be somewhat flattened and sticky. There was some excess of fluid at the base of the brain, the lateral ventricles contained an excess of fluid. There was much lymph at the base of the brain, extending round the middle cerebral arteries. The choroid plexus and velum were granular ; numerous tubercles in sylvian fissures.

Here, I think, there could be no doubt that the channel of infection was from the middle ear to the meninges.

PLATE 16.

FIGS. 1 and 2.—Same section of lung under low and high power ; the tubercle in close relation to the vessel has begun to caseate. The alveoli are seen filled with catarrhal products and numerous tubercle bacilli (miliary caseous pneumonias).

FIG. 1.—Zeiss, Ob. D., Oc. 4.

FIG. 2.—Zeiss, Ob. imm. $\frac{1}{12}$, Oc. 4.

FIG. 2.—Includes the three alveoli seen at the top of the caseous tubercle surrounded by a small circle.

Fig. 1

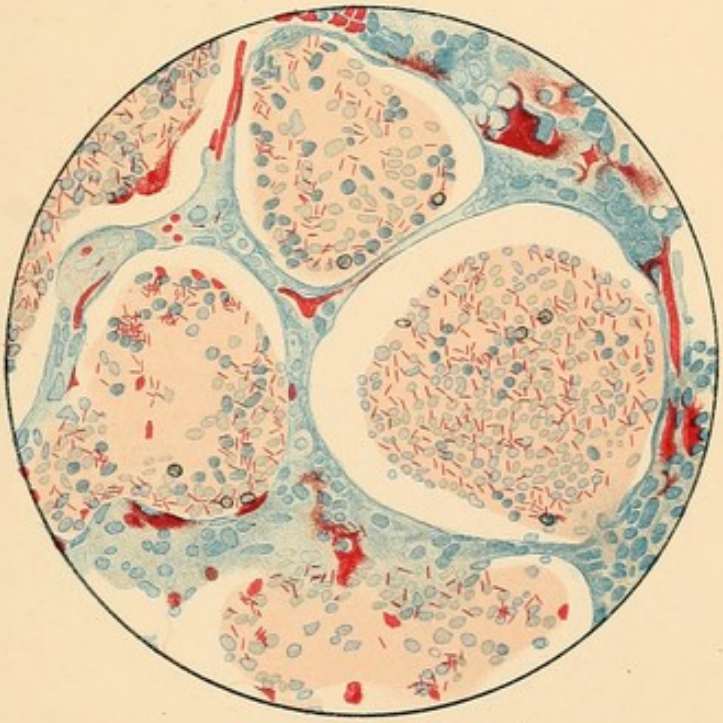

Fig. 2

Bale and Danielsson, Ltd., Del. and Lith.

PART II.

THE CONDITIONS, ORIGINAL OR ACQUIRED, THAT RENDER THE TISSUES VULNERABLE.

THE CONDITIONS, ORIGINAL OR ACQUIRED, WHICH RENDER THE TISSUES VULNERABLE.

WHETHER or not there be a direct hereditary transmission of the disease there can be, I think, no doubt that there is an hereditary transmission of soil. In 1,000 cases Williams found 48·8 per cent. with a family predisposition. I should have hardly put the percentage so high, as in 1,000 cases of tuberculosis of my own the percentage worked out at 32. It is very difficult, as Hilton Fagge pointed out long ago, to draw a line between hereditary and accidental tuberculosis, as naturally children of an affected parent are more liable to accidental contamination. The whole question is most difficult to determine.

Sir Richard Douglas Powell has defined the constitution of a man "as 'his build,' the integrity or otherwise of the tissues of which each part of his body is made up, and the wholesomeness or otherwise of the juices with which they are bathed; the sum of his vital force, his cell-quickening power which shall bear the call of judicious expenditure for a long or but for a brief period of time. This material and dynamic constitution is born with the infant, developed during the period of growth, and maintained with waning completeness during the wear and tear of subsequent life. Hereditary constitutional defect means unsoundness of original

construction with regard to some organ or tissue at birth. Acquired constitutional defect means that some part of the human mechanism has suffered deterioration from deficient supply of the needs of growth and function through wilful or involuntary exhaustion of vital powers, or from imperfect recovery from acute disease."

But a man starting life with or without a constitution favourable to the growth of the tubercle bacillus can, by his habits and environment, over which he generally holds some control, to a large extent alter his tissue resistance either to his advantage or disadvantage ; yet at the same time, there is many a disease for the incidence of which upon him he is in no way responsible, and such a disease may, in its turn, so affect his tissues that the tubercle bacillus can readily grow and flourish where before it had met with an overpoweringly hostile reception.

I shall now consider some of the acquired conditions which render the tissues vulnerable.

Now of all the various conditions which lower resistance and render the tissues vulnerable, two stand out in marked contrast to the rest. They deserve special attention because they are the commonest and therefore the most important causes which render the tissues and organs of the body liable to the attack of the tubercle bacillus. They are :—

(1) The want of fresh air and sunlight.

(2) Insufficient food.

These two conditions act as general rather than local causes.

A physician to a Chest Hospital, when endeavouring to trace the cause in an individual case before him, must have it frequently forced upon his notice that

one or both of these conditions are responsible. A patient presents himself in the out-patient room with pulmonary tuberculosis. He is admitted to the hospital, and after a residence of from six to eight weeks he has much improved and gained weight. But on his discharge he goes back to live his old life, to his unhealthy surroundings, perhaps back to his infected room or workshop, and he returns to the hospital in from six weeks to two months, as bad as before.

While in the hospital with good food and sufficient cubic space he does well. An interesting example of the want of a proper supply of food is given by the late Professor Peter of Paris. It is as follows :—

A perfectly healthy man had stricture of the œsophagus, due to swallowing sulphuric acid. This led to starvation and he died after lingering for some months. At the *post-mortem* examination the lungs were found to be stuffed with recent tubercle. I think this case demonstrated the importance of a sufficiency of food to ward off the attacks of the tubercle bacillus.

I will now proceed to discuss certain diseases which predispose the tissues and organs to tuberculosis, but I am sure from a moderately long experience as a physician to a Hospital for Diseases of the Chest, the two conditions I have mentioned stand far and away above all others in rendering the tissues vulnerable.

According to Dr. Freund, one of the predisposing causes to the attack of the tubercle bacillus on the lungs is certain changes that take place in the upper ribs. Dr. Freund says what takes place is an ossification of the cartilages of the first and second ribs, and the consequence is that they shrink up and become shorter, and in some cases the size of the cartilage from the end of the bone to the sternum is diminished two-thirds.

Both upper ribs become thus rigid and immobile with the result that all expansion upwards ceases. Dr. Freund goes on to say in some cases a false joint is formed, thus repairing the mischief somewhat. Now I suppose all pathologists will agree that ossification of the upper rib cartilages is a very common condition in people, even quite young people, who have died of pulmonary tuberculosis. But I have always regarded this condition rather as the result of the tuberculosis than a predisposing cause. I think it is only part of a widespread degenerative change which is found in the bodies of people dead of pulmonary tubercle. We find the same change taking place in the upper rib cartilages as life advances; possibly if this ossification occurs early in life it may, by limiting the respiratory power of the apices, become a predisposing cause.

The Relation of Alcohol to Tuberculosis.

With regard to the influence of alcohol in rendering the tissues and organs of the body vulnerable, most diverse opinions have been expressed.

On the one hand it has been asserted that alcoholism is antagonistic to tuberculosis, while on the other, a special form of alcoholic phthisis has actually been described. A large section of the public, even at the present time, believe that alcohol protects the body from the attack of the tubercle bacillus.

This belief is probably due to the teaching of the older physicians, as the medical opinions of the public of to-day are generally those of the past generation of physicians.

There can be no question that physicians in the middle of the past century did not consider alcohol

predisposed the organism to tubercle. They even considered it beneficial and gave it to phthisical patients in large quantity.

Thus, Austin Flint used alcohol very freely, that is, from 6 ozs. to a pint of spirit daily, and appears to have considered it beneficial. Charteris says, concerning the administration of whisky to tuberculous patients: "In private practice I order it to be taken *ad libitum*"! Stokes also relates the case of a gentleman who recovered from tuberculosis after regularly drinking "seven glasses of punch every night." Dr. Henry Ancell, in his treatise on tuberculosis, says "That a careful consideration of all the facts brought forward by the best informed pathologists, leads to the conclusion that tuberculosis and the formation of tubercle is not one of the effects of alcohol, either in the human frame or in the lower animals," and Dr. Richard P. Cotton says: "It is worthy of remark that the habitual drunkard is not very often the subject of phthisis."

In recent years, however, the view that alcohol predisposes the tissues and organs to tuberculosis has been steadily gaining ground.

Dr. Hector Mackenzie believes "That alcoholism must be regarded as a powerful predisposing cause of tuberculosis. It is almost invariable to find tubercle in the lungs of patients dying in the course of alcoholic paralysis." He goes on to point out that tubercle of the peritoneum and pleura frequently complicates cirrhosis of the liver. It is a well-known fact that the majority of patients suffering with alcoholic peripheral neuritis perish from tuberculosis, mostly pulmonary. But reference to the experience of the *post-mortem* room perhaps affords the most reliable data as to the relationship of alcoholism to tuberculosis.

Dr. Kelynack says: "I collected a number of fatal cases of peripheral neuritis occurring in chronic alcoholics. Eight cases were subjected to pathological examination, and pulmonary tuberculosis was met with in seven. That is, in 87 per cent." Personally I should not have put the percentage as high, as out of nine cases of peripheral alcoholic neuritis of my own, pulmonary tuberculosis was present in only four.

Out of the 200 *post-mortem* examinations on cases of tuberculosis, I found five only that gave unmistakeable evidence of chronic alcoholism. That is, in only 2·5 per cent.! They were as follows:—

(138) *Post mortem.*—Wm. B., aged 19, bottler. Chronic pulmonary tuberculosis. Cirrhosis of the liver.

(135) *Post mortem.*—Fred. P., aged 32. Clerk. Nephritis. Fibrous increase in liver and kidneys. Chronic pulmonary tuberculosis.

(196) *Post mortem.*—Ada M., aged 25, married. Acute pulmonary tuberculosis. Chronic alcoholism. Fatty liver.

(189) *Post mortem.*—Sarah B., aged 36, married. Acute pulmonary tuberculosis. Alcoholic neuritis.

(139) *Post mortem.*—George W., aged 48, wheelwright. Cirrhosis of liver and kidneys. Tuberculosis.

The question as to the action of alcohol in predisposing the tissues to tuberculosis is a difficult one to decide with certainty.

It has been suggested that it is not so much the alcohol itself which renders the tissues vulnerable, as the habits it engenders in its victims which render them more liable to tuberculosis than temperate men. Dr. Kelynack, in a paper read before the Congress of Tuberculosis on this subject, says: "There can be no doubt but that the non-hygienic surroundings of many

chronic alcoholics afford very important conditions suitable to tuberculous invasion. The vitiated atmosphere of the public-house, the uncleanly habits of many of the frequenters, the over-crowding and promiscuous congregation of individuals in varying states of health and disease furnish circumstances peculiarly suited to the spread of tuberculosis. But most important of all, the filthy and dangerous condition of many bars and beer-houses, from the reckless deposit of sputum on the floor, when quickly becoming dry, it mixes with the dust, which is continually being raised by the moving crowd, furnishes a further source of infection."

From a clinical experience of over seven years at a Consumption Hospital, I should certainly say that alcoholism does render the tissues vulnerable, and that the tuberculous disease advances quickly in these patients.

As in patients the victims of syphilis and diabetes, so in tuberculous alcoholics, the disease often assumes an acute pneumonic type, that is to say, the channel of infection through the lung itself is an epithelial one

The Relation of Diabetes to Tuberculosis.

The following short *post-mortem* notes well illustrate the type of tuberculosis and the acuteness of its course in diabetics.

(17) *Post mortem.*—C. N., aged 21, tobacco worker. Diabetes ; acute pulmonary tuberculosis, large irregular recent cavity at the apex of the right upper lobe surrounded by caseous pneumonia, middle and lower lobes congested, with a few scattered tubercles ; large recent cavity, size of an orange, at the apex of the left upper lobe, bronchial glands enlarged, not caseous to

unaided eye. Pancreas very small. On microscopic examination there appeared to be very little healthy pancreas tissue left; hæmorrhages in places. Tubercle bacilli on microscopic examination were found in lungs, bronchial and cervical glands.

Before the discovery of the tubercle bacillus, pathologists were in doubt as to the unity of pulmonary phthisis in diabetics. Pavy and Wilks believed that the pulmonary mischief was not always tuberculous in nature, even when it ran a closely similar course, but that it consisted in a chronic inflammation leading to the breaking down of the lung tissue and the formation of cavities.

Sir William Roberts writes:—"The most common and formidable complication is pulmonary tuberculosis, which affects nearly one-half of the cases protracted to the third year. A low and fatal type of inflammation is also liable to arise in the lungs, pleura or peritoneum."

From the above passage I think it is clear that Sir William Roberts was of the opinion that there were two distinct disease processes observable in the lungs of diabetics, one tuberculous, the other not.

Sir Richard Douglas Powell, in writing on diabetic phthisis says:—"Dr. Dreschfeld, who has given much attention to the subject of pulmonary complications in diabetes, characterises the caseous broncho-pneumonic lesions as tuberculous, and has found in them, *post mortem*, tubercle bacilli. Dr. Dreschfeld has, however, observed two cases of chronic croupous pneumonia resulting in excavation of the upper lobe in diabetes which presented the clinical sign of phthisis, but in which no bacilli were found either in the expectoration or in the lesions *post mortem*."

These cases of Dr. Dreschfeld's appear to be conclusive that the lung changes found in diabetics are not

always due to tubercle. As far as my own much more limited experience goes, I should have said that the pulmonary lesions were always tuberculous. During the last seven years I have admitted to the hospital three well marked cases of diabetes. They all died in hospital of pulmonary tuberculosis, proved by the presence of tubercle bacilli in the sputum during life and by *post-mortem* examination.

The Relation of Pulmonary Tuberculosis to Mitral Stenosis.

Many valuable papers on the ætiology of mitral stenosis have been written since M. Fauvel published his paper on the stethoscopic signs of narrowing of the left auriculo-ventricular orifice of the heart in the *Archives Générales de Médicine*, in 1843. Since that time the following physical signs are almost universally regarded as diagnostic of mitral stenosis. A presystolic thrill at the apex ; a presystolic murmur ending abruptly in a short, sharp first sound, with accentuation of the second sound at the left base ; and evidence of hypertrophy and dilatation of the right side of the heart. All observers are agreed that of the several forms of valvular disease of the heart, mitral stenosis owns rheumatic inflammation as its cause the least often, but there is a wide diversity of opinion as to the proportion of the rheumatic to the non-rheumatic cases. Sir Dyce Duckworth, in a valuable paper on the Ætiology of Mitral Stenosis, in *St. Bartholomew's Hospital Reports*, makes rheumatism responsible in 70 per cent. of cases. The late Dr. Hilton Fagge, on the other hand, would put the proportion as low as 50 per cent. Of 81 cases of pure uncomplicated mitral stenosis under my care during

the last three years, 35 gave a distinct history of rheumatism, chorea, or scarlet fever, complicated with rheumatism, leaving 46 unaccounted for; but some of these cases were very probably of rheumatic origin, although no history could be obtained. The indications of rheumatism in childhood are frequently very slight; as Dr. Goodhart truly remarks, "a large number of children suffer from rheumatism in this way, and never go to bed at all, and are never seen by a doctor; and years afterwards when some old valvular mischief needs explanation, there is no memory of the pre-existence of any disease." Some physicians again regard a certain proportion of these cases of pure mitral stenosis as congenital in origin; with these *I* cannot agree. From an experience of over six years at a Children's Hospital, I should say that mitral stenosis as a congenital defect was a very rare condition. From some recent investigations of French physicians, mitral stenosis is asserted by them to be tuberculous in origin. It is with this latter assertion I wish especially to deal.

It was formerly supposed that pulmonary tuberculosis and valvular disease of the heart existing together was an extremely rare condition. In fact, some authors asserted that the two diseases never occurred together in the same patient.

Rokitansky, for instance, wrote as follows: "Persons labouring under enlargement of the heart, whether primary or super-induced by mechanical obstruction at its orifices, do not contract tuberculosis." This is much too sweeping a statement, as pulmonary tuberculosis and valvular disease of the heart are not infrequently found in the same patient, but this is quite a different thing from saying that the one is the cause of the other.

M. Teissier has lately written a paper containing a report of a large number of cases, in which he asserts that progressive narrowing of the mitral orifice is due to tuberculosis.

Dr. Sansom, in a very interesting paper in the *British Medical Journal*, while not agreeing with M. Teissier, says "that there is some relation between mitral stenosis and tuberculosis, I quite agree."

Potain found *post-mortem* evidence of tuberculosis in 12 cases out of 35 of pure mitral stenosis and M. Teissier brings evidence to show that this proportion is below the mark.

Dr. Sansom goes on to say that, taking the cases in Teissier's abstract with those cited by Dr. Percy Kidd and others, he finds a total of 31, in which the association of tuberculous lesions with mitral stenosis was found *post mortem*.

On my appointment as pathologist to a Consumption Hospital, upwards of nine years ago, I determined to investigate this point as fully as the *post-mortem* material at my disposal would allow. Out of 200 *post-mortem* examinations of persons dead of acute, chronic and miliary tuberculosis, I found mitral stenosis once only in a woman aged 41. The heart weighed 13 ozs. The mitral orifice was greatly stenosed, only just admitting the tip of the little finger. The other valves of the heart were normal. The right side of the heart and the left auricle were hypertrophied and dilated. There were a few old adhesions at the apex of the right pleura. There was a cavity about the size of a small marble at the extreme apex of the right upper lobe of the lung. This cavity was cut off from the surrounding lung tissue by a fibrous capsule. There appeared to have been no attempt for the tuberculous process to spread

through the lung. There were no infarctions and no other trace of tubercle in the body. Tubercle bacilli were obtained from a scraping of the cavity.

In 12 *post-mortem* cases of pure mitral stenosis, the lungs were quite free from tubercle. In a series of 133 *post-mortem* examinations reported by Drs. Harris and Beale, mitral stenosis was found three times. In Fagge's "Principles and Practice of Medicine" it is said that mitral stenosis is almost a complete bar to the development of pulmonary tuberculosis, the *post-mortem* records of Guy's Hospital supplying only four cases of this association in thirty years. Dr. Percy Kidd, in a valuable paper on the association of pulmonary tuberculosis with diseases of the heart, found out of 500 *post-mortem* examinations of cases of pulmonary tuberculosis, well-marked signs of disease of the heart in 27, but in only one of these was there stenosis of the mitral orifice. In the reports of the others we read of thickened mitral and aortic valves, but nothing is said of stenosis of the mitral orifice. In my own series, out of 200 *post-mortem* examinations on persons dead of pulmonary tubercle, I found well-marked signs of heart disease in 21, mostly thickening of the aortic and mitral valves, but only once a typical mitral stenosis.

Dr. Sansom, in his article in Allbutt's "System of Medicine" (vol. v.), says he has observed two cases *post mortem*, one in a woman aged 29. The mitral aperture was very narrow, with much thickening of the adjacent structures. Both lungs were studded with tubercles, some miliary, others yellow and softening. Dr. Sansom says he had also observed a well-marked case under the care of Dr. Sutton. M. Teissier admits that a search in the diseased endocardium of his cases

of mitral stenosis for the bacillus tuberculosis, or of any specific tuberculous lesion, had always been negative. I suppose all who have made many *post-mortem* examinations on cases of pulmonary tuberculosis will admit that the endocardium is frequently found thickened in places, especially in the left ventricle, in the neighbourhood of the aortic segment of the mitral valve, but never to the extent of producing a narrowing of the mitral orifice. I have made many microscopical examinations of these thickened patches in the endocardial lining of the heart, for the presence of tubercle bacilli or tuberculous changes, but always without result. I still think that, in this country at least, the association of mitral stenosis and pulmonary tuberculosis, as shown by pathological records, is of rare occurrence. From the clinical side of the question we cannot speak with the same degree of assurance as from the pathological, but I venture to think that clinically the rarity of the two diseases in the same patient is apparent. During the last three years I have had 1,000 cases of well-marked pulmonary tuberculosis under observation without one displaying any of the signs of mitral stenosis. Also during the same period I have had under treatment 91 cases of pure mitral stenosis giving the physical signs as stated in the beginning of this paper, that is, with none of the signs of regurgitation or evidence of any of the other valves of the heart being affected. In 3 out of these 91 cases there was, on superficial examination of the chest, signs that might easily have been taken to prove the evidence of tuberculosis of the lungs.

Case 1.—A woman, aged 41, had all the typical signs of mitral stenosis. There was also dulness on percussion, and crepitations at the apex of the left lung.

In this case I first thought I had a mitral stenosis complicated with phthisis of the left apex. The patient had had slight hæmoptysis and cough for six weeks before coming under observation. Tubercle bacilli were examined for on more than one occasion, but with a negative result. The patient remained under treatment from November to December 11, of 1897. She improved somewhat under treatment, but the physical signs of the left apex remained. This patient came under observation again one year after, in July, 1898, with cough and hæmoptysis, being now six months pregnant. The physical signs at the apex of the lung had completely cleared up.

Case 2.—A woman, aged 23, who first came under treatment in March, 1899. She had never had rheumatism, chorea or scarlet fever. She had had a cough for four years with occasional streaks of blood in the expectoration. As in the former case, there were physical signs of typical mitral stenosis with dulness and crepitation at the left apex. This patient was admitted to the hospital. Tubercle bacilli were never found after frequent examinations of the expectoration, and during a residence of nine weeks in the hospital the physical signs completely cleared up at the left apex.

Dr. Ormerod informs me that he remembers having under treatment a girl with all the typical signs of mitral stenosis and phthisis. The patient died in the hospital and at the necropsy no tubercle was found, the physical signs being due to pulmonary embolism. The physical signs of dulness to percussion and crepitations limited to one or other apex in patients with evidence of mitral stenosis must be received with great caution, and the diagnosis of pulmonary tuberculosis can only be made certain by the discovery of the bacillus tuberculosis.

As Dr. Sansom truly remarks, many cases of mitral stenosis show signs which can be easily mistaken for those of pulmonary tuberculosis. A case which simulates pulmonary tuberculosis when mitral stenosis is present is not of such grave significance as a case in which mitral stenosis is absent. One can hardly help coming to the conclusion that M. Teissier must so have mistaken some of his clinical cases. I think mitral stenosis and pulmonary tuberculosis existing together in the same patient is so rare a condition that the one cannot be regarded as the cause of the other, although not perhaps antagonistic to each other.

Although mitral stenosis would appear to defend the lung against the attack of the tubercle bacillus it does not defend other organs, as the following case well illustrates.

(109) *Post mortem.*—H. S., aged 9 years. Morbus cordis. Tuberculous meningitis.

The mitral orifice is much stenosed, only admitting the tip of the little finger.

On examination of the brain well-marked tuberculous meningitis was discovered.

The Relation of Pulmonary Stenosis to Tuberculosis.

I shall next consider pulmonary stenosis.

Here the condition is exactly opposite to mitral stenosis; nearly all cases of pulmonary stenosis perish by the way of tubercle.

Any conditions which lead to lung congestion appear to protect the organ more or less from the attacks of the tubercle bacillus, while any condition that leads to pulmonary anæmia predisposes the lung to the tuberculous attack.

The following case well illustrates this :—

(176) *Post mortem.*—A. C., aged 18.

Heart.—Weight 12½ ozs., pericardium normal. The pulmonary orifice was much stenosed. The anterior segment of the pulmonary valve was attached by its two extremities, only being quite free between. The other segments were in much the same condition, but the attachment to the wall of the vessel was more intimate, only leaving a very small orifice. The right ventricle was greatly hypertrophied. All the cusps of the pulmonary valve were greatly thickened. The pulmonary orifice just admitted a thin pencil. The pulmonary artery was dilated beyond the stenosed orifice ; the ventricular septum was complete. Bronchial glands enlarged and tuberculous.

Lungs.—There was a large cavity excavating the whole of the upper and part of the middle lobes. There was also a smaller cavity situated in the middle of the right lower lobe. Tuberculous infiltration throughout all three lobes.

There was a large cavity excavating nearly the whole of the left upper lobe. The lower lobe was much congested, there were only a few recent tuberculous nodules in this lobe.

Microscopical Examination.—The cervical and bronchial glands were found to be tuberculous.

It has been asserted that emphysema, as leading to pulmonary anæmia, is a predisposing cause of tuberculosis. I think this assertion must be received with reservation.

Undoubtedly we very often see emphysema of the lungs in making *post-mortem* examinations of persons who have died of pulmonary tuberculosis, but we must remember that much of this emphysema is consecutive.

Out of my 200 *post-mortem* examinations I only met with two cases in which the emphysema could be regarded as primary, but in this connection the following *post-mortem* examination is, I think, of interest :—

(118) *Post mortem.*—N. W., aged 41. Fibroid phthisis. Granular kidney.

The left pleura was much thickened and universally adherent. The adhesions were very old ; the upper and lower lobes of the left lung were in an advanced stage of fibrosis, but there were numerous tuberculous nodules scattered through both lobes. The right lung was markedly emphysematous, but was free from tubercle.

In this case we had already tubercle in the body with a markedly emphysematous right lung, and yet it is found free from tuberculosis. From a clinical experience of over seven years I should say that pulmonary tuberculosis in emphysematous chests was uncommon.

The Relation of Lymphadenoma to Tuberculosis.

Great confusion has existed and still exists as to the relationship of lymphadenoma and tubercle, some pathologists maintaining the tuberculous nature of all cases of lymphadenoma which are not leucæmic or sarcomatous, while others maintain that lymphadenoma and tubercle are perfectly distinct diseases, although tubercle and lymphadenoma may coexist in the same patient.

At a recent discussion on lymphadenoma in its relation to tubercle at the Pathological Society of London, Mr. Butlin, who opened the discussion, said : "With regard to the relation of this disease to tubercle, I can state in three sentences all I know about it. In

the first place the disease I have been talking about is certainly not tubercle. In the second place the disease does not in the least exclude tubercle nor does it seem to render a patient in the least degree immune to an attack of tubercle. And I would go a step further and say I have a suspicion that lymphadenoma renders a patient, on the whole, a little more disposed or liable to an attack of tubercle, than he would be if he were not suffering from this particular disease."

Dr. F. W. Andrewes, in an admirable paper contributed to the same discussion, showed, I think, conclusively, that lymphadenoma and tuberculosis are perfectly distinct diseases. He showed, moreover, that tuberculosis might become engrafted on a lymph-adenomatous gland.

He showed clearly the histological difference between the two, and went on to say that tuberculosis in lymph glands is at first a focal lesion, but by fusion of different foci the whole gland may ultimately be affected; but one does not see a primitively diffuse affection of the gland as in lymphadenoma. In this I cannot agree with Dr. Andrewes. I have, I think, seen a lymphatic gland diffusely affected from the beginning in tuberculosis in that condition which I have described above as large celled hyperplasia.

Dr. Andrewes sums up by saying :—

(1) Lymphadenoma is a distinct disease not due to the action of the tubercle bacillus.

(2) There is a form of tuberculosis of the lymphatic glands clinically indistinguishable from lymphadenoma, but recognisable by histological and bacteriological examination.

(3) There occur a fair number of cases of lymphadenoma in which secondary infection with tubercle takes place.

It is very probable that lymphadenoma does render the lymphatic glands more liable to the attack of the tubercle bacillus than glands not so affected.

The Relation of Cancer to Tuberculosis.

In cancer of whatever part a tuberculous lesion in the lungs is very common. Obsolescent tubercle in the lungs occurs in about 9 per cent. of all *post-mortem* examinations and in these cancer occurs in by far the greatest proportion.

In Dr. Fowler's statistics they form two-fifths of the cases, and in those of Dr. Sidney Martin two-sevenths. These statistics were obtained from the Middlesex Hospital, where a large number of cases of cancer die yearly.

Dr. Sidney Martin says that in the cancer cases pulmonary tuberculosis is rarely found in an active state, but is almost always retrograde. With this statement I cannot agree. I have frequently seen the two conditions going on together *post mortem*, and in the majority the tuberculous process was certainly active. The following case well illustrates this :—

Post mortem.—(3) John W., aged 45, labourer. Cancer of œsophagus ; pulmonary tuberculosis, pneumonia right lower lobe. Tubercle in left supra-renal.

Body much emaciated, some bronzing of the skin of neck and axillæ, no pigmentation of mouth. Recent adhesions all over left lung, most marked at apex. Few adhesions at right apex. In the upper lobe of the right lung there was much tubercle, both recent and old ; there was also some fibroid change.

The right lower lobe was solid with pneumonia in a state of red hepatisation ; the lung sank in water. The bronchial glands were cancerous.

At the apex of the left lung there was recent tubercle and a small cavity.

About three inches above the cardiac end of the stomach opposite the bifurcation of the trachea was a large ulcerating mass completely occluding the lumen of the tube, the glands about the œsophagus contained growth and the cancer was invading the root of the right lung.

The *post-mortem* examination of the above case showed conclusively that the tuberculosis was active at the time of the patient's death.

Dr. Sidney Martin goes on to say that although the condition induced by cancer tends to the invasion of the body by the tubercle bacillus, it is inimical to the spread of the disease.

It is probable that cancer does predispose to tuberculosis, but I do not think we have sufficient evidence to show that it does not spread throughout the body.

The Relation of Pregnancy to Tuberculosis.

Dr. Pollock says: "Pregnancy is found to complicate, to develop, or to precipitate phthisis remarkably."

Surely there must be some mistake here. To say that pregnancy develops tuberculosis must be going further than facts warrant.

It is generally stated that when a woman affected with tubercle becomes pregnant, the tuberculous process becomes for the time arrested, but develops with great rapidity after delivery.

With this statement I cannot agree. During the last seven years many of my tuberculosis out-patients have become pregnant and the majority of them have done well. I have not seen that alarming progress of the disease after delivery.

In illustration I give the following case:—

R. T., aged 28, came to the out-patient room five

years ago. She had well-marked physical signs of tuberculosis of the right apex. Some years after this she married and I lost sight of her. She came again under observation in 1902. The baby was 14 months old. As far as physical signs went there was little alteration to be found. She had gained in weight, and expressed herself as feeling quite well with the exception of a short dry cough.

I give this as one case out of many. In only one instance could I find evidence of the rapid progress of the disease after delivery.

I should say that pregnancy did not predispose a woman to tuberculosis, and even when pregnancy does occur in a tuberculous woman the complication is not a very serious one, although, of course, it is a complication we would rather be without.

The Relation of other Diseases to Tubercle.

Whooping cough and measles are undoubtedly predisposing causes, in both of which catarrh of one or other of the respiratory passages takes place. This catarrh of the respiratory passages undoubtedly lowers their resistance to the tubercle bacillus.

Influenza, again, must be included in the list of acute specific diseases that render the tissues and organs vulnerable.

How often does the tuberculous patient date the onset of the disease to an attack of influenza? Undoubtedly some of this so-called influenza is in reality the onset of tuberculosis. But, as in measles and whooping cough, the respiratory form of true influenza is a powerful cause of lowering the resistance to the onset of tubercle.

Rickets in certain cases unquestionably renders the tissues susceptible.

Given a case of uncomplicated rickets it may safely be said that it almost invariably gets well. But, on the other hand, bronchitis with atelectasis and a distorted chest is a serious matter from liability that exists in such cases to the production of caseous bronchial glands and subsequent tuberculosis.

Race is well known to be a predisposing cause.

Some races of mankind are peculiarly liable to tuberculosis, especially negroes. During the last few years I have had two such patients under treatment for pulmonary tuberculosis. In each the disease progressed with great rapidity, death following in each case within three months of the apparent onset of the disease.

But here I must needs stop. This Essay falls very far short of my mental ideal as to what it should have been, but I remembered the motto that stands on the cover and took courage. I therefore venture to send it for the consideration of the adjudicators.

APPENDIX.

SINCE the essay was finished I have received from Dr. Johan Scharffenberg, of Trondhjem, Norway, an important paper on the subject of Schrön's capsules. The paper is written in Norwegian, but Dr. Scharffenberg very kindly sent with it an abstract in French. I have here added a translation of this abstract. I have also appended an abstract from a paper by Dr. Aufrecht, of Madgeburg, Germany, published in the *Berliner Klinische Wochenschrift*. This paper well illustrates the attitude of the more advanced school of German physicians towards Inhalation Tuberculosis.

SCHARFFENBERG (JOHAN), SUR LES CORPUSCULES HAPTOCHROMATIQUES "DE SCHRÖN" TROUVÉS DANS UNE GLANDE COLLAIRE TUBERCULEUSE.

THE author proposes, in the first place, instead of the German term "saurefest" (acid-fast), the adjective "haptochrome," with the substantive haptochromy (from the Greek ἅπτειν, to bind, and χρῶμα, to colour), as an international technical term, for the property found in certain bacteria of being decolourised with difficulty by mineral acids when once they have taken up the stain. If, among the haptochromatic bacteria, it is wished to distinguish between those that stain easily and those that stain with difficulty, the following expressions may be created: *haptochromophiles* (for example, the bacilli

of leprosy, which stain easily and decolourise with difficulty), and *haptochromophobes* (for example, tubercle bacilli, which are less susceptible of receiving the stain, but are capable of retaining it strongly).

The bacteria which strongly retain the stain only in special circumstances, for example, when they are impregnated with fatty matter, will be designated by the term *pseudohaptochromes*.

The materials collected by the author were furnished by the case of a Norwegian woman, aged 23, at whose house the brother of the author, Dr. H. Scharffenberg, of Mysen (Norway), extirpated, on October 12, 1900, a certain number of enlarged and tuberculous glands in the neck (scrofulous); one of these, a gland the size of an almond, was preserved in alcohol at a temperature of 96°, and examined microscopically during a stay at Copenhagen in the autumn of 1901. This examination demonstrated the existence of a typical glandular tubercle. Upon staining for bacilli it was not found possible to discover more than one bacillus typical of tuberculosis, but, on the other hand, a large number of round and oval bodies taking the stain like tuberculosis bacilli.

These bodies are what have been called "capsules of Schrön." This term is badly chosen, and the author proposes to replace it by that of "*corpuscles of Schrön*, considering that they are not capsules at all, and that they do not appear to possess special membranes. They were first described by Professor Schrön, of Naples, from whom the author has not been able to procure the original work; later, these corpuscles were figured and described by a pupil of Schrön, G. d'Arrigo, an Italian ("Ueber die Gegenwart und über die Phasen des Koch, schen Bacillus in den sogenannten skrofulosen Lymphdrüsen," *Centrablatt für Bakteriologie*, 1st section, vol.

xxxviii., 1900, pp. 481-485), and by the Englishman, Hugh Walsham ("Some Observations on the Tuberculosis of the Cervical and Bronchial Lymphatic Glands") in the *Journal of Pathology and Bacteriology*, vol. vii., 4th part, November, 1901, pp. 409-419.

The author gives an account of the descriptions furnished by G. d'Arrigo and Hugh Walsham, and expresses the opinion that they might well be the same bodies as were described by Eugen Czaplewski in 1891, in "Die Untersuchungen des Auswurfs auf Tuberkelbacillen," page 59, fig. 31.

The author then goes on to describe in detail the way in which these bodies behave when treated with reagents.

Their form may be round, oval, or elliptic; their dimensions vary from a least diameter of 1 μ in the smallest round forms to 5—6 μ in length and 2—3 μ in breadth in the longest elongated forms, these latter being therefore very much larger than ordinary tubercle bacilli. The largest forms are visible under a No. 7 objective (of Leitz).

In non-stained sections these bodies were strongly refracting, with a yellowish-green luminous reflection. With the staining generally used for tubercle bacilli (carbol-fuchsin, hydrochloric alcohol, or sulphuric acid at 25 per cent., alcohol at 70 per cent., methylene blue), they generally take deeply the colour of fuchsin, and appear most resistant to decolouration; they stain either dark red or only rose-colour (in the case of the smallest forms), or reddish-brown; sometimes a dark central nucleus is seen surrounded by a brighter area, sometimes brownish-yellow.

They cannot be stained by Lœffler's method any more than by Gram's (thus being distinguished, from a staining point of view, from the ordinary bacilli

of tuberculosis, which do stain by Gram's method), nor by hæmatoxylin, nor by any other stain used by the author.

They do not furnish the amyloid reaction, nor can Perl's (ferric) reaction be recognised; they are not visibly modified when treated with dilute caustic potash, alcohol, ether, xylol, ethereal oils, mineral acids. They are met with in the peripheral portions of the gland, adjoining the capsule, and are there seen in vast collections, more often free, but sometimes also in the interior of cells: it is in this way that the author has seen them in the interior of a typical giant cell (myeloplax [or osteoclast]), and in an epithelioid cell resembling nuclear segmentation (karyokinesis).

The smallest forms are sometimes collected in groups around nuclei of cells.

The author thinks that he has seen the same bodies in urine secreted by tuberculous patients.

In conclusion, he discusses the nature of these bodies.

Walsham expressly states that they have been found in pure cultures of tubercle bacilli; their connection with tuberculosis would then be proved; but as the author himself has not studied the original works, he does not venture to express himself in so positive a manner as G. d'Arrigo and Walsham; but he intends to continue his researches, as these bodies having been met with in tuberculous glands in Italy, in England and in Norway.

The author is, however, disposed to consider them as a form of the tubercle bacilli. He agrees with the authors who think that in reality tubercle bacilli, in the same way as actinomycosis, belong to organised fungi of the highest order: he does not, in consequence, think that one can simply get out of the difficulty by declaring them to be "involution forms." Authority

to pronounce on this point should not be granted to physicians at all, but to botanists.

The microscopical investigations took place in the summer of 1901 ; the demonstration of the preparations was made before the Trondhjem Medical Society, with a brief discussion on November 12, 1903 ; the memoir itself was drawn up at Trondhjem, in February, 1904.

Abstract from Dr. Aufrecht's Paper.

Dr. Aufrecht, after an elaborate discussion of the whole question of the channels of infection in tuberculosis, sums up as follows: "The fear of infection as a result of inhalation of the tubercle bacillus is unfounded and unnecessary ; for the bacillus does not arrive within the lung tissue through penetration of the mucous membrane of the respiratory tract. On the contrary, it is taken by the mucosa of the digestive tract, especially by the tonsil—mostly in childhood—and borne through the lymphatic glands to the blood. Thus (1) the tonsils are to be regarded as an undoubted portal of entry for the bacillus ; (2) the tubercle bacillus is propagated from the tonsils along the cervical lymphatic glands to the mediastinal glands ; (3) when the mediastinal glands containing bacilli adhere to the pulmonary artery or to one of its larger branches the bacillus may pass through the intact vascular wall into the pulmonary circulation, and then finds in the pulmonary apex favourable conditions for lesion of the wall of the finer vessels, with the subsequent production of tuberculous foci."

Dr. Aufrecht maintains that tuberculosis of the pulmonary apex always begins as a tuberculous infarction. I here give these opinions because I think they deserve attention, but without altogether accepting them as proved.

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