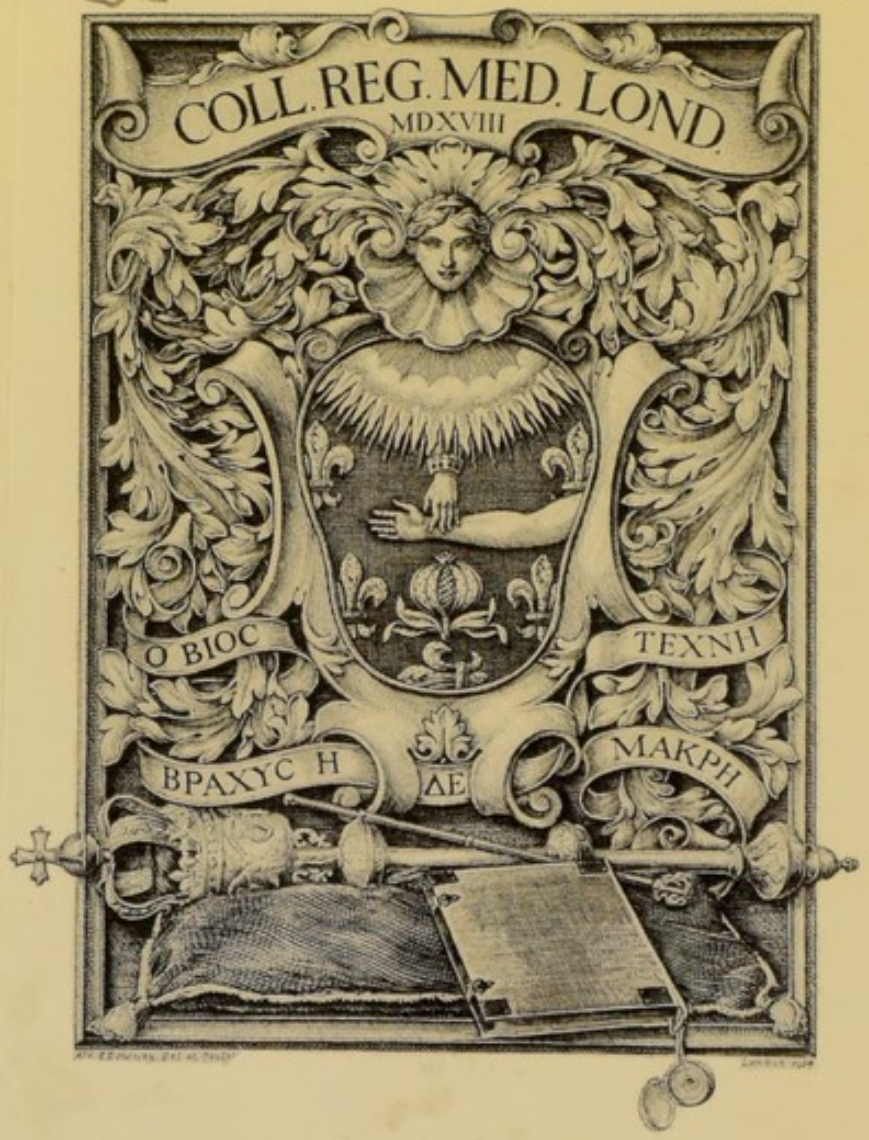
The diagnosis of tuberculosis of the lung, with special reference to the early stages / by K. Turban ; with an introduction by Sir Dyce Duckworth ; translated by E.C. Morland.

The Diagnosis of Tuberculosis of the Lung

WITH SPECIAL REFERENCE TO THE EARLY STAGES

TURBAN

Translated by E. C. MORLAND



The Diagnosis of Tuberculosis of the Lung

WITH SPECIAL REFERENCE TO THE EARLY STAGES

BY

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WITH AN INTRODUCTION BY

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INTRODUCTION.

THE translator of this work, a former House Physician of mine, has requested me to write a short introduction to it, and I have willingly acceded to his wish.

I think that Dr. Morland has wisely determined to render the labours of his friend, Dr. Turban, accessible to the majority of the profession in this country.

No one can peruse and ponder over the several chapters of this work without gaining fresh and fruitful ideas respecting the detection of pulmonary tuberculosis in its earliest phases. The author has studied his subject by the light of a full and wide experience, and is intimately acquainted with most of the views and teaching of the best authorities upon it. He, perhaps, hardly shows as much knowledge of our British literature as might have been expected in one who has paid such special attention to a malady which is so prevalent, and now so carefully studied, in this country.

Dr. Turban's main object in writing this book is to urge the importance of detecting at the earliest possible moment the onset of tuberculous invasion of the lungs, and thereby to help forward the special advantages of the early resort to appropriate treatment.

As the Director of the Sanatorium at Davos-Platz, he has learned there, as do all Directors

of such Sanatoria, the supreme importance of combating pulmonary phthisis in its earliest stages—those, indeed, in which a satisfactory arrest of the morbid process is most often to be hoped for.

His descriptions and directions for enquiry and examination of the patient are most minute, and are not to be met with in ordinary text-books. Only in special works on the subject could such details and suggestions in method be expected, but in this instance the author appears to have surpassed most previous writers in these respects.

Dr. Morland has edited in the present volume the first two sections of Dr. Turban's book. The third section relates to the Sanatorium methods of treatment and their results, and the translator hopes to deal with this section at some future time.

I can only further congratulate Dr. Morland on the admirable translation he has made, and express my appreciation of the type and style in which he has issued the volume. It may be strongly commended to the careful study of all thoughtful practitioners of our art.

DYCE DUCKWORTH.

September 20, 1905.

NOTE BY THE TRANSLATOR.

THIS book is a translation of the first two sections of Turban's "*Beiträge zur Kenntnis der Lungen-Tuberculose*," published in 1899. In preparing it I have had Dr. Turban's constant co-operation, and many additions and corrections have been made, so that it may be taken throughout as the expression of his views at the present time.

The book consists of two originally distinct papers: the one, "On Early Tuberculosis of the Lung and the Classification of the Disease into Stadia"; the other, "Physical Examination in Tuberculosis of the Lung." No attempt has been made to fuse these, and the title of the translation is to be regarded as a compromise.

If any justification be required for the publication of Dr. Turban's work in England, it is to be found in his own words (p. 52): "How necessary it is that parallel with the therapeutic activity which has led to the Sanatorium movement, should run an increasing accuracy in physical diagnosis, especially of the early stages, rendering possible a right selection of cases which may be cured or improved." This exactly reflects the need of the present time.

It is further hoped that the uniform adoption of Dr. Turban's classification may render possible that strict comparison of results which is the final criterion of any method of treatment.

E. C. M.

Davos-Platz,
October, 1905.

The Translator is responsible for the footnotes throughout the book.

THE

DIAGNOSIS OF TUBERCULOSIS OF THE LUNG,

WITH SPECIAL REFERENCE TO THE EARLY STAGES.

SECTION I.—Early Tuberculosis of the Lung.

INTRODUCTORY: BEING A DISCUSSION RELATIVE TO THE COMMENCEMENT OF TUBERCULOSIS OF THE LUNG.

(*) *References at end of Volume under author's name.*

Diagnosis of Tuberculosis of the Lung in the Absence of Bacillary Sputum.

THE question whether the diagnosis of tuberculosis of the lung can and should be made, when tubercle bacilli are not present in the sputum, is one which has produced more difference of opinion among writers than almost any other in the whole region of diagnosis.

v. Ziemssen.

von Ziemssen* says: "It may rank as one of the best established rules of diagnosis that . . . tuberculosis may be excluded in any case of lung affection, in which repeated skilled examination has failed to demonstrate tubercle bacilli."

von Strümpell's* opinion is less extreme: "At the present time," he says, "the examination of the sputum for tubercle bacilli plays the most important *rôle*, and the only decisive one, in the recognition of commencing phthisis."

v. Strümpell.

Gerhardt* and Eichhorst* express themselves very differently. The former says: "On the other hand, I know cases in which bacilli were not found for months, or only in the sixtieth specimen, but where the diagnosis of tuberculosis was established by examination of the chest." And Eichhorst writes: "Now and then, one certainly finds cases in which no tubercle bacilli are found in the sputum, even after daily examination of several specimens, in spite of the undoubted existence of pulmonary consumption."

Gerhardt.

Eichhorst.

Finally, Grancher* says: "In ordinary phthisis, the appearance of bacilli in the sputum is tardy. It is preceded by physical signs of the first stage, often complete enough to establish the diagnosis."

Grancher.

In a communication laid before the Eleventh International Congress,* describing commencing tuberculosis of the lung, I endorsed Grancher's view, and summed up my own opinion thus: "Clinically, the first stadium of tuberculosis of the lung may be demonstrated before bacilli appear in the sputum."

Turban.

This divergence of opinion continues in the most recent publications. Dettweiler* makes the following definition: "We have to do with tuberculosis of the lung from the moment at which the finding of bacilli in the sputum supplements the evidence of respiratory disturbance, either of recent occurrence or of some previous duration."

Dettweiler.

Oestreich,* endorsing the opinion of his master, Krönig, says: "In commencing phthisis, the anatomical changes . . . . are frequently of such a kind that the tubercle bacilli actually present in the tissues can find no means of exit, whilst the foci are large enough to be demonstrated by percussion. . . . A negative result, then, of sputum examination in no way excludes the existence of foci producing physical signs, so that in these cases the earliest recognition of the disease can only be obtained by physical examination."

Oestreich.

As this confusion persists, it seems advisable to examine in detail the subject of commencing tuberculosis of the lung, in view of the overwhelming importance of its early diagnosis. This variety of opinion, in the estimate of a disease at once so common and so important, is very striking. The explanation can only be that some writers cling to the distinction between non-tubercular and tubercular apical catarrh, and to the notion of a transition from the one to the other.

"Apical Catarrh."

Apical catarrh, or more correctly, chronic pneumonia of the lung apex, is held to make a soil favourable to the development of the tubercle bacillus. Thus Liebermeister* says: "In the majority of cases, after it has existed for a longer or shorter time, chronic pneumonia is followed by tubercular infection."

According to Biedert and Siegel,* these chronic pneumonias are confused with commencing phthisis on account of their apical site and the occurrence of hæmoptysis, and they probably precede for a longer or shorter time every case of actual phthisis.

Modern Pathology and the Origin of Tuberculosis of the Lung.

But modern pathological anatomists ascribe a very different origin to chronic tuberculosis of the lung. On the sound basis of *post mortem* observation they describe the manifold variety of morbid changes produced by the tubercle bacillus ; but of processes regularly preceding tuberculosis they know nothing. They teach us that, in the lungs, the tubercle bacillus starts not only cell proliferation, diffuse or circumscribed, but also inflammation with effusion (*cf.*, *e.g.*, B. Schmaus*) ; and that, as a rule, the origin of tuberculosis is certainly primary.

Primary and "Secondary" Tuberculosis.

This view of the pathological anatomy is in harmony with the teaching of Laënnec, and agrees with all the results of bacteriological research ; moreover, it in no way excludes the previous existence of local disturbances of nutrition. It need not be reconsidered in view of the few cases of assumed

secondary tuberculosis recently collected by Hansemann,* in support of Virchow's teaching of "duality." The cases are in no way conclusive, and could at most prove the possibility of secondary tuberculosis, which scarcely any one would deny. The question of the normal development of the disease is not affected by it.

Tuberculosis in relation to the Exanthemata, and the Konioses.

The incidence of tuberculosis of the lung in connection with measles, whooping-cough, &c., must be construed as an extension of tubercle already present (A. Fränkel*); the bacillus being already established in the lung, or invading it from the bronchial glands under the softening influence of acute infection (Weigert, A. Fränkel). And even the combination of tuberculosis with pneumonokoniosis, advanced as the favourite and most striking example of secondary tuberculosis, leaves the question open whether the dust or the bacillus was first on the scene, when the terrible frequency of tubercular foci in the lung is borne in mind. Further, without, of course, assuming that every chronic pneumonia is produced by tubercle bacilli, on examining sections of the nodules commencing caseation with giant-cells is found much more frequently than is usually supposed, even when no macroscopic elements of tubercle are visible (*vide* p. 10). But it is the examination of processes limited to the lung apex, which has yielded almost without exception tubercle bacilli or their products;

and where careful examination has failed to find them, it is almost always in late cicatricial processes, the sequel of favourable tuberculosis, where the original irritant has died out. The occurrence of certain rare forms of disease other than tuberculosis at the lung apex will be discussed later. The immediate question here is, whether the physical signs of such extraordinary frequency at the apex of the lung are, as a rule, to be regarded as tubercular or not, in the absence of bacillary sputum. If not, some other apical disease of a non-tubercular nature must frequently be found at autopsies. But since, in point of fact, pathological anatomists know nothing of such whilst finding apical tuberculosis in one-third or even one-half of all autopsies, we are bound to conclude without further argument that the apical lesions diagnosed during life are, in the highest degree of probability, tubercular.

Causes of Survival of Theory of "Duality."

The firm adherence of many physicians to the theory of duality may be traced to several sources. In the first place, the splendid work of Fränkel and Troje,* demonstrating the agency of the tubercle bacillus in producing acute as well as chronic pneumonia, is insufficiently known and recognised, whilst the view that the so-called "scrophulous"[1]

[1] For the modern view of *scrophula* as a clinical entity distinct from or of wider scope than tuberculosis, *see* Cornet.*

lymphadenitis is tubercular has been generally adopted. Secondly, many persons assume that the tubercle bacillus must be present in great numbers in every tubercular lung, and must therefore be easily found ; whereas we have to recognise the high toxicity of the dead as well as of the living bacillus, and often search long in vain in undoubtedly tubercular abscesses and fungous granulations. But thirdly—and here is the crucial point—it is quite certain that the assumption is generally made, even when not expressly stated, that tubercular nodules in the lung must develop in the following orderly sequence : infection, cellular infiltration, caseous necrosis, softening (or fibroid change) ; whereas the behaviour of tubercular glands and joints teaches us that such inflammations and granulations may remain stationary for years, and no retrogressive changes be visible. Then may not an occurrence, which we see every day in organs more conveniently situated for observation, be also a frequent one in the lung ?

From the researches of Loomis* and Pizzoni,* who were able to produce tuberculosis in animals with material from healthy bronchial glands, the conclusion must be drawn that, like the seed on stony ground, the tubercle bacillus can persist in a viable condition in an insusceptible host. We may picture the development of tuberculosis as occurring at the moment when certain weakening influences, which

Tubercle Bacillus lying dormant.

we recognise as *predisposing causes*, come into play in the human economy. In one case we may assume that many years elapse between the inception of the bacillus and the breaking down of the prophylactic mechanism ; in the other that the bacillus finds a suitable soil from the moment of its invasion, and tuberculosis develops at once ; it may be in the glands ("scrophula") or in the lung. And this conception reconciles the contending views of heredity, fœtal infection and contagion, and affords a ready explanation of every several case.

Pause in course of Disease, "La trève."

Now, when the organism has reacted to the invasion of the bacillus with inflammation and tissue proliferation, clinical observation shows us that there may be a pause before softening occurs. This is the case in various organs, not only in the glands and joints, but also, *e.g.*, in *infiltration of the larynx.* The pause is temporary or permanent, and occurs at any rate once in an overwhelming proportion of cases of chronic tuberculosis, and very frequently several times in the course of the disease. This state of equilibrium in the damaged organ has been happily termed by French authors, "la trève," a suspension of hostilities (Legroux, Hallopeau*). We see examples of stationary tuberculosis when death has occurred from accident or intercurrent disease ; and it is then found that the pause and retrogression occur either immediately

after formation of granulations, or even after necrosis has already set in.

That tubercular changes may exist for years in the lung without leading to necrosis, and even without the appearance of bacilli in the sputum, is proved by the following interesting case with its instructive autopsy :—

Case of long-standing Tuberculosis of the Lung without Necrosis and without Bacilli in the Sputum.

Mr. Z., aged 20, with no tubercular heredity, had frequent attacks of broncho-pneumonia in early life, pertussis at 5, and has had a cough ever since ; a year ago slight hæmoptysis, *but at no time any sputum.* The consultant finds infiltration at the right apex, and sends the patient into the Sanatorium. On admission I find condition as follows : appearance cachectic, cyanosis, drum-stick fingers, slender build with slight contraction of the right side. RS.,[1] dulness, harsh insp., br. ves. exp. and cracking [*Knacken*],[2] in front down to third rib, behind to ang. scap. ; also RPS. and LPS. markedly weak breathing. After some encouragement he succeeded in bringing up some putrid pus, which contained some elastic fibres, but no tubercle bacilli. Patient admits having for many years swallowed his sputum out of consideration for com-

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[1] The following contractions are used throughout in describing signs in the chest :—

R = right side.	L = left side.
A = anterior.	P = posterior.
S = superior.	I = inferior.

Thus RPS. = right posterior superior or upper part of the right back. A few other contractions will be readily understood.

[2] Here and elsewhere the German equivalent for the râles is given [in square brackets] for reasons stated on p. 101.

pany. On further examination, br. breathing and coarse musical râles are heard, now and then, over both lower lobes. Tubercle bacilli not found in the sputum, which is now abundant.

Six weeks after admission three injections were made at intervals of three days, of 0·0005, 0·001 and 0·004 gm. of Koch's tuberculin. After the first dose the temperature rose to 99·7°, after the third it remained several days at 100·0°, and first reached normal seven days later. During this febrile reaction and the following two months, the sputum contained tubercle bacilli, in small number but indubitable, which completely disappeared again later. Four months after the injections the sputum was for some time increased in quantity and blood-stained, but without bacilli. After an eight months' "cure" patient left the Sanatorium with general condition much improved, and with lessened bronchial secretion. He returned in the following autumn with lung signs unaltered, and fifteen months after his first admission he took in the Sanatorium an acute double croupous pneumonia with right empyema (pneumo- and streptococcus), of which he died on the fifth day.

The autopsy showed large cylindrical bronchiectases in both lower lobes, from which bands of connective tissue invaded the surrounding lung. The whole right lung and the left upper lobe were hepatised. But while the greater part of this hepatised tissue gave the usual microscopic appearance of acute fibrinous pneumonia, sections of the upper lobe showed: the alveoli filled with more or less tightly packed epithelial cells and proliferating foci, in which were giant cells; some of the alveolar septa thickened and containing processes of epithelial cells; miliary tubercles and caseous foci entirely absent.

This case admits of but one explanation: that tubercular granulations were present and remained

stationary at the apex, certainly for a year, probably for much longer.

The following case illustrates the length of time which may elapse between infection and manifestation of the disease :—

Case illustrating length of time elapsing between Infection and Manifestation of the Disease.

A woman, somewhat anæmic, otherwise sound, married a man in whom tuberculosis showed itself some years later. For twelve years she nursed him as he went about, careless, in spite of every warning, of his sputum, which was constantly laden with tubercle bacilli. She slept in the same room with him, scarcely ever stirred from his side, and died suddenly of tubercular meningitis, after having for years complained of headache, while he still lived on.

It is inconceivable that for twelve years the bacilli expectorated by the man were not virulent ; and it is also in the highest degree improbable that they first found their way into the wife's organism after the lapse of twelve years, knowing the ease with which they reach the bronchial glands through healthy lung. The case suggests the further question, whether the bacilli first produced tubercular changes at its termination, or whether such had already taken place years before in the lymph glands and other organs, but remained in a condition of "trève."

Apical Tuberculosis without Symptoms.

That apical tuberculosis may remain quite symptomless during life, even though of an advanced degree, we know well enough from *post mortem* observation. Perhaps the very first begin-

nings never produce symptoms. Whether the disease is manifested early or late depends on the degree of the toxicity of the bacillus, on the production of antitoxins by the organism, and the consequent quicker or slower development of the disease, as well as on its localisation in the bronchi and alveoli, or in the interstitial tissue. In any case it is quite false to assume that clinical symptoms must begin as a rule with bacillary sputum.

"Closed" and "Open" Tuberculosis.

It may be well to repeat that bacilli are in general first found in the sputum when foci soften and invade a bronchus, *i.e.*, when tuberculosis until then "*closed*" becomes "*open.*"

This epoch is reached sooner or later according to the localisation of the foci and the rate of their development; in any case later than is generally assumed. Sometimes tuberculosis remains closed until shortly before death, as is shown by the following clinical history :—

Case of Tuberculosis remaining "Closed" until shortly before Death.

Miss T., aged 20, with hereditary predisposition, had pneumonia at 6, but otherwise healthy. From 16 years on, rapid growth with great bodily weakness. Menses began at 18, and at the same time a dry cough. No sputum or sweats. For years past great excitability with headaches.

On admission: typical phthisical habitus with thorax deformed by rickets, paretic and scarcely expanding, the left side moving even worse than the right. At the right apex, slight dulness with weak breathing and medium râles; the whole left side dull: above—breathing

br. ves. and ves. br., in places cogwheel, with medium and coarse râles; below—very weak breathing with fine pleuritic sounds. KCC. at LPS. weaker than at RPS. Menses absent for three months.

Patient remained eighteen months in the Sanatorium. During this time there was almost constant slight fever, sometimes rising to 100·4° before her periods, which had soon returned. Emaciation increased. The left lung became much contracted, the heart uncovered and drawn to the left. Over the right apex the breathing became sharper and louder, exp. longer, and finally the râles extended further down and became more musical. Chorea developed after a severe fright, but disappeared at the onset of the next period. Cough was always slight and quite dry. No sputum during the whole time she was under observation.

Patient died seven months after leaving the Sanatorium, having during the last few weeks of life freely coughed up pus from cavities, and this contained tubercle bacilli.

Such cases should, of course, not be confused with those in which the patient regularly swallows his sputum. They are generally women of the upper classes or children, and careful observation of the act of coughing clears up the doubt.

Duration of the "Closed" Form.

If such a late change from closed into open tuberculosis occurs but seldom, yet in cases running a normal course, the time during which the closed form lasts must be of considerable duration—weeks, months, or years. Pathological anatomy shows us all the various forms and phases of development which occur in chronic tuberculosis of the lung. Most frequent, of course, are the early stages of the tubercular

process ; granulations and gelatinous changes ; miliary tubercles ; pneumonia, nodular or diffuse, lobular or extensive ; bronchitis and peribronchitis. Next the various stages of caseation, with softening beginning but not so far advanced as to open a bronchus. And finally, connective tissue formation, which may also be present without softening as the direct outcome of the granulation stage. While much development of connective tissue is certain evidence of long-standing disease, I must put in a warning against regarding its absence or slight development as conclusive of a recent process, without further evidence (*cf.* p. 10).

The Symptoms of Early Tuberculosis of the Lung.

As remarked above, such closed foci may long remain without symptoms, throughout life indeed. But there are, on the other hand, a great number of cases in which, long before the appearance of bacilli or elastic fibres in the sputum, a series of symptoms of ill-health may be noticed, these not at first definitely pointing to tuberculosis. In others the whole army of signs characteristic of the fully developed disease appears. In between these extremes lie cases in which only a single one of the following symptoms is present, or at most a combination of two or several of these. The clinical picture is in consequence a variegated one,

and when, as often happens, symptoms due to other organs occupy the foreground, Sokolowski's* term of "*masked*" tuberculosis is justified.

General Symptoms.

Disturbances of blood formation, of the circulation, of the digestive organs and of the nervous system demand especial attention. Patients look pale or frequently change colour, are easily excited, easily tired in mind and body, have but little appetite, maybe an actual repugnance to food, their bowels may act irregularly, and they lose flesh (Dettweiler*).

A condition considered by Dettweiler as a further symptom of the first stage, *viz.*, brittleness of the nails and dryness of the hair and skin, I can state from my own experience to be first characteristic of a somewhat later stage of tuberculosis. In cattle also, shagginess is not an early symptom.

Chlorosis.

The association of chlorosis and tuberculosis has long been known; the only doubt in any case is as to which was primary. Either may occur.

To distinguish between simple chlorosis and its complication with latent tuberculosis, Papillon* tests the arterial blood pressure, which he asserts to be reduced in the earliest stage of tuberculosis. In a chlorotic with a pressure in the radial artery of less than 13 cm. Hg., he assumes the presence of tuberculosis of the lung.

Circulation.

Especial importance attaches to an *irritable weakness* affecting both the *heart* and the *vasomotor system*. The pulse is either persistently frequent, usually without irregu-

larity, or very inconstant, rising from 70 or 80 to 100 or 120 or more, on the slightest mental or bodily excitement. The latter is the more usual form. Many patients are quite unconscious of this tachycardia, others complain of palpitation or of oppression and difficulty of breathing. The temperature is either quite normal, or at any rate not raised in proportion to the pulse frequency. The vasomotor system is in the highest degree excitable. Patients redden whenever they are spoken to, get a hot head after every full meal or after lively conversation, and sweat so freely that, during examination, for instance, great drops run down from the armpits. This erethism, which is regarded by many as predisposing to tuberculosis, is in fact due to *tuberculin intoxication*, which is also responsible for the reduced energy and the "pseudo-dyspepsia." Tachycardia especially has some prognostic significance as an expression of defective antitoxin formation. Some time ago Heitler* noted the unfavourable course of tuberculosis accompanied with a frequent pulse, more recently Sirot,* Faisans* and others.

Tachycardia.

In his noteworthy research, Faisans deals exhaustively with the origin of tachycardia. Whilst recognising the toxin as the causal agent in most cases, he believes that an implication of the vagus in masses of bronchial glands is answerable for certain very severe cases of tachycardia, as well as for the occasional occurrence of bradycardia ; and he supports this by *post mortem* evidence. If the author has observed acceleration and

inconstancy of the pulse as one of the earliest symptoms in almost all his cases of tuberculosis in Paris, I must conclude that this symptom depends to some extent on racial temperament, as I have often failed to find it in the Germanic race.

The *temperature* shows the same fluctuations as the pulse. Careful measurements show slight but persistent elevation, especially after the principal meals, and considerable rise after moderate exercise (Penzoldt,* *v. post.*, p. 33).

Temperature.

The measurements must be taken every two hours under the tongue (eight to ten minutes) or in the rectum. Frequent rise of mouth temperature to 99·3° or 99·5° during rest must be regarded as fever. In most people during rest the mouth temperature rarely exceeds 99·0° under normal conditions.

Less common is a high morning temperature, but this sometimes approaches the evening one, or may exceed it. In women the temperature may show a regular monthly wave with a rise before and a depression after menstruation. This early fever was first described by Kernig,* and is often associated with night sweats; it may last months and even years, generally overlooked by physician and patient because it gives rise to little or no direct trouble; or if discovered is mostly put down to gastric disturbance, malaria, typhoid and so forth. Suspicion of the last two diseases is still further increased when the spleen is at the same time

Premenstrual Pyrexia.

found to be enlarged (Landouzy*). The exciting cause of the pyrexia may in these cases be *as much in the bronchial glands* as in the lungs. The two curves, figs. 1 and 2, show the results of two-hourly measurement from 8 a.m. to 8 p.m., during a week. In both cases the pyrexia lasted with slight variation for months.

Fig. 1 is from the chart of a female patient, aged 31, who had slight infiltration at both apices. In the patient's mother autopsy showed a tubercular nodule in the lung. The patient herself had had "influenza" every winter for years; hæmoptysis six months before; now coughs but has no sputum.

Fig. 2 is from the chart of a male patient, aged 20, with no tubercular heredity; father insane, mother with heart disease, a brother with spinal caries. One lung apex affected, the other suspected. Had hæmoptysis recently, now a cough with scanty sputum containing no tubercle bacilli, and great excitability of pulse and vasomotor system.

Fig. 3 shows the great influence of menstruation on the temperature in a female patient, aged 27, with tubercular heredity. Besides slight double apical disease she had chlorosis, tachycardia and anteflexion of the uterus. There were no bacilli in the sputum. The curve includes daily maxima and minima for three months.

This patient, after severe excitement, soon succumbed to her disease. Both the others are now healthy.

Fig. 4 shows the pyrexia in a case the history of which I give at greater length:—

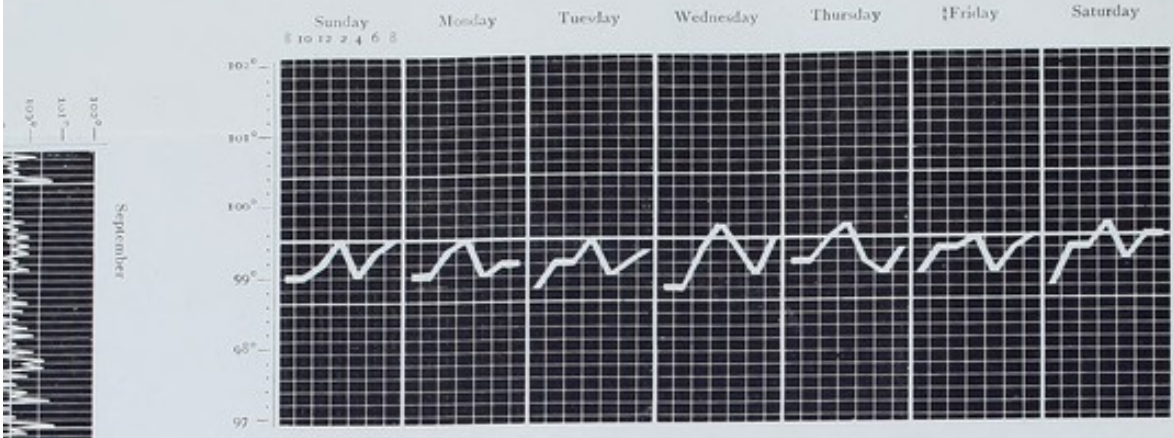

FIG. 1.—Commencing "closed" tuberculosis of the lung. High morning temperature and slight daily variation. Mouth temperatures.

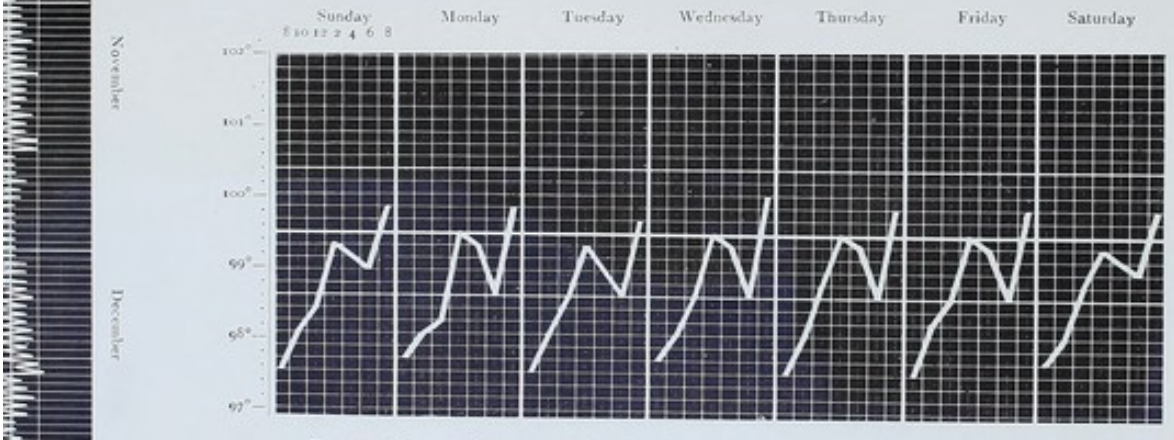

FIG. 2.—Commencing "closed" tuberculosis of the lung. Low morning temperature and considerable daily variation. Mouth temperatures.

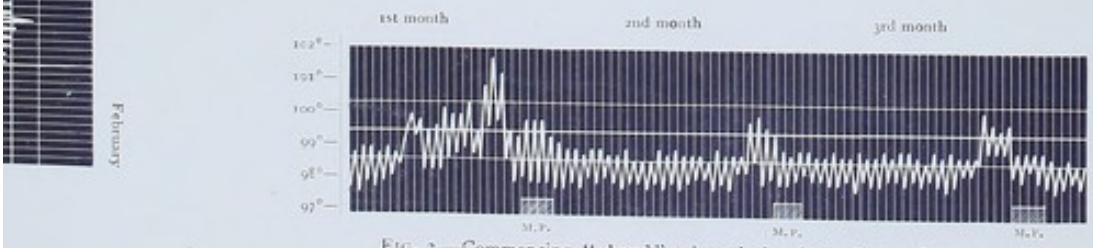

FIG. 3.—Commencing "closed" tuberculosis of the lung. Premenstrual fever. Mouth temperatures. (M.P. = Menstrual period.)

Miss G., aged 25, with no tubercular heredity, but had lately lost a brother from rapid phthisis, came to the sanatorium as companion to her younger sister, who had severe tuberculosis. For many years she had suffered from palpitation, and occasional swelling of the upper lip, but otherwise always well, and had neither cough nor sputum. Out of curiosity she took her temperature, and found it 100·4°.

Examination showed some wasting, anæmia, a long rachitic thorax. LS., slight dulness, weak, rough insp., prolonged exp., occasional crepitation [*Knistern*]. RS., rough insp., prolonged exp. As the fever proved very refractory tuberculin was exhibited (0·0001 to 0·015 gm. of Koch's old tuberculin). Slight reaction resulted, both general and local; cough and sputum appeared and a few unquestionable tubercle bacilli were found. After this treatment the fever disappeared, with accompanying favourable evidence of contraction at the left apex. Since then patient has remained healthy.

Pain.

Not at all infrequently pain is a marked symptom, not so much pleuritic pain at the seat of the disease or over the lower lobes on the affected side, as a characteristic dull boring or stabbing pain in the shoulder and radiating down the arm. This may be referred by the patient to the shoulder-joint, and often leads to a diagnosis of rheumatism.

Cough and Sputum.

The cough may or may not be accompanied with expectoration. In tuberculosis commencing insidiously, cough as a rule precedes expectoration by months or years. Every physician of experience knows the short dry cough ("hacking," Ger. *Anstossen*), usually regarded

as a precursor of tuberculosis of the lung, not actually a symptom of it. But the cough is not always short and dry; the character and quantity of the sputum depend on the extent to which alveoli and tubes are involved. At first, and it may be for years, the sputum is simply greyish mucus, in towns impregnated with soot, and not infrequently showing under the microscope the branching of the smaller bronchi. Alveolar epithelium and myelin cells may almost always be recognised. In bronchial irritation of longer standing the sputum often becomes muco-purulent; in the final stage of the acute bronchitis which frequently supervenes, it is for a time purulent; and lastly in those cases in which, without caseation and softening, the gradual contraction leads to dilatation of the bronchi, the sputum becomes permanently purulent and as a rule fairly profuse.

Character of the Sputum.

According to the researches of Teichmüller,* "months before the evidence of bacilli is arrived at" the sputum contains eosinophile cells, which diminish in number with the incidence of the bacilli or disappear altogether. Teichmüller sees in this the effort of the organism to rid itself of an infection, and finds in favourable cases an increase of these cells, in unfavourable a decrease. In those hereditarily predisposed, in the anæmic and badly nourished, they are absent altogether. In a research carried out by Dr. Wunsch in my laboratory, the occasional presence of eosinophile cells in both open and closed tuberculosis was confirmed, but with no sort of relation to the course of the disease.

Eosinophile cells in Sputum.

And since these cells also appear in the sputum in cases of asthma and simple bronchial catarrh, their significance for diagnosis and prognosis is questionable.

Hæmoptysis.

The occurrence of *hæmoptysis* in closed tuberculosis is deserving of special notice. The streaks and spots of blood, as well as the still less considerable traces, have an origin analogous to those occurring in acute croupous pneumonia, and are as easily explained. Larger hæmorrhages are generally followed by expectoration containing bacilli ("initial hæmoptysis"), and hence usher in the open stage. But considerable hæmoptysis does also occur without the subsequent appearance of tubercle bacilli.

Case of Hæmoptysis without appearance of bacilli.

Miss C., aged 25, with tubercular heredity on both father's and mother's side, has had from childhood a scrophulous nose and lip; and from puberty has suffered from glandular swelling and chlorosis. Four years ago, tubercular glands removed from one side of the neck, and a few months ago from the other. Feeling much run down after the second operation, patient went to live in the country, but was soon homesick for town-life again. Three weeks ago, without coughing, she spat up a couple of drachms of blood, and two days later this was repeated.

On examination I find RS., slight dulness, weak insp., prolonged exp., and scanty crepitation [*Knistern*]. LS., also some crepitation. RI. and LI., pleural sounds. No bacilli or elastic fibres in the sputum. Enlarged glands in various parts of the body, especially the left axilla. Patient is very excitable, reddens on the slightest occasion, is restless during sleep, and has a very variable pulse rate, often over 100. Temperature also very

irregular ; at the beginning of her cure rising to 100°—100·2° during the week preceding her period, later on only to 99·5° for four or five days ; at other times as a rule not above 99·3°, but as high in the morning as in the evening. To small doses of tuberculin patient reacted with a temperature of 104°, severe cough, increase of dulness and râles RS., and painful swelling of the lymphatic glands ; and on a single occasion a few bacilli were found in the sputum.

Under tuberculin treatment both physical signs and erethism improved and patient left the Sanatorium in excellent health. A year later during perfect health at home hæmoptysis occurred in consequence of excitement immediately before a period ; it ceased for a day at the onset of the period and returned the next. The whole amount was two spittoons full. In spite of repeated examination no tubercle bacilli were found. Some weeks later the patient re-entered the Sanatorium. I found dulness RAS., somewhat more definite over a limited area in the first space, otherwise no change. No tubercle bacilli or elastic fibres in the sputum. The premenstrual fever disappeared, but the morning temperature still as high as the evening (99°).

Since then Miss C. has remained quite well, although not sparing herself in any way.

In cases such as this the possibility cannot be excluded of a small nodule having softened and ruptured at the time of the hæmoptysis and then immediately quieted down. But the method of growth of fungous granulations into the lumen of a vessel is quite sufficient to explain the rupture of a vessel wall and the exudation of blood among the soft granulation masses in the alveoli, bronchioles and bronchi, without the complete liquefaction of the tubercular tissue.

Besides hæmoptysis, a number of other episodes often interrupt the insidious course of tuberculosis in this stadium. Above all, many patients are especially liable to attacks of catarrh and inflammation over the whole respiratory tract; *laryngitis, bronchitis, pneumonia and pleurisy.* Catarrh often begins with an ordinary cold in the head, with pharyngitis, angina or laryngitis, creeps gradually down, and at last settles firmly in the affected area of lung or throughout the bronchi as a whole. In these cases the catarrh of nose and throat, coupled with hoarseness, whether acute and transient, or becoming chronic, are the only symptoms obvious enough to be noticed by the patient, are regarded as quite harmless, and no thought of severe deep-seated mischief arises. Besides dry and exudative pleurisy, the various forms of lobular and extensive pneumonia often occur; these radiate readily from the existing locus of diminished resistance, and may occur repeatedly in the same subject. The exciting agents are the influenza and the pseudo-influenza bacilli, Fränkel's diplococcus, streptococci, and probably many other micro-organisms, known or unknown. These infections may pass away without causing permanent mischief, when I call them *"transient" mixed infections.* They often attract attention by their tedious course, and in the event of a favourable termination may raise the first suspicion of a tubercular nodule

Catarrh.

Mixed Infection.

unobserved before. But not infrequently they are fatal by leading to destruction of the tubercular tissue owing to the prolonged fever, or producing wide-spread dissemination with fatal result. The influenza bacillus especially is to be suspected in the early stages of tuberculosis of the lung; for if it is not certainly proved that tubercular individuals suffer more often than others from influenza, at any rate the infection more frequently passes off without pneumonia in the healthy than in the tubercular; and in the latter it easily leads on to a *chronic influenza mixed infection*, which, as I have shown by numerous researches, both cultural and microscopic, shows itself in prolonged irregular fever, or in repeated acute febrile attacks (broncho-pneumonia).

If the acute bronchitis, pneumonia and the like, which are here set forth as complications of tuberculosis already present, are pressed by some writers into the service of the dualistic theory, as various forerunners of the tubercular process, they should recall the arguments on the significance of measles and other acute infections in the etiology (*v.* p. 5), which certainly have their bearing here. That local disease of any kind may smooth the way for tuberculosis (Dettweiler*) is just as possible as the converse. In fact, in this respect, there appears to be a regular vicious circle, from chronic catarrh of the air-passages to tuberculosis and back again.

Dissemination.

Again, without the assistance of a mixed infection, tuberculosis may be widely disseminated from a small nodule, by way of the bronchi, or by the blood or lymph vessels. The simple tubercular pleurisies may be first mentioned. According to Eichhorst's* inoculation researches two-thirds of all serous pleurisies are of a tubercular nature; but as a rule the bacillus is present in small numbers and is difficult to demonstrate in the exudate. In dissemination from nodules previously closed, strains and tears of the tissue concerned may play a part, as in the cases cited by Bäumler.* Dissemination may also follow hæmoptysis; as soon as patient and doctor have their attention called to it the condition may already be a serious one. In other cases where rupture occurs into the bronchi there is no acute incident, and it may pass unnoticed except for the presence of tubercle bacilli. I have seen several patients with slight apical disease in whom for years the examination of the sputum was negative, and bacilli appeared quite suddenly *during excellent health.* Sometimes the matter is cleared up with the extrusion of a small caseous nodule; in other cases, after a prolonged period of quiescence, an insignificant disturbance like a slight attack of influenza leads, years after, to fresh softening of a small nodule, and to the expectoration of a single tuberculous sputum, after which quiet again reigns,—*transient open tuberculosis.* In a few cases I have seen bacilli appear for a while in

connection with a spring catarrh not apparently involving the bronchi to any extent, and disappear again on the subsidence of the catarrh.

The transition from closed to open tuberculosis is illustrated by the following clinical history :—

Case Illustrating Transition from "Closed" to "Open" Tuberculosis.

Mr. M., aged 22, with no tubercular heredity, had severe scarlet fever at 11, and has coughed ever since. For years has complained of nasal and faucial catarrh, sometimes also of hoarseness, and of stomach and bowel disorders and nervousness. He has never had to take to bed, and has endured all the fatigues of a military calling until a short while back.

Examination shows retraction of the left lung apex, slight damping of the percussion note above both clavicles, at first more distinctly L., later R. Breathing at both apices somewhat sharpened, RAS. scanty crepitation [*Knistern*], LPS. pleuritic rub. Chronic catarrh of nose, throat and larynx. Neurasthenia with gastric hyperacidity. No tubercle bacilli in the sputum. Spirometer 256 cub. ins. Patient developed influenza in the Sanatorium (it was the winter 1889-1890) of a type often observed at that time ; beginning with two days of fever (to 102·6°) accompanied with headache and pains in the limbs, then after two apyretic days a relapse lasting another two days, but without recurrence of the pains. The following summer patient contracted an acute pneumonia ; his condition after it was not worse than before, but in the spring tubercle bacilli appeared in the sputum. After this he settled in South Africa where his health is reported to be good.

Retrogression.

In contrast to such termination or further development of closed tuberculosis are numerous other cases which become stationary or retrogress, with contraction and con-

nective tissue formation. The tuberculosis is "cured" without bacilli ever appearing in the sputum; and it is certainly in these cases that the term "cure" is earliest admissible.

The Physical Signs of Early Tuberculosis of the Lung.[1]

Percussion and Auscultation of the Lung.

Of the *physical signs* of commencing tuberculosis of the lung the earliest are *rough* (not to be confused with sharpened) *vesicular breathing*, weak vesicular breathing, and a combination of the two—weak and rough. Very early, too, the affected apex begins to lag behind the other in inspiration, as shown by inspection or palpation.

Generally somewhat later is added a *weakening or rise in pitch of the percussion note*, not infrequently with a tympanitic component, often only elicited by gentle digital percussion. Only when contraction has already taken place occur what are usually regarded as the early signs—sharpened inspiration, prolonged and sharpened expiration, hollowing of the fossæ above and below the clavicle, with retraction of the upper border of the lung.

Oestreich,* who only treats of percussion, not auscultation of the apex, considers retraction of the apex one

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[1] The third section of the book is devoted to a detailed discussion of the physical signs.

of the very earliest physical signs. Doubtless contraction may begin and be recognisable very early on, but exact study of auscultation will generally reveal still earlier a deviation from the normal type of breathing.

Cogwheel breathing, which also reckons as an early symptom, is at the same time sharpened, and in my experience principally occurs in the zones between affected and healthy lung, only seldom at the extreme apices where tuberculosis takes its origin. *Râles* may be present very early or may long be wanting; they are generally fine or very fine and tough, more rarely of medium size; sometimes of both kinds. Often there is only a solitary cracking [*Knacken*] to be heard during inspiration. Medium râles in any considerable number first occur with commencing softening at the apices, and coincide with the appearance of bacilli in the sputum. When moist râles are absent, attention should be directed to a not infrequent sign at the affected apex; a localised short whining [*Giemen*], as of a puppy, only perceptible after cough. Pleural sounds are heard in a minority of cases over the affected areas varying in quality from a gentle soft rub to a loud rough scrape, sometimes transient, at others very persistent. They are frequently to be heard at the edge of the lower lobes in commencing apical disease, where may also be found small exudations or their remains, which have produced no symptoms.

There still remain to be mentioned some signs

of more or less importance, and with some direct bearing on the contraction of the affected lung. The *subclavian murmur*, occurring during both in- and expiration, must be referred to adhesion of the pleural layers to each other and to the sheath of the subclavian artery. Although occasionally heard in the healthy, it is far more frequent with apical disease, and suspicion must arise when it occurs (Sahli*). A fairly constant sign of right-sided contraction is a *displacement to the right of the absolute cardiac dulness.*

Other Signs. Subclavian murmur.

Schäffer* has described *slight* symptoms of *adductor paralysis* accompanied with chronic laryngeal catarrh as an early symptom of commencing tuberculosis. Certainly a slight grade of this affection is not infrequent, but actual *recurrent paralysis* is much rarer; both grades may be referred to pleuritic adhesions, and they occur much more frequently on the left side, owing to the peculiar course of the left recurrent nerve. But even when laryngeal symptoms first draw attention to apical disease on the same side, the connection between the two is not necessarily a causal one; quite apart from the scarred pleura, pressure may be exerted on the recurrens by a mass of tubercular lymph glands. Besides the mediastinal glands those lying in the supraclavicular hollow of the lung apex are to be considered (M. Schmidt*), and these can easily be palpated. I have seen many cases of recurrent paralysis in

Larynx.

connection with apical tuberculosis; they were all on the left side, and in some cases the first sign of tuberculosis, and as the paralysis was not well marked and was accompanied with some catarrh, it had led to prolonged local treatment of the larynx, naturally not attended with much success.

Unequal Dilatation of the Pupils.

An interesting symptom, little recognised until now, was first described by Roque,* and more recently by Destrée.* In consists in an *unequal dilatation of the pupils*, often accompanying tuberculosis of the lung, and sometimes preceding its development by years. The authors attribute it to irritation of the sympathetic by tubercular bronchial glands. Destrée, with repeated daily examination, has found this sign absent in only 3 per cent. of his cases, and in individual cases has seen it precede the manifestation of lung mischief by as much as five years. For myself I have observed dilatation of the pupils on one or both sides of frequent occurrence in different stages of tuberculosis of the lung, but very variable in intensity and duration; in a few cases also before the outbreak of the disease. An example of this follows:—

Mr. N., of a healthy family and himself healthy except for frequent sore throat, at 22 occasionally showed a marked dilatation of the right pupil without any other symptom. At the right apex expiration was prolonged. A year after the dilatation was first noticed, with otherwise good health, a slight but persistent cough began with a little mucous expectoration; this disappeared

three months later. The pupillary dilatation gradually became less and at last disappeared. Mr. N. remained well until aged 30, when after a recent catarrh he had a severe hæmoptysis and the right apex showed distinct dulness with prolonged expiration, but no râles; the sputum contained numerous tubercle bacilli. No glandular swelling to be detected; pupils normal.

Frédéricq and Thompson have called attention to a red or bluish *line along the margin of the gums* as a symptom of tuberculosis of the lung; and more recently Sticker.* The red line is said to correspond to the acute form, the blue to the chronic. I have myself repeatedly found this symptom very early in closed tuberculosis, especially in children; but it is often entirely wanting, particularly when attention is paid to the mouth.

Line along the Gums.

A concomitant of the first stage of tuberculosis of the lung is a slight *swelling of the thyroid gland*, which I have noticed in a fifth of my cases in the first stadium; more rarely later in the disease. A similar observation has been made in syphilis (Engel-Reimers*). I have not included in this number patients with regular goître, or those from goîtrous families or surroundings. Sometimes the swelling occurred under observation; in a few cases chlorosis and tachycardia were also present, and it was doubtful whether there was a coincidence with tubercular tachycardia (*v.* p. 16), or an incomplete form of Graves' disease. Well-marked Graves' disease, as well as many other chronic diseases with which we

Swelling of the Thyroid Gland.

are not here concerned, may be combined with tuberculosis of the lung: the association is not always so clear as in the case of diabetes, where nutrition is profoundly affected.

Intermittent Albuminuria.

Teissier* has observed and described *intermittent albuminuria* as occurring before the outbreak of tuberculosis of the lung, especially in young people with hereditary predisposition. The urine is at the same time rich in phosphates and highly toxic, but without casts. I have myself sometimes found albuminuria, both intermittent and lasting, associated with slight apical lesions in such cases; but so long as we know nothing of a specific toxicity of the urine in tuberculosis we cannot attach much value to Teissier's symptom-complex. *Phosphaturia* I have frequently observed both before the appearance and during the course of tuberculosis, more often the latter; but it is such a common disturbance of metabolism that we must not assume its connection with tuberculosis without further proof when it occurs at the same time as tuberculosis of any organ.

The Diagnosis of Early Tuberculosis of the Lung.

Diagnosis without Bacillary Sputum.

We have now arrived at this point: that without the occurrence of bacilli in the sputum, the *diagnosis* of tuberculosis of the lung is suggested to the physician by any of the

host of symptoms now detailed—ill-looks, wasting, tachycardia, slight cough, blood-spitting, and so forth—and his attention called to make an accurate physical examination of the lung, as well as observation of the temperature over a period of several days.

Penzoldt* and his pupil Höchstetter* have laid down "that phthisical patients otherwise apyretic may have their temperature raised to fever level by exercise," and in doubtful cases they recommend as a diagnostic test the taking of the temperature before and after an hour's walk. But as I have satisfied myself that patients with slight pelvic exudation and other deep inflammations may react in a similar manner, the observation should be taken with reserve, as Penzoldt has himself emphasised elsewhere.

Differential Diagnosis.

In the first rank of importance must stand the result of *physical examination.* Given a chronic pneumonic process limited to the apex of the lung, or preponderating there, we may diagnose it as tubercular with the same degree of probability as we can attain in most internal diseases. In the differential diagnosis must first be considered chronic pneumonias of a non-tubercular nature. These are almost confined to the lower lobes, in which consequently a differential diagnosis cannot be made on physical signs alone. In doubtful cases, as for instance the chronic pneumonias of young children, the tubercular nature of the lung disease may be rendered probable by heredity or by the existence of scrophulous glands.

As far as the apices are concerned, I am only aware that the various konioses need be mentioned; and here the history may serve to distinguish, although in those apical konioses in which no tubercle bacilli occur in the sputum, complication with tuberculosis cannot be excluded. According to the current view the koniosis assists the settling of the tubercle bacillus, but the converse is just as likely and the primary tubercular nodule in the apex favour the deposition of dust in this situation, when the koniosis may develop further while the other remains quiescent. This consideration applies to other apical pneumonias of unusual duration or incomplete resolution, whether due to diplococcus, influenza or streptococcus infection. If in such cases careful attention is paid to the history as well as to the physical signs, suspicion will often arise of a tubercular affection of longer standing, *e.g.*, such factors as predisposition, a slight cough, hæmoptysis, or some old contraction may be discovered, when the case is evidently one of *primary tuberculosis with a transient or lasting mixed infection.* Finally, given apical changes without previous pneumonia, and when the inhalation of dust can be excluded, then the diagnosis is almost certain; but still syphilis, actinomycosis, echinococcus and new growths must be considered.

from the Konioses.

In *syphilitic* subjects, a chronic apical affection is as a rule set down to syphilis if tubercle bacilli

from Syphilis.

are absent from the sputum. But the white pneumonia of hereditary syphilis, both in its lobar and lobular form, chiefly affects the central and lower lobes of the lung; which is also the case with the gumma of the tertiary stage. Apart from these forms syphilis of the lung is but little known, and in the great majority of cases which have been called syphilitic in the absence of tuberculous sputum, these have later been proved to be of a tubercular nature by the appearance of the bacilli. We must therefore set down as at any rate probably tubercular, all cases of apical disease in the syphilitic, even in the absence of bacillary sputum—a tuberculosis of the closed variety either primary or secondary.

A closed form of *actinomycosis* of the lung apex may occur and be confounded with tuberculosis.

from Actinomycosis.

But since it shows little tendency to pause, the characteristic mycelium will soon in due course be found in the sputum. There still remain *echinococcus* and *new growths;*

from Echinococcus and New Growths.

here, too, the course will clear up the diagnosis, at any rate in the case of echinococcus and the usual forms of carcinoma and sarcoma. But there is one form which may, even under prolonged observation, be confused with closed tuberculosis: this is a kind of fibro-sarcoma of very slow growth, taking years to invade the lung apex from the mediastinum.

I have seen such a case with Dr. Pradella, in which, many years before, asthmatic symptoms occurred, with slight changes in the left lung. We found dulness over the left upper lobe and a striking limitation of bronchitic râles to the left side. We diagnosed primary apical tuberculosis with secondary asthma ; the autopsy showed fibro-sarcoma.

In these cases dulness between the shoulder blades behind and beneath the sternum in front is more extreme than at the apex itself, a point which may have diagnostic value.

Tuberculin in Diagnosis.

In doubtful cases the diagnosis may be decided by the use of *tuberculin.* Against its diagnostic application it has been urged that it sometimes produces no reaction in obvious cases of tuberculosis, and that reaction may occur in non-tubercular cases. But during the winter of 1890-91 I observed that patients with commencing closed tuberculosis *reacted with especial intensity* to small doses of tuberculin, even $\frac{1}{2}$ to 2 mgm. raised the temperature to 102°—104°, besides producing evidence of irritation at the suspected apex—dulness and fine râles. Continued observation since then has confirmed the assertion that, the fewer the physical signs, the more intense and certain the reaction in otherwise apyretic cases. It seems natural to assume that with more advanced disease the reaction is hindered by a certain degree of auto-tuberculinisation, which is naturally absent at the commencement. Slight reaction in non-tubercular cases is, moreover, not unintelligible to

those who maintain the specific nature of the toxin: if there is not a concealed tubercular focus somewhere present, it is a question of the *similar reaction* of allied diseases (*e.g.*, actinomycosis), which finds a counterpart in the partial agglutination of other species of bacteria by certain sera (R. Pfeiffer*). But no one has observed the occurrence of an intense reaction to tuberculin in the healthy, or in other diseases. We know that in cattle tuberculin makes the diagnosis certain in 80 to 90 per cent. of cases, and there is no reason why there should be an exception for tuberculin in the case of man, whose organism responds so specifically to the various infections.

Method of using Tuberculin.

I have myself made much use of tuberculin as a diagnostic agent and have *never seen any bad result* from its use. After the patient's temperature has been taken two-hourly from 8 a.m. to 10 p.m. for at least two days and a very careful physical examination made, first $\frac{1}{2}$, then 2, and finally 5 mgm. of Koch's old tuberculin are injected at intervals of three days. In children $\frac{1}{10}$ to $\frac{1}{2}$ of this dose is employed, according to age. Since the reaction may not begin until the third day, *i.e.*, more than forty-eight hours later, not less than two complete days must elapse between the injections. If fever results *it is essential that the patient be confined to bed until it disappears.* In order not to miss the ensuing local reaction, which may possibly run its course without fever, a physical

examination is made at a fixed hour daily during the period of injection. The sputum which may appear during and after the reaction is carefully collected, and in this way bacillary sputum is sometimes obtained from patients who in the ordinary way expectorate little or nothing. But on the other hand, intense general and local reaction does occur without trace of sputum.

Iodide of Potassium in Diagnosis.

Sticker* has obtained a local reaction similar to that of tuberculin by the use of *iodide of potash.*

"In patients with slight apical lesions in whom the diagnosis rests at first solely on slight changes in the percussion note, a difference in the upper limit of the lung apex, or a modification in the normal breath sound; the administration of small (3 gr.) or moderate doses of iodide of potash for several days frequently produces signs of local catarrh over the suspected area. Now and then the signs of consolidation obtained by percussion become at the same time more definite, distinct and extensive. More or less free expectoration generally takes the place of what was until then a dry cough; and in this sputum, almost without exception, are found tubercle bacilli."

I can myself confirm Sticker's very remarkable observation, with the exception that in undoubted cases of tuberculosis I have more often failed to find bacilli in the sputum. The reaction, if it does not lead to the discovery of bacilli, is of course not a specific one for tuberculosis, as Vetlesen* appears to assume, but only for any local lesion of the lung. Its significance is on this account

inferior to that of the tuberculin reaction, although the local signs and especially the increase of secretion are frequently more marked than in the latter. But it may be of use when the patient refuses the administration of tuberculin.

Similar Reaction of certain Mineral Waters.

Certain *alkaline mineral waters* also, after many days' use, produce a similar reaction in apical lesions; Schnyder* has demonstrated this for Weissenburg water, Aronsohn* for Ems. The appearance of bacilli for the first time during a cure at a spa may raise the patient's suspicion that he has been infected there.

Serum Diagnosis.

The *serum diagnosis* (agglutination), as applied to tuberculosis by Arloing* and Courmont,* has been shown by numerous researches in my laboratory to be untrustworthy. Horton-Smith* and Beck* have also repeated Courmont's experiments and failed to confirm them.[1]

The Prognosis and Treatment of Early Tuberculosis of the Lung.

Early Diagnosis and Prognosis.

The bearing of the earliest possible recognition of tuberculosis on the prognosis of the case has been freely discussed of recent years. Early diagnosis can alone lead to

[1] The determination of the amount of tuberculotropic substances in the blood—the *opsonic index* of Wright*—although of undoubted value as a guide to treatment, does not at present offer any definite help in diagnosis.

early treatment, and *the percentage of favourable results stands in inverse proportion to the duration of the disease, as well as to its extent.* The statistics of my Sanatorium furnish exact proof of this relation :—

> Of patients treated during the years 1889 to 1896, whom their home doctors reported permanently benefited, 80·4 per cent. were in the 1st Stadium, 48·8 per cent. in the 2nd, and 17·0 per cent. in the 3rd. When the disease had existed for one month or less before Sanatorium treatment began, those permanently benefited in all Stadia numbered 72·7 per cent.; when six months or more, only 40·2 per cent. (Turban and Rumpf*).

Early treatment may not always be practicable, since the disease may develop to a very variable degree before producing any subjective symptoms. In families where tuberculosis has already claimed several victims, it has sometimes occurred that the solicitude of relatives has occasioned a physical examination in the absence of any symptoms, and this prophylactic measure has resulted in timely recognition and treatment. More rarely an examination for military service or life insurance, or even a casual taking of the temperature (as in the case described at p. 19), leads quite *accidentally* to a diagnosis. It is of the utmost importance and urgency that attention be paid to the first symptoms of ill-health, in the entire absence of any symptoms definitely pointing to the respiratory organs, and a *thorough* examination of the lungs be made without delay.

When a lesion of the lung has been demonstrated no time should be lost in administering remedies such as creosote, albumen, cod liver oil, somatose and the like, but if circumstances at all permit of it *sanatorium treatment* should be at once entered upon ; as this leads not only to an immediate result unobtained by any other method in so short a time, but it teaches the patient for his whole future to keep the spark from the powder barrel. To this end it is indispensable to enlighten the patient with regard to his condition, and this, if done in tactful manner and with a hint of a happy result, need cause no harm to the most sensitive nature ; whilst a timid shirking of the news with such terms as "weak lungs," "catarrh of the lung," or "bronchitis," simply renders appropriate treatment impossible.

Treatment.

Detailed *treatment of commencing tuberculosis* of the lung only differs from that applicable to later stages in that somewhat more exercise may be employed in the former, granted that fever is not present. Fever must be treated with absolute rest ; in nervous patients and in the plethoric who are liable to congestions, if the temperature remains raised only a few fifths, careful exercise may be tried after prolonged rest. Tuberculin is a very potent agent in reducing the extremely persistent fever often associated with commencing closed tuberculosis, when as is usually the case this does not exceed 100·4°.

SECTION II.—Classification of Tuberculosis of the Lung.

Division of the Disease into Stadia.

Classification of Tuberculosis of the Lung

In spite of Maragliano's* contention to the contrary, the practical necessity is recognised of a classification of tuberculosis of the lung into certain stages. With the varied picture and changeful course of the disease, it is quite easy to understand that in the attempts hitherto made to effect such a classification, the utmost variety of basis has been taken. It seemed quite natural at first to start from a basis of pathological anatomy ; the developmental phases of the tubercle and of the disease as a whole. In this way Petruschky* divides tubercular disease in general into a *primary* stage with affection of the lymph glands, a *secondary* with formation of tubercles in the tissues (pleura, skin, lung, &c.), and a *tertiary* stage of tissue necrosis. In tuberculosis of the lung he assigns to the secondary form only the very earliest stages of lung infection, in which loss of tissue has not yet occurred and consequently proper bacillary "lung sputum" not yet produced ("closed tuberculosis," *v. sup.*, p. 12).

based on Pathological Anatomy Petruschky.

Of the tertiary form he makes three sub-sections: tuberculosis proper, septicæmia, and the transition period with acute infective attacks. Excellent as is this classification from a scientific standpoint, it is difficult to carry out in practice. In the same case different phases of development of tubercular tissue occur in close proximity, and clinically they cannot with certainty be separated. Absence of sputum in no way excludes the existence of softening (*v. sup.*, p. 10), and mixed infection is sometimes present very early, as, *e.g.*, in Petruschky's second stage; at other times it is not recognisable even in the final stage with well-marked hectic symptoms (Spengler,* Schabad*).

The occurrence of hectic fever without mixed infection I can entirely confirm from a series of investigations in my laboratory.

Petruschky's definitions may nevertheless find their place in the formation of sub-groups in a different classification (*v. inf.*, p. 47). The practical significance of his separation of the second and third stages lies in this: that the patient with closed tuberculosis does not yet menace his surroundings with the risk of infection, whilst open tuberculosis in a patient necessitates the enforcement of measures for the public health (Grancher*).

Quite useless as a primary classification is the old clinical division into a fibrous and colliquative form; they represent only the extremes of the possible clinical course, and are rather the sequels of the

disease. An overwhelming number of individual cases, viewed from their final stage, must be set down as fibro-colliquative.

Brehmer's Classification.

Brehmer's* classification into (1) infiltration, (2) cavities, large or small, and (3) colliquation, appears simple and appropriate; but it pays too little attention to the fact that the severity of the disease depends not so much on the presence or absence of a cavity, as on *the actual extent of the morbid process in the lungs.* The primary question is not the *intensity* but the "*extensity*" of the disease (Heitler,* Jaccoud*).

Hanseatic Assurance Institution.

A classification involving an estimate of both these factors in eight groups has been advanced by the Hanseatic Assurance Institution* for ill-health and old age :—

(1) Simple catarrhal disease of one apex.
(2) Simple catarrh of both apices.
(3) Wide-spread catarrhal disease.
(4) Infiltration of small extent at one apex, and so on.

Besides including non-tubercular disease, objection must be taken to this classification on the grounds that there does not exist a "simple catarrhal disease of the apex" (the term "apical catarrh" should be altogether avoided); that the number of groups is much too great, and that in spite of their number the definitions are too vague for a sharp separation of the groups, and leave room for too much individual equation.

Königer* has devised a simple and not inappropriate classification into—

Königer.

Slight cases, with one apex affected ; cases of medium severity, with one or both apices affected to a greater extent ; severe cases, with disease of one or more whole lobes.

Here due regard is not paid to intensity, which is not altogether comparable in the groups ; and too much latitude is left for personal equation in the delimitation of the groups themselves.

In order to make it possible for every doctor to tabulate his cases in some scheme of general applicability, it is absolutely necessary that not too many stages be distinguished, and that these may be differentiated with the utmost simplicity and exactness. I now give the classification which has served me in good stead in my work, and which appears to me worthy of adoption.

Turban's Classification.

I distinguish three Stadia :—

(1st) Disease of slight severity, affecting at most one lobe or two half-lobes.

(2nd) Disease of slight severity, more extensive than 1st, but affecting at most two lobes ; or severe, and affecting at most one lobe.

(3rd) All cases of greater extent and severity than 2nd.

But little explanation of the foregoing is necessary. By disease of "slight severity" is to be understood : disseminated foci manifested clinically by slight impairment of resonance, rough or weak breathing, either vesicular, vesico-bronchial or

broncho-vesicular, with fine and medium râles. By "severe" disease: compact consolidation and cavities, recognised by great impairment of resonance, tympanitic note, very weak ("indeterminate") broncho-vesicular, bronchial or amphoric breathing, with musical or toneless râles, either medium or coarse. Simple pleuritic dulness, if only of a few centimetres extent, is to be neglected; if it is considerable it should be specially named among the complications (*v. inf.*). *The extent of "one lobe" is always to be taken as equivalent to that of "two half-lobes,"* and so on. Slight alterations in the breath-sound, such as rough breathing or prolonged expiration, without change in the percussion note and without râles, are also to be neglected.

The classification is simple and renders possible rapid and certain tabulation. That in spite of this doubt may occasionally arise as to where a case is to be put, can be easily understood, and is not to be avoided by any sort of classification.

Meissen's Modification of Turban's Classification.

Meissen,* who knew my classification, has inserted a prophylactic stage before my 1st Stadium, and a hectic stage after my 3rd. This extension does not commend itself to me, because, firstly, five Stadia are much more difficult to distinguish than three; secondly, the "prophylactics" are either healthy and out of place in the scheme at all, or else fall into Stadium 1; and thirdly, the "hectic" may easily be distinguished *within* Stadium 3.

Two other systems of classification have recently been published by Meissen's co-workers at the Hohenhonnef Sanatorium ; Spiegel,* and Schröder and Mennes.* The latter turn their attention to demolishing Spiegel's term of "apical catarrh."

Systematic Records.

On the other hand, Meissen's* suggestion to make two sub-headings, according as fever is present or not, is a valuable one. I would suggest denoting the febrile cases by an F or f, F standing for high fever, f for moderate : the limit being a daily maximum of 101·3° suggested by Strümpell.* The mixed infections are denoted by the letters S, J, P :—

S = Streptococcus mixed infection.
J = Influenza „ „
P = Pneumococcus „ „

To distinguish open and closed tuberculosis, the signs + and − may be used to denote the presence or absence of bacilli in the sputum. Complication with tuberculosis of another organ may be indicated by adding the name of the affected organ (lymph glands, pleura, larynx, intestine, and so on), thus :—

III + FS larynx, intestine . . . denotes, in brief, a septic tuberculosis of the third stadium, with high fever, and complicated with tuberculosis of the larynx and intestine.

I−f . . . closed tuberculosis of the first stadium with slight fever.

Such a classification properly carried out presupposes accurate physical examination with a com-

plete mastery of method, and the devotion thereto of a considerable amount of time.

Method of Statistical Comparison.

For a statistical comparison on a large scale, useful material can only be provided by observers of equal experience.

A scheme[1] for such a statistical comparison was drawn up by the author,* and accepted by the International Conference on Tuberculosis held at Copenhagen (May, 1904). It is as shown on the opposite page.

[1] Recently recommended for adoption by the American National Association for the Prevention and Study of Tuberculosis, May, 1905. "Report of the Committee on Clinical Nomenclature," *Med. News*, May 25, 1905.

SCHEMA FOR COMPARATIVE STATISTICS IN TUBERCULOSIS OF THE LUNG.

1 ...	Stadium (Turban) = extent and severity of disease in the lung	I. II. III.	Definition on p. 45.
2 ...	Disease quiescent or progressing ...	⌒ ... ... ⟶	⌒ = Quiescence. ⟶ = Progression.
3 ...	Length of time since onset	Three months ...	To date from first occurrence of symptoms, such as persistent cough, hæmoptysis, or pleurisy.
4 ...	General condition	A ... ... X	A = Satisfactory. X = Unsatisfactory.
5 ...	Digestion	B ... ... Y	B = Normal. Y = Abnormal.
6 ...	Pulse frequency	90	To be taken in the morning during repose.
7 ...	Temperature	F ... ... f ... ... Tn	F = Daily maxima over 101·3°. f = Daily maxima between 99·7° and 101·3°. Tn = Temperature normal with two-hourly rectal temperature (mouth temperature 0·4°—0·5° lower).
8 ...	Tubercle bacilli and mixed infection ...	+ ... ... − ... ... M	+ = Tubercle bacilli present. − = Tubercle bacilli absent. M = Mixed infection.
9 ...	Tubercular complications	Larynx	Name of the affected organ.
10 ...	Other complications	Alcoholism	Name of the disease: serious complications such as heart disease, nephritis, or diabetes are to be noted.
11 ...	Capacity for work	a ... ... b ... ... c	a = Full, undiminished. b = Slightly reduced. c = Much reduced or lost.
12 ...	Result of treatment	Positive Negative †	Positive = improved. Negative = not improved. † = Died.

Nos. 1-10 are filled up on admission or commencement of treatment.
Nos. 11 and 12 on discharge.

SECTION III.—Physical Examination in Tuberculosis of the Lung.

"Faulty diagnosis due to superficial examination and hasty observation, is without excuse."—NOTHNAGEL.

INTRODUCTORY.

Physical Examination of the Chest.

The importance of a thorough physical examination in the recognition and estimation of tuberculosis of the lung is underrated by many physicians at the present time. In the early stages of the disease, when the signs are doubtful, it is certainly customary to base the diagnosis on the result of sputum examination, positive or negative. But when the symptoms are well marked, the physician generally contents himself with recognising the existence of infiltration or of cavities, and the uni- or bilateral character of the disease.

In the earlier sections I have endeavoured to prove that physical examination may, as a rule, make diagnosis possible before the appearance of bacilli in the sputum. But the task of diagnosis is by no means achieved with the *qualitative* diagnosis of tuberculosis: it must rather lead to a *quantitative* diagnosis in every individual case. The most exact enquiry into the degree and extent

of the disease in the lung; the discovery of small concealed foci in what appeared on superficial examination to be healthy areas of lung; these are of the greatest value in forming a prognosis, since this depends on the *extent* of the disease in such proportion as to outweigh all other factors—constitution, general condition and the like (Turban and Rumpf*). Even with a single examination prognosis is certain in proportion to its exactness. And this applies with greater force to repeated examination, since only a knowledge of the finest minutiæ will afford a basis for the proper estimate of a disease, the course of which, in the majority of cases, is so chronic that only slight changes are to be noted during long periods of time.

A detailed description of the method of conducting an examination in tuberculosis of the lung, and of the means adapted thereto—whether those of mature experience or of recent origin—is beyond the scope of any text-book or manual and, as far as I know, cannot be found in medical literature. On this account it does not seem superfluous to relate the technique of this examination in detail with its various devices, and to discuss the bearing of the results on tuberculosis of the lung. In so doing I must take for granted what is essential in the ordinary teaching of diagnosis, especially as far as concerns the last stage of the disease with its unmistakable physical signs. Using as a basis the methods and nomenclature

which I saw employed by Dettweiler at Falkenstein ten years ago, I can add thereto observations and experience which my special work has since afforded. How necessary it is that parallel with the therapeutic activity which has led to the Sanatorium movement should run an increasing accuracy in physical diagnosis, especially of the early stages, rendering possible a right selection of cases which may be cured or improved. Every-day experience in Sanatoria proves this necessity, to which Nahm* has recently made pointed reference.

Time and Place of Examination.

Before passing to physical examination itself something may be said with reference to the *time and place* of its carrying out. The history must first establish whether the examination should be undertaken at all. If the patient has recently spat blood it is best to postpone examination; where that is not possible, a short one must suffice. When other lesions of a serious nature are present, *e.g.*, acute pneumonic processes with high fever, pneumothorax, or any wide-spread disease in general, careful consideration should be given to whether examination is to be extended beyond the ascertaining of the gross outlines; for the full examination as set forth here seldom take less than half an hour, and even with the greatest care and consideration is for many patients a severe tax. It may be advisable, too, when signs of fatigue are observed, to break off the examination and finish it on another day. If the

physician can choose the time of day, the morning is to be preferred. Small foci which only reveal themselves by scanty râles are more easily missed the more the patient has expectorated, and this generally depends on the amount of exercise he has taken, how much he has talked and eaten, and how deeply and irregularly he has breathed during the day. At times such râles are only to be heard after prolonged rest, as in bed in the early morning before the patient has moved or coughed. With a negative result in the daytime it may chance that a spot of disease is found on examination soon after waking. Conversely it may happen that nothing is to be heard in the early morning, while after a walk distinct râles occur. The latter is the less frequent, and the early morning immediately after waking is the time, *par excellence*, for the examination of doubtful cases. This applies not only to patients who cough (O. Vierordt*), but with greater force to those who do not. Though it is true that, in doubtful cases, auscultation repeated at varying times of day may give a correct conclusion if the signs are very evident, yet in general *examination should be repeated as far as possible at the same time of day for the same patient.* It may be urged that the breath sounds and râles are very apt to vary in the same patient, according to whether particular bronchi are plugged with secretion or not. This certainly applies to bronchiectases and large purulent cavities, and especially to the more severe

cases with free secretion, in which even the percussion note may depend on the amount which has accumulated. Here observant patients can give their physician useful information as to what extent they have already performed their lung "toilet." But in the cases with scanty or moderate secretion with which we are here concerned, every observer must be impressed with the constancy of the signs at the same time of day, provided always that the patient spends one day exactly like every other. The value of this fact in estimating the course of the disease need not be enlarged upon. It goes without saying that it is more often observed in the minutely ordered *régime* of the Sanatorium than in the private house or open health resort, and that marked irregularities may have a marked and definite influence on the physical signs. The influence of alcoholic excess is generally threefold: it increases expectoration by lively talking, singing, &c.; it deprives the tissues of water by direct influence of the alcohol itself and by transpiration; and it reduces the production of fresh secretion: the result being that on the following morning but few râles are to be heard. Foolish patients versed in such matters sometimes utilise the fact "to obtain a good report." The decrease of secretion scarcely lasts as long as the resulting headache, and the "catarrh" recurs on the second day, very likely with increased severity.

Effect of Exercise, Alcoholic Excess, &c., on Physical Signs.

A more frequent cause of deception is the *influence of variations in the atmospheric moisture on catarrhal symptoms.* Sometimes in the same locality differences in the signs are unmistakable after a period of dry or of wet weather. The more constant the climate, as far as concerns the moisture of the air, naturally the less these changes occur. Many cases of striking transitory improvement or the reverse, generally attributed at the time to favourable or unfavourable weather, have a simple explanation in the reason assigned. Transition from a moist climate to a dry one, and *vice versâ*, must also be considered. Regard for this fact may keep doctor and patient from many a hasty conclusion.

Influence of Climate and Weather.

Apart from climate and weather certain physiological states and therapeutic measures influence the physical signs. After heavy perspiration catarrhal symptoms are reduced ; in women they are often increased before menstruation ; balsams, tar and its derivatives diminish secretion, iodides increase it. Certain mineral water cures (Ems, Weissenburg) have at first a similar action to that of iodides, after allowing for the share of the climatic factor. Iodides and the mineral waters mentioned may also bring to light concealed foci by producing local reaction, in the same way as tuberculin (*v. ante*, p. 39).

Other Influences.

For examination a quiet well-lighted room should be chosen. Daylight is to be preferred. Examina-

Method of conducting Examination: Posture, &c.

tion in bed is undesirable on account of the difficulty of getting a good light from the front, on account of the influence of mattress and pillow on the percussion note, and the awkwardness of getting at the lower part of the thorax behind. Whenever possible the patient should sit with legs hanging down (Leube*), and be always examined in the same position, since the limits of certain organs are affected by change of posture, *e.g.*, the lower limit of the lung (Gerhardt*) and the absolute heart dulness. I am in the habit of putting the patient opposite a bright window, on an unupholstered chair, the back of which does not reach beyond his lowest ribs. The chest must be completely uncovered, or at any rate the clothes must all be removed from it for the examination. Prudery is incompatible with exact diagnosis and with economy of time, and though there may be female patients who submit to a gynæcological examination more readily than to exposure of the chest, I have not met with serious opposition in a single case. Patients are generally ignorant of the extent of the lung in the thorax and they see the necessity of a complete exposure of the chest as soon as the matter is explained to them. The room must of course be warm enough; if feeling of cold ("goose skin") is complained of, examination must be hastened or suspended, and the patient's back and shoulders briskly rubbed with a rough towel before dressing. With very feeble subjects,

after making a careful inspection, the thorax may be covered with a shawl for the purpose of prolonged percussion and auscultation, leaving only a small area exposed at a time.

Inspection.

The examination begins with *inspection*. Care must be taken that the light falls on the patient exactly from in front; the brighter it is the better. Somewhat more frequently in the subjects of tuberculosis of the lung than in the healthy, may be noted considerable venous networks, and fine ramifications of the smallest venules in the skin. The former are blue and spread over the ront of the chest; they are never so well-marked as, *e.g.*, in mediastinal tumours. The latter are violet and occur chiefly on each side of the manubrium sterni, and on the lower ribs on both sides of the ensiform cartilage; also behind in the neighbourhood of the seventh cervical and upper dorsal vertebræ. The reaction of the bared skin is to be noted. Sometimes it becomes pale and goose flesh appears. Remarkably frequent, even in vigorous subjects with slight disease, is the occurrence of excessive sweating from the axillæ during examination.

Venous Networks.

Inspection may lead to valuable conclusions with respect to the general habitus, the shape of the thorax, the type of breathing and its depth. The relation of abdomen to thorax, and the whole alteration of attitude due

General Habitus.

to unilateral contraction of the lung, can only be seen when the body is entirely bared, and must often be foregone on this account. The general build does not always tally with that of the chest. It is convenient to distinguish three forms of *build*, *robust, medium and slender*, and to contrast them with the *phthisical habitus*, the characteristics of which are: a narrow thorax of slight depth but of great length, with wide intercostal spaces; hollows above and below the clavicle; a long slender neck, and a thin layer of fat with slight muscular development (Schmaus*). But not only do transitional forms occur, but all the criteria of the phthisical habitus, even the paralytic thorax, may accompany an otherwise robust build. The thorax also may be so wide in broad-backed patients, that its great length and the width of the intercostal spaces may escape notice. Other forms of thorax are due to the warping and stunting effects of scoliosis, kyphosis, kypho-scoliosis and rickets. The more extreme grades of rachitic thorax, in which I include the funnel-shaped chest, have an especial relation to the settling and spread of the tubercle bacillus.

Expansion on the two sides.

By comparison of the movement of the two sides of the chest in deep breathing, the first intimation will often be obtained of the side affected, even in slight lesions of the lung or pleura. The expansion of the affected side is delayed as compared with the other, and all grades

may be recognised, from a simple lagging, in which it reaches almost the same maximum as the sound one, but later than it, up to complete immobility. This *lagging of one apex*, in the absence of actual thoracic deformity, is certain evidence of lung disease ; thickening of the pleura without disease of the lung scarcely having any existence at the apex. When both apices are affected the want of expansion can generally be recognised in comparison with the lower parts of the thorax, whether the breathing be of costal or abdominal type. Here practice is necessary, and to gain this a careful study of the breathing in healthy chests, both male and female, is desirable. Lagging of the whole side of the chest may be due to disease of the lung, but equally to disease of the pleura, or of both. *Crossed lagging*, *e.g.*, RS. and LI., arises from infiltration in the first and pleurisy in the second position. Want of expansion in the lower parts of the chest may have its origin in disease of the abdominal organs on that side, including tumours and the instinctive avoidance of pain (E. Rumpf*). Percussion, auscultation and palpation (especially of the vocal fremitus) clear up the diagnosis. At the back, too, expansion may be defective ; it may be observed with a pleural effusion only an inch or two in extent, and with old pleural thickening of even less extent. For this the patient must be seated with his back to the light ; if a man, best in riding position. On

direct inspection from in front, slightly deficient expansion at an apex may not be noticed; the observer should then stand behind the patient and look down the front of the chest from above; in this way the slightest difference in the convexity of the infraclavicular regions during inspiration may be easily recognised. Frequently deficiency in expansion is combined with flattening or drawing in of the parietes. The deep hollows above and below the clavicles are especially characteristic of tubercular disease; slight grades may indeed be simulated by extreme rachitic distortion of the clavicle, which sometimes has the appearance of a badly united fracture; but in normal chests deep hollows are almost only observed in conditions of marasmus (*v.* p. 79).

Hollows above and below the Clavicle.

Cushions above the clavicle, a recognised sign of emphysema, do not exclude the presence of tuberculosis in this situation. Extreme emphysema is often found *post mortem* in the neighbourhood of old foci, and in patients who were at one time under observation with deep hollows and all the other signs of apical tuberculosis, I have repeatedly found a marked development of cushions above the clavicles, in a few cases under my own eyes.

Cushions above the Clavicle.

Not very uncommon are plate-like depressions or dimples near the sternum, between the first and fourth ribs; they denote old infiltrations, or cavities become fibrotic.

Limitation of Movement and Contraction.

It may be well to repeat that limitation of movement, as the expression of diminished functional activity, is present at the commencement of the disease, whilst contraction is evidence of a secondary change—fibrosis—and first supervenes at a later stage ; that in a favourable result functional activity may be almost entirely recovered, and the limitation consequently disappear, whilst the flattening is not made up. *The more recent the disease, the more evident is the limitation.* In double apical disease this may have a practical application. In cases where one apex was flattened but expanded fairly well, whilst the other was not flattened but was much restricted in movement, I have been repeatedly able to recognise without further examination that the former was affected earlier, and the latter quite recently ; a deduction subsequently proved to be true by the account of the patient and family doctor, and by the further course of the disease.

Contraction of a whole side.

If the whole side is contracted inspection shows : in front, flattening of the thorax ; at the side, narrowing of the intercostal spaces most marked in the anterior axillary line ; and behind, in addition to the flattening, a definite shortening of the transverse diameter of the chest. There is no definite proportion between the degree of contraction of the thorax and that of the lung ; how far the thorax yields depends

on its elasticity, and this in turn chiefly on the age of the patient. In female patients the breast sometimes appears smaller on the affected side because it lies further back; occasionally it is drawn somewhat outwards.

When contraction is great, left-sided in particular, attention should be paid to the region of the heart and great vessels. With increasing retraction of the lung a larger and larger surface of heart comes into contact with the thoracic wall; finally the lung retracts also from the great vessels and extensive areas of pulsation become visible in the intercostal spaces. In contraction of the left lung the normal apex-beat gives place to a diffuse systolic shock, visible over two or more intercostal spaces, and in female subjects the whole breast may pulsate. If the heart is not fixed by pleural or pericardial adhesions, it is drawn either directly outward or upward and outward, and the apex-beat is to be seen between the fourth and eighth ribs, generally extending over two intercostal spaces and from the nipple to outside the axillary line. Even with moderate retraction of the lung, pulsation occurs in the fourth, third and second left intercostal spaces near the sternum, due to the heart and pulmonary artery (Traube*). Finally, the pulmonary artery is also uncovered in the first space near the sternum and produces pulsation in this situation, which with increasing displacement may extend to the anterior

Results of Contraction: Unusual Pulsation.

axillary line. Since in these cases the dulness caused by heart and great vessels is directly increased to the left by that of lung and pleura, the boundary of the organ is better made out by inspection and palpation than by percussion (*v. inf.*). It should not be forgotten that pulsation may be observed through a thin stratum of lung tissue, especially if this be infiltrated; auscultation showing the existence of râles over the pulsating spot. A side light is best for observation of these pulsating shocks.

Compensatory Hypertrophy.

If the healthy right lung has undergone compensatory enlargement, the inspiratory movement of its front border may be visible in thin subjects to the left of the sternum. The left intercostal spaces for a distance of ½ to 1 inch are seen to bulge forward while the rest of the left side remains almost or quite motionless.

Contraction commoner on Left than Right Side.

Such extreme grades of contraction with uncovering and shifting of the heart and great vessels are, in my experience, incomparably more common on the left side than the right. I cannot agree with Nothnagel in regarding this as a mere coincidence. I believe that the anterior edge of the left upper lobe, the so-called "lingula," is especially predisposed to contraction on account of its thinness, before it can be fixed by the formation of adhesions. Still, marked contraction of the right lung does occur, when pulsation appears to the right

of the sternum in the third and fourth intercostal spaces, whilst the normal apex-beat disappears from interposition of the left lung. The position of the thoracic organs may then be so remarkable as to lead to a faulty diagnosis of partial transposition of the viscera.

Litten's Diaphragm Phenomenon.

The *diaphragm phenomenon* discovered by Litten is easily demonstrated when the light is sufficient and the patient in the right position. The normal amplitude of the visible wave is $2\frac{1}{2}$ to $2\frac{3}{4}$ inches, which agrees with the Roentgen ray results, and in healthy adults in good light and position this movement of the diaphragm is found to be constant, provided there is no great accumulation of fat and that the breathing is of maximal depth. Slight apical disease does not lessen the stroke, but as soon as the disease reaches in front down to the third rib, or to the middle of the scapula behind, or as soon as small nodules occur in the lower lobes, I have in every case observed a reduction of the amplitude, even when no concurrent affection of the pleura was present. Expansion of the lung in inspiration is principally downward, even with costal type of breathing, and the inactivity of even a part of the lung far removed from the diaphragm must influence its movement, if the extent of the diseased area is not too slight. Complete absence of the phenomena points to fluid or air in the pleural cavity or to extensive adhesions; a lessening of it to pleural or pulmonary disease. The

phenomenon will scarcely give an indication for differential diagnosis in tuberculosis of the lung, as it is also produced by disease of the abdominal organs (E. Rumpf*). Its application is made yet more difficult, since the necessary maximal breathing is no inconsiderable addition to an already fatiguing examination, and the patient has to be put in a horizontal position with clothes removed down to the level of the lowest ribs to avoid disturbing shadows; while the rest of the examination is in a sitting posture. In my own experience the diaphragm phenomenon has sometimes confirmed other methods of diagnosis, or has led to further confirmatory examination; it has not itself been the means of saving any other method.

Palpation.

Palpation is directed chiefly to testing the *vocal fremitus*. This is diminished in pleural effusion, even though quite small; in old thickening it is increased or diminished according to its consistency. The increase of the vocal fremitus above an effusion is worthy of note; the compressed lung floating on the exudate gives a similar fremitus to that of pneumonic consolidation. Over tubercular nodules the fremitus is very variable, a fact easily intelligible when their varied elasticity is taken into account.

Vocal Fremitus.

Palpation carries the results of inspection a stage

further. In commencing contraction the extension of the apex-beat, and especially the pulsation of the pulmonary artery, are to be sooner felt than seen. In tubercular contraction of the left lung I have sometimes observed an interesting phenomenon not before described ; the apex-beat, which had been displaced outward and to the left beyond the nipple, was *only to be felt at the height of inspiration*, or most distinctly then. The explanation of this apparent paradox can only be that at the position of the apex-beat the heart was covered by a thin layer of infiltrated lung tissue closely adherent to the chest wall (lingula), and that this layer was stretched and rendered yet thinner during inspiration.

Palpation in Contraction.

In well-nourished subjects narrowing of the intercostal spaces can only be appreciated by touch. The spaces may disappear altogether so that the finger only recognises with trouble the shallow grooves between the closely wedged ribs. Lagging may also be revealed by appropriate palpation (O. Vierordt*). In general I prefer inspection in a good light which admits of examining both front and sides of the chest at a glance.

From *perimetric measurement* of the chest, the value of which for military selection cannot be gainsaid, no conclusion can be drawn as to the state of the lung. Either extreme may be seen ; cases of enormous perimeter with severe disease present, and of very narrow thorax

Perimetry.

with normal lungs. The measure of the perimeter of the chest, taken in military fashion just below the angle of the scapula in the respiratory pause, the arms being outstretched, gives a good notion of the build when compared with the body-length. If the perimeter in the respiratory pause does not come up to half the body-length, an ill-developed thorax is present, which is to be regarded as predisposing to tuberculosis ; but nothing further can be argued from the quotient perimeter ÷ body-length. Not without value in the estimate of lung function is the respiratory expansion, which should not be under 2 inches for medium body-length. For a single examination this measurement often gives a better result than the spirometer (*v. post.*), the proper use of which requires a certain amount of practice. I would suggest that *body-length*, *chest perimeter*, and *chest expansion* be recorded as a matter of routine in Sanatoria, in addition to *body-weight*, on admission and discharge ; the proportion of these four figures giving a picture of the habitus and state of nutrition.

Respiratory Expansion.

Comparative measurement of the two sides of the chest with the perimeter has little value : "the instrument most convenient for doctors and patient, giving also the quickest results, is the practised eye" (Wintrich*). In special cases the outline of the thorax is suitably recorded by means of the *cyrtometer*, which is used at the level specified above. The simplest form, introduced by Gee, is to be recom-

mended; it consists of two rods of very soft flexible lead-alloy united behind by a piece of rubber tubing, and the two diameters of the curve should be controlled by measurement with calipers.

Spirometry.

Spirometry, which has to-day fallen into disuse, has been shown by v. Ziemssen to be not without value in the diagnosis of tuberculosis of the lungs. He has made use of the relation between vital capacity and body-length, first observed by Hutchinson, to deduce a limiting value between normal and abnormal amplitude of respiration. He considers a minimal proportion of 1 inch body-length to 3,1 cubic inches capacity may be assumed for a healthy man, 1 : 2,6 for a healthy woman. The author surmises a considerable disturbance in the organs of respiration when this ratio falls below 1 : 3,1 (1 : 2,6 for a woman). If the ratio is 1 : 3,9 (1 : 3,4) and over, any such disturbance is *a priori* unlikely. In my experience the first assumption only is valid; a reduction in the denominator of "Ziemssen's Quotient" must raise a suspicion of lung mischief in cases in which no suggestion of it had previously arisen (H. Vierordt*). On the other hand, high denominators do not exclude the presence of even a considerable lesion of the lung. I have found, for example, a ratio of 1 : 3,6 in a case of tubercular disease of right upper and lower lobes, and of the left apex; and one even of 1 : 4,3 where disease had spread over the greater part of the left upper lobe.

"Ziemssen's Quotient."

In both cases the chest perimeter was a large one. In relation to Ziemssen's quotient the influence of the size of the breast (Arnold*) must be borne in mind, as well as that of the trunk, estimated from its length and circumference (C. W. Müller*).

In patients who are accustomed to the use of the spirometer the result is very constant for a long time, if the condition of the lung remains unchanged. The highest variation in the reading is about 3 cubic inches, avoiding the influence of the taking of food by making the observation at the same time and in the same relation to meals. A sudden reduction of the capacity by 9 to 12 cubic inches in such cases points with certainty to a new focus, which may be inaccessible to auscultation and percussion by reason of its deep position, and hence is recognised only by the spirometer. Any conclusion as to reabsorption of an infiltration based on an increase of the spirometer readings is less certain, as mere practice may account for it. The use of the spirometer is not permissible at all in severe lesions, and in any case care is required unless the patient's condition is very accurately known. Phœbus' apparatus, which is both simple and cheap, is all that is required for spirometry.

Percussion.

The *choice of instruments* for percussion and auscultation is in many respects a mere question

Choice of Instruments.

of taste and practice, and text-books of diagnosis are certainly right in recommending the simplest apparatus for use at first. A question to be considered is whether the various methods of more detailed examination give strictly comparable results. To begin with percussion, after using finger-finger for ten years, I have myself given it up for the purpose of examination of the thorax in favour of Piorry's finger-plessimeter. Instead of Piorry's plessimeter I use Seitz's, which must be strong enough not to bend in the least with firm pressure, and is better made of ivory than rubber. Curschmann's modification in celluloid is serviceable. Seitz's plessimeter adapts itself everywhere to the chest, even in the deepest supraclavicular fossa, and placed edgewise may also be used for linear percussion. In finger-finger percussion the varying structures of the percussed finger give varying resistance. This may be partly overcome by practice, but it tends neither to the proper production of the percussion note, nor to the proper transmission of the sense of resistance to the percussing finger. Some practised observers (*e.g.*, R. Geigel*) even use the percussed finger to estimate the sense of resistance ; but as this finger is in contact with bone and soft parts of varying thickness and elasticity, this manipulation does not conduce to recognition of the finer distinctions. A homogeneous medium is afforded by the plessi-

Finger *v.* Plessimeter.

meter. On the other hand, the hammer can be no substitute for the percussing finger, however well it may serve for purposes of demonstration.

Finger *v.* Percussion-hammer.

The transference of the percussion stroke—in itself a difficult requirement—to a handled instrument must, by increasing the arm of the lever, necessarily cause an increase in the small inequalities which are inherent to the movement; whilst conversely the sensation of resistance has to be transmitted through the hammer to the finger which holds it. And in percussion of the thorax much more value is to be attached to this sensation of resistance than, *e.g.*, in percussion of the abdomen with its constantly changing contents. This "*touch*" *percussion* is an important part of the technique. The old direct one-handed percussion of Auenbrugger* was itself a method of "touch" percussion which has been allowed to lapse without reason, and may still find a place by virtue of its simplicity. After some practice its results are surprisingly exact, especially in determining boundaries of organs; otherwise Auenbrugger* could not have made his "Inventum novum." I have made use of it for some years, *e.g.*, to rapidly determine the limits of the lower border of the lung during auscultation, employing the apposed tips of the three middle fingers. Verriest,* who has recently advocated the revival of the method, uses the middle finger only, and has assured

"Touch" Percussion.

Auenbrugger's Method.

himself of its trustworthiness by using long pins on the cadaver. Another valuable adjunct to examination of the chest is to be found in Ebstein's* method of "touch" percussion; with wrist held stiff the middle finger strikes the plessimeter and notes the resistance. Whilst the inventor appears to confine his method to limiting the true heart boundary, I have for many years obtained useful results with it in percussion of the lung. It is evident that similar conditions obtain in deep-lying infiltrates as in the case of air-containing lung overlying the heart; and I have in fact often been able to demonstrate *post mortem* nodules indicated during life by Ebstein's percussion, when other methods were doubtful. The method may also be employed for the percussion of greatly enlarged bronchial and mediastinal glands, if not in adults, at any rate in children, in whom marked swelling of these glands can be percussed out, whether lying anteriorly near the sternum or near the spine at the level of the upper dorsal vertebræ. Here also *post mortem* confirmation has been obtained.

Ebstein's Method.

Ordinary percussion of the lung should be *light* and carried out during shallow breathing. With deep breathing the change of note described by Friedreich may occur and lead to illusion. The plessimeter must be firmly applied ("deep percussion," Weil) and the more firmly the thicker the parietes. A good plan is to

Light *v.* heavy Percussion.

percuss thrice on the same spot ; once lightly, once more firmly, and the third time in Ebstein's manner. Behind, percussion must in general be somewhat more heavy than in front. Apart from obesity, heavy breasts or herculean muscles, the heavy percussion in general use is futile except for purposes of demonstration.

It is clear at once that it requires relatively heavy percussion to set in vibration air-containing tissue lying behind airless, whether in the case of normal lung in an obese subject or of lung separated from the chest wall by a thick layer of exudation. On the other hand, I cannot subscribe to the view generally accepted that heavy percussion is useful for recognising airless masses lying deeply behind air-containing tissue, *e.g.*, relative heart and liver dulness and deep lung infiltration. The complete divergence of opinion of authors with respect to the size and shape of the relative heart dulness obtained in this manner stands in marked contrast to their agreement as to its theoretic basis. It is self-evident that heavy percussion produces not only a greater shock, but one affecting more deeply lying organs ; but manifestly too little attention is paid to the fact that because of the elasticity of the thorax the acoustic influence of heavy percussion is felt far more in breadth than in depth, and that on this account observation of parts lying vertically under the percussed spot is rendered uncertain by the vibration of laterally adjoining tissue containing air.

It seems also to be little recognised that the lightest percussion producing a note gives an acoustic wave sufficient in depth for determining relative heart dulness and similar data, without the disturbing lateral factor, thus attaining what Weil and others attempt by heavy percussion. Any practised observer can convince himself that this very light percussion reveals the true heart limits and not merely an arbitrary relative heart dulness, although it certainly fails in emphysema of high grade. I am not alone in this assertion. Many years ago Krönig* recommended light percussion for early lung disease. Verriest returned to direct percussion, as in his experience the percussion wave of the plessimeter and even that of the finger was transmitted to too great an area of chest wall, so that lateral air-containing tissue vibrated when the stroke fell only on airless. And recently Petersson* and Laache emphatically recommend light percussion to determine the true heart limits. That this observation has escaped so many can only have this explanation : that the ideas of light and loud, weak and heavy percussion are of a very subjective and relative nature ; that in general percussion is too loud ; and that most observers have never tested the very light percussion here recommended.

Thick soft parts make percussion more difficult ; they require the exhibition of more force, and the foregoing of certain of the finer results of lighter percussion. But

Influence of thick Parietes.

the difficulty of percussion is not dependent alone on the thickness of the soft parts, but almost as much on their elasticity, a matter likewise too little noticed. Flabby, flaccid parietes give a duller, more toneless sound to the air-containing tissue beneath than firm, well-conditioned ones (Laennec*); recourse will be necessary more often to "touch" percussion in the former case. There is especial difficulty with lax mammæ, the weight of which in the erect attitude hinders deep transmission of the percussion wave. In such cases better results are obtained by percussion in the prone position, when the mamma is supported by its base and its weight acts in the same direction as the percussion stroke.

Upper Border of the Lung.

Percussion of the lungs begins with defining the limits of the organ above, below and towards the heart; the edge is then marked down with a dermatograph not only for comparison of the two sides, but to show later on the area for auscultation. The displacement of the borders is then tested by deep breathing. Marked differences prevail amongst authors as to the form and position of the outline of the upper border of the lung, a point of great importance in tuberculosis; these have their origin in the divergent result of light and heavy percussion. Weil* makes the line on the neck behind run in a curve convex downwards to the seventh cervical spine; v. Ziemssen* describes the line with convexity upwards; Krönig gives it as a blunt curve convex towards the spine

joining the vertical line of the posterior border at the level of the space between the second and third dorsal spines. As a result of numerous observations I can verify Krönig's data obtained by light percussion. After marking out the borders obtained, simple inspection is sufficient to recognise retraction of one lung apex (v. Ziemssen). Double retraction may make the examination very difficult, as the extent to which the lung apex protrudes through the upper lung aperture is not constant in health; auscultation assists in such cases. If percussion shows retraction of an apex whilst auscultation gives a negative result, then according to Krönig the anterior lateral border of the lung apex should be defined, as in two such cases the author found a "compensatory outward extension" of this border. In retraction of the median border I have found without exception a pathological condition on auscultation, but I am convinced that the percussory projection of the lateral border is much dependent on the shape of the supraclavicular fossa and on the amount of the fat cushion. Still, Krönig's assertion demands attention.

Retraction of the lower border of the lung occurs not only in contractions and the like, but also in the healthy lungs of children and chlorotic adults (F. Müller*).

Percussion of the Front of the Chest.

The front of the chest should be percussed while the upper part of the body is held as upright as possible, and with the head exactly in the median line. Beginning above

the clavicles, percussion is applied to precisely symmetrical spots until the lower border is reached. It is not sufficient to place the plessimeter once in each intercostal space, as the lateral and median parts on the same side must be compared. The weakening of the percussion note caused by unilateral muscular development, and that due to the great vessels under the clavicles, is easily distinguished from lung dulness. On the clavicle itself direct one-handed percussion may be employed. The axilla, too, must be accurately percussed; I have sometimes found at its summit distinct dulness which otherwise was doubtful at the apex.

Percussion of the Back.

For percussion of the back slight bending forward of the upper part of the body is of assistance; the arms are crossed over the chest and the levatores anguli scapulæ relaxed, so that the scapulæ are turned outwards and downwards to the utmost extent. In this way a considerable area between and above the scapulæ can be examined; percussion of the scapula itself, especially below the spine, does not show the fine differences, but it must, of course, not be omitted. Great care must be taken that the scapulæ are held symmetrically, and that the plessimeter is also so placed, since over, below and by the side of the scapula the normal variations of percussion note are considerable. When the result of examination of the back is doubtful, I recommend Laennec's method of control; going over the same spots again standing on the other side of the patient from at first.

Varieties of Percussion Note.

All imaginable varieties of percussion note occur in tuberculosis of the lung; of especial frequency are *changes of pitch without material change of intensity* (amplitude). When both apices are similarly affected and no confirmation is forthcoming from comparison of the two, recognition of the finest changes in the note at the apex requires much practice and experience in judging the absolute quality of the note (Oestreich). Not infrequently in early disease the note over the apex has a tympanitic quality, and again when the dulness is clearing; sometimes this quality arises during cicatrisation in consequence of emphysema developing. The changes which are run through in from five to ten days in acute croupous pneumonia may be seen to come and go in as many months in cases of slight favourable apical tuberculosis, without, however, finally reaching quite normal conditions. If over one apex the note is found of higher pitch but clearer and more sonorous, whilst over the other it is deeper but flatter, some doubt may arise as to which side is affected; or when a change of note is elicited by soft percussion on one side and by heavier on the other. Auscultation and prolonged observation generally prove that both sides are affected. It may happen, then, that of two physicians who examine the patient at a short interval, one may pronounce the right, the other the left side affected; nor is the patient's mind set at rest by a third who establishes the bilateral

character of the disease. Even under continuous observation the clear note at one apex may become flat, and simultaneously the flat note at the other apex becomes clear, so that after weeks or months the reverse conditions obtain. I should like to call especial attention to the observation that the trifling impairment of note in the first stadium sometimes becomes more intense whilst the condition is improving, evidently owing to formation of much connective tissue in the contracting stage, the breath sounds at the same time becoming louder and more prolonged (*v.* p. 93).

"Crossed" Dulness.

In so-called "*crossed*" *dulness* (*e.g.*, RAS. and LPS.) I have scarcely ever observed complete immunity of the corresponding sites (RPS. and LAS.), or a "crossed" clear note. The impairment was only unequal in front and behind on the same side, and light percussion has in my hands often given crossed dulness when heavy percussion showed a clear note.

Dulness without local Disease.

Kernig* has observed impaired percussion over lung apices without local disease. Bilateral apical dulness was present in marasmic patients, auscultation giving only more or less weak vesicular breathing, and the autopsy showed healthy apices. The author explains this very rare occurrence, which has much diagnostic importance, by lessening of the air capacity of the apex in bedrid wasted subjects. Since the observation was made solely in extreme

marasmus, confusion with commencing or healed tuberculosis should be easily avoided; but Kernig's observation is to be borne in mind. Under exactly similar conditions Edlefsen* has found an increase in the absolute heart dulness, due to retraction of the border of the healthy lung from the heart. At the lower edge of the lung, especially behind, narrow strips of dulness, $\frac{1}{2}$ to $1\frac{1}{2}$ ins. wide, are easily overlooked; they are due to slight previous or existing pleural exudate, of which the patient is generally quite unaware. Of my tubercular patients they were present in about one-half. These strips of dulness may be confused with the relative dulness due to pressing up of the vault of the diaphragm by the abdominal viscera, a result not obtained with heavy percussion (Weil*), occasionally with light. Distinction is to be made by testing the diaphragm phenomenon, vocal fremitus, the movement of the edges of the lung, and by auscultation. If the pleural dulness consists of fluid exudate, it is *movable* so long as adhesions have not formed; with the patient in the sitting position this can be conveniently tested by percussion of the anterior and lateral lower border with the body first bent strongly forwards and then backwards. Emphasis has already been laid on the great value of Ebstein's percussion and its use often gives decisive results in determining the true heart limits.

Strips of Dulness at lower edge of Lung.

Displacement of Cardiac Dulness.

In lung contraction the absolute heart dulness may be affected in one of two ways; either it is increased towards the affected side, or without increase in size it is shifted in the same direction. In the latter case the compensatory emphysema has gained on the heart dulness on the sound side to the same extent as the heart has been uncovered on the other. The heart itself may retain its position or be drawn over to the affected side. Whether the former or the latter has occurred can never be decided by the absolute heart dulness, but may be by the lightest percussion of the heart limits or by the method of Ebstein. *Displacement of the heart dulness $\frac{3}{4}$ inch or more to the right*, with or without displacement of the heart, is such a frequent symptom of moderate contraction at the right apex, that I consider it *a typical and cardinal symptom of right apical disease of some standing*. The absolute heart dulness has its centre on the sternum, or at least reaches from left to right as far as the middle line. This symptom is often present even before tubercle bacilli appear in the sputum. In this connection the relative heart dulness which extends to the right of the sternum is easily mistaken for a nodule of disease in lung or pleura, or for evidence of enlargement of the right ventricle. It can now be easily understood that in tuberculosis of the lung the relative dulness gives but little indication of the actual size of the heart. But

since the latter is of great importance in prognosis, assistance must be obtained from the very lightest percussion or from Ebstein's method. I have obtained the most trustworthy results by Ebstein's *percussion with the body bent strongly forward.* Gumprecht* recommends this position for ordinary percussion of the heart, and by this artifice has succeeded in determining enlargement of the left heart masked by emphysema. With the combined method stated above, enlargement of the right heart may also be detected, provided that the emphysema is not of too high a grade.

Special Changes of Percussion Note.

I need not here go into detail as to the various kinds of alteration of percussion note associated with the names of Wintrich, Williams, Gerhardt, Biermer and Friedreich.

Wintrich: Rise of pitch and distinctness of the tympanitic note over cavities on opening the mouth.

Williams: The same phenomenon occurring over infiltrations, contractions and compressions of the lung apex and due to a resonant column of air in bronchi and trachea.

Gerhardt: Increase in pitch of the tympanitic note over cavities on the patient changing his position.

Biermer: Change of pitch of the metallic note heard over pyo- and seropneumothorax on change of position.

Friedreich: The respiratory change, *i.e.*, the increase of pitch in the tympanitic note heard at the height of inspiration.

I will only remark that Friedreich's change may occur even if no distinct tympanitic quality is

present. That Wintrich's note is best distinguished from Williams' tracheal note by light percussion (Weil). Also that where ordinary percussion reveals only dulness, the opening of the mouth may cause a distinct tympanitic note and rise of pitch ; and that opening of the mouth and Weil's addition of putting out the tongue, is not sufficient for the observation of Wintrich's note ; it is necessary to make certain that the patient is breathing through the mouth, and if he is not expert, he must hold his nose.

Auscultation.

The Phonendoscope.

Before turning to auscultation proper, a few remarks on the *phonendoscope* will not be out of place here, since in the opinion of its inventor it is to supersede not only auscultation but also percussion, especially in determining the boundaries of organs. There is no doubt that with phonendoscopic auscultation the limits of organs may be determined with comparative ease, using the sound caused by the finger rubbing on the skin ("stroke" auscultation). The grooves between the lobes may also be "stroked" out without difficulty, but the certainty of the finer results depends very much on the degree of elasticity of the skin and subcutaneous tissues.

Aufrecht* and Arnd have suggested a simple and very cheap form of binaural stethoscope to take the place of the phonendoscope, with a caoutchouc

membrane stretched over it, which performs the same functions in defining the edges of organs. Two years ago, in association with Dr. Kündig, I convinced myself that *the ordinary wooden stethoscope may also be used for the purpose of "stroke" auscultation* and gives similar results to the phonendoscope; since then I have demonstrated the limits of the lobes of the lung by this simple method to a succession of colleagues. Finally I found that any rod which conducted sound—a thick pencil, an indiarubber in a wooden case—with one end on the chest wall and the other placed against the ear, served to determine the limits of organs, even through the clothes. Further, that the ear placed directly on the chest can be so used, and in simple cases such as the determination of the lung-liver boundary (RAI.), a change of note on stroking over lung or liver can be recognised by the ear without actually touching the chest wall. Here we nearly come back again to Auenbrugger's simple one-handed percussion.

"Stroke" auscultation has a practical value in cases where the boundary is to be determined between two airless masses, as heart and pleural exudate, or between two air-containing ones, as lung and stomach; here percussion fails and I can recommend for this purpose the instrument[1]

[1] This is a form of the binaural stethoscope in ordinary use in this country, consisting of a small glass funnel with two rubber tubes proceeding from it to the ears.

introduced by Ruedi, which has this advantage over the ordinary stethoscope, that it is at the same time possible to listen, stroke and see.

The phonendoscope is then at any rate not indispensable for these researches, and in simple auscultation it cannot take the place of the instruments in use, much less improve on them (Egger*).

Stethoscopic *v.* direct Auscultation.

For auscultation a stethoscope is required. Traube's, with the shell-shaped ear-piece, seems to me to serve better than the various models with ivory plates, or the wide wooden tube. With the latter the sound is quite sharp but the resonance of the instrument itself is too strong. *Direct auscultation* is of service when a general impression of the breathing over a large area is required. Phenomena which are evenly distributed over an area at least as great as that of the pinna, *e.g.*, weak breathing, metallic tinkling, are better appreciated by direct auscultation, as by summation of impression over the whole area the sounds become louder and more distinct (O. Vierordt*). But whenever different kinds of sounds are crowded into a small space, whether breath sounds or râles, or both, exact differentiation without the stethoscope is impossible. If with Gerhardt* we get "more and more accustomed to use the unaided ear for examining the lung, and the ear-trumpet for the circulation," we forego along with it the finer diagnosis of tuberculosis of the lung, however

appropriate direct auscultation may be in acute disease with coarse physical signs, such as diffuse bronchitis, lobar pneumonia, or pleurisy with exudation. In the supraclavicular fossa it is simply impossible to apply the ear. And the variety in the *post mortem* appearance of any tubercular lung shows how necessary is auscultation of *small enough* areas. But how often can we be quite sure that we have before us a lung free from tubercle? In the case of massive infiltration or cavities or pneumothorax, direct auscultation gives a rapid survey for subsequent comparison and completion, which cannot be altogether spared; but I have many times observed the ease with which the finer details are missed by the physician, even with a highly trained ear, who uses only direct auscultation.

Directions for Auscultation.

In auscultation of the lung the patient should breathe regularly through the nose "somewhat more deeply than usual," but not in any way forced. If nasal breathing is obstructed, which must be assumed to be the case when mouth breathing gives louder breath sounds, then mouth breathing must be enjoined. But the lung does not expand so regularly with mouth breathing as with free nasal breathing. From top to bottom the whole lung must now be examined. In each intercostal space the stethoscope must be placed, both in front and behind, at least two to four times according to the size of the thorax; and twice above the clavicle, once near the median, once near

the lateral border of the lung. In commencing tuberculosis the lung margins are of especial importance ; in the first place, of course, the extreme apex, but also the anterior median edge in which not infrequently small nodules lie. As scanty râles may only be audible at the height of inspiration, care must be taken to listen *beyond the limits found and recorded for quiet breathing*. The anterior borders must be examined behind the sternum as well as by its side, and it has already been noted that in contraction the healthy lung may extend beyond the sternum. Doubt may then arise as to which lung is beneath the stethoscope ; percussion is of little use to distinguish, as the heart and great vessels produce dulness beneath the edge of the sound lung. Auscultation, however, for the most part shows a sharp vertical limit, on one side of which is normal or sharpened breathing without râles, and on the other weak or bronchial breathing with râles. "Stroke" auscultation and inspection in thin subjects will confirm this limit.

Auscultation of the lung, too, should not be omitted over the absolute heart dulness, as very often the edges of the lung nearly or quite overlap the heart at the height of inspiration ; and precisely here, especially in the "lingula" on the left side, râles may occur.

Auscultation over Cardiac Dulness.

Of the various changes of the normal breath sound one of the most important is *rough breathing*, which must not be confused either with sharpened vesicular breathing,

Rough Breathing.

or with a certain kind of rough pleuritic rub which obscures the breath sound. It appears not to be recognised by most authors ; at any rate in the text-books I find it either not mentioned at all or the expression "rough breathing" (*e.g.*, Gerhardt*) is used as synonymous with sharpened puerile breathing. Sahli* describes the sound, and French authors appear to have long recognised it (Grancher* and others).

This rough vesicular breathing is distinguished from ordinary vesicular breathing—which whether soft or sharp gives the impression of a fairly regular *smooth* sound—in that it appears to be composed of a series of sounds in rapid succession. On the rapidity with which these sounds follow one another, and on their individual loudness, depends the possibility of differentiation by the ear. In this respect rough breathing recalls Näf's hammer in an induction machine. Its origin Sahli traces to the fusion of pure vesicular breathing with added sounds due to the presence of secretion in the bronchioles. "When these added sounds can be distinctly differentiated as such from the breath sounds, we speak of râles ; if not, they merely give an impure rough character to the vesicular breathing."

Origin of Rough Breathing.

Grancher thinks that the vestibule, or part of the bronchiole immediately next the acinus, is narrowed and made uneven by the development of tubercle, and the result is rough breathing.

Dettweiler, who appears to have been the first in Germany to use the term "rough breathing" in this sense, suspects that tumid swelling of the finer air passages is at the root of the matter.

I consider it probable that a further factor in the causation is that small airless nodules are scattered through the air-containing tissue, and the air rushes in jerks into alveoli still patent but obstructed by the proximity of these nodules. At any rate, where rough breathing has been heard the result of the autopsy fits in with this hypothesis. Catarrh is absent more frequently, both clinically and anatomically, than in the case of other pathological breath sounds. Rough breathing may be faint or loud; more rarely it occurs also in expiration. It is more frequently heard over the apices, over the clavicles and the spine of the scapula; sometimes only over the extreme summit. Now and then it may be heard somewhat further down, especially behind; over the lower lobes it is rare, probably because the breathing here is hardly ever delayed in the same way as at the apices.

Rough Breathing in Emphysema.

Rough breathing is one of the first signs, often indeed the very first, in commencing apical tuberculosis, before percussion affords any evidence. It occurs more rarely in emphysema and is then distributed over various parts of the lung; regular breathing in adjacent functional alveoli is hindered as much by excessively stretched and rarefied areas as by actual

solid nodules. Hence, though rough breathing at any particular spot cannot be diagnosed as a tubercular nodule, a conclusion may with great probability be drawn when for long periods rough breathing can be constantly heard over the same areas limited to the apex, viz., small tubercular nodules scattered in functioning lung tissue, since apart from tuberculosis such nodules scarcely have any existence.

Related to rough breathing in its manner of origin is *cogwheel breathing*, which is put down by most authors to catarrh causing "valvular swellings of the mucous membrane" or an increase in secretion which must be displaced to one side by the air stream (Sahli).

Cogwheel Breathing.

My own opinion is that the explanation given above for rough breathing applies also to cogwheel breathing, the phenomena being much coarser in the latter case. The obstruction lies in the fact that considerable surfaces of tissue, functioning either weakly or not at all, lie adjacent to others of normal or almost normal function, and that in this limiting area the sound tissue can only expand in jerks when the air streams in. Generally the phenomenon is present over a considerable fraction of a lobe; not infrequently when about half the lobe is infiltrated, the breathing in the other half is cogwheel. After arriving at an explanation from clinical and anatomical observation I found a similar conception in French authors.

Causation.

"The healthy portions of lung are emptied first and then the parts invaded by granulations," says Peter, cited by Grancher, and the latter adds: "but this can only occur when the granulations are already numerous and have attained a certain size." But since cogwheel breathing is generally *sharpened vesicular*, and since larger nodules alter the breath sound, we must assume the existence of functioning tissue where we hear the cogwheel, but with adjacent infiltration.

Other Forms of Cogwheel Breathing.

The cogwheel breathing discussed here is that limited to portions of the lung, not the form dependent on heart action. Cogwheel breathing heard equally all over the lung, consequent on a jerky thoracic movement, I have observed, *e.g.*, in patients with highly paralytic thorax when obliged to breathe deeply. Besides these it may be heard in nervous patients, particularly children, during a rigor (Wintrich), and in acute pleural pain. Cogwheel breathing dependent on the movement of the heart and heard principally in its neighbourhood, — systolic vesicular breathing — occurs somewhat more frequently in the tubercular than in the healthy and is associated with the excitability of the heart.

Cogwheel Breathing as an Early Sympton.

Cogwheel breathing at the apex is reckoned an early sympton of tuberculosis ; in my experience it is comparatively uncommon at the apices, and I agree with Grancher that it is less frequent and less early than rough breathing. In undoubted apical tuberculosis I have most frequently heard it from the edge of the affected area downwards, *e.g.*, in the

first and second intercostal spaces, behind at the middle of the scapula. The *sharpening* of the breathing observed at the same time I take rather as a sign of increased respiratory function than of the presence of catarrh. It is highly remarkable how persistently this sharpened cogwheel breathing may remain at the spots mentioned without any râles occurring.

Sharpened Vesicular Breathing.

It is well known that *sharpened vesicular breathing* (called by many authors "rough breathing") may be produced by catarrh as well as by increased respiratory function; of the latter may be mentioned its regular occurrence in the upper parts of both lungs in tight-laced women (Eichhorst, O. Vierordt); over one whole side in wide-spread disease of the other (acute pneumonia, tubercle, and especially marked in extensive pleural effusion), and in the lower parts of the lung when the upper are affected (tubercle). Sharpened vesicular breathing localised at one apex is, like cogwheel breathing, regarded as a sign of tuberculosis and is generally set down to accompanying catarrh. In point of fact, it does occur with fair frequency in apical tuberculosis and may in many cases owe its origin to local bronchitis. But as it is heard with much greater frequency in connection with old processes not accompanied by catarrhal symptoms, whilst it is a cardinal symptom of diffuse bronchitis, increased respiratory function must be assumed to be the cause in apical tuberculosis, at

any rate in the majority of cases, this increased function being in the neighbourhood of small nodules. It occurs especially where there is contraction and development of connective tissue, and in the neighbourhood of solid nodules; it becomes constantly louder and more diffuse (blowing vesicular breathing), and in healed processes remains unchanged for whole decades. As it presupposes air-containing tissue and, after the occurrence of diffuse infiltration, gives place to other breath sounds, it is reckoned among the early signs of tuberculosis. Gerhardt indeed regards it as one of the "earliest signs of commencing tuberculosis of the lung," although he puts it along with contraction of one part of the lung and considerable stretching of the surrounding tissue. But the whole development of the tubercular process precedes contraction, and during this development and at its height the breathing is—as has been already said—often rough, *in other cases weak vesicular.*

Weak Vesicular Breathing.

Next to rough breathing, *weak vesicular breathing* is the earliest sign of apical tuberculosis; it is a result of considerable swelling of the bronchi, and is more often accompanied with catarrhal sounds than is rough breathing; with the latter they are entirely lacking or appear as scanty crepitation [*Knistern*] or cracking [*Knacken*]. Weak breathing is not always pure vesicular; it may either have a rough component—weak rough vesicular breathing—or

show the character of the transitional form between vesicular and bronchial breathing to be presently described. Pure weak vesicular breathing occurs as an individual and racial peculiarity (*e.g.*, it is especially frequent in Slavs) over the whole lung, and is then without pathological significance. Often obstruction to nasal breathing by turbinate swelling, polypi and the like, is the cause of weak breathing heard uniformly over both lungs; in these cases the breathing immediately becomes good vesicular when the mouth is opened. Weak breathing over a whole side occurs in stenosis of a large bronchus by tumours, and syphilitic and other scars. Over the lower lobes, especially the lower edges behind, it frequently remains as the only sign of a long past pleurisy. At tubercular apices it may last until the period of caseous dissolution and even during its progress. But generally weak and rough breathing both become louder and sharper in the course of the disease the more the small nodules become confluent, finally approximating to the bronchial type.

Transitional Breathing.

The *transitional* forms between vesicular and bronchial breathing naturally play a large part in tuberculosis. When air-containing and infiltrated tissues are together under the stethoscope, the conditions are supplied for the production of this "composite breath sound" (Eichhorst), the "transitional breathing" of O. Vierordt and West*—provided that the airless

nodules have reached a certain size. Two forms are properly distinguished according as the vesicular or the bronchial element preponderates, thus : vesicular breathing with a bronchial element, and bronchial breathing with a vesicular element. Frequently, but by no means always, the experienced ear can analyse the sound into a more superficial vesicular and a deeper bronchial element. At the same time there are undoubted transitional forms which the ear cannot differentiate, plainly because air-containing and infiltrated tissue are blended beneath the spot auscultated.

These different forms may be written down thus :—

Vesicobronchial or ves. br. = vesicular breathing with a bronchial component.

Bronchovesicular or br. ves. = bronchial breathing with a vesicular component.

$\frac{\text{Ves.}}{\text{br.}}$ = superficial vesicular, deep bronchial breathing.

In all these combinations rough breathing may also occur :—

Rough ves. br.,
Rough br. ves.,
$\frac{\text{Rough ves.}}{\text{br.}}$ breathing.

"Indeterminate" Breathing.

These sounds may be very loud or very soft, and it has been customary to group them together under the term "*indeterminate*" *breathing* (Skoda*), especially if they

are only faintly heard. Weak vesicular and weak bronchial breathing are also for the most part included in this term. "Indeterminate" breathing is a euphemism for sounds difficult to define and is hence mischievous and should either entirely disappear from nomenclature or at least be reserved for sounds exceptionally difficult to determine. I have myself never heard a breath sound which did not remind me of vesicular or bronchial breathing or of both, but I have often heard no breathing at all where other observers have professed to hear indeterminate breathing. In such cases it would be better to speak of *suppressed* or *muffled* breathing, râles or friction sounds alone being heard.

Suppressed Breathing.

The principal causes of suppressed breathing are pleuritic exudation and plugging of a large bronchus with secretion. The latter event occurs for the most part in cavities and bronchiectases with abundant secretion. A powerful cough may often suffice to get rid of the secretion and reveal bronchial amphoric breathing, which is then generally accompanied by numerous consonating râles. In the case of blocked bronchiectases in the lower lobes, when the patient has been for a long time in the upright position, a horizontal position with the shoulders low may set in motion the stagnating secretion and with a sudden rattling cough the breathing becomes free. The cough occurring in this position, with moist râles and expectoration, I should regard as

an early and absolutely pathognomonic sign of bronchiectasis of the lower lobes. By this simple procedure I have been able to assure the diagnosis in cases in which physical signs and symptoms had not yet spoken, and expectoration had either not been produced in striking amount or regularly swallowed by the patient.

Expiration and its Quality.

What has been said here about the various qualities of breath sound applies first to inspiration. *Expiration* is influenced in the most various ways by tubercular nodules; it is to be heard—rough, sharpened, vesicobronchial, bronchovesicular and bronchial, and is in addition prolonged or drawn out. At the very first commencement of tuberculosis with rough or weak inspiration, expiration is sometimes not even audible, but may be already distinctly vesicular, rough vesicular, sharpened vesicular, or vesicobronchial, but never very loud or very much lengthened. When the disease is of some standing and considerable infiltration has occurred it first becomes louder and more blowing, bronchovesicular to bronchial; with the development of scar tissue and fibrous nodules it becomes much lengthened, partly in consequence of actual surrounding emphysema, often also very loud and then showing the qualities of sharpened vesicular or of bronchovesicular breathing ("scar breathing"). But care must be taken in diagnosing scar tissue from physical examination alone; "scar breathing"

does not exclude a fresh active process, and only prolonged clinical observation of the whole case can distinguish. In general it may be said that expiration comes nearer to bronchial breathing than does inspiration, and this applies as a rule also to apical tuberculosis, *e.g.*, vesicular inspiration is accompanied with vesicobronchial expiration, and vesicobronchial inspiration with bronchovesical or bronchial expiration.

Prolonged expiration to be heard over the whole lung is recognised as a sign of bronchial catarrh or of emphysema; if it occur over healthy areas in tuberculosis it may be concluded that emphysema has already developed there, while sharpened inspiration over the same denotes only compensatory increased respiratory function (*v.* p. 92).

Prolonged Expiration.

Prolonged expiration audible over the whole lung may also be caused by obstructed nasal breathing :—

In a patient with slight impairment of note at both apices and downward displacement of the lower borders of the lung, there was to be heard over the whole lung a prolonged loud blowing expiration, which disappeared at once on opening the mouth and then became limited to the apices. Examination of the upper air-passages showed moderate post-nasal adenoids. I diagnosed tuberculosis with secondary emphysema; a diagnosis of primary emphysema having been made by another doctor.

As to *bronchial breathing* and its varieties, only a few remarks need be made. Between the scapulæ

Bronchial Breathing.

at the level of the second to fourth dorsal vertebræ it is more distinctly audible when the bronchial glands are enlarged than under normal conditions (H. Neumann*). In tubercular infiltration bronchial breathing is commonly not so sharp as in croupous pneumonia, because the infiltration is less homogenous. It appears that what I have above called broncho-vesicular breathing is by many doctors put down as bronchial, as it approaches very nearly to the bronchial type and the vesicular element is quite overlooked. Pure bronchial breathing sometimes becomes evident after cough, where with quiet breathing only a much weakened breath sound

Amphoric Breathing.

was heard. The same is true of *amphoric breathing*. The latter is one of the most certain signs of the existence of a cavity next to Wintrich and Gerhardt's change of note on gentle percussion; exception must be made for the amphoric note sometimes occurring in health between the scapulæ, but never intense in character. Attempts to determine the size of the cavity by the pitch of the amphoric breathing lead to frequent failure, chiefly because small cavities situated on a large bronchus or a group of small cavities may give a similar note to large cavities on a small bronchus. The *metallic breathing* of pneumothorax, which is often very soft in the closed form, is better heard with direct auscultation, as has been already mentioned (*v.* p. 85); that of

large cavities, too, is sometimes better appreciated in this way. In pneumothorax with a fistulous opening surrounded by soft granulations a hissing sound may sometimes be heard with the stethoscope, not distinct from the vesicular breath sound. Wintrich states that he has heard the same over cavities whose walls on section showed no air-containing tissue, and premises that the sound is due to the same mechanism as when made by the mouth.

"Metamorphic" Breathing.

A phenomenon little studied on account of its rarity is *metamorphic* breathing, which is very differently described in the different text-books. Seitz, its discoverer, describes different kinds having this only in common; that *a part of the inspiratory phase*, it may be any third of it, *is occupied by a sharp stenotic sound, while the rest of the inspiration shows the character of one of the usual breath sounds.* The term might well be used for any breath sound which changes its type during inspiration. Thus, pure vesicular breathing may become rough towards the end; or the first half may be vesicobronchial becoming suddenly bronchovesicular or almost bronchial in the second; in the latter case a powerful cough may do away with it. The explanation must be that during inspiration air first enters one, and in the second half the other, of two unequally affected tissues lying beneath the stethoscope. Moreover, the bronchus leading to the latter area

may be plugged. Seitz's phenomenon makes the presence of a cavity probable, though the change of type just described does not do so; in the few cases in which I have obtained it there was more or less scarring present in the neighbourhood of a cavity, and the occurrence of a stenotic sound thereby explained. A short hissing sound not yet described I have observed over old contracted cavities on making the patient cough, and occurring for months and even years: I should denote it as a "stenotic hiss."

Classification of Râles.

Râles are usually classified into dry and moist; the moist again into musical (consonating) and toneless (non-consonating), and into coarse, medium and fine. Considerable confusion prevails in the nomenclature with regard to the distinction between dry and moist râles. This distinction should be given up altogether merely on the ground that the "dry" râle does not indicate especial dryness at all. It is preferable that a name should be chosen for each sound which most resembles the particular râle; an onomatopoetic method already frequently tried. Subdivision according to size and pitch may remain.

We have then[1]:—

[1] The words used in the original German are much more adapted for expressing sounds than any possible English equivalent; hence they are retained here side by side with their nearest equivalent, and are also inserted in other places in the text.

(1) Humming [*Brummen*]. Piping [*Pfeifen*].
Whizzing [*Schnurren*]. Whining [*Giemen*].
Groaning [*Stöhnen*]. Peeping [*Juchzen*].
Snoring [*Schnarchen*]. And so forth.

(2) Snarling [*Knurren*], as of a dog.
Rattling [*Knattern*], as of musketry.
Cracking [*Knacken*], as of a broken twig.

(3) Musical [*klingend*] and toneless [*klanglos*] râles; or consonating and non-consonating; which are further divided into :—

Metallic consonating.
Consonating.
Half-consonating.
Loud, Soft } non-consonating.

(2) and (3) fall into: coarse, medium and fine.

(4) Crepitation [*Knistern*], as of hair rubbed between the fingers; with its transitions to group (3) with which it should not be classed.

The names under headings (1), (3) and (4) need no further explanation. A short groan [*Stöhnen*] or gasp [*Keuchen*], of fairly low pitch, heard only on coughing, is sometimes the only auscultatory sign of bronchitis of the large tubes; a short peeping [*Juchzen*] or chirping [*Piepen*] of high pitch, also only perceived on coughing, and recalling the short whining of a puppy, not infrequently occurs in bronchitis of the smaller tubes of greater or less extent. It may be the only catarrhal symptom when tubercular nodules are deeply placed, and if limited to one apex is a valuable sign. A fine chirping [*Piepen*], fairly short but lasting longer than the

sound just described and heard during quiet breathing, I have sometimes noted in miliary tuberculosis when the tubercles were scattered through all parts of the lung that had not been previously destroyed.

Whining [*Giemen*] and piping [*Pfeifen*], originating in a large bronchus and often heard over the whole side or over a whole lobe, may at a particular spot, generally the apex, take on a *definite metallic note* retaining elsewhere its usual character ; it is a rare but certain sign of a cavity.

Group (2) Defined.

What is understood by rattling [*Knattern*] seems scarcely to need explanation. What Gerhardt defines as the rattling râle, "single, coarse, dry, but not consonating," I cannot reconcile with the name. To my mind rattling [*Knattern*] only conveys the impression of a longer or shorter *series* of sharp, fairly regular sounds in slow or rapid succession, and either consonating or at least half-consonating (= ratatatata sharp and loud). By snarling [*Knurren*] I understand a fusilade [*Salve*] of dull, tough sounds also regular (= r r r r r dull and more or less soft). By cracking [*Knacken*] I denote quite separate sounds, short and either coarse, medium or fine.

Occurrence of Râles.

All the different râles here mentioned occur in tuberculosis, and, more frequently than in other diseases, various kinds may be heard at the same spot, as, *e.g.*, over recent infiltration both fine and medium râles ; over areas

where softening is commencing, both fine toneless and coarse consonating râles. Sometimes râles are only to be heard at the height of inspiration, sometimes only after deep expiration, very rarely at the beginning only of inspiration. In simple acute and chronic bronchitis the various râles are now heard at one, now at another spot; in tuberculosis, on the contrary, they are very persistently localised to definite spots. Râles, therefore, which on repeated examination are constantly to be heard limited to a definite area are very suggestive of tuberculosis, and only exceptionally denote nodules of chronic pneumonia or bronchiectases. Only at the lower borders of the lung behind can medium and coarse râles remain constant in simple bronchial catarrh as well as in bronchiectasis. If diffuse bronchitis with abundant râles is present along with tubercular or other bronchopneumonic nodules, the existence of the latter may be surmised by the presence of a particular spot where the râles are especially closely packed.

Their Sequence.

In tuberculosis which is slowly proceeding to softening there may be heard in the course of weeks, months or even years, first fine crepitation, then fine, medium, and at last coarse râles; the same sequence as is run through in pneumonia in the course of a few days (*cf.* p. 78). If dulness or an alteration in the breath sound is heard extending further from the apex than the râles, one may assume an old retro-

grading affection, setting aside recent acute pneumonic processes; but the converse may not be assumed without further proof. Beneath the clavicle especially and the lower halves of the scapulæ may be found in favourable cases zones of br. ves. or ves. br. breathing (with or without damping of the percussion note) but *without râles*, whilst râles are still present at the more severely affected apices.

Crepitation.

Fine *crepitation* [*Knistern*] probably originates from separation of alveolar walls which have become glued together, and may be recognised in simple atelectasis, when it is known as an "unfolding sound" [*Entfaltungsgeräusch*]. This sound is heard most frequently and distinctly over resolving pleural exudates in parts of the lung not concerned in ordinary breathing, but which expand with a deep breath. At apices where the breathing is already weak small atelectases occur in the neighbourhood of the nodules; hence crepitation here is a sign of commencing tuberculosis.

The interpretation given of crepitation appears to me to be applicable in certain cases to somewhat coarser sounds. In cases running a favourable course, for years after cough and expectoration have disappeared, there may often be heard the same fine or medium râles which were to be heard at the height of the disease, especially after an effort to cough. It is impossible to distinguish

these sounds from the true râles dependent on catarrh.

Conduction of Râles.

Loud piping [*Pfeifen*] and whining [*Giemen*] arising on one side may be conducted across to the other, especially in small chests, *e.g.*, in children and very slim adults, a fact which has not escaped careful observers. The conducted sounds may be heard all over the healthy side or only in regions adjoining the side affected. An occasional but little noticed occurrence is the *conduction of moist râles from one side to symmetrical points of the other.* I have made this observation in front over the clavicle and the first intercostal space near the sternum, behind along the whole vertebral column, above and over the spine of the scapula and somewhat further out. In conduction of râles from one apex to the other I have found without exception signs of infiltration at the latter; in other situations where conducted râles were heard there was often no evidence of disease forthcoming. At the place of origin the râles were always loud, partly or wholly consonating, and the build of the body almost always very slight. Bony conduction is a ready explanation when it occurs in front through the sternum and its firm union with the clavicle and first rib, or behind through the vertebral column; if it occurs further out than this some factor must come into play, such as a layer of good conducting infiltration, or of thickened pleura on the side of

origin, and small cavities acting as resonators on the other. The phenomenon demands great care and may lead to mistakes in diagnosis and prognosis. To distinguish between conducted and "*autochthonous*" râles after the remarkable agreement in rhythm and other characters has raised the suspicion, the stethoscope should be slowly moved from the point of their maximum intensity to the other side, in front across the manubrium sterni, behind across the vertebral column, when as a rule the gradual dying away is evident. Loud râles may, of course, under some conditions of conduction by bone and consolidation, be heard some distance from their seat of origin on the same side; when differentiation even in the way mentioned above becomes difficult and uncertain. I have heard the metallic breathing of an open pneumothorax in much weaker degree on the sound side.

Conduction of Heart Sounds.

The conduction of heart sounds on the left side by large cavities is well known, giving to them a metallic tick; infiltration may conduct the heart sounds far, even over to the right side. I have, for instance, made a diagnosis of severe deep-lying disease of the right lung in a case in which the heart sounds were heard with remarkable clearness RPI., examination showing besides only slight dulness and weakened breath sounds over the right middle and lower lobes, with the heart in normal position and no disease of the vessels; this was confirmed

by the sequel, as the patient after some improvement went downhill with rapid sepsis.

Value of Cough in Auscultation.

Many an important point in diagnosis will be missed if auscultation is only practised during quiet and deep breathing, without employing from time to time *short efforts at cough.* This fact was well known to Laennec. Tubercular nodules may be situated at any spot in the lung and be undetected by percussion and ordinary auscultation, until they are discovered by a sharply circumscribed râle after a cough. The whole lung must therefore be listened to in quiet breathing and after coughing. After one quiet inspiration and expiration the patient should make an effort to cough immediately before the second deeper inspiration, granted that his condition admits of this slight exertion. At an apex previously only suspect, and in the anterior median borders of the lung, may often be heard in this way a whole fusilade [*Salve*] and a correct prognosis can then be made. I know a patient who has been through many doctors' hands, and who decides the diagnostic ability of his adviser by whether or not he has asked him to cough during examination. And certainly he is not far wrong. Mention has already been made (*v.* p. 99) that eccentricities of the breath sound also are sometimes first heard on coughing.

Of *pleural sounds* the novice may easily interpret those which give the ear a distinct impression of

Pleural Sounds.

rubbing, from soft brushing and scraping to loud scratching and cracking that may be felt. But there are pleural sounds which simulate all manner of catarrhal râles, moist and dry, consonating and toneless, humming [*Brummen*], coarse and fine cracking [*Knacken*], rattling [*Knattern*], and with especial frequency crepitation [*Knistern*] and fine tough râles. These fine pleural sounds are often the first sign of a recent fibrinous deposit on the pleura ; I have heard them in acute dry pleurisy some minutes after onset of the pain at a spot which I had shortly before found quite free. The most frequent site is over the lower lateral regions in front, between the fifth and eighth ribs, in and near the anterior axillary line. They are more rarely than other pleural sounds audible during expiration ; sometimes there are only fine isolated cracking [*knackend*] sounds distributed over the period of inspiration. They are very frequent in the course of tuberculosis of the lung and also in its early stages ; as frequent, I might say, as the small adhesions found at autopsy over various parts of the lung, the result of dry pleurisy. The sounds are very easily confused with an "unfolding" râle also very frequent and occurring over the same area, which is, however, only to be heard in the second half of inspiration and often only at the height of a maximal inspiration ; this râle must be referred to small atelectases. These atelectases

occur at the lower lateral edges of the lung with or without pleural adhesion; in the latter case the sound generally disappears after a few deep breaths, in the former it will persist, because at the beginning of each fresh breath the adhesion holds back the alveoli lying beneath it. Jürgensen* has described a rubbing sound of especial softness and delicacy as a sign of subpleural miliary tubercle. Soft pleural sounds are not as a rule audible to the unassisted ear, as they are covered by the louder breath sound.

Distinction between pleural Sounds and Râles.

There is no way of certainly distinguishing between pleural sounds and râles. If the following data are urged as criteria of sounds of pleural origin: That they are often to be felt; that they are increased by firm pressure of the stethoscope, but not altered by cough—it must be added that the increase on stethoscopic pressure is often wanting, and that undoubted pleural sounds may be increased by cough or even first evoked by it. It is clear that under conditions in which quiet breathing is insufficient to produce a pleural sound, the stronger and faster rubbing caused by a cough may suffice to do so. The movements of the heart may also evoke cogwheel pleural sounds in its neighbourhood, especially during expiration. If these sounds vanish on coughing then a pleural origin is certainly excluded. Further points are the pain which is often felt by patients at a deeply lying spot; the

nearness of the sound, which appears to originate immediately under the stethoscope, and the fact of its being audible during expiration. In the case of old pleural deposits simulating coarse râles and rattling [*Knattern*], an additional point is the extraordinary constancy of the signs over months and even years, often after the expectoration has quite dried up. With fine and medium râles the distinction is more uncertain (*v.* p. 105); it should be remembered that those sounds which only occur after coughing mostly arise from the lung, seldom from the pleura. Observation continued over a long period will often give a certain result in the difficult cases, just the most frequent in tuberculosis, in which sounds of pleural and of bronchial origin are to be heard at the same spot.

Other Sounds simulating Râles.

Only brief mention need be made of the sounds which may cause confusion with râles and friction sounds on auscultation, and may be due to faulty position of the stethoscope or to a hairy chest. The latter can be most readily silenced by rubbing the hairy spots with a wet piece of soap. Muscle sounds, generally produced by the trapezius, will not disturb if the patient assumes the position mentioned on p. 77, and if the examiner takes care that the shoulders are in a position of rest and not raised. On the other hand, bronchial and pleural sounds are not infrequently simulated on auscultation over the scapulæ by another sound, "*shoulder rubbing*"

("shoulder cracking," Penzoldt), arising from rubbing of the fasciæ of the back, perhaps also of bursæ, between the moving thorax and the motionless scapulæ; this sound is heard also as cracking [*Knacken*], snarling [*Knurren*], humming [*Brummen*], rubbing [*Reiben*], or jolting [*Holpern*]. It disappears or is much weakened if the patient makes a few revolutions of his outstretched arm, and is therefore not a muscle sound. A source of troublesome confusion in auscultation of the apex arises from *œsophageal sounds*, not only descending but also ascending ones. According to the size of the air-bubbles they may suggest coarse, medium, or fine râles, and lead to faulty diagnosis of cavity at the apex. There are patients who involuntarily swallow every time they make an effort to cough, and who can only with difficulty be induced to give up the habit. Sounds caused by ascending gases are heard for the most part in examining excited neurasthenics. Metallic sounds proceeding from the stomach may be observed over the lower parts of the left lung. Careful observation will establish the source of all these sounds, if the examiner has only once learned to pay attention to them.

Auscultation of the Voice.

Much stress has been laid by Laennec, the founder of stethoscopy, and by his disciples, Skoda, Wintrich and others, on *auscultation of the voice;* with these older authors it occupies the larger part of the chapter on auscultation. Nowadays it is dealt with briefly in

the text books and regarded as not very essential, because the signs obtained from it are similar to those from auscultation of the breathing, only more difficult to interpret (Gerhardt). Any one who is specially occupied with the diagnosis of tuberculosis of the lung may make for practice an exact study of the phenomena of strong and weak, clear and dull broncophony, and of pectoriloquy, and compare them with the results of vocal fremitus and of auscultation of the breath sounds. In the earliest stages of tuberculosis, auscultation of the voice is often entirely useless, when auscultation of the breathing already shows deviation from the normal (rough breathing).

Auscultation of the whispering voice (Bacelli) may be dispensed with altogether.

Frequency of Examination.

The first physical examination does not always afford entire certainty as to the signs; either the signs themselves may be obscure, or the examination may have to be partially postponed on account of the patient feeling tired or cold. There are besides patients who do not breathe properly or who do so very irregularly, and others who cannot cough to order. Then the examination must be repeated. In general I would sound a note of warning against too frequent examining in chronic tuberculosis of the lung. There are physicians who consider it to be their duty to thump and listen to their patients every other day, if not actually every day; the patient naturally wants to know something new each time, and the doctor runs the risk of drawing too wide

conclusions from small changes and having to withdraw them later. On the other hand, the patient becomes tired of the too often repeated assurance that the condition is unaltered. A good view of the course of the disease is obtained by one examination monthly, as is the practice in many Sanatoria. At the same time it should be understood that the patient is carefully observed in the intervals, and any change in his condition made the occasion of a careful examination.

Roentgen Rays.

The most modern addition to physical diagnosis is afforded by *illumination of the thorax with Roentgen rays.* If this method cannot be regarded as final either in technique or in diagnostic value, it is yet indicated to give a retrospect of what has been already reached. Out of the great number of workers occupied with the subject need only be mentioned Levy-Dorn,* Grunmach,* G. Rosenfeld, Bouchard, Kelsch, Maragliano and Jaworski. In illumination of the normal thorax the heart and its movements are distinctly seen, and the lower borders of the lungs with the powerful movement of the diaphragm; normal lung is transparent for the rays and hence is not seen. The various diseases of lung and pleura are more or less distinctly marked in the Roentgen picture. Deep shadows are cast by pleuritic exudate (Bouchard*), and by bronchiectases filled with secretion, less deep by the infiltration of acute pneumonia; with tubercular infiltration and pleuritic thickening the shadows are naturally

of very varied depth. According to Rosenfeld,* small pleuritic shadows are distinguished from those of peripheral lung nodules by the fact that the former are "more diffuse and have more surface," while the latter are "solid, fading off more at the edges." Cavities are seen as bright flecks on a dark ground; now and then they cannot be recognised by the rays when their presence is established by other methods, and later by autopsy; nor does the depth of the shadow of tubercular infiltration always correspond with the severity of the disease. It is clear that the negative picture of the cavity and the positive one of surrounding infiltration may obliterate each other; and this occurs by no means seldom in the softening sponge-like infiltration of tuberculosis. In this way the value of the illumination is considerably limited; negative finding cannot prove that the lung is healthy. The recent researches of Kelsch* and others, in which the Roentgen rays are utilised to detect commencing tuberculosis of the lung in apparently healthy subjects, are opposed to the observations of Jaworski* and Rosenfeld; the latter finds the shadows of muscle and bone in the upper aperture of the thorax interfere with the illumination of the apices of the lung. However, Kelsch and others (Bouchard, Rosenfeld) have made a very important observation for early diagnosis; they have seen enlarged bronchial and mediastinal glands. Bouchard and Claude picture the appearance of their bronchial glands as dark round flecks extending beyond the

shadow of the vertebral column at the level of the second to fourth dorsal vertebræ. Rosenfeld gives a skiagram of such a gland visible to the right of the spine at the level of the sixth rib; on the left side the shadow of the heart interfered. In my opinion the scanty and uncertain signs of tuberculosis of the bronchial glands obtained by percussion and auscultation, supplemented by the X-ray appearances, may render diagnosis possible, at any rate in children and in cases where the enlargement extends in some degree to the right of the spine.[1]

Need for more Research.

The need of more observers to apply themselves to the further development of physical diagnosis in pulmonary tuberculosis does not only apply to the study of X-rays. I would specially commend research on such cases of tuberculosis as yield an early autopsy in consequence of acute incidents as hæmoptysis, pneumothorax and the like; as well as on cases of suspected apical disease which after some clinical observation die from other causes; presupposing that the lungs of these patients have been examined during life with more than usual exactitude. Part of the results should be turned to account in diagnostic courses for the help and happiness of tubercular patients of whom so many fall a victim to the late diagnosis of the disease.

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[1] For further information on the early diagnosis of tuberculosis of the lung by Roentgen rays, see *Trans. Brit. Congr. on Tuberculosis*, 1901 (H. Walsham, Bonnet Léon, Espina y Capo), and a general *résumé* of the subject by J. F. H. Dally.*

Conclusion.

In conclusion, the way in which the results of physical examination agree among themselves and with the findings of pathological anatomy may be shown on a schema, which illustrates the gradual development of tuberculosis in the lung from above downwards, and which with the necessary modifications is not infrequently observed *intra vitam* and *post mortem*. The schema (*v. inf.*) gives the notes for the back, right or left side.

SCHEMA.

Localisation	Pathological Anatomy	Percussion and Palpation	Auscultation
Above spine of scapula	Cavities surrounded by induration	Tympanic note with Wintrich's change. Vocal fremitus much increased	Amphoric in- and expiration. Coarse metallic consonating râles.
Somewhat below spine of scapula	Firm infiltration, with commencing softening	Much impaired note. Vocal fremitus increased	Bronchial in- and expiration. Medium half-consonating râles.
Midway between spine and angle of scapula	Numerous broncho-pneumonic nodules with commencing caseation	Moderately dull note	Br. ves. insp., bronchial exp. Medium râles.
Somewhat below middle	Less numerous and smaller nodules	Slightly impaired note	Ves. br. insp., br. ves. exp. Medium and fine râles.
Angle of scapula	Small scattered peribronchitic and miliary nodules	Clear note with tympanitic component	Rough ves. insp., prolonged ves. exp. Fine râles.
Somewhat below angle of scapula	Boundary zone between affected and healthy tissue	Clear note ...	Cogwheel sharpened ves. insp.
Midway between angle and lower border	Healthy tissue ...	Clear note ...	Ves. insp.
Immediately over lower border of lung	Slight pleuritic exudate or thickening. Beneath it healthy tissue	Slightly impaired note with somewhat weakened vocal fremitus	Weak ves. insp. "Unfolding" sounds.

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