"THE USE OF THE SEDIMENTATION TEST TO THE CLINICIAN IN THE PROGNOSIS AND TREATMENT OF PULMONARY TUBERCULOSIS".

H. SHAFFER.

One of the most pressing problems in the study of medicine to-day, is that of tuberculosis; this in the adult manifests itself usually as a lung lesion, popularly known as consumption and phthisis. From time immemorial Man has shown a keen interest in the study of diseases of his fellow men, and pulmonary tuberculosis has always had a large share of these studies. Accurate descriptions of phthisis are found in the clinical writings of Hippocrates, Galen and others.

The study of medicine on a scientific basis was retarded considerably owing to the superstitions of the Middle Ages, and it was not until the middle of the nineteenth century that any real progress commenced. The researches in physiology, pathology and bacteriology, during the past seventy-five years have added greatly to the advances of medicine.

Although numerous diseases, such as cholera, typhus, typhoid and plague, have in the past caused a greater periodical mortality than phthisis, they

have been epidemic or pandemic in their incidence. Furthermore, if the patient recovered, their working and physical capacities were not impaired. The advances of medicine have done much to control them in relation to epidemiology, treatment and mortality, and so relegated them to a very much lower position in the scale of diseases affecting mankind.

Pulmonary tuberculosis has also been benefited, but not to nearly the same extent, or at least the success of the others. Consumption is always present, exacting its toll of human lives and suffering everywhere. In spite of increased knowledge of diagnosis and treatment this disease claims the second highest mortality, cancer alone being greater. Moreover cancer makes its claim in the late middle and beginning old age, but the ravages of pulmonary tuberculosis are greatest during adolescence and early manhood; one third of the deaths occurring between the ages of twenty and forty-five are due to consumption. Furthermore, the permanent crippling and physical disability that occur in many cases is enormous. Thus it is very evident that the high mortality and economic loss produced, make pulmonary tuberculosis in the adult one of the vital considerations of medicine to-day.

It was not until 1882, when Robert Koch isolated the causal organism, that any real progress was made; this important discovery created a wave of enthusiasm in the further studies of tuberculosis. As my investigations have been towards aiding and increasing the clinical aspects of pulmonary tuberculosis in the adult, I will endeavour to very briefly survey some previous procedures that have been carried out and the results obtained.

The first of these were the tuberculin tests, originally introduced for the purpose of diagnosis. There were a large number of them, having a common basis, which consisted of the allergic or hypersensitive response of tubercle infected individuals to treated products of the growth of the tubercle bacillus. A positive test in tubercular individuals was manifest by local, focal and general reactions.

Tuberculin has been applied in many ways. Koch in 1891, introduced tuberculin directly into the circulation by injecting it subcutaneously, producing all three types of reaction in the individual. In 1892, Escherich introduced the Stichreaktion, whereby a minimal amount of tuberculin was introduced so as to produce a local reaction along the needle track; this

test was never very popular outside of Austria and Germany. Calmette, in 1907, placed tuberculin in the conjunctival sac to be normally absorbed, with a view to producing a local hyperaemia in susceptible patients. Von Pirquet, 1907, caused the tuberculin to be absorbed directly into the lymphatic system by scarifying the skin; a local reaction was thus produced in tubercular patients. Mantoux, in 1908, injected the testing agent intracutaneously; a positive reaction was indicated by a local red area. Last among the well known investigators was Moro, who, in 1908, rubbed the substance in the form of an ointment directly into the skin - the so called percutaneous method.

Most of these tests, as introduced by the original workers, have not proved of very great value in the diagnosis of phthisis. With the exception of the Von Pirquet and Mantoux tests they have been practically discarded by the majority of present day authorities, for the following reasons. A positive reaction only indicates tubercular infection; but it does not signify whether it be active, latent or "healed". Many cases with advanced clinical lesions give a negative reaction. They are apt to be dangerous, either locally as Calmette's test, or generally as Koch's subcutaneous test. Other

substances such as proteins and sera also produce positive reactions in tubercular individuals.

More recently D'Arcy Hart (1) has shown, that, by using the Von Pirquet and Mantoux methods in various dilutions, the tuberculin reaction is of value in diagnosis, state of activity and epidemiology. Much fuller investigations have yet to be carried out to prove the importance of his findings.

A second line of investigation carried out was the complement-fixation test. As a result of the success of the Wasserman reaction in syphilis, similar methods were applied to pulmonary tuberculosis; here again there was the usual difficulty of differentiating active from latent and "healed" lesions. Furthermore conflicting results were obtained partly due to the use of different antigens, and partly due to variance of methods in interpreting results.

Another procedure was the Arneth count. Arneth attached importance to the number of individual nuclei or indentations in the polymorphonuclear neutrophile cells. Cummins and Acland (2) conclude that this test is of value only in prognosis and as a means of measuring the constitutional balance of a case before, during and after treatment.

A fourth test which attracted attention, is the estimation of the vital capacity. Burrell (3) states that the vital capacity is altered by many conditions apart from phthisis, and therefore is of more value in estimating prognosis and results of treatment than in aiding diagnosis. At the same time a normal vital capacity undoubtedly renders a diagnosis of pulmonary tuberculosis very unlikely.

A further principle gone into was Wright's opsonic index. This test is based on the principle that, in all toxaemic conditions resulting from bacterial products being present in the blood, there ensues an increase of the opsonic index. However it has not proved very satisfactory in the hands of various workers.

Mention need only be made of both the autourine and autoserum test, and Verne's resorcin test, neither of which proved very useful (4) (5).

Thus we see that very few of these investigations have been of value in the clinical aspects of phthisis; usually also the technique and interpretation are difficult for those who are not specialized in their use.

In early diagnosis, the improved use and

understanding of x-rays have done much to overcome this difficulty.

However in the vital question of prognosis and also of assessing the benefit of various forms of treatment so important to the patient and the clinician, we have very little to guide us; a few clinical signs and symptoms, x-rays, temperature, weight, the Arneth count and possibly the vital capacity, upon which we hang our faith in interpreting the possible future physical status of the patient. It is in this field that I feel the urgent need of further laboratory tests, to be taken along with clinical findings, for the purpose of forecasting the future course of the disease, and the success or failure of specialized treatment.

In comparatively recent years the sedimentation test has attracted considerable attention. Although much has been written for and against this clinical aid, I still feel that its special value has not been fully realized and still requires much further investigation. In the days when blood-letting was the chief therapeutic measure for all and sundry ailments, it was noted that the red cells or erythrocytes sank to the bottom in a column of drawn blood. Further, it was found to vary in rate and amount in different toxic states. The test

was first applied to phthisis for the purpose of diagnosis but met with very little success. (6).

However as the rate was increased in toxicity, the test was next tried out as an aid to prognosis. It is in this field that I feel it is undoubtedly of great value. The sedimentation rate does not provide absolutely new information unobtainable by the astute clinical observer; but I will endeavour to show that it does afford a new method of measuring the constitutional balance of a case before, during and after treatment. The test is simple in technique; no specialized laboratory experience is necessary, especially in the use of complicated apparatus; and the reading of results is free from confusion and misunderstanding.

Thus, if the significance of the sedimentation test be clearly and concisely understood, I feel it is, and will be of inestimable value in the prognosis of adult phthisis, and in the assessment of any line of treatment. It is on these lines that my investigations have been carried out and conclusions arrived at. My clinical experience in pulmonary tuberculosis has been gained in the past two years from many cases in general practice , general hospital duties, and also through being in close touch with patients in a sanatorium and tuberculosis colony during the past six months. One hundred and fifty

cases of phthisis were investigated by means of the sedimentation rate and a total of over five hundred tests carried out; the patients were all adult males.

Instead of going on directly to the technique of the sedimentation test, a brief resume of the history and rationale must first be given. The phenomenon, now known as the sedimentation of erythrocytes, has been observed by clinicians for literally centuries. The yellowish coloured layer above the sinking cells of drawn blood was termed the "buffy coat" or "crusta sanguinis", and was considered to be an extremely important clinical sign in disease.

In the seventeenth century Thomas Sydenham (7) observed that, in widely different acute diseases such as smallpox, pleurisy and rheumatic fever, there were two common and constant features, namely, fever and the presence of a "buffy coat" in drawn blood. It was inferred from this that the materies morbi were in the crusta sanguinis itself; there were however a few clinicians who viewed the presence of a "buffy coat" as an indication for further blood-letting.

Hewson in the eighteenth century (8) after many experiments was able to elucidate something of the pathology of the buffy coat, hitherto in complete obscurity. He

showed the "inflammatory crust or size" to be not a new formed substance but merely the coagulable lymph separated from the rest of the blood. He also concluded that the formation of this layer was due rather to the increased velocity of the red cells in sinking, than to delayed coagulation, although delay in coagulation time was a constant feature in "sizy" blood. Further he showed that the formation of the buffy coat was not due to an alteration of the specific gravity of the corpuscles, but to some change in the plasma itself; he reasoned thus from the fact that corpuscles of sizy blood sank with the same velocity as the corpuscles of normal blood when suspended in the same medium.

Scudamore (9) in 1826, proved the fibrin content of buffy blood to be increased. Ten years later, Nasse (10) noticed that the corpuscles in buffy blood have a peculiar tendency to cluster. He went further than Scudamore by showing that although the red cells tend to sink more slowly in defibrinated than in fresh blood, they sank more rapidly in defibrinated sizy blood than in defibrinated normal blood. Thus by the end of the nineteenth century it was recognized that agglutination of red blood cells was brought about by some change in the blood plasma. Furthermore, an increased rate of sedimentation occurred in diseased states and also in pregnancy, resulting in the production of the buffy coat.

This was attributed to an increase in the fibrin content of the plasma and also to some other change as yet undetermined.

Interest in the phenomenon waned following the cessation of blood-letting as the chief therapeutic measure of the times.

Fahraeus (11) in 1918, revived interest in the suspension stability of the blood by publishing his investigations into the subject, complete with an excellent historical review. In this review he dealt with the theoretical development of this phenomenon and also supplied the missing factor concerned. He believed that this consisted of an alteration of the serum-globulin content as well as the fibrinogen portion of the blood. Fahraeus thus summarized the subject by saying that, whilst viscosity and specific gravity of the plasma have some small effect, the two most important factors in the stability reaction of the blood are changes in the fibrinogen and serum-globulin contents. These in turn depend upon the cellular activity and tissue destruction present in various diseases.

The character of reduced stability of erythrocytes in disease, was first applied to pulmonary tuberculosis by Westergren in 1921 (12). He believed that the factors underlying variations in the sedimentation of the red blood cells were not fully explained. He advanced the hypothesis

that in normal blood, the red blood corpuscles are highly charged with electricity due to the predominance of albumens and thus there is no tendency to agglutinate. In pathological processes, which are associated with fever and tissue destruction, there is an increase in the serum-globulin and a consequent decrease in the albumin-globulin ratio, plus an increase in the fibrinogen content; thus the opposite to normality results, with a tendency to agglutination and hence increased sedimentation.

Westergren concluded that, although in no way a specific reaction, the sedimentation rate could very likely have a diagnostic value for tuberculosis; and that frequently valuable prognostical evidence may be obtained.

The technique of the sedimentation test which I have employed is that devised by Westergren (13) with several minor modifications.

A solution of 3.8 per cent sodium citrate in sterile distilled water is the only reagent necessary; 0.4 cubic centimetres of this solution are drawn up into a 2 c.cm. Record syringe. Observing strict asepsis, a superficial vein at the bend of the patient's elbow is punctured and 1.6 c.cm. of blood drawn up into the syringe. The contents are now expelled through the needle into a dry test-tube and intimately mixed. The apparatus for holding the column

of drawn citrated blood consists of a pipette, thirty centimetres long with a capillary bore of 2.5 mms, and a special rack or stand by means of which a spring maintains the narrow end vertically against a piece of indiarubber. The pipette is graduated in millimetres up to 200 divisions. Care must be taken to have the apparatus dry before using and the blood free from air bubbles. The citrated blood is now drawn up to the 200 mm. mark and placed in the stand. Series of readings are then taken at intervals over a period of twenty four hours, by noting the height of the layer of plasma in millimetres, from the lower border of the meniscus of the free surface to the upper border of the red cells. If this lower border be indistinct the measurement is taken to a point where the general frequency of the blood corpuscles seems to begin. I always divide the reading by two thus giving the result as a percentage. This plan tends to avoid confusion of interpretation of results no matter what technique is employed.

An alternative method has been used by various authorities in which smaller proportions of blood and citrate are employed. The blood is obtained by pricking the finger and a capillary tube of much smaller bore is used, graduated to 100 mm. This procedure is of particular value in children as it obviates the necessity of venous puncture. It has

one important disadvantage, in that the corpuscles occasionally adhere to one another and the clot formed may block the tube, so spoiling the test.

The optimum temperature for sedimentation of red cells is eighteen degrees Centigrade, the rate then increasing slowly with rise of temperature up to twenty-five degrees Centigrade; thereafter it continues much more rapidly. In practice it is sufficient to keep the rack containing the one or more pipettes away from any source of heat.

When first instituting investigations I was anxious to determine which reading or series of readings would supply most information concerning the patient.

The following table shows varied types of adult phthisis; readings in these initial observations were taken every half-hour up to three hours from commencement of the test, and again at the end of twenty-four hours.

TABLE I. SHOWING THAT THE "FIRST HOUR" READING OF THE SEDIMENTATION TEST IS MOST SUITABLE AND ADVANTAGEOUS TO THE CLINICIAN.

CASE	READINGS DURING 24 HOURS. ½ hr	1 hr	1½ hrs	2 hrs	2½ hrs	3 hrs	24 hrs	REMARKS	
1. E.C.	25	49	55	56	57	58	62	Active pyretic	All are bed cases with very active disease. Large local and systemic factors are present, seen in the marked toxaemia.
2. W.H.	10	45	53	56	58	60	65	Extensive disease.	
3. W.As.	21	44	48	50	53	55	62	Extensive lesion-died.	
4. R.P.	20	38	45	47	49	50	67	Extensive and pyretic.	
5. W.Ar.	16	34	37	43	47	51	60	Pyretic-died.	
6. H.C.	13	28	36	45	47	51	60	Extensive cavitation-died.	
7. D.F.	10	20	25	32	40	42	60	1½ hrs. housework daily.	Mild activity with occasional slight toxic constitutional reactions.
8. E.G.	5	10	15	20	23	30	58	3 to 5 hrs. daily.	
9. J.L.	8	10	16	24	30	35	60	3 hrs. poultry daily.	
10. R.G.	3	10	20	24	29	34	45	1½ hrs. housework.	
11. E.P.	5	10	16	24	30	35	60	6 hrs. carpentry daily.	
12. C.J.W.	0.5	2	4	5	7	10	30	(Settler (6 hrs. daily office work.	Quiescent or arrested cases with no toxaemia and very few clinical signs.
13. F.H.	1	3	5	6	8	10	32	6 hrs. daily printing.	
14. R.M.	0.5	0.5	1	1	1	2	4	Settler.	
15. A.K.J.	0.5	1	1.5	1.5	2	2	14	Settler.	
16. A.L.	1	2	3	4	4.5	5	30	Prospective colonist.	

The figures indicate sedimentation rate readings in millimetres per cent.

It is apparent from the above cases that the more advanced and active the lesions are clinically the greater is the toxaemia and the more rapid the sedimentation rate. In cases 1 to 6, sedimentation was almost complete in three hours, and in cases 1 and 2 it was practically finished in two hours. Furthermore, in each of the six cases the most rapid fall occurred during the first hour.

The last five examples, which were taken from cases with very little or no activity and showing no definite signs of toxaemia, also include colonists and prospective settlers. In these types the sedimentation rate approaches the normal, in that the fall occurs slowly and regularly throughout the twenty four hours, comparatively little sedimentation having occurred in the first hour.

Cases 7 to 11 inclusive, represent patients with mildly active lesions and although showing fair powers of resistance yet they had occasional flurries of toxaemia. Case 7 showed a greater fall in the first hour than during any other, thus conforming to the sedimentation of acute cases; he proved to be more unstable than any of the other mildly active ones. In case 8 the changes during the first and second hours were equal, whilst in 9, 10 and 11 sedimentation occurred faster during the second hour; these cases however showed no difference clinically in the amounts of toxaemia present from

case 8. In all these cases the major amount of sedimentation occurred within the first three hours.

Thus, whether the lesion be quiescent, arrested or with varying degrees of activity, the first hour reading gives a true indication of the amount of toxaemia present and the physical status of the patient. Furthermore the first hour reading gives a wide variation between normal and pathological figures and so wrong interpretation of results is minimized. In my tests I have never found a first hour reading that was not borne out clinically. Zeckwer and Goodell (14) are also of this opinion. They state that within the first hour the difference between normal and pathological blood is most striking. In cases with very rapid rates the maximum fall occurred within this short interval, while in more normal blood sedimentation has scarcely begun.

Some authorities prefer several readings taken during the twenty four hours which are then charted against time. However, by experience the first hour reading will itself give some inkling as to the type of curve; the higher the sedimentation rate during the first hour the nearer will the subsequent chartings approach a right angle. Furthermore the twenty four hour reading is a measure of amount rather than rate and indicates cell volume.

I have not been able to perform the test extensively on definitely normal cases for the purpose of control but most reliable authorities are in perfect agreement over this point. Up to 3 millimetres per cent sedimentation during the first hour is considered normal, from 4 to 10 millimetres is of doubtful normality, while above 10 mm. the case is definitely pathological.

In my clinical researches I have used the sedimentation rate in the first hour to study cases over varying periods of time and undergoing various forms of treatment. This reading always gave the most accurate indication of the clinical condition, as compared with any other single or series of readings during one test.

The increase of sedimentation which occurred in pathological conditions with tissue destruction, caused the test to be applied to a number of toxaemic conditions.

My first experience of the test occurred when as a student at the Rotunda Hospital, Dublin, an increase of the sedimentation rate often raised suspicion of some pelvic sepsis during the puerpurium. The rate was also found to be increased during menstruation. It was agreed, that it was of no use as a test for pregnancy, because the sedimentation was not accelerated before definite clinical evidence of pregnancy was present. However in puerperal sepsis the rate was much increased and took a very long time to return

to normal.

Westergren, Levinson (15) and other workers confirmed the observations of many of the older physicians. They found an increased stability of the red blood cells in acute infectious diseases especially when associated with high fever; the rate also increased in syphilis, acute nephritis, pneumonia and in cases of malignant tumours with cachexia.

Payne, Bach and Hill (16) have investigated acute rheumatism in children from various aspects. They found the sedimentation rate to be increased markedly during the active phases, but when the clinical picture was that of quiescent rheumatism or rheumatic carditis unassociated with clinical signs of activity, the rate approaches normal limits. Furthermore the sedimentation rate may be of value in the diagnosis of doubtful cases.

Thus it is seen, from a close scrutiny of the rationale and clinical experiences of various workers, that the sedimentation test is a true index of toxaemia.

Before going on to discuss actual cases, I wish to draw particular attention to several details which are of the utmost importance in the clinical study of pulmonary tuberculosis in the adult. These points are intended to show the intimate relationship between the pathology, bacteriology and the toxic or systemic factor produced

therewith. As the basic principle of this investigation in general is to show the relationship between the sedimentation rate of the red blood cells and the amount of toxaemia and resistance present in the phthisical individual, it behoves me to briefly demonstrate how the general toxic factor is the all important one.

The tubercle bacilli gain entrance into the body by inhalation or ingestion, although sometimes too by inoculation; there occurs almost invariably sooner or later a lung lesion, irrespective of the other organs affected by tubercle. This spread to the lung occurs either by direct inhalation, as shown by Koch, Findel, Schmorl and Birch-Hirschfield (17), or by ingestion as shown by Calmette. Many workers such as Aufrecht, Baumgarten (18) and Wingfield (19) claim that spread to the lung always occurred via the blood stream.

Another important factor is the elaboration of toxin by the causal organism. Studies which have been for the most part accepted up to the present, show that these toxins are of various types and are contained in the body of the bacillus proper (20); they are called endotoxins. Fishberg (21) states that the general disturbance in the various functions of the invaded body can only be explained as caused by some poison liberated

by the bacilli. He goes on to say that the toxins or poisons appear to be part and parcel of the living protoplasm of the bacilli, and are set free only after the latter have been destroyed.

With the localization of the bacillus in the lung parenchyma and resulting elaboration of toxins, there is first of all produced a local tissue reaction; and secondly a general reaction and changes in the body fluids.

The local tissue reaction results in the formation of the elementary tubercle, which is the fundamental lesion and consists of a "giant-cell" system. This in turn consists of three types of cells, - the epithelioid or endothelioid, the giant cell and the lymphocyte. The fusion of several of these elements forms the grey tubercle, seen typically in miliary tuberculosis. However in pulmonary tuberculosis the grey tubercle increases in size; necrosis of the central portion occurs, owing partly to the absence of blood supply, but chiefly to the poisonous products of the bacillus, -- the said toxins producing the avascularity itself. This process results in Weigert's "coagulation necrosis" (22). Sometimes a certain amount of fibrinous exudate is added forming a mass of caseous material in the centre of the tubercle; the whole process is spoken of as caseation. However if the body forces

and resistance are sufficient to be on the offensive (vide infra) the disease becomes retrogressive. The tubercles now become surrounded by fibrous tissue and so walled off; at a still later stage the caseous mass may become calcified by the deposition of lime salts.

The other phenomenon occurring is the general reaction and change in the body fluids. As a result of elaboration of toxins in the pulmonary lesion, there ensues absorption of these poisons by means of a hyperaemic area surrounding the tubercle and their general diffusion throughout the body.

A slight digression must be made to mention briefly the question of immunity, resistance and re-infection. This subject is very complex and not thoroughly understood. However, it is believed that in adults there is a relative immunity to re-infection by tubercle bacilli as compared to that of a child, although the mechanism cannot be satisfactorily explained (23). Osler (24) states. "In an infected person certain changes occur in the blood serum depending upon the development of so-called antibodies, the presence of which may be demonstrated by the method of complement-fixation; and the serum also contains agglutinins which possess an agglutinating action on the tubercle bacillus. Either directly themselves or through

their toxic products there are brought into play certain cellular and humoral reactions which are capable of destroying the infecting agents or of neutralizing their effects or of limiting their activities".

Through post-mortem studies or by means of the Von Pirquet tests, anywhere from 75 to 90 per cent of adults in civilized countries have had at some apex of the lung a tubercular focus. By means of the protective properties present in the serum, in all but approximately one-tenth, the lesion becomes arrested, quiescent or "healed". This reaction produces the fibrotic and calcified pulmonary foci, mentioned above.

Thus by the time adult age is reached there is developed a relative immunity and general resistance in the body fluids sufficient to hold the bacilli in check. These factors are also dependent on hereditary predisposition and natural selection, state of nutrition and environment. Many authorities (25) consider phthisis to be a manifestation of immunity, otherwise miliary tuberculosis would be more common in the adult.

On the other hand, if the resisting powers be lowered by various etiological conditions such as general debility, due to malnutrition, overwork, or any other condition

robbing the body of its natural defences and deviating antibodies which are needed for the repulsion of tubercle bacilli and their toxins, there ensues a state of "anergy". This implies a diminished resistance to re-infection; two theories are put forward to account for the manner in which the latter is produced. Re-infection may be explained by the endogenous theory, that is re-lighting and spread of the primary lung lesion; or by the exogenous theory, that is re-infection occurs from without — tubercle bacilli being so ubiquitous that we can hardly escape them.

The tables are now turned and the bacilli assume the offensive; local spread occurs in the lung, and more and more of their toxins are absorbed into the blood stream to be circulated throughout the body. There is produced in the patient all grades of symptoms from the slightest reaction to the most profound toxaemia with high fever and ending in death. This toxaemia is manifest by many constitutional symptoms. Fever is a most valuable measure of severity and progress of the disease, under which may be included an increased pulse rate and general malaise. Drenching sweats occur, especially at night time. Weakness, wasting, loss of appetite and anaemia are also present.

Thus it cannot be too strongly stressed that the important feature in the clinical picture of pulmonary

tuberculosis is the toxic or systemic factor. This is closely related to resistance, the greater the systemic factor the less the resistance, and vice versa.

The general impression I have received in my brief clinical experiences and reading, is that formerly too much value was placed in the pathological and clinical impressions often based only on a few physical signs, obtained as a result of an overenthusiastic confidence and reliance in the use of stethoscope. This was especially true in prognosis, and resulted in phthisis being viewed as purely a local disease in its effects and site. Nowadays a truer concept of the effects and results of pulmonary tuberculosis, is prevalent and we look at the disease as a systemic affliction, stressing importance of the generalized toxic factor.

This more recent and obviously sounder outlook is the more reasonable. Quite frequently it is some component of the systemic factor that brings the patient to the physician for treatment; and physical signs are read in terms of, and in relation to constitutional disturbance. The clinician realizes that the protective and defensive mechanism of the body are beginning to crack and break before the onslaught of the disease. Pulmonary tuberculosis may be looked upon as a constant struggle between

the bacilli and their toxins on the one hand, and the body fluids containing their resisting forces, on the other. The lung may be viewed simply as a battlefield and the body as the country or nation which suffers privations (toxaemia) as a result of a losing fight.

It is not the lung primarily that is of importance. Experiments and clinical experiences show that although more than half the total lung surface be functionless, as occurs in one-sided pneumothorax and partial disease of the other, the individual can still carry on quite comfortably; it is the effects of the toxaemia on the body that provides the key to the situation. It is agreed that the patient dies of toxaemia or its effects rather than asphyxia. Again, taking for example the severe carbuncle, the patient dies, not due to the local lesion, but to the general toxaemia.

To sum up, the estimation of the toxic or systemic factor is of utmost importance to the clinician inasmuch as it is direct evidence of the ability of the bodily resistance to cope with the toxins of the advancing bacilli. Again, it is a more constant factor; physical signs are often variable, sometimes extremely difficult of correct interpretation, or perchance few in number. Sir Robert Philip introduced this feature in his classification of

tuberculosis. He indicates the local or as in phthisis the lung lesion, by L (small) or L 1,2, or 3, thus denoting the various degrees of the lesion; similarly he uses an s or S 1,2, or 3, to denote the systemic or toxic factor. He points out further, that the toxic factor is more important than the local factor in the clinical aspects of pulmonary tuberculosis.

Hence there is needed in the study and treatment of phthisis some further guide to the amount of toxicity present in the individual patient. A laboratory test that will do this and so estimate the resistance of the patient would be of great value. The usefulness of this guide must be fully tried by testing its compatibility with routine clinical examination and experience.

The test may be of service in early diagnosis by determining whether the disease is becoming active and thereby producing a mild toxaemia. Once phthisis is established, a laboratory guide to the amount of toxaemia and resistance present at various times will materially aid and strengthen the prognosis. Furthermore, treatment could be regulated and specialized forms instituted in accordance with the information supplied by the test; new forms of treatment might be controlled by

such an aid.

In so far as the stability of the erythrocytes in the blood plasma is affected by toxic states, the sedimentation test should fulfill some or all of these undoubted needs. I shall now show to what degree of success in these problems, the sedimentation test attains in pulmonary tuberculosis.

The sedimentation test, in its application to pulmonary tuberculosis, was, as I have stated, first tried out for diagnostic purposes. Westergren, Levinson and Willems (26) have shown the lack of specificity of the test for phthisis, and so to be of little use in differential diagnosis. They found an increased sedimentation rate in many other pathological conditions, and also in the physiological conditions of menstruation and pregnancy. Furthermore, they maintained that a normal rate is unlikely in active phthisis.

As the majority of patients under my care had definite pulmonary tuberculosis, it was impossible for me to investigate in any detail the diagnostic conclusions put forward. I have found in most cases that a sedimentation rate of five and under was against a diagnosis of active phthisis, and in my investigations I considered five as the limit of normality. However,

as will be shown later, I consider it wrong to diagnose inactivity solely on the test when the rate is normal, in certain types of cases the clinical picture and skiagrams must always be taken into account. On the other hand when the rate is in the neighbourhood of ten and over, active pulmonary tuberculosis may be definitely suspected; but then other means must be used to eliminate different conditions that also affect the sedimentation rate.

The following case illustrates the lack of specificity of the test.

A boy F.K. aged nineteen, was admitted under my care last October. He gave a history of loss of weight, bouts of fever, cough and occasional blood-stained expectoration for some weeks prior to admission. His skiagrams showed what appeared to be thickened pleura and some mottling over the right upper lobe. The physical signs were vague, suggesting pleural thickening over the right lung with consolidation beneath; a pleural rub and pain were present from time to time. The sedimentation rate on admission was 30, and after slight improvement settled to 23. About two months after admission he began to expectorate large quantities of offensive sputum; often several ounces would be

brought up during a bout of coughing. The patient also began to have febrile reactions, during which the sputum and breath would become offensive; then he would settle down for a time and the process would repeat itself. During his entire stay in sanatorium his sputum was repeatedly negative both by Ziehl-Neelsen stain and the concentrated "petrol-ether" method. The sedimentation test, performed every three or four weeks, varied from 16 to 30. With the changing character and quantity of the sputum, febrile reactions and complete absence of tubercle bacilli, phthisis was ruled out and a tentative diagnosis of pulmonary abscess was made. Physical signs were still indefinite, although signs of cavity were suspected beneath the thickened pleura on the right side. I might add, the left side had always been free from disease, both by physical examination and skiagrams. Lipiodol was then given to differentiate a possible bronchiectasis. A further x-ray confirmed the diagnosis of pulmonary abscess, and on February 14th 1933 the boy was transferred to a general hospital for further treatment.

The lesson taught by this case is twofold. Firstly, the sedimentation test has no value in differ-

entiating phthisis from bronchiectasis and pulmonary abscess. Secondly, the test does indicate the amount of toxaemia present, no matter what the cause. Althertum (27) corroborates these findings. He indicates that the test fails to distinguish between abscess, gangrene, tumours and tuberculosis of the lungs; similarly there is no differentiation between certain toxic diseases elsewhere in the body.

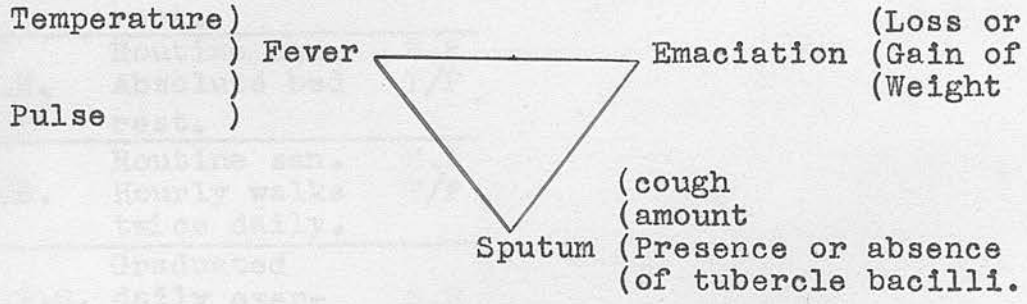
When the problems of prognosis arise, the sedimentation test has much more to offer; but first of all the question of the presence and degree of activity must be gone into, and whether the test be of value, therein.

Many authorities disagree as to an accurate definition of activity, but in the majority of tuberculous individuals activity manifests itself invariably by symptoms of bacterial intoxication. If there are no symptoms of constitutional toxaemia the patient may have been infected with tubercle bacilli - and who has not been? - but he is not ill with the disease and therefore does not require treatment. (Vide infra Case A.X.)

I have therefore confined my investigations of the test, in relation to activity, to the two chief symptoms

of toxaemia, namely, fever and emaciation, constituting the S or systemic factor; and to the chief local or L factor, which is evidenced by sputum.

Richard Morton graphically demonstrated this in his triad.



I will first consider the relation of the sedimentation rate to fever, taking into account its two chief manifestations, increased temperature and pulse rate. Fever, in phthisis, depends on the activity of the lesion, mobilization of tubercle bacilli, mixed infection with pyogenic organisms, softening of lung tissue, with free drainage of necrotic foci and other resulting products into the circulation.

The following table shows, primarily, the relation between the temperature and the sedimentation rate both on admission and during treatment in the sanatorium. These cases of phthisis have not been specially chosen but are representative of groups of patients, showing all degrees of severity of the disease and undergoing various types of treatment.

T A B L E II.

CASE	TREATMENT		ON ADMISSION	1.	2.	3.	4.	5.	6.	NOTES OF PROGRESS.
			MONTHS AFTER ADMISSION.							
1. Wm.As.	Routine san. Absolute bed rest.	S.R T/P	28 99.2/108	50 99./110	50 99./115	44 99./135	23 99./135	40 99.4/130		Patient never improved at any stage. Died.
2. Wm.Ar.	Routine san. Artificial Pneumothorax.	S.R T/P	40 101.8/112	25 101.2/115	15 99.4/106	6 98.8/102	37 102./128	42 101.2/135		Improved remarkably for a time. Relapsed and died.
3. H.C.	Routine san. Absolute bed rest.	S.R T/P	25 100./104	31 100.4/108	30 100.6/112	35 101.2/112	28 101.6/116	36 99.8/116	32 100.6/110	Extensive disease showing no improvement.
4. E.C.	Routine san. Absolute bed rest.	S.R T/P	35 98.8/88	42 98.8/85	36 99.2/92	43 99.4/100	45 99.4/94	40 99.8/106	37 99.6/100	Very unstable.
5. G.M.	Routine san. Absolute bed rest.	S.R T/P	33 98.8/84	30 99.6/86	28 99.8/90	14 99./86	25 99.4/82	27 99.2/84	30 100.2/84	Active pyretic gloomy outlook.
6. F.B.	Routine san. Hourly walks twice daily.	S.R T/P	24 99.2/86	27 99.4/94	20 98.4/80	3.5 98./90	5 98.2/88			Marked improvement.
7. E.A.C.	Graduated daily exercise up to 3 hrs work.	S.R T/P	35 99.4/80	19 98.4/84	6 98./72	5 98.2/72				Asbestosis plus phthisis. Progressed very well. Requested discharge.
8. J.R.	Bed for months. Up to 3 hrs work.	S.R T/P	40 102.4/120	36 98.6/96	25 98.4/96	19 98.2/92	9 98.2/84	4 98./80		Very active and pyretic at onset. Settled and improved generally.
9. R.P.	Routine san. Absolute bed rest.	S.R T/P	12 98.8/92	23 99./96	20 98.6/100	29 99.2/96	38 99.6/94	28 98.6/92		Active pyretic with marked extension.
10. J.V.R.	Up resting. on housework at intervals.	S.R T/P	18 99./92	20 98.8/94	21 99.2/96	19 99.2/96	28 99./94	33 100.2/110	35 99.6/100	Disease extending with increasing activity.
11. J.D.	Varied either 3 hrs poultry or carpentry daily.	S.R T/P	17 98.4/92	15 98.2/80	11 98.4/80	9 98.4/76	8 98.2/74			Cavitation. Did very well. Requested discharge.
12. A.T.	Artificial pneumothorax 4 hrs carpentry.	S.R T/P	15 98.6/84	14 98.4/84	10 98.4/90	12 98.2/86	8 98.2/84	4 98.2/84	4 98.2/80	Improved markedly. Requested discharge.
13. P.S.	Routine san. A.P.T. and Sanocrysin.	S.R T/P	12 98.4/76	8 98./88	7 98.6/94	6 98.4/80	13 98.6/82	6 98.2/80	7 98.4/80	Improving very slowly.
14. S.P.	Routine san. Absolute bed rest.	S.R T/P	10 99.4/94	21 99.2/96	25 99./104	23 99.2/100				Tendency for disease to extend.
15. F.B.	Routine san. Absolute bed rest.	S.R T/P	10 100.6/110	28 99.2/100	30 98./96					Extensive disease with fibrosis and cavitation.
16. D.F.	Exercise up to 3 hours daily.	S.R T/P	10 98.4/88	10 98.6/88	14 98.4/84	15 98.4/84	11 98.4/92	11 98.2/90	10 98./90	Holding steady with a fair amount of activity.
17. F.C.L.	Advanced to 6 hrs printing daily.	S.R T/P	6 98.2/76	7 98.2/80	5 98.4/80	2 98.4/78	3 98.4/76	1 98.2/74	3 98./74	Showing excellent resistance. Sputum positive.
18. T.C.G.	4 hours carpentry daily.	S.R T/P	7 98.4/86	8 98.4/80	7 98.2/74	8 98./80				Good resistance but activity still present.
19. R.M.	4 to 5 hrs poultry daily.	S.R T/P	7 98.4/76	7 98./76	5 98.4/72	5 98.2/72	2 98.4/74	3 98.2/74	2 98.4/76	Incipient phthisis.
20. F.N.	3 hours poultry daily.	S.R T/P	7 98.4/80	7 98.4/76	9 98.6/80					Complicated by chronic bronchitis & bronchiectasis.
21. H.G.	4 hours carpentry daily.	S.T T/P	4 98.4/76	3 98./80	2 97.4/60	2 98./68				Incipient phthisis after onset of pleurisy.

S.R. denotes the sedimentation rate in millimetres per cent.
P. signifies the average pulse rate during the month.
T. denotes the average evening temperature for the month.
In some of the febrile patients the average temperature reading, as indicated in this table, is not as outstanding at first sight as was actually the case. This occurs when a patient has marked pyrexia for 2 or 3 days and then an almost normal temperature for several days. Therefore the average evening temperature, when raised even slightly, must be looked at in the light of indicating regular pyrexial reactions.

In discussing cases of pulmonary tuberculosis, I have described the sedimentation rate as being low, medium, or high. These adjectives are not intended to compare the sedimentation figures given with the normal but rather to infer in general terms the amount of toxaemia present. High sedimentation rate includes all those over 20; medium includes the rates between 10 and 20; while low denotes the sedimentation readings up to 10.

It will be seen from table II that cases 17 to 21 inclusive, having a low sedimentation rate on admission, for the most part had no elevation of temperature. Furthermore, no matter how extensive the lesion was anatomically, a low sedimentation rate and a normal temperature were maintained throughout the period of observation.

Other patients having a medium sedimentation rate on admission or during their stay in sanatorium varied as to whether or not periods of pyrexia occurred. Cases 11, 12, and 13 showed a lowering of their test readings and a steady normal temperature. However a number in this group, 9 and 10, had some elevation of temperature on admission, which was maintained at intervals, coinciding with a rising sedimentation rate.

Now when we look at the first eight cases who were admitted with a high rate and also for the most part a high temperature, both high sedimentation rate and temperature were maintained for some time. In cases 4 and 5 the average temperature readings on admission did not indicate the gravity of their condition: it was not till after admission that they showed any febrile reactions, in keeping with the severity of their lesion. Numbers 7 and 8 were admitted with elevations of temperature which soon settled accompanied by a lowering of the sedimentation rate.

Thus generally speaking, I have found a low sedimentation rate associated with a normal temperature, and an increasing rate with a rising temperature. This prevailed whether on admission or during the course of the disease. Furthermore I have never seen a normal sedimentation rate (under 5) in pulmonary tuberculosis accompanied by a high temperature, colds and minor complaints affecting the temperature being ruled out. On the other hand, as frequently as not, a normal temperature is accompanied by a raised blood stability reaction. Thus I have always found that the test was more certain to indicate the amount of toxaemia than the temperature.

Judging the possible or probable course of the disease by means of the initial sedimentation test is impossible in a large minority of cases. The prognosis depends chiefly on the degree of activity and the amount of resisting antibodies the body fluids can form. The difference between these two factors is evidenced by toxaemia, whilst the sedimentation of the red blood cells indicates the amount present. The sedimentation is directly proportional to the toxaemia, and from this the amount of activity and resistance are inferred.

I have found that cases with a low rate on admission as a rule did well in relatively a short time, as seen in cases 18, 19, 20 and 21. There is a small number, for example 14 and 15, with low sedimentation rates on admission who do rather badly. The subsequent increase in the sedimentation readings was borne out clinically by toxaemia and extension of the tubercular focus. The latter rather exceptional types may be due to early observation of what proved to be a very active lesion; the body defences have not been completely depleted and so toxaemia is not marked at that particular time. As the disease advanced, the sedimentation rate increased indicating the full amount of activity and lack of resistance.

Those patients with a medium sedimentation rate (10 to 20) on admission varied in their subsequent history. Cases 11, 12 and 13 did well clinically with lowering of their sedimentation figures; cases 9 and 10 did badly. The latter two showed a rising sedimentation rate and clinically pyrexial elevations at intervals and progressive extension of the disease.

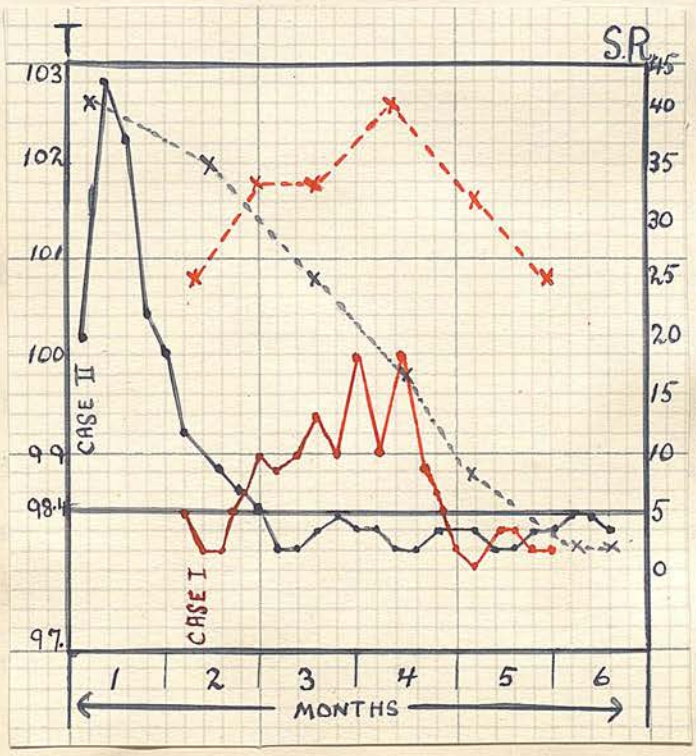
When the sedimentation rate on admission was high the patients as a rule did not respond readily to treatment. The readings remained high continuously and in several, the gloomy prognosis given was verified by a fatal termination. However a small minority of cases belonging to this group, as for example 7 and 8, did very well; again the progress is accurately recorded by changes in the sedimentation test signifying diminished toxaemia.

Thus a single test is useless for the purpose of prognosis. It is true generally that a low rate at the onset of illness is favourable and a high rate unfavourable; but there are too many exceptions to allow the clinician to be satisfied with this alone. One must ascertain whether or not the condition is progressing. A series of tests performed at fortnightly or monthly intervals, depending upon the type of case, will indicate

the course of events and the prognosis. In each case in Table II the readings of the sedimentation tests alone, indicate the progress of the patient. I have found that when the sedimentation rate is repeatedly high or showing increased readings, the prognosis is gloomy indeed. Again, in those cases that showed a persistent lowering of their sedimentation rates or a persistently low one, the prognosis was good.

Temperature has always been a reliable guide to activity but the sedimentation test is even more valuable. Treatment in the form of absolute bed rest often brings the temperature down to normal, yet marked toxaemia may still be present. I have found it advantageous to be guided by the sedimentation rate after the temperature has settled.

Chart A demonstrates lagging of the sedimentation rate behind temperature.



T = temperature:

S R = sedimentation rate in millimetres per cent:

Case I :- solid red denotes temperature, dotted red the sedimentation rates.

Case II :- solid blue denotes temperature, dotted blue the sedimentation rates.

In both cases the temperature curves represent the average weekly "evening rise" charted over a period of several months.

Case I aged 57 years. The patient had a long history of pulmonary tuberculosis with cavitation at the right apex. He was in poor condition and had had a sedimentation rate varying between 20 and 25 for quite some time. For some two months, he remained steady, doing short walks daily and showing no temperature reaction. However during the recent epidemic he developed influenza and so further depleted what slight body resistance he possessed, resulting in an increased activation of his tubercular lesion. This was evidenced clinically, and by a still further increase of his sedimentation rate. When the temperature did settle by means of prolonged bed rest, the sedimentation rate took six weeks longer to return to its previous level.

Case II aged 40 years. The patient came in with a very active lesion indicated both by a high sedimentation rate and pyrexia. As a result of treatment his temperature settled in two months; however the sedimentation rate did not drop to a low level for a further eight weeks.

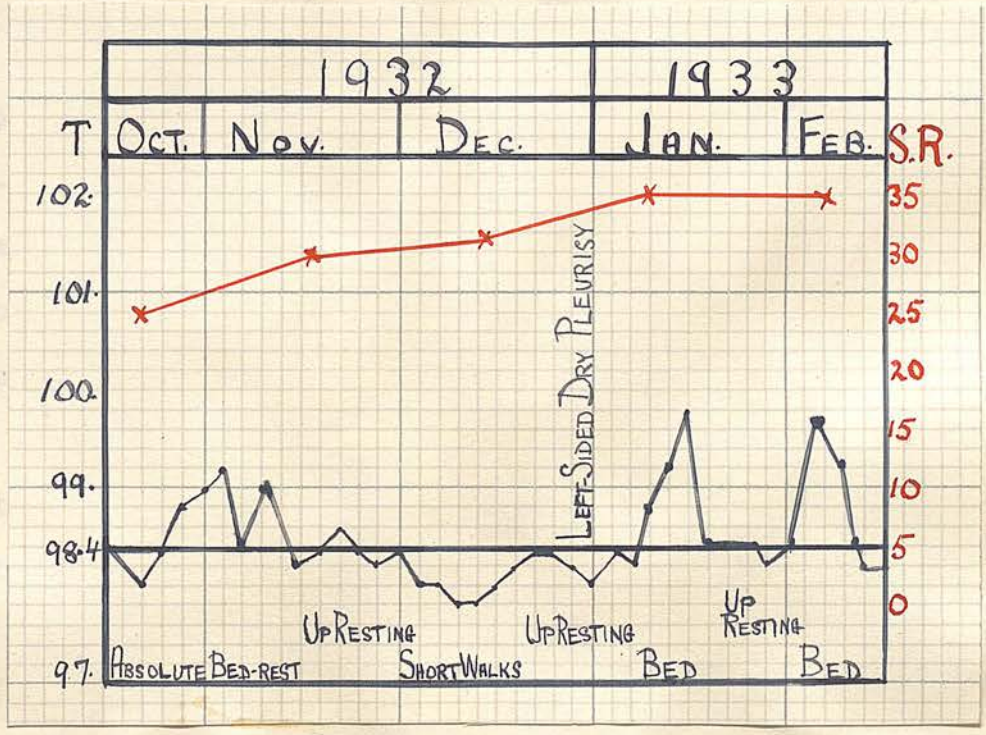
Thus the sedimentation test is of more value to the clinician than the temperature; the settling of the

stability reaction of the red blood cells several weeks or months after the temperature indicates that toxaemia is still present. The importance of this, apart from prognosis, lies in the fact that the clinician must not be over hasty in putting the patient on to graduated exercise and work even if the temperature has been normal for some time. He must be guided by a lowering of the sedimentation rate before allowing a move of this sort to be taken; otherwise reactions and relapse are certain to occur.

Motzfeldt (28) states that the sedimentation usually returns to normal a month after the temperature, whereas he claims that Scheel allows his patients to get up after the temperature has been normal for a fortnight.

I have found the sedimentation rate to take longer than one month to settle and then, it may only return to the level present before pyrexia occurred. Furthermore I have found, to my regret, that a normal temperature is not sufficient evidence as to whether a patient should be allowed up or not.

Chart B demonstrates an example out of several patients in whom the temperature was normal and the high sedimentation rate disregarded.



T = temperature. The curve in solid blue indicates the average evening rise estimated every three or four days for several months.

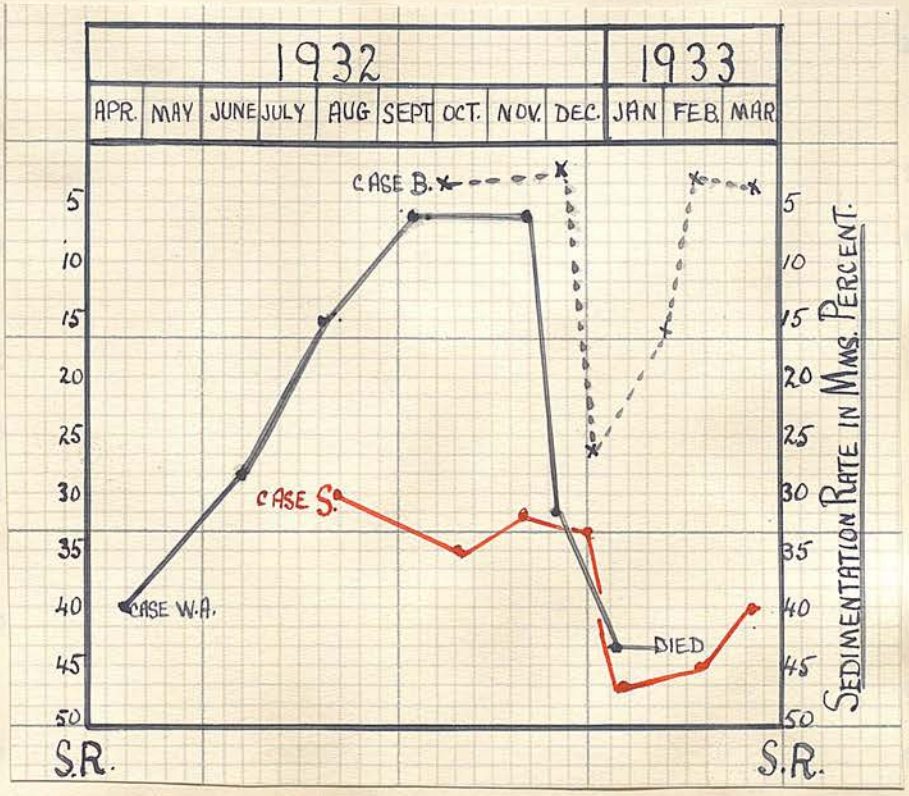
S R = sedimentation rate in millimetres percent.

The patient was kept on absolute bed rest until the temperature and pulse had been normal for a short time. Disregarding the maintained high sedimentation rate I allowed him up for a few hours during the day; this really implied resting, the only exercise consisted of going to the dining room for his meals. Half-hourly walks twice daily were also allowed occasionally. Invariably there ensued febrile reactions, increased pulse rate, increased weakness and the patient had to return to bed.

Thus with a returning of temperature to normal limits the sedimentation test must be relied on for further evidence of toxaemia before allowing the patient to be up and about, and also in giving a prognosis.

In certain other instances I have found the sedimentation rate to be more useful than temperature, in that a sudden marked increase of the patients readings is a warning of an impending calamity.

Chart C shows three representative cases in which the sedimentation test was the first clinical evidence of some complication or change for the worse.



Case W.A. (solid blue) aged 20 years. Patient had an extensive right-sided lesion and a high sedimentation rate on admission. There was no definite evidence of activity on his left side either by skiagrams or physical examination. After months in bed he improved very slowly and was at the stage where he was allowed up daily for two hours. The sedimentation rate had settled to 6 in September and when he

came under my care over a month later it was still 6 and his condition was very good. On routine examination during the first few days of December his sedimentation rate was found to have risen to 32. Four days later the temperature and pulse were much increased; physical signs were now present on the left side, which had previously been clear, and the patient died six weeks later running a hectic temperature. A post-mortem was not performed, but what probably happened was a tuberculous broncho-pneumonic spread on the left side.

Case B (dotted blue) aged 32 years. This patient had been working five hours daily in the shops. There were very few physical signs in his chest and his resistance was excellent clinically, supported by a normal sedimentation rate for several months. Without any apparent cause on December 25th 1932 his rate increased to 27. However a week later he developed a tubercular epidydimitis, which settled in three weeks as regards temperature and local symptoms. On the other hand, his sedimentation rate did not settle until the middle of February.

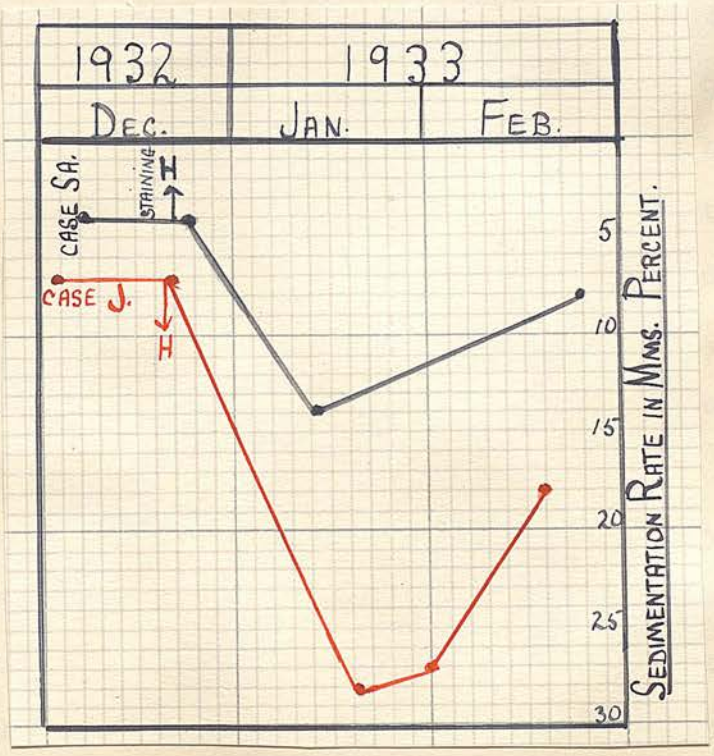
Case S (solid red) aged 57 years. This patient was never very well. Extensive disease was present on

both sides with right sided cavitation. From October to December I found his condition stationary with only slight constitutional reaction, and a sedimentation rate varying between 30 and 35. Then during the first few days of January his rate increased to 47 and a few days later the patient ran a hectic temperature, which became "inverse" in character, plus increased physical signs. This continued for eighteen days and the temperature then became subnormal. The whole picture denoted a relapse of grave significance which was corroborated by repeated high sedimentation readings.

Thus I have found that a sudden increase of the sedimentation test above the individual patient's customary level, is prodromal of some ensuing complication. This verifies Tegtmeier's view (29). He states that an increased rate might precede by some six to eight days a change for the worse in the clinical picture.

However there is one type of complication which an increased sedimentation rate fails to prophesy. This is the rupture of an aneurysm of the Rasmussen type, which is located in a dry and contracted cavity in a quiescent case.

Chart D illustrates two cases in which the sedimentation rate failed to predict the onset of certain forms of haemoptysis.



H = Haemoptysis.

Both cases are almost identical. Both had negative sputa, very few physical signs, and low or normal sedimentation rates for several months; they were also working six hours daily as prospective colonists. Both had small cavities as seen by skiagrams. The sedimentation test was done just after the haemoptysis and found to be low in one case and definitely normal in the other. The sedimentation rate was raised subsequently, but not

until the temperature and the presence of tubercle bacilli in the sputum had already indicated re-activation of the pulmonary lesion. Physical signs were increased, and activity definitely seen in skiagrams. Thus the sedimentation test does not help us in forecasting this type of complication. I have not been able to find any literature to contradict or verify this statement. However since the sedimentation rate is raised as re-activation goes on, the amount and also the resisting powers of the body can be estimated and so further treatment decided upon.

The other important manifestation of fever, as an indication of toxaemia and activity in pulmonary tuberculosis, is tachycardia. Looking back to Table II and generally in all patients, I have found a close relationship between an increased sedimentation rate and a rapid pulse. A raised reading is associated with a rapid toxic pulse and as the sedimentation rate falls the pulse returns to normal. However, as with temperature, the toxic pulse may be considerably reduced in spite of active disease and yet the sedimentation rate remains high. Here again I am of the firm opinion that subsequent treatment in the form of

graduated exercise must be regulated by the sedimentation rate. However, apart from activity, toxaemia and treatment, there are several other factors that may influence the pulse rate. These may be a certain nervous element, or even of a mechanical nature, such as pleuro-pericardial adhesions, fibrosis and emphysema. The importance of the sedimentation rate comes in those patients whose only clinical sign, apart from the chest, for a period of months is a fast pulse; aside from this, there are no other systemic manifestations, the temperature remaining normal and no loss of weight occurs. An increased sedimentation rate will differentiate a toxic pulse from the other types mentioned; the toxaemia present is ascertained and the subsequent exercise or work regulated.

Table III demonstrates cases whose only clinical manifestation of toxaemia is a rapid pulse.

T A B L E III.

CASE		WEEKS OF OBSERVATION. 1	2	3	4	5	6	7	8	REMARKS
1. E.L.	T	97.6	98	98	98	98.2	98	98	98.2	Progressed very slowly. Was on hourly walks twice daily.
	P	86	84	92	95	90	96	98	90	
	SR		29			36			30	
	Wt	113	113	112	113	112	113	113½	114	
2. J.H.	T	98.2	98.4	98.2	98.2	98.	98.	98.2	100.4	Varied either half-hourly walks daily, or complete rest. Relapsed.
	P	100	95	96	100	96	100	96	100	
	SR	32		37		35		47		
	Wt	146½	146½	146	145	135½	135	144	145	
3. I.H.	T	98.4	98	98.4	98.2	98.2	98.4	98.4	98	Carried on either resting or short walks.
	P	90	85	92	90	96	92	90	92	
	SR	35			32		25		30	
	Wt	110	110	111	111½	112	111	111½	112	
4. R.S.	T	98.	98.4	98.4	98.2	98.2	97.4	98	99.4	Patient did short walks - tended to expectorate blood stained sputum.
	P	85	92	88	92	90	96	96	98	
	SR		32			29			40	
	Wt	134	137	136	137	136	136½	136	136	
5. E.B.	T	98.2	98.2	98.	98.	98.4	98	98.4	98.2	Hourly walks twice daily.
	P	92	88	92	96	96	96	94	90	
	SR	20		16		24	27		14	
	Wt	119	119	120	121	122	121	122	122	
6. A.O.D.	T	98.4	98	97.8	98.2	98	98.4	98.4	98.2	Hourly walks twice daily.
	P	92	90	88	88	96	92	90	96	
	SR	20			32		28		35	
	Wt	135	136	135	136	136	135	134	135	

T = Average evening temperature.

P = Average pulse rate.

These cases are quite similar as regards the point I wish to emphasize. The sedimentation rate was consistently high, and a rapid pulse the only clinical sign apart from signs in the chest. A guarded prognosis was given in each case and the amount of exercise limited. In several other patients, likewise only exhibiting a rapid pulse and in whom the high sedimentation rate had been disregarded or the test not done, I have found that, when the amounts of exercise were increased, they invariably reacted. For that matter, cases 2 and 4 did not do well at all, but that only proves that what exercise they were on was too much for them and in view of their high sedimentation rate absolute rest was indicated.

Again, in many cases that have lasted for months or years, I have found fever to be no criterion as to the amount of activity, and toxaemia. The organism seems to have adapted itself to the disease and does not react any more to the same degree as it would have done earlier. Case 4 Table II, and Case S Chart C (before relapse occurred) illustrate this

point. In this type of patient the sedimentation rate stresses the severity of toxaemia present and that the defensive powers are in abeyance, even although there may be only slight febrile reactions. I have also found that a rising sedimentation rate and a temperature coming down to normal limits and then being maintained at a definitely subnormal level, are definite indication of an early fatal termination.

The second element of the triad of activity, consists of cough and sputum. Cough may be dismissed briefly by saying that it is too often a variable factor to bear any constant relation to the sedimentation test. Sputum, comprising the presence or absence of bacilli and amount, is of more importance relatively, in a percentage of cases.

Table IV illustrates the relation between sputum and the sedimentation test on admission, and again after several months sanatorium treatment.

TABLE IV.

	ON ADMISSION.				AFTER SEVERAL MONTHS.		
	SPUTUM.				SPUTUM.		
CASE	Amount	Bacilli	SR.	CLINICAL NOTES.	Amount	Bacilli	SR.
1. E.C.	2 oz	+	35	Disease advancing.	2 oz	+	40
2. R.P.	3 oz	+	12	Disease advancing.	2 oz	+	28
3. A.T.	2 oz	+	4	Improving generally. Doing three hours work daily.	2 oz	+	2
4. J.E.	2 oz	+	22	Improving slowly. Up and about.	Nil	-	9
5. G.L.	4 oz	+	10	Improving - three hours daily at shops.	1 oz	+	2
6. F.C.L.	1 oz	+	5	Marked improvement, six hours printing daily.	1 oz	+	2
7. W.P.	4 oz	+	15	Slow gain. Hourly walks twice daily.	1 oz	+	3
8. P.S.	3 oz	+	12	Improving slowly. On short walks.	1 oz	+	6
9. T.C.G.	3 oz	+	10	Very much better - five hours carpentry daily.	2 oz	-	7
10. J.D.	6 oz	+	17	Four hours daily work - discharge requested.	Nil	-	5
11. E.	1 oz	+	2	General condition much better.	Nil	-	2
12. J.R.	3 oz	+	40	Remarkable improvement. Four hours work daily.	1 oz	-	4
13. W.	4 oz	+	22	Slow gain. Complicated by bronchiectasis.	4 oz	-	2

SR. = Sedimentation rate in millimetres per cent.

Amounts of sputum indicate the daily expectoration. Positive or negative bacilli, signifies their presence or absence in the sputum. Whenever bacilli have not been present in the sputum, they have only been judged so after several repeated examinations.

The general opinion is that a positive sputum indicates activity of some degree, but I do not believe that the presence of tubercle bacilli in the sputum gives any inkling to the amount of activity or toxaemia. I have always found in pulmonary tuberculosis that when the sedimentation rate is over 10 tubercle bacilli will be found in the sputum. On the other hand a low rate (under 10) indicating slight toxaemia may or may not be associated with a positive sputum. Many cases such as 3, 5, 6, 7, and 8, developed good resistance, evidenced both clinically and by a decreasing sedimentation rate, yet they showed bacilli in their sputum for many months. Others such as 9, 10, 11, 12 and 13 showed an absence of bacilli corresponding to a lowering of the sedimentation rate. Furthermore, the significance of amounts of sputum is

inconclusive. In a few cases as 4, 7, 8 and 12 the amounts diminished with a lowering of the sedimentation rates. However in the majority of patients under my care I have found that the amount of sputum was affected by complications such as chronic bronchitis and bronchiectasis (Case 13) even although the general condition be improving. Thus the bacilliary reaction and amount of sputum are not nearly so reliable a guide to the amount of activity, and toxaemia as is the sedimentation test.

The last cardinal symptoms of Morton's triad is emaciation; both gain and loss of weight have to be considered and their relationship to the sedimentation test.

Table V shows the relation between changes in weight and changes in the sedimentation test.

T A B L E V.

CASE	WEIGHT	S.R.	WEIGHT	S.R.	WEIGHT	S.R.	WEIGHT	S.R.	REMARKS.
1. R.M.	132	7	141	5	146	0.5	147	2	Incipient phthisis. Improved rapidly.
2. J.OM.	134	25	131	30	134	32	136	36	Very unstable. On "absolute bed rest".
3. F.H.	124	25	125	19	122	25	121	23	Considerable activity. Febrile reactions.
4. J.D.	135	17	141	11	150	9			Marked clinical improvement, 3 hrs poultry.
5. H.Q.	124	20	129	15	126	28	120	48	(Marked activity. Stationary for a while, (now progressively worse.
6. F.C.	126	5	138	5	137	3	139	2	Doing 6 hrs work daily for several months.
7. J.V.R.	135	18	129	21	129	28	123	35	(Chronic case with cavitation. Frequent (set-backs.
8. W.A.	121	40	121	28	120	6	119	42	(Clinical improvement for some time. (Relapsed and died.
9. J.D.	137	1	148	3	157	2			(Doing very well. Complicated by (chronic bronchitis.
10. X.E.	100	2	111	2	117	2			Doing well. Discharge requested.
11. W.J.	123	36	124	44	124	45			(Advanced lesions - low resistance. (Discharged to mend domestic troubles.
12. H.S.	121	5	138	3	142	2			(3 hrs carpentry daily. Discharge (requested.
13. W.B.	109	20	111	16	112	15	113	15	Active disease with frequent set-backs.
14. A.T.	109	15	113	12	116	8	121	4	Improving - 4 hrs carpentry daily.
15. H.I.S.	120	30	131	10	133	5	134	5	Discharged later as quiescent.
16. H.G.	164	4	171	3	174	2			Excellent progress.
17. H.B.	116	24	127	3.5	130	3			(Did very well. Areas of consolidation (clearing up after admission.
18. A.D.	122	25	133	20	125	28	135	35	(Extensive activity - doing very badly in (spite of gain in weight.
19. D.F.	159	10	165	15	170	11	176	11	(Clinically active in spite of marked (increase of weight.
20. R.S.	139	28	143	32	140	29	135	40	(Did well at onset but has been (losing ground recently.

S.R. = Sedimentation rate in millimetres per cent.

Weight in pounds was estimated at definite intervals.

I have found in most cases, that a rapid sedimentation rate indicates a considerable loss of weight, and a low rate points to an increase to the normal or, if anything, a very slight loss. Patients 1, 4, 10, 12 and 15 show considerable gain in weight associated with a falling sedimentation rate; this was always substantiated by further clinical evidences of improvement and diminishing activity. Others, such as 3, 5, 7 and 20, having a maintained high or increasingly rapid sedimentation rate, showed a further loss of weight and other clinical signs of activity. Cases, such as 2, 13 and 18, whose weight was stationary or even slightly increased, showed a more rapid rate in time and clinical manifestations of extension of the lung lesion. This can be explained by the fact that the loss of weight before admission had been excessive but by means of treatment some slight increase of weight had occurred, even though the disease was still very active or advancing. Thus the sedimentation test is further evidence in estimating the amount of toxaemia and activity, when judging the significance of gain or loss of weight, and, what is more important, belies any possible fallacy.

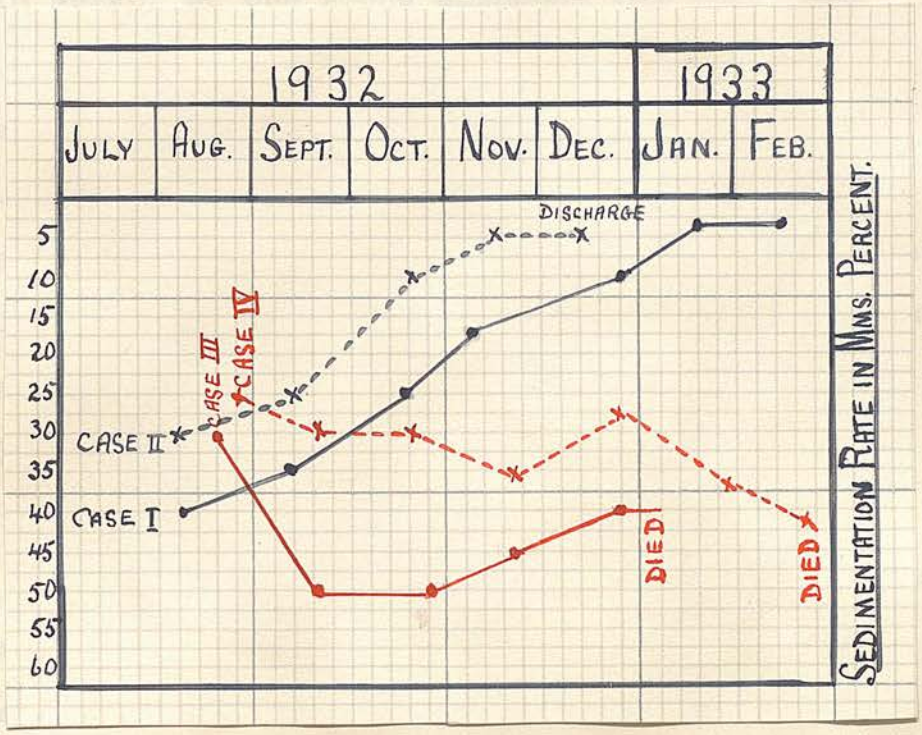
Thus it is seen, from the aforegoing charts and tables, that an abnormal sedimentation test is associated with one or more of the three cardinal symptoms denoting activity, toxaemia and lack of body resistance. The sedimentation rate, as an index of the toxaemia present, is related to the patient's resistance and reaction to activity rather than the extent of activity of the tuberculous process. I do not regard the test as an index of activity, although from the amount of toxaemia this may be inferred. A high sedimentation rate (over 20) will thus imply extensive active disease; if this be maintained for a time a gloomy prognosis is evident, even though constitutional symptoms be absent. Similarly, when the sedimentation rate becomes low and then normal and is thus maintained over a long period, it indicates a good resistance, lack of toxaemia, and so inactivity may be inferred and a good prognosis given. Similarly, we may infer an exudative type of pulmonary lesion from a series of high sedimentation readings, and a proliferative picture from a low series. Furthermore it is not the absolute sedimentation figure which is of paramount importance but the alteration in the rate in the same patient, as observed on repeated examinations which is

of marked prognostic value. Even when a single test will, if interpreted correctly, give some indication of the future, it is only by repetition at regular intervals do we get a true bird's-eye view of the case and a justified prognosis arrived at.

The value of the sedimentation test in gauging the effects and assessing the benefits derived from various recognised orthodox forms of treatment, must next be demonstrated. It may also be used to estimate the value of new forms of treatment, but this field has not been open to investigation at the institution I am working in.

I shall first discuss the use of the sedimentation test in patients undergoing routine sanatorium treatment. This briefly consists of absolute rest in bed followed by graduated exercises and work in the shops; advance is made, stage by stage, depending upon the clinical condition of the patient.

Chart E illustrates the progress of four patients undergoing routine sanatorium treatment only; two of whom did very well and two ending fatally.



Case I (solid blue) aged 41 years, was admitted in August 1923 with extensive disease of both lungs. Marked activity, evidenced by considerable constitutional reaction and a high sedimentation rate, was present; the patient had been ill for some months prior to admission without treatment. He was kept

in bed for ten weeks during which the sedimentation rate settled to 19. Clinically, when he came under my care the temperature had settled and there was a gain in weight of one stone although the pulse was still rapid. In view of the steady decrease in the sedimentation rate the patient was advanced on to various forms of exercise; in December his rate had become quite low and he was doing several hours housework daily. By the end of January his test readings were within normal limits, sputum was free from bacilli, the pulse rate had settled and he was doing three hours carpentry daily.

Case II (dotted blue) aged 24 years. Had been suffering from pulmonary tuberculosis for five years with extensive disease and cavitation. Although marked fibrosis was present, the disease appeared very active, as evidenced by a sedimentation rate of 30, and also clinically. The patient did very well and improved remarkably during several months in sanatorium. When he requested his discharge the sedimentation test was 5 and he was working three hours daily.

Case III (solid red) aged 20 years. The patient had extensive bilateral disease and a sediment-

ation rate of 28 on admission. When he came under my care I found the sedimentation rate to be increasing and clinically the patient showed blood-stained expectoration and febrile reactions. The rising rate indicated failure to respond to treatment and a gloomy prognosis was given. The patient died in January 1933.

Case IV (dotted red) aged 38 years. This patient also had extensive bilateral disease with cavitation and a high sedimentation rate. Activity was further emphasized by marked systemic reactions. A rising sedimentation rate substantiated the increasing toxaemia, in which the "spes phthisica" was prominent, and compelled a fatal prognosis to be given to the relatives in December. By February 1933, the sedimentation rate had risen to 40, and the temperature became subnormal for three days before death occurred.

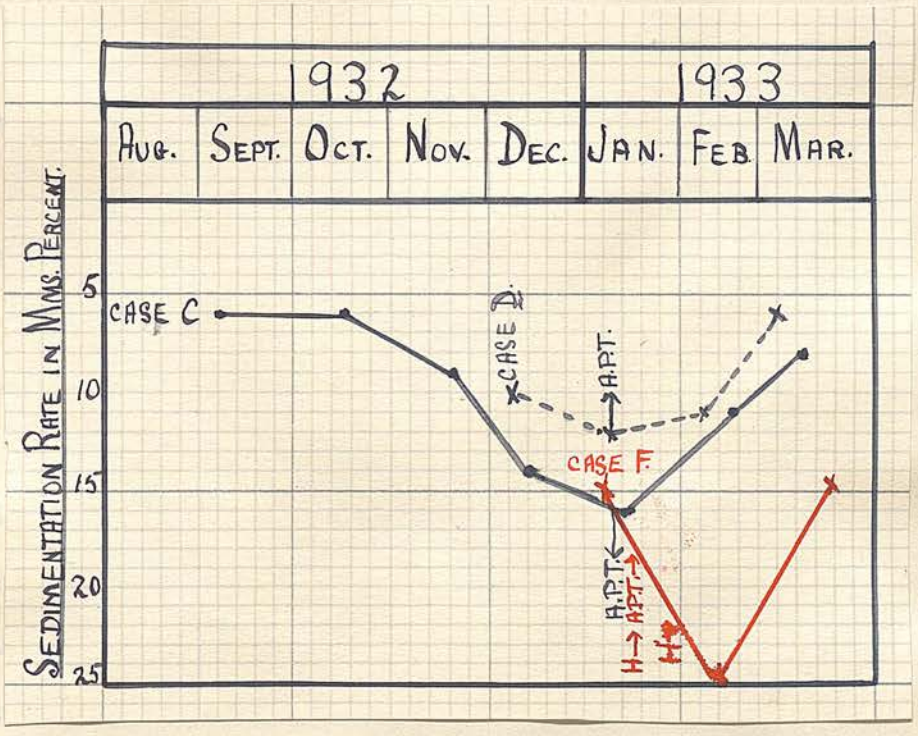
Thus in the above cases, as indeed in all cases undergoing routine sanatorium treatment, I have universally found the variations in the sedimentation rate to depict the changes occurring during the course of the disease. Apart from prognosis, the readings indicated whether or not a patient was reacting to

the treatment and the rate thereof.

Furthermore I have found the test more trustworthy than clinical findings when the question of exercise or work arose.

A number of patients under my care received various specialized forms of treatment.

Chart F shows the sedimentation changes in three cases undergoing artificial pneumothorax therapy.



A.P.T. denotes induction of artificial pneumothorax.

H. indicates haemoptysis.

Case C (solid blue) aged 22 years had been in this institution three years ago with a left sided lesion. Artificial pneumothorax therapy had been carried out and he was discharged, much improved, to continue refills outside the sanatorium. The collapsed lung had been allowed to come out after two years treatment. In September 1932 he was sent back to the sanatorium with suspicion of right apical involvement. He was readmitted with a sedimentation rate of 6 and when he came under my care in October it was still 6. Skiagrams now showed a definite active lesion on his right side although he gained weight steadily and showed no constitutional reactions during November and December. However his sedimentation rate rose to 14 indicating toxaemia and activity. It was not until returning from Christmas leave that the patient showed definite systemic manifestations; the sedimentation rate was now 16 and the sputum was excessive in amount. In view of the rising sedimentation rate and toxaemia I induced an artificial pneumothorax on January 12th 1933. By means of frequent refills at first, a good collapse was obtained, and on February 6th his sedimentation rate had come down to 11 and the sputum was scanty in amount. During the first week

of March his rate had fallen to 8; the patient felt much improved as a result of his refills and was doing several hours housework daily.

Case D (dotted blue) was admitted on December 13th 1932 with a right sided lesion and some slight involvement of his left apex. The sedimentation rate was 10. Toxaemia and activity were further evidenced by a rapid pulse rate and the presence of bacilli in the sputum. During the first week of January 1933 his sedimentation rate increased to 13, and the pulse was still rapid. I induced an artificial pneumothorax on January 12th. During the early part of February the sedimentation rate was 11 and during the first week of March it was 6. The patient felt much better, good collapse being obtained on screening; he was gaining weight and increasing his amounts of exercise.

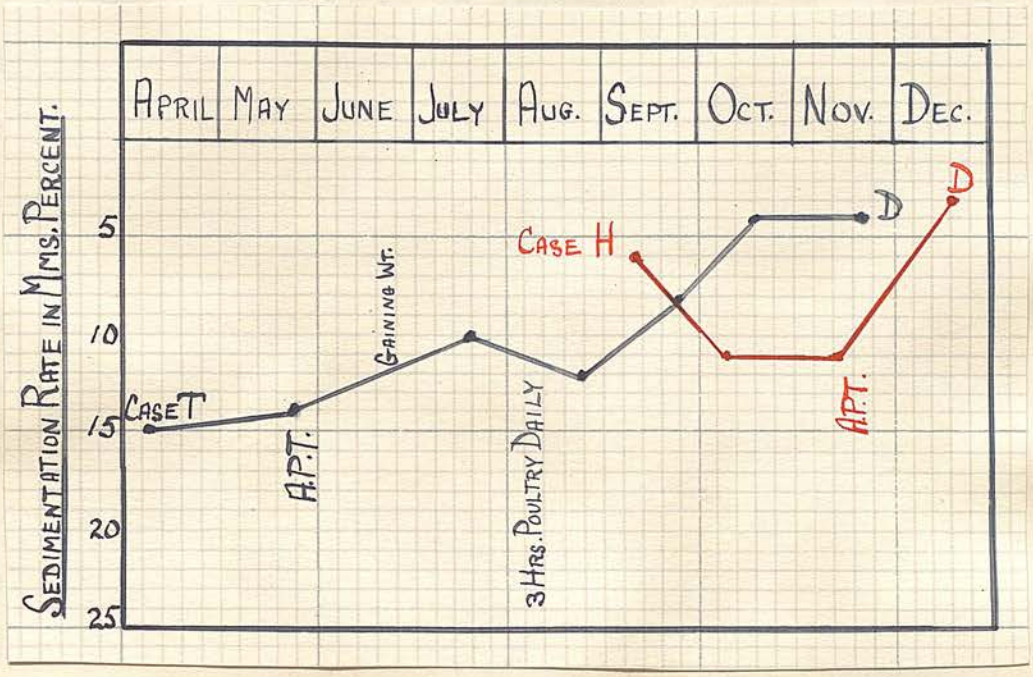
Case F (solid red) was admitted on January 6th 1933 with an exudative lesion of his left apex. The right side was clear by skiagram but nevertheless symptoms of mild toxaemia were present, evidenced by a sedimentation rate of 15 and slight febrile reactions. Pneumothorax therapy was suggested but the patient refused to consider it. After a few days in

bed, he settled generally and was put on half hourly walks as an exercise test. Coincident with, or due to this exercise he had an haemoptysis of one and one-half pints on January 19th. Artificial pneumothorax was induced next day as symptomatic treatment. The haemoptysis ceased but the sedimentation rate soon increased to 25, denoting increased activity and toxaemia. On being screened on several occasions, the collapse was seen to be very limited owing to an easily movable mediastinum, which produced praecordial pain and palpitation. On January 28th the patient brought up another half pint of blood, but a small refill controlled it. A paraffin preparation of "gomenol" was introduced into the pleural cavity to strengthen the mediastinum by causing a mild inflammation and fibrosis. Smaller and more frequent refills were then given and a better collapse obtained. By March the patient had improved slightly, the sedimentation rate having returned to 15.

Thus it is seen that cases C and D showed improvement almost immediately, as evidenced by their sedimentation rates and also clinically. Furthermore the increasing toxaemia and activity, as shown by the sedimentation test, was an indication for

pneumothorax therapy. Reading the rates of Case F, the increased toxaemia present after admission was due to increased activity resulting from the haemoptysis. He improved slightly after his pneumothorax induction and refills, but the sedimentation rate truly indicates that at the present he is at a standstill. However it is still early to come to any final prognosis and conclusion as to whether the artificial pneumothorax therapy will be of any benefit to him.

Chart G demonstrates further, the changes in two different types of patients treated by artificial pneumothorax therapy.



A.P.T.: Artificial pneumothorax induced.

D : Discharge from sanatorium.

Case T, (solid blue) aged 19 years, had a lesion of the right apex and toxaemia indicated by a sedimentation rate of 15 on admission. Artificial pneumothorax therapy was induced on May 26th 1932 and from

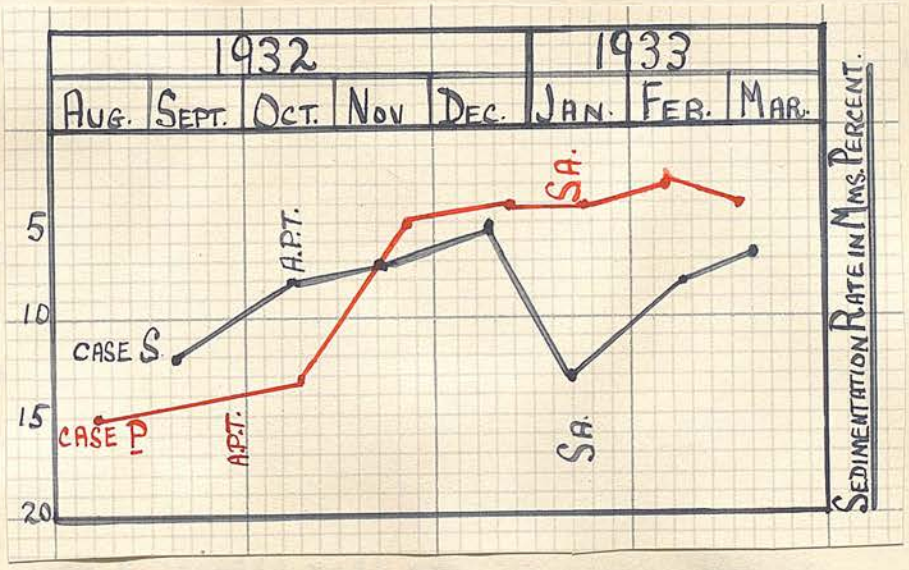
that time onward the patient improved steadily. Prior to discharge he was working four hours daily in the carpentry shops.

Case H was admitted in September 1932 in good condition with a sedimentation rate of 6 and a right sided lesion. When I saw him in October his clinical signs suggested the complication of bronchiectasis being present. This was diagnosed definitely by the use of lipiodol and skiagrams. By the beginning of November his sedimentation rate had risen to 10, and the sputum was increasing in quantity. The patient expectorated blood-stained sputum on several occasions and had slight febrile reactions. On November 24th I induced an artificial pneumothorax and carried on with refills. The patient soon felt much better, his sedimentation test at the end of December was down to 4, and the sputum was scanty in amount. He was discharged in good condition to continue his refills at his local "dispensary".

Thus again is the value of the sedimentation test shown. Case H evidenced the necessity of pneumothorax therapy and in both cases alterations in the rate indicated the amount and rapidity of the benefit derived.

Artificial pneumothorax therapy was instituted in several other patients but had to be reinforced by chemotherapy.

Chart H illustrates the changes in the sedimentation rates of two patients undergoing artificial pneumothorax and sanocrysin treatment.



A.P.T. signifies induction of artificial pneumothorax therapy.

Sa denotes commencement of a course of Sanocrysin totalling 5.5 grams.

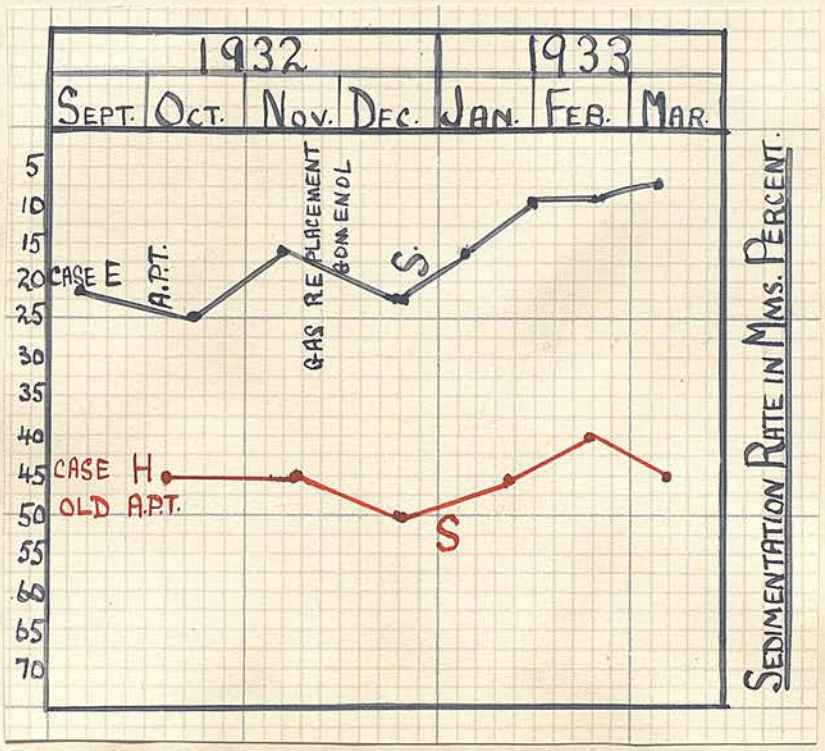
Case S (solid blue) aged 25 years. The patient was admitted in September with an extensive left sided lesion and a sedimentation rate of 12, which was indicated clinically by mild toxaemia. Artificial pneumothorax was induced on October 13th and I found him to improve considerably until after Christmas leave. On returning he showed increased toxaemia, as seen by his sedimentation rate of 13 and also clinically; physical examination and skiagrams revealed activity at the right apex and also good collapse on the left side. Refills were continued to control the left side and I instituted sanocrysin to control the right side. After completing a course of gold treatment the sedimentation rate was again low and the patient felt much improved.

Case P, (solid red) aged 19 years, was admitted on August 27th with a left sided lesion; toxicity present was indicated by a sedimentation rate of 15. Artificial pneumothorax therapy was commenced on September 27th, I noticed the patient to improve rapidly and in December his test readings were down to normal limits. At this time a skiagram of the

right apex showed mottling, although no evidence of activity was present there clinically or by the sedimentation test. Refills were being carried out to maintain the good collapse obtained on the left side and a course of 5.5 grams sanocrysin given to control any possible exacerbation on the right side. By the beginning of March the sedimentation rate was still within normal limits and the patient felt much improved.

Thus readings of the sedimentation test, in Case P, showed that he reacted quickly and well to pneumothorax therapy and that the lesion on the opposite side was controlled by sanocrysin. In patient S, the chart indicates early improvement due to artificial pneumothorax and also later extension of the disease necessitating some further form of treatment. Readings during and at the end of the course of sanocrysin indicated that the patient benefited thereby, although it is rather early to state definitely whether the improvement is temporary or permanent.

Chart I illustrates the sedimentation rate changes in two cases undergoing various forms of treatment.



A.P.T. signifies induction of artificial pneumothorax.

S denotes onset of course of sanocrysin totalling 5.5 grams.

Case E (solid blue) was admitted in September 1932 with a right sided lesion, a sedimentation rate of 32, and clinically many signs of toxaemia. No activity was detected in the opposite lung either by physical examination or by skiagrams. The patient

did not benefit by routine sanatorium treatment, and the sedimentation rate remained high at 25. Artificial pneumothorax was induced on October 3rd 1932, and in the ensuing month I found that fluid had developed. In spite of this complication the patient improved, indicated by the rate falling to 14. Skiagrams revealed the lung to be fully collapsed, but the fluid continued to increase in amount displacing the mediastinum. As the fluid showed no signs of being absorbed and was producing embarrassing symptoms it was aspirated on several occasions being replaced by either gas or gomenol. In December signs of toxaemia began to be evident, the sedimentation rate rising again to 22. Skiagrams at this stage showed an early lesion commencing on the opposite side and sanocrysin therapy was then decided upon. After the course of 5.5 grams was administered the patient improved once more, the sedimentation rate having fallen and was maintained at a low level. The sputum became very scanty, and negative on three occasions; further, at this stage he was taking hourly walks twice daily.

Case H, aged 40 had been a patient for three years undergoing artificial pneumothorax therapy.

He had a good collapse of the left side for almost two years, and when he came under my observation in October, refills were being carried out monthly. The patient had a sedimentation rate of 45, loss of weight, excessive expectoration, and in poor condition generally. Skiagrams now showed activity of the right apex. Sanocrysin treatment was instituted but had to be discontinued when the course was only half finished, owing to intestinal reactions. The patient failed to progress clinically, the sedimentation rate being maintained at a consistent high level.

Thus it is seen, from the sedimentation test readings, that in Case E it was necessary to institute various forms of treatment and also the benefit derived therefrom. Case H, on the other hand maintained high sedimentation rates indicating a failure to react to different therapeutic measures.

In all cases of artificial pneumothorax therapy where collapse is efficient, I have found that there is a decrease in the sedimentation rate, often to within normal limits. This should be so, when the sedimentation test is considered to be an index of toxaemia and so an expression of the intensity of the

exudative and destructive lesions setting their toxic products free into the body. Collapse of the lung interferes with the continuous flow of these toxins and so the blood becomes more normal; this is evidenced by a more normal sedimentation rate. When collapse is incomplete or activity present on the opposite side the sedimentation rate does not record beneficial changes but remains raised. Thus it is clear that when the rate fails to decrease or rises during artificial pneumothorax therapy it means failure to control the disease and either abandonment of treatment or instituting some further specialized form of treatment as an auxiliary measure, such as gomenol or sanocrysin. Further changes in the sedimentation rate are indicative whether or not benefit is being derived from these adjuncts.

Rita Gripenberg (30) mentions several observers whose observations agree with my results. They found a decrease of rate in cases treated by artificial pneumothorax where collapse was efficient, whilst in cases with only a partial collapse or where the other lung was diseased the sedimentation rate did not change, or was increased.

Therefore I have shown, that when the sediment-

ation test is used in connection with routine sanatorium treatment or other recognised efficient forms of specialized treatment, it indicates the clinical progress, the efficacy of the treatment and the possible further need of a combination of therapeutic measures. Furthermore the changes in the sedimentation test during the two or three months after the commencement of any form of treatment indicate not only whether or not the patient is responding to treatment, but also the rate at which this improvement is taking place and therefore the ultimate chances of recovery.

Lack of opportunity owing to dearth of material at this institution, has not allowed me to apply the test to the surgery of pulmonary tuberculosis and to new forms of medical treatment. I feel however, that having stood the test of clinical experience with generalized orthodox forms of treatment it would also apply to the other methods.

In some few cases of pulmonary tuberculosis, I have found a normal sedimentation rate, denoting the absence of toxaemia and so signifying inactivity, controversial to clinical findings. In the following two patients the clinical signs of activity conflict

with normal sedimentation readings, which were maintained over a period of several months.

Case C.L. aged 21 years was admitted in January 1932 with a two years history of pulmonary tuberculosis. Physical examination on admission revealed very slight involvement of both apices and the sputum contained tubercle bacilli. During the next nine months physical signs became progressively less and the patient was working as a printer, six hours daily. The sedimentation rate was first done in August 1932, and was 5. When I examined him two months later the rate was down to 3, and physical examination of the chest was normal apart from cog-wheel breathing. During the next five months the sedimentation rate remained normal and the weight stationary; however the sputum was, and has been consistently positive since admission. The patient never showed any febrile reactions.

Case A.X. aged 30 years was admitted under my care on November 2nd 1932 with a five years history of pulmonary tuberculosis; he had been in several other sanatoria at various times. On admission the sedimentation rate was 3 and the sputum contained tubercle bacilli. Skiagrams showed signs of acti-

vity at both apices and a cavity on the left side; physical signs were in agreement. During the next four months the patient gained seventeen pounds in weight, maintained a normal temperature and pulse, and advanced to five hours work daily. The sedimentation rate was persistently normal, varying between 2 and 4. However, tubercle bacilli were always present in the sputum, and physical signs in the chest.

The question now arises whether or not the lesions in these patients are to be considered active? Both cases show one of the cardinal signs of activity, namely a positive sputum, and yet maintain a normal sedimentation rate. Therefore, either the test is not accurate, or else a positive sputum is not necessarily a sign of activity.

I put forward two theories to account for this seemingly paradox. Possibly the situation may be explained by the existence of "carriers" in pulmonary tuberculosis, similar to the state of affairs in dyphtheria and typhoid. If this were so the lesion would be considered inactive.

The other explanation, which I think is more probable, is a change in the character and severity

of the disease; the protection and resistance of the body fluids is such that the constitutional and systemic factor is now practically and clinically nil. That is, the disease has been limited to the local or lung factor. There are no clinical evidences of toxaemia and sedimentation rate is normal, yet, there are bacilli in the sputum and physical signs in the chest. There has been no doubt that the lesion was active, but is it to be considered so under the aforegoing circumstances, which have been present for some time? Many authors claim there is no disease without toxaemia. Westergren (31) asserts that no lesion is active when the sedimentation rate is normal. According to the rationale of the sedimentation test I hold that it is an index of toxaemia, and as such the test does not fail in the above cases. If to take a hypothetical case, the patient had the same physical signs in the chest and a normal sedimentation rate, but no bacilli in the sputum and no definite immediate past history, I would declare in favour of inactivity and absence of disease. With the presence of tubercle bacilli, a possible "carrier" theory would only account for a few isolated cases, and so I would view them as active. If they continued on for a long per-

iod of months or even years with a low sedimentation rate and no constitutional symptoms, I would consider them for practical purposes as inactive, although not without danger to the community at large. Thus, whereas an abnormal and high sedimentation rate is reliable in inferring activity in pulmonary tuberculosis a low and normal reading, during the course of the disease, must be taken along with clinical findings.

What would appear, at first sight, to be a further fallacy of the test is an increased rate in a few patients who show quite definite improvement clinically. However there is always some extraneous factor, affecting the sedimentation rate, to account for this apparent contradiction. I have noticed that patients, developing such dental conditions as pyorrhea, or an alveolar abscess, showed a definite marked increase in their sedimentation rates although clinically they were in good condition and improving. Another patient under observation showed an increasing rate whilst his lung lesion was progressing favourably. In this case a septic varicose ulcer accounted for the rising sedimentation readings. With the clearing up of the intercurrent condition the sedimentation rate

returned to its customary level. Similarly I have found a temporary increased sedimentation rate in patients during the recent epidemic of influenza. This rise was not due to extension of their lung lesion, as the patient's condition returned to normal in a week or ten days, the sedimentation rate returning to its previous level much about the same time.

Whilst these and other intercurrent conditions affect the sedimentation rate to some degree, yet, if the clinician be on the outlook, he need not be in error in the correct interpretation of the test.

Again patients in sanatorium often suffer from "common colds", neuralgia of various types, and chronic bronchitis during the rigorous winters, yet I have always found the sedimentation rate to be uninfluenced by these conditions.

Thus although the sedimentation rate may lack specificity, as an index of toxaemia it stands the test of clinical experience. As such the test is a worthy asset to the clinician in dealing with pulmonary tuberculosis, and it has a definite place in prognosis and treatment.

S U M M A R Y.

I. There is a definite need for a reliable test to guide the clinician in dealing with the problem of pulmonary tuberculosis.

II. The sedimentation of the erythrocytes in blood plasma is increased in conditions in which there is an increase of the fibrinogen and serum-globulin contents of the blood. This occurs in diseases associated with toxaemia and tissue destruction.

III. The sedimentation rate is an index of the amount of toxaemia present, and this in pulmonary tuberculosis infers the degree of activity and powers of resistance.

IV. The "one hour" reading of the sedimentation test in millimetres percent conveys most information to the clinician and is compatible with clinical experience.

V. The sedimentation test lacks specificity and hence is of limited value in the diagnosis of pulmonary tuberculosis; an abnormal rate does however indicate that a lesion is active and the extent.

VI. A series of tests, performed at intervals over a period of several months, affords valuable data upon which a prognosis may be based. Further it gives information concerning the powers of resistance present, and enables the clinician to judge the amount and rate of progress.

VII. The sedimentation test is not only more sensitive than clinical findings in indicating the amount of toxaemia but also in prophesying ensuing complications, save in haemoptysis due to rupture of the Rasmussen type of aneurysm.

VIII. The test excels as a means of regulating routine sanatorium treatment. It also evidences the need of instituting additional forms of treatment and depicts further progress.

IX. When a maintained normal sedimentation test, in a patient that has been definitely active at some time, conflicts with the continued presence of tubercle bacilli in the sputum or some other single sign of activity, the whole clinical picture and rate must be viewed in relation to each other and the case kept under observation for many months before quiescence and inactivity are definitely considered.

X. In a certain number of patients a rising sedimentation rate does not coincide with the definite clinical progress present; further observation will reveal some outside influence.

BIBLIOGRAPHY.

1. D'Arcy Hart, P. "The Value of Tuberculin Tests in Man", Medical Research Council 1932. pages 30-35, and 55.

2. Cummins, S.L. and Acland, C.M. "An Analysis of Blood-Sedimentation Tests and Nuclear Indices in 200 Classified Cases of Tuberculosis". Tubercle, October 1927. Vol. IX. No. 1. page 1.

3. Burrell, L.S.T. "Recent advances in Pulmonary Tuberculosis". Second Edition, page 32.

4. Fishberg, M. "Pulmonary Tuberculosis". Third Edition, page 393.

5. Burrell, L.S.T. "Recent Advances in Pulmonary Tuberculosis". Second Edition, page 57.

6. Schellenberg, G. and Naucke, H. "Ueber die Senkungsgeschwindigkeit der Roten Blutkorperchen bei Lungentuberkulose". Beitr. Z. Klin. d. Tuberk. 1923. Vol. 57, page 81.

7-11 (Inclusive). Fahraeus. "Acta Med. Scandinavica" 1921. Vol. 55, pages 1-11.

12) & 13) Westergren, A. "Acta Medica Scandinavica" 1921. Vol. 54, Pages 247-281.

14. Zeckwer and Goodell. "The Sedimentation rate of Erythrocytes". American Journal of Medical Science. 1925. Vol. 169, page 209.

15. Levinson, S.A. "The Suspension Stability Rate of Erythrocytes in Pulmonary Tuberculosis". American Review of Tuberculosis. 1923. Vol. 7, page 264.

16. Payne, W.W. Bach, F. and Hill, M.J. "Acute Rheumatism and the Sedimentation Rate". The Lancet. January 9th 1932. Pages 75-77.

17. Tidy, L. "Synopsis of Medicine". Fifth Edition, page 136.

18. Fishberg, M. "Pulmonary Tuberculosis". Third Edition, page 391.

19. Wingfield, R.C. "Chronic Pulmonary Tuberculosis: A New Conception". British Medical Journal. February 4th 1933. Page 180.

20. Bigger, J.W. "Handbook of Bacteriology". Second Edition, page 376.

21. Fishberg, M. "Pulmonary Tuberculosis". Third Edition, page 35.

22. Muir, R. "Text-Book of Pathology". Second Edition, pages 13, 138-141.

23. Muir, R. "Text-Book of Pathology". Second Edition, page 378.

24. Osler and McCrae. "Principles and Practice of Medicine". Tenth Edition, page 162.

25. Fishberg, M. "Pulmonary Tuberculosis". Third Edition, page 153.

26. Willems. "Sur la Vitesse de Sedimentation des Globules Rouges". Arch. Med. Belges. 1925. Vol. 78, page 350.

27. Althertum, L. "Ueber die Senkungsgeschwindigkeit der Roten Blutkorperchen bei Lungentuberkulose". Beitr. Z. Klin. d. Tuberk. 1923. Vol. 55, page 511.

28. Motzfeldt. Norsk. Mag. fur Laegevedinsk. 1928. Vol. 29, page 637.

29. Tegtmeier, L. "Ueber die Senkungsgeschwindigkeit der Roten Blutkorperchen in Zitratblut bei der Lungentuberkulose". Beitr. Z. Klin. d. Tuberk. 1923. Vol. 49, page 1113.

30. Gripenberg, R. "Ueber die Senkungsgeschwindigkeit der Roten Blutkorperchen bei Lungentuberkulosen mit Kunstlichem Preumothorax". Acta. Tub. Scanda. 1925. Vol. 1, page 121.