with the dust from infected houses, he was able at the end of a very large number of experiments to demonstrate the presence of the tubercle bacilli in all houses where phthisis was known to have been present. His paper should be read by every medical man, and his conclusions acted upon.

Dr. Crocker (M.O.H. Richmond) in his report for 1901, suggests, among other measures for preventing the spread of phthisis in this town, the notification of the disease. I think the brief notes I have read show the value of such notification, especially if followed by proper disinfection of the rooms or house by the sanitary authorities. Were such measures made compulsory, the present high rate of mortality from phthisis in Richmond would, I believe, be promptly lessened.

THE DIETETIC TREATMENT OF PULMONARY TUBERCULOSIS FROM THE POINT OF VIEW OF ITS HAEMATOLOGY AND HISTOPATHOLOGY.

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IN studying the reaction of the tissues to the stimulus of bacteria and their products, the tendency has been recently to turn to the blood as being the only tissue which can be fixed while still alive and undergoing these changes. The histological condition of the blood may be taken as an indication of the state and activity of the solid tissues, of which it is at once the product and the pabulum. The indications derived from the serum are as yet too vague to warrant any conclusion being drawn: it can only be regarded as the vehicle for the conveyance of the secretory products of the various cells which it contains, or with which it comes in contact. The cell elements, setting aside the red corpuscles, which have at least one definite function, play various parts in the resistance of the body to disease. That all the varieties of leucocytes, although they may have a common origin, have not the same part to play, is evident from their different behaviour in response to stimuli; thus, the digestive leucocytosis is mostly lymphocytic, while that of sepsis is polymorphonuclear. If a leucocytosis can be taken as the evidence of a reaction of the blood cells to the presence of toxins, the extent of the reaction varies with the acuteness of the infection, though this rule is not universal, for, in typhoid and measles, leucocytosis appears to be absent.

A marked feature of uncomplicated tuberculosis is the total absence of a leucocytosis. This would seem to indicate either a chronic toxic state, in which the stimulus is too slight to elicit a response, or, what is more likely, a state of equilibrium which is gradually produced, the reaction to the poison not exceeding its production. The importance of this consideration, from a therapeutic standpoint, is perhaps not realized.

From this point of view, cases of pulmonary tuberculosis naturally group themselves under two headings: Those in which the recuperative power of the system is sufficient to produce a reaction, capable, when properly guided and sustained, of stopping the progress of the disease; and those in which the system is incapable of stimulation by the ordinary means and the disease progresses towards a fatal issue.

The recuperative power itself also falls naturally under two headings: The physiological tissue reaction, which is the main factor in recovery, and the physical capability of the infected organ for repair. The former, in many cases, is sufficient to arrest the progress of the disease, while the latter may be unable, owing to the extent of the lesion, to bring about a healthy condition with total extirpation of diseased tissue and its replacement by a sound scar. A lung may be so involved as to render this physical shrinkage impossible for anatomical reasons, even where the physiological reaction has been sufficient to check the advance of the disease. Hence the importance of maintaining the tonicity of the tissues in chronic cases after the active treatment is at an end, and the frequent relapses following apparent recovery.

The physical repair being dependent on and necessarily preceded by the physiological reaction, the artificial production of a reaction is the aim of all treatment. In the tuberculin treatment a small amount of toxin is introduced into the system, producing a reaction characterized by local phenomena at the seat of the lesion, and, what is most important from the point of view of the present article, by a rise of temperature and a leucocytosis accompanied by an eosinophilia (Bischoff)¹

The reaction produced by the sudden access of toxin persists after the actual toxic increase stops. Cases in which no benefit results are those in which the toxic action has exceeded the reaction, or where the reaction itself has not persisted, that is where the requisite response is not forthcoming.

The benefit of a nitrogenous diet lies in the production of a general tonicity of the tissues. In the blood marked changes in the numbers of the leucocytes following the absorption of certain constituents of the food occur, and an increase in weight is the evidence of an improved metabolism in the tissues generally, making a physiological use of the foodstuffs supplied, rather than of the plethoric storage of excess material.

The specific substances which produce the leucocytosis are nuclein and its various derivatives. The leucocytosis so produced is a true increase in the number of leucocytes in the circulation, and therefore of the number of cells functionally active. This, as one would expect, entails an increased leucocytic death-rate, if one may put it so, and therefore an increased excretion of the products of cellular metabolism. The nuclein derivatives which cause this action themselves contain those products, but the increase in excretion is greater than would be accounted for even were the total quantity of nuclein absorbed and excreted as such. To quote Milroy and Malcolm, "there is absolutely no doubt that nucleic acid (one of the nuclein derivatives) produces a hyperleucocytosis within four hours after its ingestion, and an accompanying or subsequent leucolysis."²

Early stages of pulmonary tuberculosis are characterized by the total absence of leucocytosis, while the later stages invariably show a leucocytosis, caused probably by a mixed infection.³ In the cases observed the leucocytes, after twelve hours' fasting, showed only a slight increase, though all were cases of cavity formation, and therefore, presumably cases of mixed infection. The morning count varied from 10,000 to 13,000.

In cases treated by the open-air method and on a diet rich in animal nitrogen, the characteristic features of the blood counts are: (1) A moderate constant leucocytosis, (2) a large absorptive lymphocytosis, and (3) an almost constant eosinophilia; the eosinophile cells varying from 4 per cent. to 5 per cent. of the total leucocytes. The cases selected for observation all had a subnormal temperature and in none of them, so far as could be ascertained, were there intestinal parasites.⁴ The total number of the leucocytes varied in one case from 10,000 at 8 a.m. to 19,000 at 3 p.m. This exceptionally large increase occurred after two meals consisting mainly of nitrogenous food. The ordinary digestive leucocytosis ranged from 1,000 to 4,000.⁵ Under these conditions migration of eosinophiles into an artificial blister occurs, but probably only accidentally, as the number is small compared with the number of eosinophiles present in the blood and of polymorphonuclears present in the blister serum. The eosinophile leucocytes seem to have a special relation to the toxins of the diseases in which eosinophilia occurs. Pemphigus, for example, is characterized by a leucocytosis with marked eosinophilia. The vesicle contents, which presumably have some relation to the toxins of the disease, are found to contain eosinophile leucocytes in large numbers, while an artificial blister contains few as compared with the numbers in the blood and in the serum of the specific vesicles.⁶

In the blood may be seen at any time all gradations of cells, from the lymphocyte with a single nucleus and little protoplasm to the polymorphonuclear with or without specialized granules. These cells may have different functions at different periods, but they are all essentially similar in nature and origin. Thus a stimulation of lymphogenic tissue and a consequent production of a leucocytosis cannot but be beneficial in furthering the action of cells which are known to be inimical to foreign bodies, using the expression in its widest sense.

In septic diseases the leucocytosis is mostly polymorphonuclear and the exudation contains chiefly polymorphonuclear leucocytes. The circulating toxins exert a chemiotactic action on the leucocytes in the circulation, while the invading organisms cause a local exudation of polymorphonuclears or exert through toxins a positive chemiotactic action on those leucocytes. Both these phenomena are to be regarded as the response of the tissues to the stimulation of the toxins. In tuberculosis the rapid softening and digestion of the tissues associated with the presence and action of suppurative organisms are replaced by a slow degeneration of the cells and tissues round the nidus of the bacilli. Instead of an exudation

of polymorphonuclear leucocytes into a liquid mass of digested material there occurs a positive chemiotaxis for mononuclear leucocytes or lymphocytes resulting in the encapsulation of the toxin-secreting organisms by a surrounding zone of cell, mostly lymphocytes (Baumgarten).⁷ The slowness of the toxic process or the toxic equilibrium produced probably prevents an evident variation in the number of leucocytes in the circulation.

The lymphocytes which surround a tubercle nodule must have some function to perform in protecting the tissues from the spread of the disease. The exact nature of the protective action has not yet been determined. It may be antitoxic, antibacterial, or simply mechanical, producing in time a fibrous envelope shutting in the focus of disease, and by contraction tending to obliterate it. It may be interesting to note here that a process of reasoning starting from an entirely different point of view has led us to the same point as the strictly anatomical study of the disease, namely, that all healing in pulmonary tuberculosis is brought about by a fibrous cicatrization and obliteration of the diseased areas.

The importance of this aspect of the histopathology of the tubercle nodule lies in the fact that a digestive leucocytosis as shown above is a true increase in the number of those cells which possess a direct chemiotactic attraction for the tubercle bacillus or its toxins. It would be absurd to suppose that this selective action of the tubercle bacillus on the lymphocytes is without significance, or that it is not in some way beneficial in preventing the further spread of the disease. If the difference in rapidity between the two processes of tuberculous infiltration and pus formation be excluded, the processes are very similar in nature, each being a positive selective chemiotaxis exerted on certain specific cells. The process ends in destruction of the cell elements; in the former case by slow toxic poisoning and caseation, and in the latter by a more rapid poisoning and degeneration.

If it be true that the leucocytes have a special antibacterial action, and that changes in them are the evidence of a reaction to poisoning, which may be common to all tissues, but is demonstrable only in the blood, then only those constituents of the diet which are known to produce or favour this reaction need be in excess of the normal. The remainder is increased as the capability for making a proper use of it is gradually restored.

The digestive leucocytosis is produced, not by the absorption of nitrogenous food indiscriminately, but by the action of the nuclear constituents, and is in proportion to the amount present. A diet mainly animal furnishes the largest amount of nuclein derivatives in proportion to the quantity taken, while, if properly administered, it throws least strain on the organism.

As the leucocytosis may only be an indication of a general tissue stimulation, so the mere production of an artificial leucocytosis by the administration of pure nuclein derivatives, apart from the other nutrient constituents of the meat, would not be likely to produce so successful a result.

Tuberculosis is characterized by widespread toxic changes. All the tissues which are affected by ordinary starvation either directly waste or undergo fatty degeneration with subsequent waste. Tissues in such a state of intoxication are incapable of elaborating foodstuffs satisfactorily. Cases under treatment very commonly present the features of an increase in weight with at first an undiminished, or even an increased, amount of sputum secretion. Such a phenomenon would indicate an improved metabolism dependent on a tissue reaction and not on a diminution of toxin secretion. Such cases commonly exhibit a slowly rising weight curve, with the physical signs of stationary, as opposed to retrogressive, disease. If the case is to end favourably, the toxin production, as evidenced by the sputum and physical signs, subsequently diminishes, and a rapid increase of weight consequent on diminished toxin production takes place. It is quite possible that one of the factors in the tissue reaction is the secretion of antibodies acting on the bacilli or their toxins. Wassermann and Takaki have shown that tetanus emulsions of the central nervous system contain bodies with antitoxic properties. In certain animals other tissues than the central nervous system have the property of combining with the tetanus toxin.⁸ This proves that the production of bodies antagonistic to invading organisms is not limited to the blood cells, but that other tissues take part in the action, whether they are directly affected by the disease or not. Tubercle differs from tetanus in not having a single toxin which produces its own antitoxin. In typhoid and cholera, where the antitoxin is a compound body, Wassermann has brought forward evidence

that one constituent, the "immune body," is produced in the spleen, lymph glands, and bone marrow.⁹ The relation of the blood condition to the tissue reaction in tubercle would then be that the "complement" necessary for the formation of the complete antitoxin would be produced by the lymphocytes.

One advantage of a meat diet, in addition to its directly curative value, is that it supplies organically combined iron, and renders the administration of other organic haematinics unnecessary. The percentage of haemoglobin rapidly rises from 50 or 60 to 100 or 130, according to sex. This must considerably facilitate gaseous interchange, and thereby lessen the work of both heart and lungs, thus helping to bring about a state approximating to the ideal physiological rest, which is unattainable in a vital organ.

From a histopathological point of view, rational dieting consists, not in indiscriminate stuffing, nor in indiscriminate lessening of the food, but in furnishing a diet rich in the appropriate albuminous constituents. The diet in tuberculosis is to be regarded as possessing a directly curative value, and its chemical composition is of as paramount importance as the constitution of the active principles of any mixture, however indifferent may be that of the vehicle. The special advantage of a meat diet in this relation is that, besides containing the nuclear bodies which have a directly stimulant action, it contains also proteids which have a high nutrient value. Sufficient fat and carbohydrate must be given to meet the physiological needs, and increased later, as metabolism and absorption improve, to the maximum which can be elaborated.

Such a diet supplies, ready made, unless destroyed in the cooking, the materials for rebuilding the muscular system. Malnutrition and degeneration, the direct results of toxic poisoning, involve the heart as well as the skeletal muscles. In helping to rebuild the muscles we directly contribute to the maintenance of that organ on the efficiency of which the fate of the patient depends. Circulatory disturbance is one of the first signs of tuberculosis, and as the disease progresses the state of the pulse becomes of increasing prognostic value. A change in the character of the pulse-beat is the first evident sign of a satisfactory reaction. As Dr. R. W. Philip has pointed out, the reaction to the treatment as evidenced by an improvement in the circulation and temperature precedes the establishment of a satisfactory lung condition. "Within a day or two and with few exceptions within a week or two, the rapid, soft pulse is replaced by a slowed and comparatively resistant beat. I regard the less or greater degree to which this is established as immediately of great prognostic value."¹⁰ The improvement, in fact, is an immediate result of the treatment and not the remote effect of a diminished activity of the local lesion. It accompanies the increase in weight, and is capable of the same explanation as that offered above.

A meat diet supplies a direct physiological want. Fat and carbohydrate are known clinically to be more or less interchangeable, an excess of the latter causing an increased formation of the former. Nitrogenous food is also convertible in the one direction, but with difficulty, while no excess of any other constituent can furnish organic nitrogen. In tuberculosis it is doubtless true that there is a wasting of subcutaneous fat, but the main feature is a waste of the nitrogenous element of muscle. A great part of the remaining tissue forming the muscular masses is changed into fat, while there is extensive storage of fat in the viscera. What the exact factor is which produces this change need not be discussed, but the important point is that in the body of a patient there is a diminution of the nitrogenous element, both relative and absolute, out of all proportion to the diminution in the other elements, it is true that fat in certain localities is diminished, but there exists a vast store which would be drawn upon were it the physiological item that is wanting. It is no wonder that the breathlessness of the overfed, or rather the improperly overfed, consumptive has become proverbial, and that his metabolism suffers. Even with an enormous diet of the "suet pudding" variety, his tissues may be suffering from proteid starvation, seeing that he has to replace so great a quantity of muscle substance. The restoration of muscle, as indicated by the improvement in the circulatory condition and increase in weight, causes no dyspnoea, even when the meat diet is pushed to its extreme limit. Dyspnoea, on the contrary, diminishes with the elimination of the fatty element from the heart and muscles.

It is not within the scope of the present paper further to discuss the clinical value of the diet, but I have rather

endeavoured to follow out the indications derived from the more purely scientific study of the conditions.

The late Dr. W. P. Mears, guided by the previous clinical experience of himself and others, three years ago adopted a diet the important element in which was meat. As accumulating experience indicated its superiority in one form or another to other diets for all classes of cases of pulmonary tuberculosis, he more and more insisted on its adoption in this sanatorium, especially in cases commencing treatment. Since his death results have amply justified his methods, and they are adhered to if possible more closely than ever.

I have to thank Dr. W. R. Philip for affording me the opportunity of examining the blood of the dispensary cases quoted above, and for many valued suggestions in the course of my work.

NOTES AND REFERENCES.

¹ Von Limbeck Clinical Pathology of the Blood, p. 231, New Sydenham's Society's Transactions. ² Metabolism of the Nucleins, *Journal of Physiology*, vol. xxiii, p. 229. ³ Von Limbeck, loc. cit., p. 231. ⁴ I examined blood films taken from tuberculous patients at the Victoria Dispensary who had undergone no treatment. In these cases the highest number of eosinophiles was 5 per cent. All the films were taken in the afternoon, when food absorption was going on, or had recently taken place, and when the numbers of eosinophiles would probably be relatively or absolutely diminished. The number of cases was too small to warrant any conclusions being drawn. ⁵ Only those counts which agreed with the general appearance of films taken at the same time were accepted as correct. ⁶ Neusser, *Wien. klin. Woch.*, 1892, p. 42. ⁷ Muir and Ritchie, *Bacteriology*, 1902, p. 226. ⁸ *Ibid.*, p. 458. ⁹ *Ibid.*, p. 465. ¹⁰ BRITISH MEDICAL JOURNAL, December 14th, 1901.

THE SANATORIUM TREATMENT OF PULMONARY TUBERCULOSIS WITH ESPECIAL REFERENCE TO NORDRACH METHODS.*

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AFTER some preliminary remarks on the history of the treatment Dr. Hichens said: I propose to discuss the details of the open-air or sanatorium method of treating consumptives; to put before you briefly the results obtained by this method at a few of the chief sanatoria in the British Isles, to compare these results with those obtained at high altitudes, and finally to see if we can draw any conclusion as to what advice we should give our patients.

In Germany the lines of treatment adopted divide themselves into two somewhat opposing camps. In all cases the patients have or are supposed to have abundant fresh air and a nourishing and abundant diet but a difference of opinion has arisen as to how much rest or exercise should be given. One camp advocates what may be called the "Rest-Cure" or "Liege-Hallen" method, the other rest combined with gradual and increasing exercise. The latter method I feel no doubt from personal experience is far the best. We owe it in its details in the first place to Brehmer, of Goerbersdorf, and then to Walther, of Nordrach, and it is the details of Walther's method, which I propose now to describe.

The Nordrach method of treatment consists of three simple remedies judiciously applied.

1. Abundance of fresh air at all times and in all weather.
2. Abundance of nourishing food, one might call it superabundance.
3. Rest and exercise graduated according to the state of the body temperature.

EXERCISE.

With rare exceptions no exercise is allowed in the Nordrach method unless the body temperature is within normal limits and has remained so for at least a week. The temperature is taken in the rectum regularly four times a day—on waking in the morning about 7 a.m., at noon, at 6 p.m., and after getting into bed at night about 9.30 p.m. In health the rectal temperature may vary between 98.6° F., or considerably below it in the morning, and attain to 100.4° F. after exercise or occasionally in the evening after meals. After violent exercise the temperature may rise to as much as 102° F. or even higher. There is no doubt that the rectal temperature gives a much nearer approximation to the real temperature of the blood than can be obtained in any other way, and in a prolonged insidious disease like consumption it is most important to know the smallest variations above the normal.

* Read before the South Midland Branch of the British Medical Association.

Many objections have been offered to taking the temperature in the rectum, most of them too trivial to discuss, but there is one that must be answered, and that is that it is unnecessary. It is urged by many that mouth temperatures give a sufficiently true indication of the range of the body temperature, and that even if it were best to know the rectal temperatures, these can be inferred by observing the ratio of difference between the mouth and rectal temperatures for a few days. It can easily be shown by experiment that both these statements are entirely wrong. In the first place, a patient may have active tuberculosis going on with definite slight pyrexia every day, and yet the mouth temperatures may give no indication of this at all. In the second place there is no definite ratio between mouth and rectal temperatures. This is no doubt due to the fact that the rectum is a closed cavity and the mouth is not. As a rule—though there are many exceptions even to this—the mouth and rectal temperature approximate fairly closely to one another after the night's rest, when the mouth has been closed in sleep, but during the day there may be a difference of as much as 1°, 1.5°, or even 2° F. Some times the mouth temperature will go down while the rectal temperature rises. In my own mind there can be no doubt whatever that rectal temperatures should be taken in all cases of tuberculosis which are being systematically observed and treated, and I believe this view is now accepted by the majority of the heads of sanatoria. If the temperature were taken for 15 to 20 minutes in the mouth a fairly accurate result might probably be obtained, but I think it will generally be found that a patient will prefer to spend 20 minutes a day with a thermometer in the rectum to an hour a day with a thermometer in the mouth.

Of the four temperature records taken in the day most importance is attached to that taken before rising in the morning. In the quiescent and obsolescing stage of pulmonary tuberculosis this is not only as low as 98.4° F., but generally very much lower, somewhere between 97° and 98° F. If the morning temperature remains persistently at 98.8° or 99°, or more, it nearly always means that the tuberculous disease is not quiescent, even though during the rest of the day the temperature does not rise above the normal limits. As far as my own experience goes, the chief exceptions to this rule seems to be in women, who often have slight elevations of temperature due to their monthly periods, and also in neurotic patients, who seem to be capable of raising their temperatures from 0.2° to 0.6° F. above normal by lying in bed and worrying over what it is going to be.

When the temperature has been shown by observation to be within normal limits, the patient is allowed to leave his bed. At first he only moves on to a couch, later he begins to take carefully graduated exercise broken by stated periods of rest. In the Nordrach method of treatment no form of exercise is allowed other than slow walking at about two miles an hour at the most, with frequent stoppages to sit down and rest. The walks, too, are best taken in hilly country with the chief ascent of the walk at the beginning, so that when the patients are tired they may come home down hill. It would appear that slow hill climbing up graduated paths is a very valuable form of exercise for consumptives. Without undue effort the muscles of the heart, and the body muscles generally, are strengthened, and the healthy portions of the lungs are expanded.

The length of the walk is exactly regulated by the physician according to the patient's strength and progress. The intention is that the patient should get sufficient exercise, stopping short of fatigue, and that the temperature after exercise should not be raised above 100.4° F. At Nordrach the chief walk of the day is taken in the morning between breakfast and dinner, and in the afternoon only a short walk, in which more time is spent in sitting about than in walking. The patients are all expected to lie down on their couches for an hour before dinner and supper. They all go to bed at 9 p.m. and get up about 7 a.m., so that even the most robust patients gets much rest every day, from nine to ten hours in bed, two hours on their couches, and much sitting about during their walks. The length of the walks allotted to the patients varies from a few yards to several miles, in some cases as much as six or seven.

No other form of exercise is permitted. Some advocate allowing early cases of phthisis to dance, play tennis, cricket, fives, row, and bicycle, but this advice is undoubtedly most harmful. During such active forms of exercise violent respiratory efforts are made, freshly-formed scar tissue in the lung is broken down, and tubercle bacilli which had been shut off by adhesion from the general lung tissue are