ABDOMINAL TUBERCULOSIS AS A PUBLIC HEALTH PROBLEM IN ITS CLINICAL AND ADMINISTRATIVE ASPECTS: WITH REFERENCE TO ONE HUNDRED SELECTED CASES.

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A Thesis for the Degree of Doctor of Medicine

By

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C O N T E N T S

A. INTRODUCTION.

From earliest times tuberculosis in its various forms has been regarded as one of the greatest scourges affecting mankind. The history of medicine is rich in references to the ravages of the disease and since the inception of Public Health measures it has ranked as one of the greatest problems to be faced.

Although the abdominal variety of the disease occupies a position of minor importance in comparison with the pulmonary form, it presents an interesting problem with aspects peculiarly its own.

The origin of the disease being related to the alimentary tract, it follows that in the majority of cases the route of infection is the oral one, food being the vehicle of infection. When it is taken into account that the condition belongs essentially to childhood and the early years of life the question of milk's association with the disease is obviously of the greatest importance. Many workers have shown that the contagium vivum in abdominal tuberculosis is of the bovine type in a large percentage of cases. The English Royal Commission on Tuberculosis in 1911 reported on 29 cases of abdominal tuberculosis (mesenteric glands) finding 14 to be of bovine type, 13 of human and the remaining two mixed. In 1910 the Journal of Medical Research recorded a series of cases of which 46 per cent between the ages of five and fifteen years were of the bovine type. In Blacklock's[1] series of 66 cases with primary abdominal tuberculosis, 54 or approximately 82 per cent were found to be of the bovine type. According to Savage[2] 40 per cent of cows in this

country are infected with the tubercle bacillus and at least one per cent of cows infective at any one time. The Medical Research Council, Special Report Series No. 189[3] showed that in Glasgow, tuberculous infection in raw milk samples was found to be 13.4 per cent; in milk pasteurised by the flash method 2.5 per cent; and by the holder method 1.1 per cent. Fully 70 per cent of the milk supply of Glasgow undergoes this last process and of the remaining 30 per cent half is untreated and half treated by the flash method.

These measures alone must account for a considerable decrease in the incidence of abdominal tuberculosis but side by side with them must be ranked other measures no less important. Included in this category are the general improvements in the standard of living, particularly in housing conditions which have been a marked feature of the post-war era of Public Health Administration. In view of the progress made in the past and with anticipation of further advance in the future it is not too much to hope that the continued efforts of our Public Health Services may in time solve completely the problem of abdominal tuberculosis.

In the following study of abdominal tuberculosis an attempt has been made, first to interpret the true significance of the various causative factors, including an analytical review of one hundred selected cases, and secondly to survey the field of the subject from the point of view of Public Health Administration.

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B. HISTORICAL SURVEY OF ABDOMINAL TUBERCULOSIS.

(1) Early Accounts of the Disease.

In Scotland all forms of tuberculosis became compulsorily notifiable under the Tuberculosis Regulations of 1914. Thus was opened a new source of reliable data concerning the various manifestations of the disease which had been lacking since tuberculosis was first recognised as a definite entity. As the nineteenth century progressed tuberculosis came more and more to the forefront as a public health problem of the first magnitude. Owing to the influx of individuals to the rapidly growing industrial centres it was brought home to these communities the extent of the disease, the spread of which was being aggravated by the degree of overcrowding and vitiated conditions which surrounded the affected individuals. Administrative measures of control were launched, the efforts at first being solely directed against the pulmonary form of the disease. In England and Wales the pulmonary form only was made notifiable until the Regulations of 1912 were passed to include all types of the disease.

The reasons for the minor rôle occupied by abdominal tuberculosis were threefold, firstly this form of the disease was not so prevalent as the pulmonary or surgical types, secondly a definite diagnosis was more difficult to ascertain and thirdly the abdominal variety was neither crippling nor was it an open source of infection as were the other forms.

Prior to notification the records of abdominal tuber-

culosis are scanty and the available literature not fruitful. The condition was undoubtedly known to the early physicians. The first reference with any possible bearing on the subject is found in the writings of Hippocrates on "scrofula". The word is derived from the Greek "scropha" a pig, and six hundred years later Leonides (1535) referred to the glandular nature of the swelling, particularly in association with the neck. Galen also applied the term to lymphatic glands and noted that they developed a scirrhous hardness and were not prone to suppurate.

At this early date it is obvious that the term was not applied to any specific condition but probably included all forms of glandular tuberculosis along with certain syphilitic conditions and other inflammatory states affecting both the soft tissues and the osseous skeleton. It apparently corresponded in meaning to the term "struma" of the Latin writers.

During the sixteenth and seventeenth centuries scrofula began to be distinguished from other glandular tumours and it appeared to be a popular diagnosis for a considerable number of ailments in children until the study of pathological anatomy shed a different light on the subject. It was then proved that the name covered chronic inflammatory changes in various tissues. Following on this increased knowledge of morbid anatomy during the eighteenth century we find a new term coming into use - namely tabes mesenterica - the Latin word tabes meaning a "wasting away", being applied in the same way as the Greek word phthisis was in pulmonary tuberculosis.

Sir Thomas Watson writing in the early part of last century connected the two terms as follows. "One form of scrofulous disease common among children is what is called 'tabes mesenterica'. Phthisis is applied to the same disease in the chest to which tabes is applied in the belly." He then went on to say, "This (tabes mesenterica) is not only a common but a very fatal disease in children and young persons. The glands of the mesentery enlarge and become charged with tubercular matter, but they very rarely suppurate. Their enlargement is commonly connected with tubercular disease and ulceration of the mucous follicles of the intestine and the little patients die because the lacteals are no longer able to take up from the food a sufficient supply of nutriment: they die starved. But some few do recover from tabes mesenterica."

Under the designations "atrophia" and "phthisis mesenterica" the nature of the disease was recognised more or less in many of the systematic works which appeared towards the end of the eighteenth century and the idea of the starvation of the patient owing to obstruction of the lacteals was supported at that time.

According to Gairdner (4) it would appear that Baglivi about 1750 was the first investigator to employ the term tabes mesenterica. However no specific disease was referred to as he also discussed "mesenteric fevers" which may have included typhoid fever and other allied conditions. In his article on tabes mesenterica written in 1835, W.B. Joy refuted this theory that starvation followed mechanical obstruction of the chyle, stating that such a degree of obstruction was unusual. Here we have the first

suggestion that the toxic phenomena far outweigh the mechanical in clinical importance.

The term tabes mesenterica was apparently not a popular one in Italy, France, Germany or other European countries at that time. In France during the eighteenth century we find records of a chronic abdominal disease occurring in children which went under the popular name of "carreau". This disease was fully described by the French pathologist Jean Baumes in 1787. He accepted it as a fundamental fact that the disease originated in the mesentery. "Young children" he said, "are very subject to emaciation succeeded by atrophy, at the same time they take on a cachetic habit and the abdomen becomes infiltrated and dense, afterwards indurated and almost always painlessly. This disease has been as badly named as it has been ill described. It is certain it has its seat in the mesentery and taking into consideration the tumification and resistance of the abdomen, some have given to this the vulgar and metaphorical name of carreau: others looking only to the principal effect of the obstruction in the course of the chyle across the mesentery have named it atrophy of infants."

Bichat, the French pathologist, in 1805 in his discourse on the disease described the clinical appearance such as it might be met with today. "The carreau is the engorgement of the glands of the abdomen. It comes on commonly in infants from the second to the eighth year. It declares itself first by pains, disturbed digestion, frequent habitual diarrhoea, the belly is distended, there are frequent vomitings - there is delicacy of the skin,

flaccidity, puffiness, heightened colour of the mucous membrane, small pulse, frequent difficulty in breathing, lactessent urine ..... debility, feebleness in movement, little development of the intellectual faculties. The tension of the abdomen is due to the swelling of the glands and to gaseous matter. When the gases do not exist it is possible to feel the swollen glands but this in the most rare case. Sometimes there is voracious appetite, at other times anorexia, abdominal pain, complication with worms. The general symptoms are the disturbed respirations, which arise no doubt from the consecutive enlargement of the thoracic glands; the marasmus which some authors have given as a characteristic sign. At last the strength diminishes, the tumification of the belly is enormous, pain is excessive and shifts in position according as the mesentery is displaced by the movements of the patient, diarrhoea is habitual. Towards the close ascites or infiltration of the lower limbs supervenes. There is no disease which reduces the infant to a more frightful state of marasmus."

This clinical description of the disease, written 130 years ago, has been quoted in detail to show how closely it corresponded with the present day conception of advanced tuberculous peritonitis. Here we have also reference made to two important complications, firstly the involvement of the mediastinal glands and secondly the terminal appearance of ascites, condition not previously mentioned. Stress is also laid on the frequency with which gaseous distension of the abdomen obscures the enlarged mesenteric glands.

The question of an infective virus was first raised by Bordeu in 1818, the cause in his opinion being "une sorte de miasme scrofuleux". This view was supported by contemporary writers at the time, the milk of scrofulous nurses and the milk and flesh of tuberculous cows being suggested as a possible source of the "scrofulous virus".

However some considerable time was to elapse before this view was generally accepted. Hirsch (5) writing in 1885 criticised this theory and referred to "the speculative attempts to prove the parasitic nature of the hypothetical virus, which latter may appear to have found support in the discovery by Koch of the so-called bacillus of tubercle." Further criticism was levelled at Baumes, a contemporary of Bordeu, as follows, "Baumes says that scrofulous nurses may give these diseases to their sucklings, but he is in our debt for a proof that they have ever done so. The assertion that the milk of tuberculous cows induces scrofula rests upon mere hypothesis; not a single well-authenticated case of that kind has occurred, whereas it can be shown that the whole population of villages has eaten the meat of tuberculous cattle for years together (and doubtless drunk the milk of tuberculous cows) without any increase in the amount of scrofula having been remarked among them."

The epoch-making discovery of the tubercle bacillus by Koch in 1882 and his method of animal inoculation threw an entirely new light on the subject, proving that many cases of scrofula were tuberculous in nature. The results of this detailed work constitute the outstanding feature in the history of all forms of tuberculosis. Dur-

ing the intervening fifty years since then the amount of experimental research carried out has been both varied and considerable but although verified and amplified on numerous occasions the original findings of Koch have undergone no essential modification.

From this point onwards the nature of the disease becomes much more circumscribed, recorded data become more reliable and owing to the increasing field for bacteriological and pathological investigation a definite division has been laid down between abdominal tuberculosis and the broader term scrofulosis which embraced a wide variety of conditions in paediatrics.

It was not until the advent of notification that the declining incidence of abdominal tuberculosis became fully evident. Before coming into force this piece of legislation met with considerable opposition and when first proposed at the Parisian Congress of 1888 was turned down as of no practical value.(6) Russell writing in 1905 considered the idea "chiefly noteworthy as a warning of the direction in which science, without practical discrimination, is moving." However the passage of time modified this adverse opinion and when finally notification came into force in 1914 a new era of reliable data was opened up.

(2) Death Rate for Abdominal Tuberculosis in Glasgow.

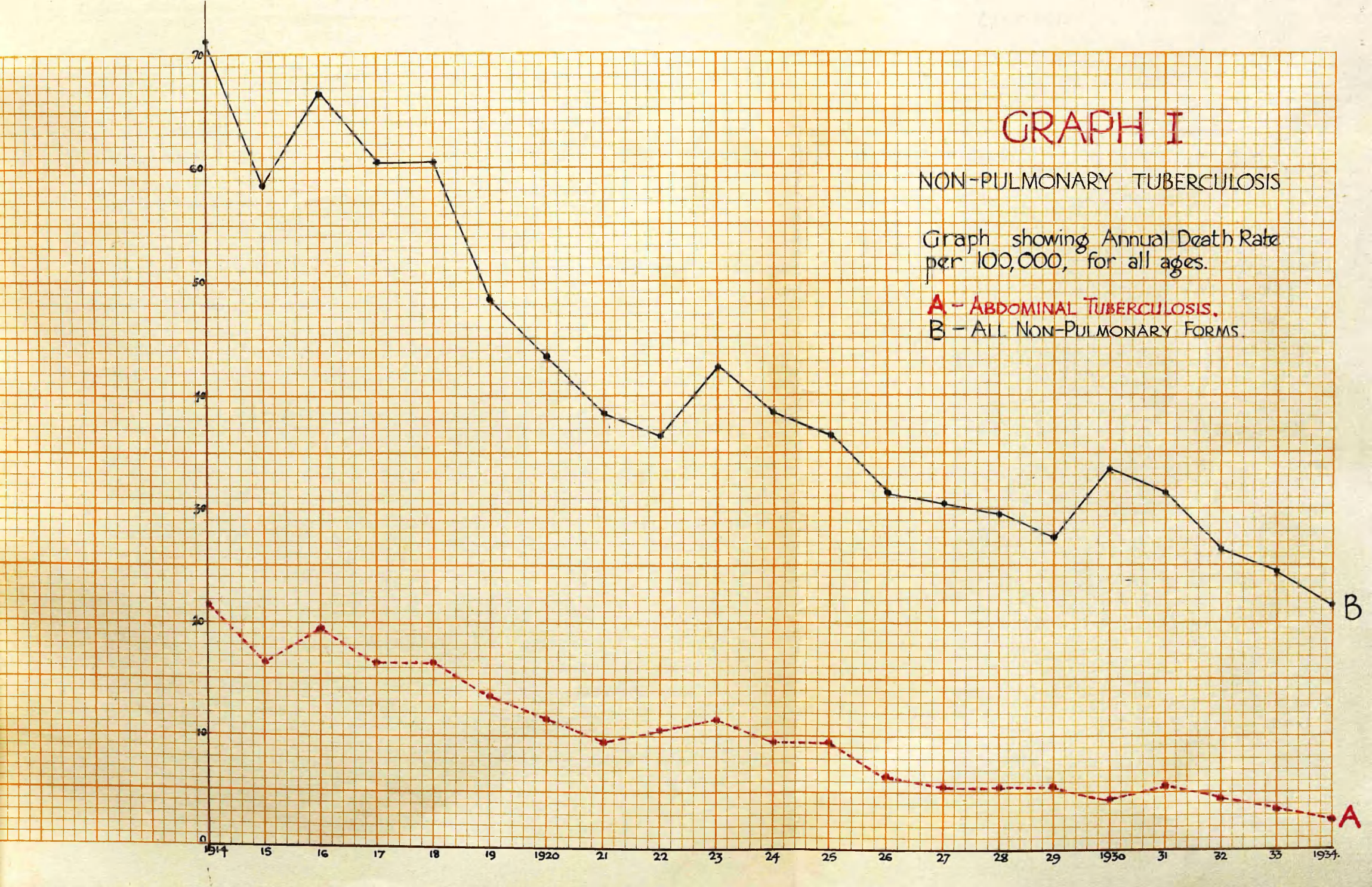
The declining incidence in the prevalence of abdominal tuberculosis presents an interesting study in epidemiology requiring detailed examination to reveal the true significance of the various factors at work. The material utilised in this investigation is the death rate per

GRAPH I

NON-PULMONARY TUBERCULOSIS

Graph showing Annual Death Rate per 100,000, for all ages.

A – Abdominal Tuberculosis.
B – All Non-Pulmonary Forms.



100,000 for abdominal tuberculosis recorded in Glasgow from 1915 onwards. Graph IA illustrates the death rate for abdominal tuberculosis per 100,000 for all ages from the year 1914. It will be observed from this graph that with slight variations the incidence of the disease shows a definite decline from 21 per 100,000 in 1914 to 3 per 100,000 in 1934. When a comparison is made between this curve and Graph IB which represents the death rate per 100,000 for all non-pulmonary forms of the disease for a similar period, a fair degree of parallelism will be seen, the two peaks in the latter curve for 1923 and 1930 being due to an increase in the number of deaths from tuberculous meningitis.

However it would be incorrect to assume that in Graph IA we have a complete pictorial representation of the changing incidence of the disease during the last two decades. In order to obtain this it is essential to consider in detail not only the many different factors at work in bringing about the decline but also the effects of these factors on the different age groups. Table I shows the death rate per 100,000 for the different age groups from 1915, to 1934. These figures are graphically represented by the four curves of Graph II, the intervals of time being laid off on the abscissa in quinquennial periods. Now it will be seen that each one of those quinquennial periods represents a different phase in the social and industrial life of the city, phases in which varying and at times antagonistic factors were at work influencing the economic and domestic surrounding of certain classes. During the years 1915-1919 the effect

GRAPH II

ABDOMINAL TUBERCULOSIS

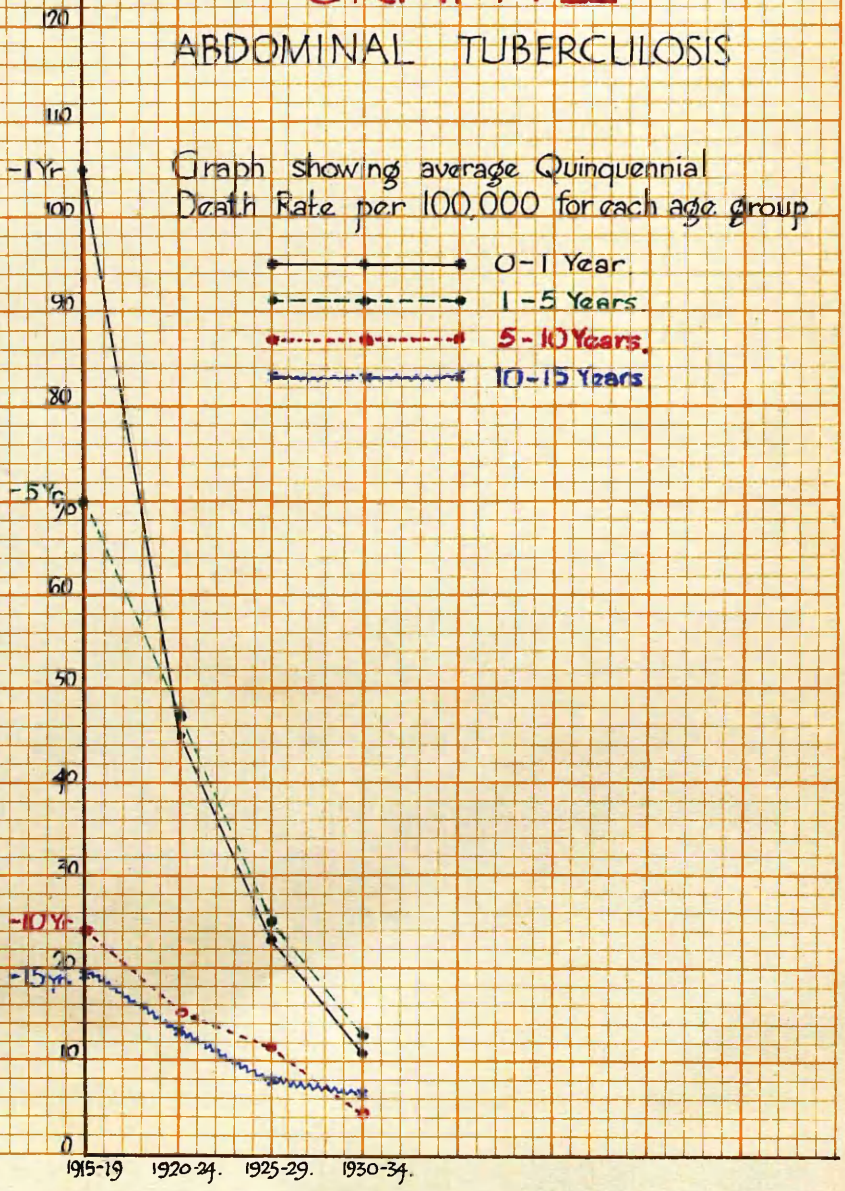


TABLE I.

ABDOMINAL TUBERCULOSIS
Death Rate per 100,000: 1915-1934.

	-1yr	1-5yr	5-10yr	10-15yr	All Ages
1915	109	74	27	19	17
1916	132	91	30	23	20
1917	115	63	23	24	17
1918	106	67	22	21	17
1919	70	63	26	14	14
1920	66	30	26	12	12
1921	54	40	12	15	10
1922	42	51	14	15	11
1923	46	62	13	8	12
1924	23	51	8	17	10
1925	26	43	14	15	10
1926	23	21	12	8	7
1927	22	24	6	6	6
1928	33	19	11	5	6
1929	14	24	11	6	6
1930	8	17	9	4	5
1931	10	10	7	13	6
1932	10	13	3	5	5
1933	5	16	4	6	4
1934	19	4	3	5	3

of the war is outstanding, the abnormal conditions of which will be discussed later. From 1920 to 1924 the community benefited from the period of post war prosperity but also suffered from the first effects of the increasing housing shortage which were further aggravated by the return of men who had been in army service. The next quinquennial period 1925-1929 saw the launching of strenuous campaigns against the evils of over-crowding,

but also during this period economic distress became accentuated, making its presence most felt among the poor. In the final five years 1929-1934, we have an era of increasing stability, both social and economic accompanied by the benefits derived from the various municipal schemes of environmental improvement.

Referring again to Graph II the outstanding feature is the marked drop in the incidence of the disease in the youngest age group, from 105 in the 1915-1919 period to 45 in 1920-24. During the former period points to be considered include the effects of a lower birth rate combined with the benefits accruing from the war time prosperity, on the other hand owing to the rationing of food certain commodities were difficult to obtain. What would appear to be of more importance is the fact that at this time the outdoor clinics were short-staffed and overcrowded, rendering accuracy of diagnosis more difficult. Thus many cases of infantile diarrhoea may have been notified as abdominal tuberculosis bringing about an inflated incidence of the disease. For the succeeding quinquennial periods the decline is maintained but is less prominent, running a similar course to the 1-5 age group.

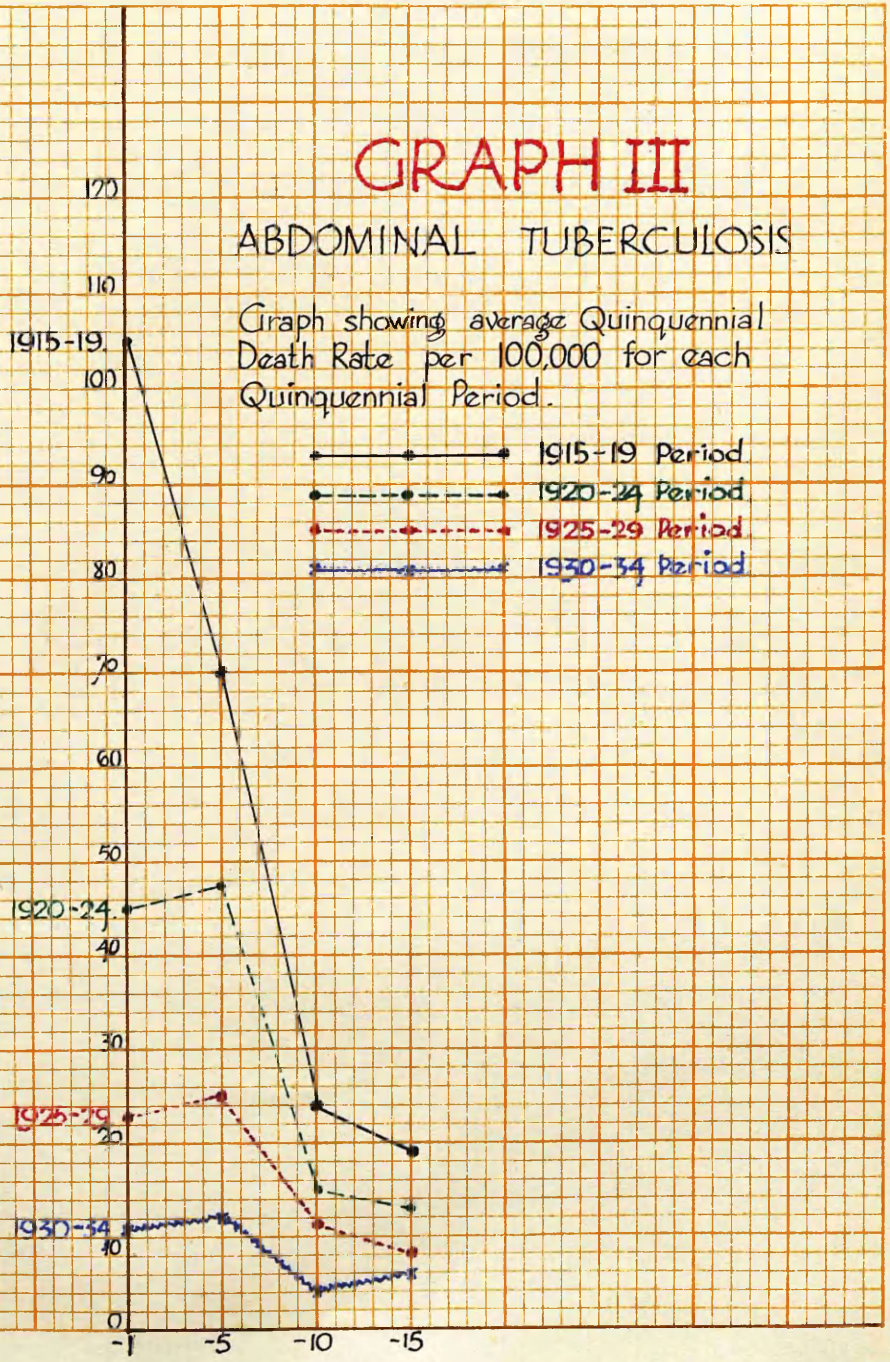
Further reference to this graph shows that in the two older age groups namely 5-10 yr. and 10-15 yr. parallelism is more evident but the decline is slightly greater in the 5-10 age group, from 24 in 1915-1919 it falls to 4 in 1930-1934, the 10-15 age group falling from 19 to 6 in the corresponding period, the total fall being less than in the younger age groups.

Graph III reveals the relative frequency of each

GRAPH III

ABDOMINAL TUBERCULOSIS

Graph showing average Quinquennial Death Rate per 100,000 for each Quinquennial Period.



age group for the four quinquennial periods. The different age groups are plotted on the abscissa or X axis while the death rate for each period is recorded on the Y axis. In the curve for the 1915-1919 period the most prominent feature is the high level, 105 occupied by the 0-1 age group and to a lesser degree the level of 70 by the 1-5 age group. In the other three quinquennial periods the decline is most marked in the 0-1 age group giving a relative increase in the 1-5 age group for each period.

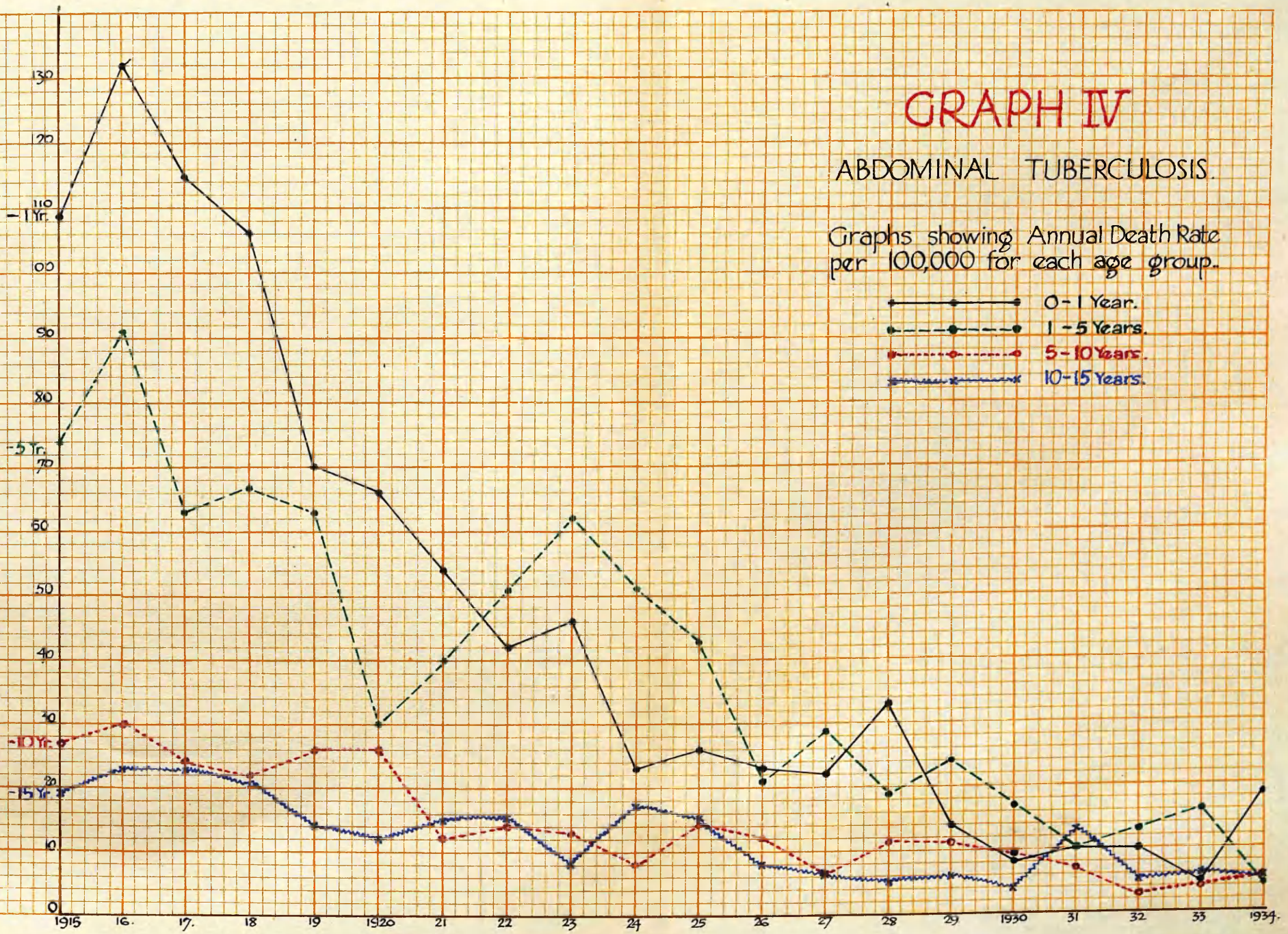
What is the significance of the dramatic drop in the 0-1 age group? Does this indicate a pure saving in life or is it correct to infer that the onset of the disease is merely delayed, making a later appearance in the older group? In attempting to interpret this variation it is essential to realise the different factors coming into play in the two age groups. In the 0-1 age group the individuals are in the stage of infancy, being kept in close association with their mothers; it is in this stage that the benefits accruing from the pasteurisation of milk and the increasing degree of control of pulmonary tuberculosis in mothers would be most noticeable. It is also in the first year of life that infantile diarrhoea is most prevalent. Increased facilities for observation as would be provided by welfare clinics would tend to diminish errors in diagnosis in connection with the two ailments thus decreasing the number of cases notified as abdominal tuberculosis.

On attaining the 1-5 age group there is a considerable alteration in the environmental conditions surrounding the child. From this point onwards the individual child becomes less of a parasite relying entirely on

GRAPH IV

ABDOMINAL TUBERCULOSIS.

Graphs showing Annual Death Rate per 100,000 for each age group.



maternal succour and can be considered more as an independent unit and as such comes to a greater extent under the influence of its immediate surroundings. In other words it is at this period of the child's life that the evils of overcrowding become manifest, including the influences of contact with active cases of pulmonary tuberculosis.

Thus it will be seen that these varied and interesting changes in the death rate for abdominal tuberculosis cannot be attritubed to any one cause but are the result of the various factors mentioned.

In Graph IV the death rate is recorded for each age group in individual years giving in more detail the data of Graph II. It will be observed that there is a general increase during the war years, explainable by errors in diagnosis occurring in overworked clinics. The curve of the 1-5 age group follows the curve of the 0-1 age group until 1917 when there is a marked divergence with the appearance of a peak in the former curve reaching its maximum in 1923. It is of some significance that during the war and in the immediate post-war years the high wages then paid tended to keep at work men who were really unfit on account of pulmonary tuberculosis and normally would be having institutional treatment. The influence of such association would make its presence felt by an increased incidence in this the most susceptible age group. The decline in the other age groups is well maintained with an absence of any marked irregularity.

Conclusions.

It will be seen from this historical survey that abdominal tuberculosis has been known to man since the earliest medical writings. Although at first ill-defined and obscured by other conditions with a superficial clinical resemblance, scientific research based on an increased knowledge of both pathology and bacteriology has revealed the condition as a definite entity. A fact of more importance is that this increased knowledge of the disease has been accompanied by a diminution in its incidence. It would also appear that not only has it declined numerically but the disease in its present type is of a more benign form than that described by earlier writers. These gratifying changes in the nature of the disease must stand as a tribute to the ever-improving standards of living and to the successful efforts of preventive medicine.

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C. THE SCOPE OF THE INQUIRY.

The source of material for this investigation has been derived from one hundred consecutive cases notified as "abdominal tuberculosis" in the Glasgow area during 1933 and 1934. These cases were restricted to children under the age of 15 years and were all considered suitable for institutional treatment and as such were admitted to Mearnskirk Hospital.

The term abdominal tuberculosis has been employed as a heading to include tuberculous lesions affecting the abdominal lymphatic glands, the peritoneum and the intestinal tract. Genito-urinary tuberculosis has not been included in this series. The lesion in each case was primarily an abdominal one as far as could be ascertained by case history and clinical findings. This excluded intestinal lesions secondary to pulmonary foci. In a few cases a subsidiary tuberculous lesions were also notified, such as cervical glandular involvement. In some cases the conditions were notified as a doubtful tuberculous lesion and were admitted to hospital for further observation as well as treatment. Thus it was found necessary to investigate and revise carefully the diagnosis in many cases, the object being to utilise the resources available in a modern hospital to make a definite diagnosis between the tuberculous and non-tuberculous cases, to make a practical classification of these tuberculous cases and where possible to determine the type of bacillus found. In all the cases coming from tuberculosis dispensaries, the provisional diagnosis of abdominal tuberculosis had been made chiefly on clinical findings

and on a history of symptoms which indicated the probability of the condition. However if we consider in detail the typical history of such a case it will be noticed that there is a lack of specific information that would lead to a certain diagnosis. The child may present a picture of ill-health, with vague abdominal tenderness accompanied by a story of loss of weight, diarrhoea, night sweats and periods of febrility. Is this a tuberculous case? Is it necessary for the child to be detained in hospital for prolonged treatment as a case of tuberculosis? Such symptoms might be due to a mild or early tuberculous peritonitis or mesenteric adenitis, on the other hand the actual cause might be malnutrition or rickets, a combination of both either alone or associated with a tuberculous lesion.

To illustrate the question further a comparison might be drawn between the diagnosis of abdominal tuberculosis and other tuberculous lesions. In pulmonary tuberculosis the history is usually more specific, physical signs definite, examination of the sputum in many cases gives conclusive results while the details supplied by radiological examination are of the utmost value. In tuberculous infection of bones and joints the physical signs including shortening of limbs and other deformities are in many cases typical, also pus can often be obtained from formed abscesses and a diagnosis made on bacteriological findings. Even in cervical adenitis the accessibility of superficial glands lends itself to an easily made pathological examination. Now it will be seen that in abdominal tuberculosis these factors are non-existent or similar only to a very slight extent. Keeping these

points in mind further investigations were carried out and as well as the clinical data the value of radiological, bacteriological and immunological findings as aids to diagnosis were carefully considered.

From the diagnosis the next step lay in the consideration of the course of the disease, the duration of activity, the reaction to carefully regulated institutional treatment and the development of complications. Finally the correlation of the disease with environmental conditions was fully investigated including nutrition, housing and contact with other forms of tuberculosis.

As well as the consideration of individual cases or individual groups of cases there arose the question of the administrative measures necessary to control the problem of abdominal tuberculosis as a whole. Are the present resources adequate? Is the present decline in the incidence of abdominal tuberculosis satisfactory? Or should the numbers be fewer when one considers the great increase in social welfare within recent years?

The question of hospital accommodation must also be considered. Is treatment in a fully equipped modern hospital essential for all cases? To what extent can they be controlled and treated through tuberculosis dispensaries only, and to what extent might they be treated by residence in a convalescent or country home? In these circumstances of course the cost per head would show a considerable reduction when compared with hospital treatment.

The scope of the inquiry is thus seen to be a general one and considers the problem of abdominal tuberculosis from a comprehensive angle.

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D. THE INVESTIGATION OF ONE HUNDRED SELECTED CASES.

(1) Number - Sex and Age Distribution.

The total number of cases investigated was one hundred. In order to clarify future references it would appear to be appropriate to state here that in the total of one hundred cases, seventy-two were found to be definitely tuberculous, fifteen definitely non-tuberculous and in the remaining thirteen the presence of a tuberculous lesion could not be established with certainty and they were accordingly classified as of doubtful tuberculous origin. The reasons for including the different cases under these headings are fully detailed in the section on diagnosis.

As might be expected the two sexes showed a fairly equal distribution in the hundred cases investigated, there being no obvious reason why one sex in childhood should be more susceptible than the other. Table II shows the age and sex distribution of the stated cases. It will be seen that four age groups are employed, namely 0-1 yr., 1-5 yrs., 5-10 yrs., and 10-15 yrs.; these groups will be adhered to throughout the work.

TABLE II.

AGE AND SEX DISTRIBUTION IN 100 CASES.

	-1yr	1-5yrs	5-10yrs	10-15yrs	Total
Male	4	19	19	17	59
Female	4	8	18	11	41

The greatest frequency occurs in the age group 5-10 yrs. It must be remembered however that in many

cases the source of information must be considered unreliable - the onset may have been gradual and protracted, the child never having been robust, with the result that the parents were doubtful as to the exact age of sickening. The figures recorded here are more or less in keeping with other authorities. Carson[7] stated that in mesenteric gland tuberculosis, "which gives the earliest incidence" 65 per cent occurred between the ages of 5 and 15 years. The average age for 52 cases was 13.9 years, being fairly evenly divided between the sexes. Andrew[8] recorded 213 cases of tubercular peritonitis 71 per cent of which occurred under the age of twenty years, the largest group 43.6 per cent occurring between 10 and 20 years, 53 per cent being males and 47 per cent females; the mortality rate was 10.3 per cent. Cassidy[9] found that of 267 cases treated in St. Thomas' Hospital, 75 per cent were under 20 years of age and those under 10 years numbered 33 per cent. Males predominated in the proportion of 54 to 45 per cent, the mortality rate being 9.7 per cent.

Further information regarding age and sex distribution was obtained from a series of 491 abdominal cases, this being the total number under 15 years of age alive in the Glasgow area in May 1926. Here also male children were in the majority, 57.3 per cent to 42.7 per cent: regarding the age of onset the greatest number occurred in the 1-5 age group, 45.7 per cent. The 5-10 age group was next with 30.3 per cent, while the 0-1 and 10-15 age groups contained many less, 11.2 per cent and 12.8 per cent respectively.

(2) Environmental Conditions.

In connection with environmental conditions one striking feature is that of the hundred cases investigated, practically all of them belonged to that section of the community which has the poorest standard of living and which is financially on a scale able to supply little in excess of the bare necessities. In other words, the majority belonged to the class known as slum dwellers. Investigation of the housing conditions showed that 60 per cent occupied houses of only two appartments, while the habitation of 16 per cent consisted of a single room. 14 per cent dwelt in houses of three appartments, 4 per cent in four-roomed houses, while one case was reported from a residential institution. On the basis of the current standard which designates a house as overcrowded when it contains more than two persons per room, a child under 10 years counting .5, 60 per cent of the houses fell below this standard and of the remaining 40 per cent the majority were little above it.

Further investigation of the housing conditions showed that the influence of overcrowding appeared to vary in the different age groups. The 0-1 age group or the state of infancy, as has been already stated is the age least susceptible to the effects of bad housing conditions. In this series 50 per cent of this age group fell below the requisite standard, while in the remaining age groups 1-5 yrs., 5-10 yrs., and 10-15 yrs., the figures showing a deficiency were 54.2 per cent, 60 per cent and 72.2 per cent respectively, that is, a steady increase was noted in each successive age group. The

number of cases being limited to one hundred further information regarding housing conditions was obtained from the 491 cases to which reference has already been made. The same standards were adopted and a marked similarity was found in the two series. Here again the youngest age group was least affected with 74.1 per cent below standard, while the oldest age group showed 90.5 per cent below this level. The other two groups occupied a closely approximated intermediate position. Although the relative positions of the different age groups have remained the same in the two series of cases, the actual number of houses falling below the standard is much less in the more recent series of one hundred cases, indicative of the improvement in housing conditions since 1926. It would appear therefore that the individual aged 10-15 yrs. is more susceptible to the effects of bad housing conditions than the newly born child.

In the consideration of the important question of nutritional factors as contributory causes in abdominal tuberculosis numerous difficulties presented themselves. The diet of a child may vary a great deal with advance in years, and apart from the feeding in early infancy, no uniform standard can be detailed. The information obtained from parents in many cases is inaccurate and often contradictory. However, provisional classification was obtained by judging the economic status and financial resources of each household. On this basis three standards were laid down, firstly those in which to all appearances diet was adequate and according to parental information no hardship was felt; these were classified as "good". At the other extreme, classified as "bad",

were the obviously ill-nourished and ill-cared-for, children from large families in many cases financially dependent on unemployment and parish relief. Between these two extremes a third group was designated as "fair" in which the economical surroundings were adequate but not excessive. Accepting these s tandards it was found that 11 came under the category of "good", while 56 were recorded as "bad", the remainind 33 belonging to the intermediate group. When these cases were again allocated to the different age groups, as might be expected the division was somewhat similar to that coming under the heading of housing conditions, that is, the age group 10-15 showed the largest number under the heading "bad" - 64.3 per cent of the group, while only 7.1 per cent could be classified as "good". In the combined groups 0-5 years the corresponding figures are 54.3 per cent and 8.6 per cent. Table III shows the figures and percentages for each group.

TABLE III.

ECONOMIC POSITIONS OF 100 CASES.

	Good	Fair	Bad
0-5yrs	3 (8.6%)	13 (37.1%)	19 (54.3%)
5-10yrs	6 (16.2%)	12 (32.4%)	19 (51.4%)
10-15yrs	2 (7.1%)	8 (28.6%)	18 (64.3%)

Another important question which presents itself in relation to nutrition as a factor in abdominal tuberculosis is the significance of pasteurised and non-pasteurised milk as part of the diet. Here again reliable information was obtained with difficulty but as far as possible the milk diet of the child was placed in one

of four groups, (1) mother's milk, (2) raw dairy milk, (3) heat treated milk, and (4) artificial or proprietory milks. In seventy cases of all ages definite information was obtained relating to the variety of milk used during the infancy of each case. Of this total 36 or 48 per cent were breast fed, 22 or 29.3 per cent had raw dairy milk as part of their diet, 14 or 18.7 per cent had heat treated milk, while the remaining 3 or 4 per cent were nourished with artificial milk. The full significance of these figures is brought out by referring each type of feeding to the individual age group. This is illustrated by Table IV.

TABLE IV

MILK DIET OF 100 CASES

Age Group	No. of Cases	Mother's Milk	Raw Dairy Milk	Heat Treated Milk	Artificial Milk
0-1yrs	6	- -	5(83.3%)	1(16.7%)	- -
1-5yrs	21	8(38.1%)	6(28.5%)	7(33.3%)	- -
5-10yrs	25	14(56.0%)	3(12.0%)	6(24.0%)	2(8.0%)
10-15yrs	23	14(60.8%)	8(34.8%)	- -	1(4.3%)
Total	75	36(48.0%)	22(29.3%)	14(18.7%)	3(4.0%)

The striking feature is the high percentage (83 per cent) of cases under one year fed on raw dairy milk, this being far in excess of any other group. The number in this group having had heat treated milk is correspondingly small (16.7 per cent), the lowest of the recorded figures. The percentage of cases fed on maternal milk shows an increase in each successive age group.

In association with environmental conditions

there must be considered the important question of the family history relating to tuberculosis and the history of contact with any previous case either pulmonary or non-pulmonary. In the hundred cases investigated 26 gave a history of contact with notified cases of tuberculosis; of these notified cases 17 had pulmonary lesions and 9 non-pulmonary, including abdominal, meningeal and bone and joint foci. When the original hundred cases were divided into the definitely tuberculous and the definitely non-tuberculous it was found that of the 15 cases proved to be non-tuberculous, only one case (6.6 per cent) had been previously in contact with an individual suffering from tuberculosis. Of the 72 cases classified as definitely tuberculous, 18 (25 per cent) gave a history of contact with other tuberculous patients, 13 (18.1 per cent) were pulmonary lesions and 5 (6.9 per cent) non-pulmonary. Of the 13 pulmonary contacts 2 (15.4 per cent) were age 0-5 years and 8 (61.5 per cent) aged 5-10 years and 3 (23.1 per cent) between 10 and 15 years. That is of the definite cases of abdominal tuberculosis in contact with active cases of phthisis 15.4 per cent were under the age of five years, and 64.6 per cent were between the ages of 5 and 15 years. It is interesting to note that in one case only was the mother recorded as suffering from pulmonary tuberculosis and here the age of onset in the case of the child was below one year.

Thirty-three of the hundred cases gave information of a positive family history, 23 of pulmonary lesions and 10 of non-pulmonary lesions. In 11 cases the history was positive on the paternal side, in 6 on the maternal side, in 3 both paternal and maternal, while 13 referred

to other cases in the same generation. In the definitely tuberculous cases the percentage with a positive family history was nearly double that found in the non-tuberculous cases.

(3) Mode of Onset of Disease.

In the investigation of this question the problem of inaccurate and unreliable information obtained from parents again presented itself. However by careful questioning, particulars about points of relevant interest were elicited, stress being laid on the acuteness of onset, the relation of the disease to the previous health of the child and the prominence and order of appearance of the early symptoms.

Of the hundred cases 26 gave a history of sudden onset and in 74 the disease made its appearance in a gradual manner. Loss of weight was the most constant feature reported by parents, this being present in no fewer than 87 per cent of the cases. Abdominal pain was present in 71 per cent, diarrhoea in 55 per cent, abdominal distension in 52 per cent and vomiting in 45 per cent. Night sweating and cough were reported in 50 per cent and 40 per cent of the cases respectively.

Abdominal pain was the first indication of the illness noted by the parents in the majority of cases, 48 of the total of one hundred: diarrhoea was the first symptom in 20, loss of weight in 17, abdominal distension in 10 and vomiting in 5. The abdominal pain noted was variable in character, was mainly of a colicy type situated in the lower abdomen and of a recurrent nature.

The question of the previous health of the child as

a factor of importance could not receive a definite answer. The significance of this was based on the general impression of the parents. In 40 per cent of the cases the previous health of the children had been considered good, 31 per cent poor and 29 per cent fair. Regarding the importance of previous infectious diseases no outstanding result followed investigation; the incidence of infection of course was lowest in the youngest age group of cases. Measles was the most frequent condition recorded in each age group followed by whooping cough and pneumonia.

The significance of previous diseases affecting the respiratory system will be referred to later in connection with the pulmonary complications of abdominal tuberculosis.

(4) Course of Disease.

In considering the sequel of events in abdominal tuberculosis reference must first be made to the pathological changes which underlie the clinical phenomena. In primary abdominal lesions the alimentary tract forms the portal of entry. In the post-mortem room it is not uncommon to find the mesenteric glands to be the seat of a tuberculous lesion without any evidence of tuberculosis in any other organ or tissue. Calmette has shown that the tubercle bacillus can penetrate the intestinal mucosa without leaving any trace of its passage, the entry being effected through a lacteal to the neighbouring lymphatic glands. Having reached this physiological barrier between ingested potential infection and the systemic system, further progress depends on both the virulence of the invading organism and the degree of resistance set up by the host, the essential elements of the latter being

either acquired or hereditary. In many cases the condition may remain limited to a localised mesenteric adenitis, the process of caseation being followed by calcification. Further spread of the disease may be by one of two routes, either by the blood stream or by the lymphatic channels. When disseminated by the blood stream the bacilli may be deposited in other organs of the body, possibly giving rise to pulmonary, meningeal or peritoneal foci, the extreme being represented by the typical miliary tuberculosis. Through the lymph channels the organisms pass directly from one group of glands to another, the dissemination of the disease being neither so rapid nor so extensive as by the blood stream. As the disease progresses one of the most important structures liable to be involved is the peritoneum, a field which would appear to be particularly suited to the propagation of the tubercle bacillus. The spread is usually accompanied by clinical phenomena of the greatest significance, but the exact origin of tuberculous peritonitis must still be considered doubtful. The condition may have a primary origin derived directly from the intestine without apparent involvement of the mesenteric glands or it may be blood borne from some distant focus. The possibility of a caseous mesenteric gland rupturing its contents into the peritoneal cavity must always be remembered.

The reaction of the peritoneum to invasion may vary widely; one extreme is represented by an acute generalised tuberculous peritonitis, sudden in onset and in most cases ending fatally. More frequently the condition is insidious, the inflammatory changes being chronic in

nature and accompanied by numerous adhesions with a potential danger of intestinal obstruction. Occupying an intermediate position between these two extremes are other pathological conditions affecting the peritoneum which may fall under two headings, firstly those cases in which ascites is present, the peritoneal lesion here being a miliary one. Under the second heading is a clinical picture in which caseation with resultant matting and adhesions form a prominent part. Carson suggests that the caseous variety has an entirely different aetiology from both the ascitic and the adhesive varieties and is a later stage of mesenteric gland tuberculosis arising from extravasation of caseous material from glandular masses.

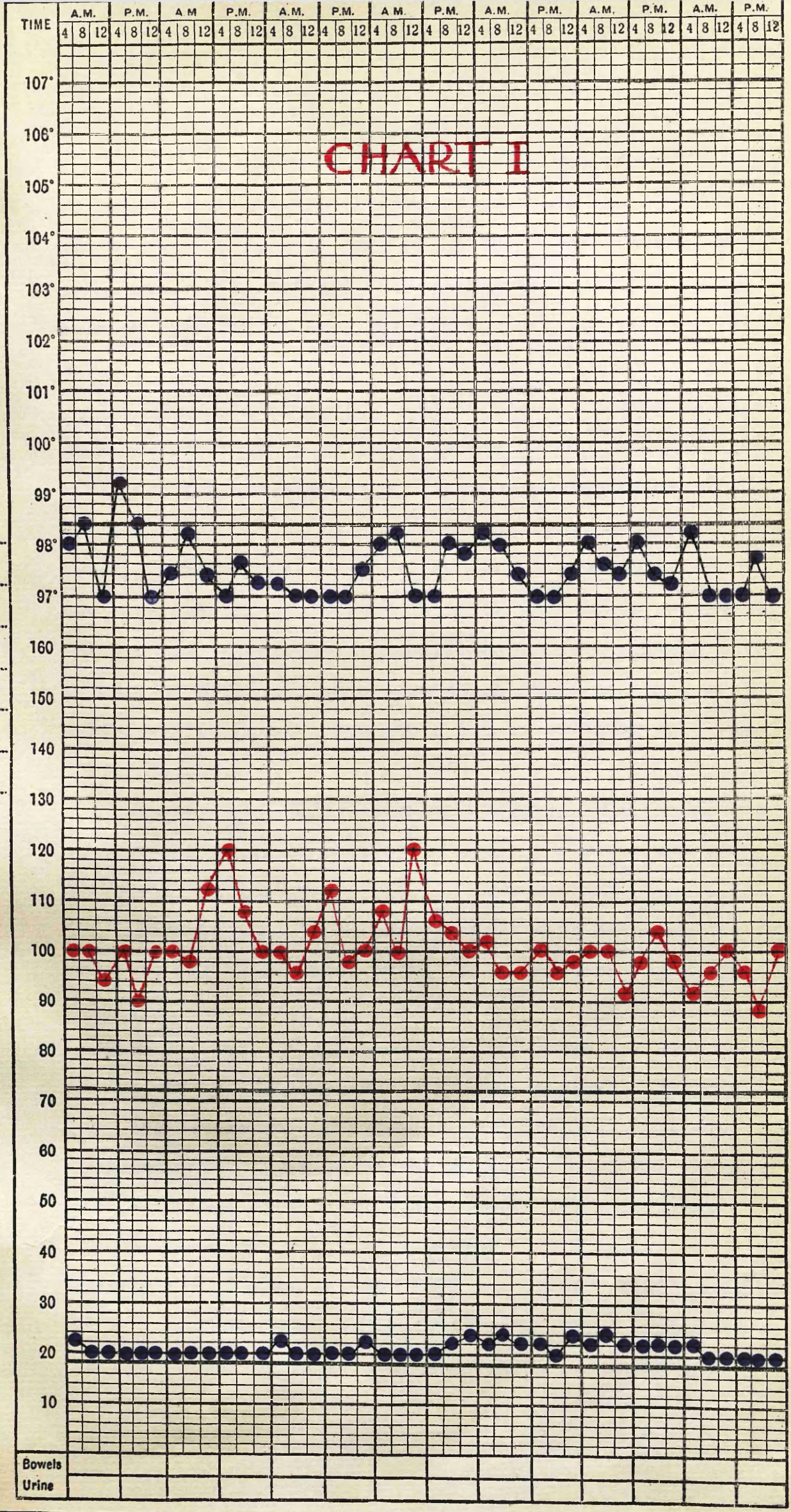
It will thus be seen that the pathological changes may vary widely in both character and extent, the accompanying clinical features being diverse but in keeping with the morbid anatomical changes. The lesion may be limited to a simple glandular involvement or tabes mesenterica, these glands in favourable cases undergoing calcification with little or no constitutional upset, the condition being compatible with apparent good health. As already stated this localisation and subsidence of the disease depends on the virulence of the infection and on the resistence of the individual. It is in connection with the latter that the importance of environmental features comes under consideration. It is quite conceivable that a well-nourished child living in healthy surroundings might show little or no reaction to a degree of toxic invasion which would markedly affect a child exposed to the ill effects of deficient nutrition and evil housing.

When the disease extends beyond the limits of the mesenteric glands a wide variety of clinical sequelae may result. Dissemination through the blood stream may give rise to widespread foci in various organs, these lesions varying in severity from superficial tuberculides to extensive active lesions in pulmonary, cerebral or other tissues. The following two cases illustrate these extremes.

CASE I, W.A., male, aged 8 years. Had a sudden onset of illness 6½ months prior to admission, the onset simulating an acute surgical emergency. Abdominal laparotomy revealed tuberculous mesenteric glands with involvement of the peritoneum. The abdominal wound continued to discharge, the child going steadily downhill, a fatal termination resulting. Necropsy showed considerable matting of the peritoneum, numerous tubercles being studded over the surface. On sectioning the lung multiple small tubercles were found scattered throughout the pulmonary tissue. Small tuberculomata were also found in the brain, being located in both cerebral and cerebellar tissue.

CASE II, O.G., male, aged 13 years. The subsidiary lesions were of minor clinical importance. The abdominal lesion was limited to a tuberculous infection of the mesenteric glands. After three months in hospital superficial abscesses, about three in number, appeared on the left forearm. Complete cure followed aspiration but a guineapig inoculated with the pus proved to be tuberculous.

As well as this generalised spread there may be extensive local invasion of the peritoneum which may be



OF ILLNESS.....

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either acute or chronic in nature. In the chronic type of lesion with the typical doughy abdomen, usually distended but not painful, the child is in poor health but not acutely ill, the symptoms taking the form of general malaise accompanied by slight irregularities in temperature.

CASE III, J.M'K., male, aged 14 years. The onset here occurred about one year prior to admission. Loss of appetite combined with loss of weight and an increasing distension of the abdomen were the salient features. This child ultimately made a good recovery but the progress of the case was complicated by the appearance of a pulmonary lesion, the significance of which will be considered later. During the early period of residence there was only a slight variation in temperature and pulse which is illustrated in Chart I.

The cases of acute abdominal tuberculosis are not so common, the clinical history is usually a short one and the onset comparatively sudden. The patient shows all the manifestations of severe toxaemia with swinging temperature and rapid pulse rate; most of these cases end fatally.

CASE IV, H.K., male, aged 9 years. The symptoms commenced one month before admission to hospital. Abdominal pain was severe and accompanied by diarrhoea. Examination revealed a considerable degree of rigidity of the abdominal wall with considerable matting of the underlying structures. The signs of toxaemia were marked, the temperature varying between 97°F and 101°F. Death occurred after a stay in hospital of five weeks. Post mortem examination showed an extensive tuberculous peritonitis with

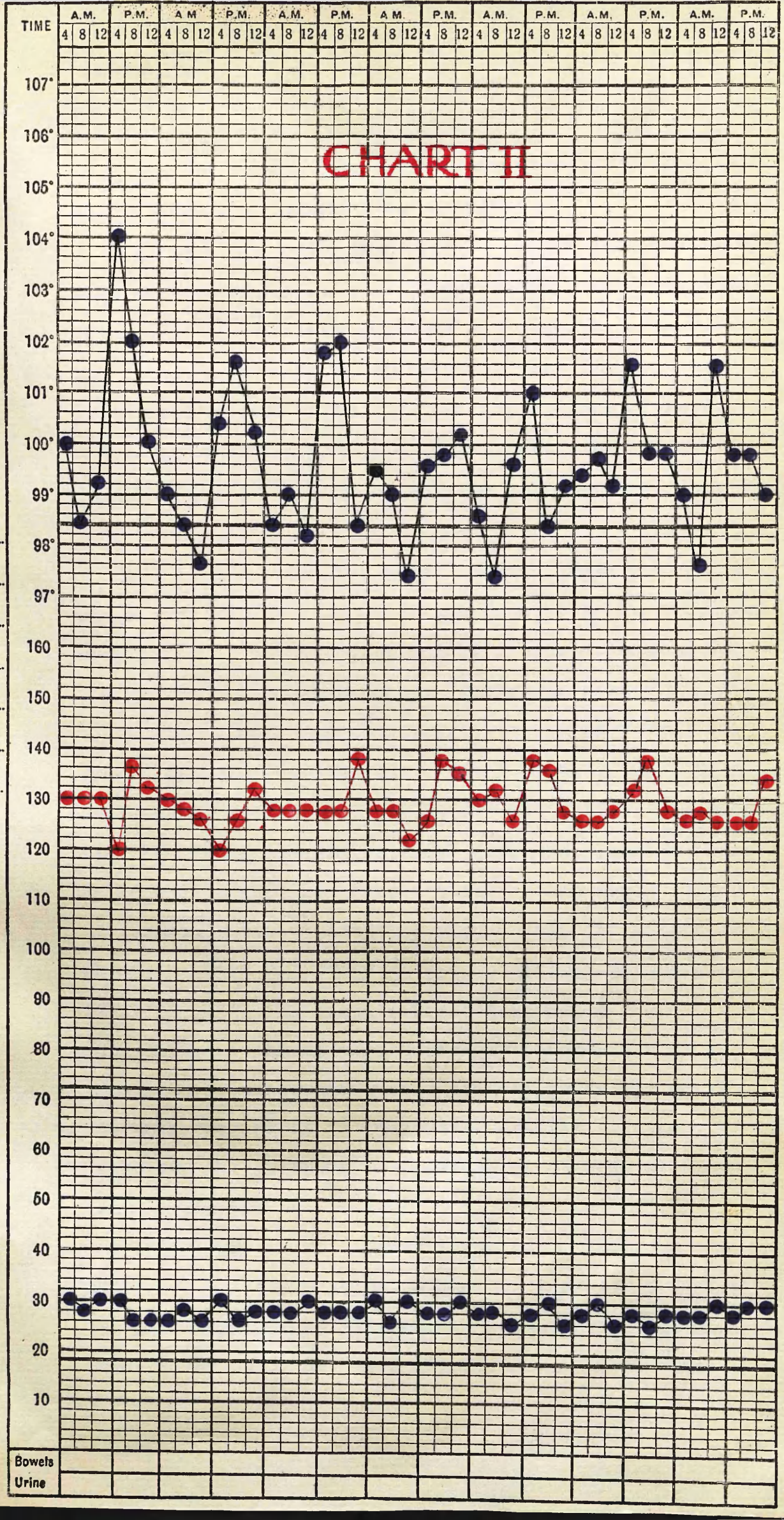
CHART II
TIME
A.M. P.M. A.M. P.M. A.M. P.M. A.M. P.M. A.M. P.M. A.M. P.M. A.M. P.M.
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F ILLNESS.....

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considerable recent adhesions present: the mesenteric glands were also extensively involved.

Between the acute and chronic stages just mentioned lies another group in which the clinical manifestations occupy an intermediate position and might be designated sub-acute. In many of these cases free fluid in the peritoneal cavity is the outstanding feature. Here again the condition is usually painless, the signs of toxaemia may not be marked and the variations of temperature inconsiderable.

CASE V, R.D., female, aged 7 years. Gave a history of gradual onset; the child was seen to be listless and complained of a feeling of weight in the abdomen which was noticed to be distended. There was also a tendency to breathlessness and occasional attacks of diarrhoea. After admission to hospital several pints of ascitic fluid were removed from the peritoneal cavity, the tubercle bacillus being readily cultured from the fluid. This child made a good recovery but during the early period of treatment the temperature showed wide variations as shown on Chart II. This elevation of temperature soon subsided following institutional treatment.

Another variety of the sub-acute condition is represented by those cases in which caseation with matting and infiltration of the mesentery are the outstanding features, the evidence of toxaemia being more evident than in the ascitic variety.

CASE VI, S.P., male, aged 10 years. Sickened three months prior to admission, abdominal distension and pain being accompanied by alternating constipation and diarrhoea. The child was very ill on admission and died

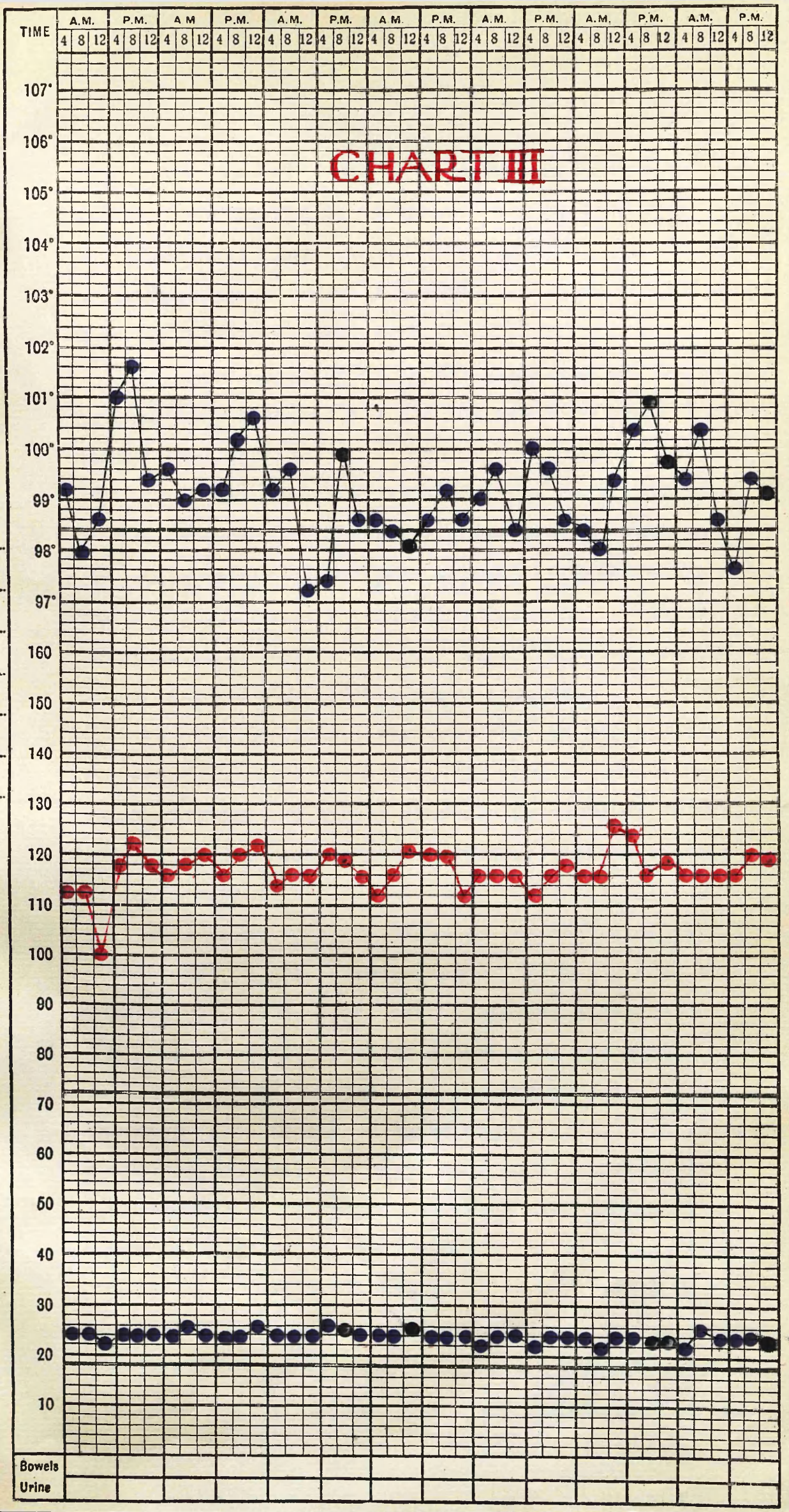
CHART III
TIME
A.M. P.M. A.M. P.M. A.M. P.M. A.M. P.M. A.M. P.M. A.M. P.M. A.M. P.M.
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Bowels
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F ILLNESS.....

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three weeks later. Post mortem examination showed the visceral peritoneum to be covered with a fibrous exudate, the mesenteric lymph glands were enlarged, caseous, and fused together. Chart III shows the pulse and temperature variations before death.

It would appear that no definite line can be drawn between this last variety and the cases of acute tuberculous peritonitis.

One other condition remains to be mentioned, that is the presence of intestinal ulceration. This condition would appear to be found only in advanced cases and might be considered a terminal phenomenon. Post mortem examination showed it to occur most frequently in those cases with well marked pulmonary lesions.

In classifying the various forms of the disease it is important to remember that the more urgent and grave manifestations may appear suddenly in cases which are apparently progressing satisfactorily towards a stage of inactivity.

This point is illustrated by the following case.

CASE VII, M.M'V., female, aged 8 years. This child was admitted to hospital with a history of abdominal pain and loss of weight covering a period of one month. Glandular masses were palpable in the abdomen, the case being classified as one of tabes mesenterica. During five months in hospital the child made good progress, the improvement in general health being accompanied by an increase in weight. The temperature, at first varying between 97.8°F and 99.8°F, settled to normal limits as shown in Chart IV, and all symptoms cleared up, the child being dismissed "with no evidence of active tuberculosis". Following dismissal she was kept under observation at the

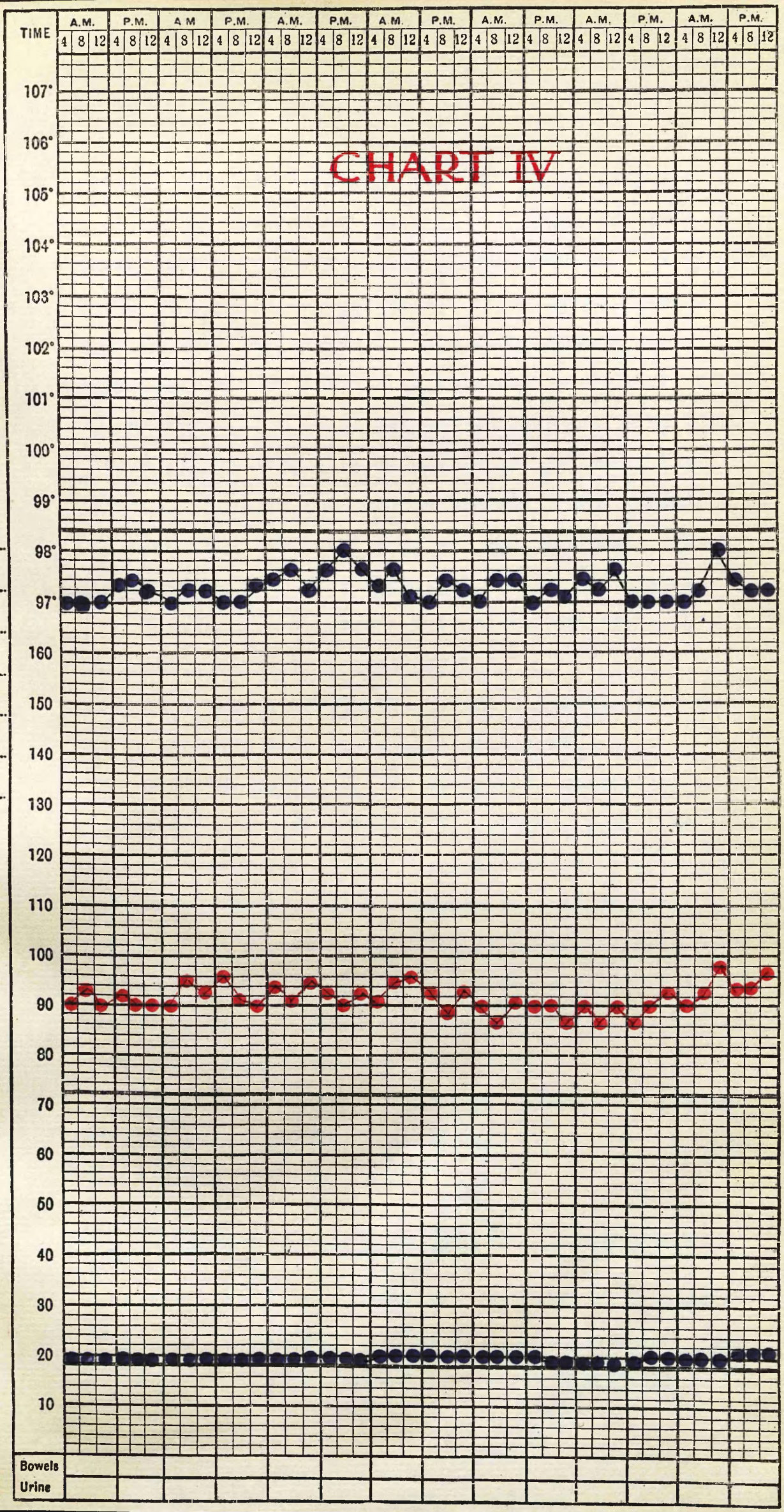
CHART IV
TIME
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Bowels
Urine

outdoor dispensary and remained free from symptoms for a period of twelve months, when complaint was made of acute pain in the right side of the abdomen. Examination revealed a palpable mass in the right iliac fossa with considerable tenderness. Laparotomy showed that the peritoneum was "studded with tuberculous deposit, chiefly calcareous. The bowel was matted together with thin fibrinous adhesions, particularly in the lower ileum which was studded with active masses. The appendix was embedded in a fluctuant mass and was removed. The lower end of the ileum was anastamosed to the transverse colon.

Diagnosis: quiescent and active tuberculosis present." The child made a good recovery.

This case demonstrates how an acute excerbation may occur in a case apparently quiescent.

When the course of the disease is considered in the series of cases under review the prognosis will be seen to be a favourable one in the great majority of individuals with a satisfactory response to institutional treatment. The ten deaths recorded occurred in patients with advanced lesions on admission and in no case did an early lesion go on to a fatal termination, while in a few extensive lesions there was a gradual cure.

The significance of secondary tuberculous lesions outwith the abdominal cavity will be considered under the heading 'Complications'.

(5) Classification in Abdominal Tuberculosis.

Abdominal tuberculosis is a term which is essentially broad in its meaning and does not convey the same information as the terms applied to the other varieties of

tuberculosis. It will be obvious from the foregoing discussion that the disease can be classified on either a clinical or a pathological basis or a combination of both. The scope of radiology in the classification of pulmonary tuberculosis is of considerable value but it has no counterpart in the abdominal variety of the disease. In this work radiograms of the abdomen were obtained in many cases, but were found to be of little value: films taken shortly before death failed to reveal massive glandular lesions either caseous or partly calcified which were found on post mortem examination.

Reference to the work of others bears out the fact that clinical and pathological findings form the standard basis of classification. Carson described three forms of tuberculous peritonitis as follows, (1) the ascitic, (2) the adhesive, (3) the caseous and as already mentioned drew an aetiological distinction between the caseous and the ascitic variety, concluding that the adhesive type was a further stage in the ascitic form, that is a stage of repair, the fluid having been absorbed with resultant adhesions forming. Cope (10) divided the whole field of abdominal tuberculosis under three headings, glandular, intestinal and peritoneal. He stressed the difficulty in separating the different peritoneal lesions which might be either localised or generalised, accompanied by fluid or by infiltrating masses of omentum and caseous glands, or a combination of these present in the one case. Marshall (11) also described three forms of tuberculous peritonitis, the ascitic, the fibroid, and the caseous. Morley (12) recognized two main clinical

groups in tuberculous peritonitis, the ascitic and the plastic type, the latter being associated with a large doughy abdomen in which tympanitis was more evident than ascitic fluid.

It will be seen that there is a marked similarity in the foregoing methods of classifications, the basis in each being more pathological than clinical, for example in the group designated as "plastic peritonitis" no distinction has been drawn between the chronic localised condition and the rapidly fatal acute generalised tuberculous peritonitis.

In the classification which follows one has endeavoured to bring out as far as possible the parallelism which exists between the clinical and pathological findings.

Classification of Abdominal Tuberculosis.

A. Glandular Involvement - Tabes mesenterica.

B. Peritoneal Involvement -
1. Acute Tuberculous Peritonitis.
2. Sub-acute Tuberculous Peritonitis.
   (a) Ascitic
   (b) Plastic
3. Chronic Tuberculous Peritonitis.

These terms employed are more or less self-explanatory, under A or glandular involvement are included all those cases wherein the disease is limited to the mesenteric glands and the clinical signs correspondingly slight. Under B or peritoneal involvement three varieties are recognised, in acute tuberculous peritonitis the lesion is rapid in onset and wide in distribution, the outstanding feature of the case being the extreme

toxaemia. The second or sub-acute variety includes two types, the ascitic and the plastic, which although differing materially in their manifestations, have this in common, that the disease is not so acute as the last-mentioned variety yet considerable local activity may be present, with a moderate amount of toxaemia. The last group, that is chronic tuberculous peritonitis, really corresponds to a stage of partial recovery in which fluid and active caseation are not apparent and the tendency to adhesion formation is present.

It must be remembered that this classification is not absolute and a definite line cannot be drawn between the groups, as any one form may either rapidly or slowly change to one of the other varieties. A simple glandular lesion may suddenly assume the characters of an acute tuberculous peritonitis, similarly an apparently healing lesion may flare up and become clinically active while an acute case may gradually subside into the chronic stage.

(6) Complications in Abdominal Tuberculosis.

Under this heading it is proposed to discuss other tuberculous lesions apart from those located in the abdomen, occurring in the cases notified as primary abdominal tuberculosis. The lesions may have appeared either early or late in relation to the original disease. In consideration of the former circumstances it must be remembered that both the abdominal and the extra-abdominal focus may have arisen concurrently from one source in which case the one lesion is not truly a complication of the other. However in order to effect a

practical classification, complications will be taken to include all lesions making their appearance after the clinical signs or symptoms of abdominal tuberculosis were manifest. Investigation shows that these lesions were diverse in both character and distribution, necessitating some preliminary classification. The lesions therefore were divided into two main groups, pulmonary and non-pulmonary, the former including intra-pulmonary, pleural and hilum forms of the disease. The non-pulmonary group, being wider in its scope, included a greater variety of lesions affecting both bone and soft tissue. Non-pulmonary complications in the cases under review were found in only seven cases, the total veing made up as follows, cervical adenitis, 2; superficial tuberculides, 2; dactylitis, 1; tubercular cystitis, 1; and one case with tuberculomata present in the cerebral tissue, this being part of a miliary infection. Of these seven cases four belonged to the group classified as tabes mesenterica, including both cases of adenitis, one with tuberculides and one case of cystitis. In the group of cases of chronic peritonitis two had non-pulmonary complications, one of superficial tuberculides and one of dactylitis. The remaining case of the seven belonged to the group of sub-acute peritonitis, the complicating lesion being miliary tuberculomata in the brain. The origin of these non-pulmonary foci would appear to be due to an implanting of the bacilli from the blood stream and it is interesting to note that the most benign complications are found in the clinically less acute forms of the disease, namely tabes mesenterica and the chronic form of peritonitis. These non-

pulmonary lesions, with the exception of the miliary one, had little effect on the course of the disease, being purely subsidiary in clinical significance in comparison with the abdominal lesion; extreme toxaemia was not evident in these cases.

An entirely different picture is presented when an investigation is made into the pulmonary complications found in abdominal tuberculosis. As already mentioned this term embraces all intra-thoracic forms of the disease and from a clinical aspect at the time of examination were divided into active and inactive lesions. The diagnosis of these intra-thoracic conditions and the estimation of the amount of activity were made chiefly on clinical and radiological findings. In some cases confirmation of these findings was obtained at post mortem examination.

Referring to the relationship between abdominal and pulmonary tuberculosis, Carson writes as follows, "the association with pulmonary tubercle has varied very much. It is quite unusual to find the association in mesenteric gland tuberculosis, nor is it usual in tuberculous peritonitis, but in tuberculous enteritis the two conditions often occur together." In considering the frequency of tuberculous enteritis in cases of phthisis it would appear that in practically all of them the lung condition is primary, the intestinal ulceration being caused by bacilli introduced through the medium of swallowed sputum and associated with advanced pulmonary lesions. The abdominal lesion being secondary, this variety falls outwith the scope of the present investigation.

Where the thoracic contents become involved, consequent upon a primary abdominal focus it is essential to discuss the ways by which the disease can thus extend its boundaries. On an anatomical basis two main channels of invasion are available, firstly by means of the blood stream, the bacilli being disseminated into the fluid medium and deposited in the pulmonary tissue. The second route of invasion is by means of a direct spread from the abdomen through the lymph channels, a temporary arrest being effected by the tracheo-bronchial lymph glands, and provided conditions are suitable, a direct invasion of the lung results. Following absorption from the intestinal tract the invading organisms first reach the mesenteric glands, over one hundred in number, which receive the lymphatic flow from jejunum, ileum, caecum and vermiform appendix; the efferents from these lymph glands drain into the pre-aortic group of glands, the majority then continuing into the cysterna chyli, but some of the efferents pass to the retro-aortic glands and from there communicate with the thoracic cavity, through the crura of the diaphragm. In the thorax the lymph glands of importance are the posterior mediastinal and the tracheo-bronchial group. This latter group consists of large individual glands, some of which are situated in the hilum of each lung and also in the lung substance. Thus there is direct continuity between the abdomen and the thorax; if the spread of the disease is limited to the mediastinal glands it is classified as hilum tuberculosis. Arrest of this process is followed by calcification as in other glands, the condition being clearly brought out

in radiograms of the chest. By interpretations of these X-ray films the cases of hilum tuberculosis were subdivided into those apparently active and those apparently inactive. Where two or more types of pulmonary lesions were present the case has been included under one heading only, that of the more extensive lesion; for example all cases classified as hilum disease have the disease restricted to the mediastinal glands and cases with definite pulmonary disease as well as glandular involvement are classified only under the heading of pulmonary lesions.

Adopting this method of sub-diving the pulmonary lesions it was found that thirteen of the hundred cases had active intra-pulmonary disease, ten had lesions pleural in nature, while sixteen showed hilum tuberculosis, in thirteen of which the disease was apparently inactive.

Table V shows the distribution of these lesions with reference to the various clinical varieties of abdominal tuberculosis.

TABLE V.

PULMONARY COMPLICATIONS IN ABDOMINAL TUBERCULOSIS.

	Number	Active Pulmonary Disease	Pleurisy	Active Hilum Disease	Inactive Hilum Disease	Total
Tabes mesenterica	31	3(9%)	2(6%)	0	10(30%)	15(45%)
Acute Tuberculous Peritonitis	3	2(67%)	0	1(33%)	0	3(100%)
Chronic tuberculous Peritonitis	26	5(19%)	4(15%)	2(8%)	1(4%)	12(46%)
Subacute Peritonitis (Ascitic)	6	1(16%)	2(33%)	0	1(16%)	4(66%)
Subacute Peritonitis (Plastic)	6	2(33%)	2(33%)	0	1(17%)	5(83%)

It will be seen that intra-thoracic complications are most prevalent in the small group of cases of acute tuberculous peritonitis, two out of the three having active intra-pulmonary disease and the remaining one active glandular disease in the mediastinum. These findings made on clinical and radiological reports were all substantiated by post-mortem examination.

The cases with sub-acute peritonitis showed the next greatest number of intra-thoracic lesions, being found in five (83 per cent) of the cases of plastic lesions and in four (66 per cent) of the ascitic group. These lesions included pulmonary, pleural and hilum varieties in about equal numbers. The cases of tabes mesenterica and chronic peritonitis have approximately the same percentage of thoracic complications, twelve out of twenty-six (46 per cent) for the latter, and fifteen out of thirty-three (45 per cent) for the former: but there is a marked divergence in the form assumed. In chronic peritonitis the lesions were mainly pulmonary or pleural, nine out of a total of twelve taking this form. In the cases of tabes mesenterica ten out of the fifteen with thoracic disease had the condition limited to the mediastinal glands with the remainder equally distributed between the pleural and pulmonary lesions.

Examination in detail of each group of complications reveals a wide diversity in location and extent. In the cases with active pulmonary disease the clinical findings are very definite. An accurate diagnosis was made by clinical and radiological investigation and in six of the total of thirteen these findings were verified by post mortem examination. The majority of these cases showed

the disease to be originating in the root glands and spreading into the pulmonary tissue. In only one case was the lesion in the lung located in the apical region, the typical adult phthisis; in two the lesion was miliary in distribution and in one definitely broncho-pneumonic. These three last cases terminated fatally, the dissemination of the bacilli apparently having been brought about by the blood stream.

In those cases where the disease in the pulmonary tissue spread from the mediastinal glands, the prognosis turned out to be more favourable, as only two deaths occurred in the total of nine cases, although one was irregularly dismissed in an advanced state of toxaemia.

The diagnosis of pleural lesions was made chiefly by X-ray examination. The condition was found to be most prevalent in the sub-acute forms of the disease, two-thirds of the total being located in this group, and equally distributed between the plastic and the ascitic variety. Pleural effusion was a prominent feature in seven cases, in some of which it accompanied intra-pulmonary disease. Effusion also was most prevalent in the sub-acute group.

The diagnosis of hilum disease presented much greater difficulties; physical examination, although helpful, was by no means conclusive and in most cases the diagnosis was established on radiological findings, the limitations of the interpretations being kept in mind. The appearance of opacities in the region of the hilum was not taken as necessarily indicating a tuberculous lesion in the adjacent lymph glands. A history of previous attacks of pneumonia or measles combined with the effects of a

smoke laden atmosphere were always taken into account as a possible explanation of the condition. In many cases, however, the appearance was quite typical, some showing evidence of calcification and others early involvement of the pulmonary tissue. In some the diagnosis was confirmed by subsequent X-ray examination showing an increase in the extent of the lesion. The distinction between active and inactive hilar disease could not be laid down along definite lines but here again the radiological appearances along with the clinical picture formed a foundation for the final opinion.

On this basis most of the root lesions were found to be inactive, only three in sixteen cases showing definite activity. The greatest number of these lesions occurring in one clinical group was found in the cases of tabes mesenterica, namely ten or 30 per cent of the total, the remainder being divided equally among the other groups.

The different varieties of intra-thoracic lesions are illustrated by the accompanying reproductions, the prints having been taken from X-ray films considered most typical of the series. Plates II to VI have been selected as typical of hilum tuberculosis.

Plate II shows definite root enlargement on the right side in a girl of fourteen years who gave a history of one year's illness before admission, and was diagnosed as chronic tuberculous peritonitis, the degree of opacity not indicating calcification. These findings were confirmed by post mortem examination, no intra-pulmonary disease being present. Plates III and IV are from cases of tabes mesenterica where the root glands are prominent, and especially in the latter calcification is more marked than

in Plate II. The clinical progress in these two cases was satisfactory and as might be expected the pulmonary condition was not progressive. Plates V and VI show the pulmonary changes in a case of chronic peritonitis. In the first there is definite glandular involvement, especially in the region of the right hilum, the lesion appearing active as there is no evidence of calcification. The second plate shows the condition six months later; the opacity in the root is denser but there is also a well marked pleural lesion at the base. The termination here was also favourable but progress was slow, the pulse and temperature showing a marked variation.

Plates VII to XI have been selected to show lesions affecting the pleura. Plates VII and VIII demonstrate the changes in a case of sub-acute peritonitis with ascites, the peritoneal effusion being considerable, from which the tubercle bacillus was readily cultured. In Plate VII there is a definite enlargment of the root glands on the right side while Plate VIII, taken six months later, shows a considerable change, there being an extensive pleural lesion with a localised collection of fluid in the upper zone. Plates IX and X also show pleural changes in a case clinically very similar to the last. Here also the tubercle bacillus was cultured from the ascitic fluid. Plate IX shows a definite basal pleurisy in the right side which has cleared considerably in Plate X taken ten months later. The root opacity is still visible. The last two cases mentioned both made an uneventful recovery.

In Plate XI can be seen pleural involvement in a case of sub-acute plastic peritonitis; the lesion is also on the right side and responded well to treatment.

Plates XII to XVI exemplify definite intra-pulmonary lesions occurring secondarily to a primary abdominal focus. As already stated these cases show a wide variety of pulmonary lesions, but all have one feature in common, that is the presence of the pulmonary condition was associated with a very grave clinical picture. Of the five cases recorded here three died in hospital, one was removed by parental wish in an advanced state of toxaemia, while only one made a good recovery, and this after a prolonged illness during which a favourable result seemed unlikely.

Plate XII shows an active pulmonary lesion spreading out from the root into the upper third of the right lung in a case of sub-acute peritonitis with ascites. This child was removed home in an extremely ill condition. Another active pulmonary lesion is seen on Plate XIII, a partial pneumothorax being present. This is the only case with active intra-pulmonary disease which made a satisfactory recovery.

In Plate XIV extensive tuberculous disease in both lungs may be seen, more extensive in the right side. This was confirmed by post mortem examination which proved the lesion to be broncho-pneumonic in distribution. Extensive caseous adenitis of the mediastinal glands was a marked feature. These lesions were associated with extensive involvement of the mesenteric glands and considerable intestinal ulceration. Plate XV is a good example of a rapidly advancing pulmonary lesion complicating an extensive acute tuberculous peritonitis. The pulmonary lesion is seen to take the form of a widespread broncho-pneumonic phthisis in both lungs. The duration

of illness in this case was short, a fatal result following rapidly. The radiological findings were confirmed by post mortem examination.

Plate XVI, taken in another fatal case of sub-acute plastic peritonitis, reveals a different pathological condition in the pulmonary tissue. A widespread miliary lesion is seen in both lungs which was accompanied by a clinical picture of extreme toxaemia. Post mortem examination showed that a miliary spread was also present in the spleen and both kidneys.

Before concluding this section on pulmonary complications it is necessary to consider the importance of the relationship between these complications and previous conditions affecting the respiratory system. Under this heading three diseases were considered, namely measles, whooping cough and pneumonia. Table VI shows the incidence of these diseases in the different clinical types of abdominal tuberculosis.

TABLE VI.

RELATIONSHIP BETWEEN PULMONARY COMPLICATIONS AND PREVIOUS INFECTIOUS DISEASES.

	Measles	Whooping Cough	Pneumonia.
All Cases (100)	58%	40%	26%
Cases with Active Pulmonary Lesions (12)	60%	33%	25%
Cases with Hilum Adenitis (12)	75%	50%	33%

However, the influence of these diseases is apparently not an important factor predisposing to pulmonary involvement, as their frequency is little above that found in cases without pulmonary complications.

The incidence of measles shows a slight increase in cases with active pulmonary disease and is more marked in the group with hilum adenitis. The incidence of previous existence of whooping cough and pneumonia is also increased in this group. It would appear that a hilum adenitis resulting from one of these conditions might predispose to a tuberculous invasion of the glands.

Conclusions.

Owing to the different methods of dissemination, the lesions complicating abdominal tuberculosis can assume a wide variety of locations, practically every tissue and every organ being a potential field for the propagation of the tubercle bacillus, spread by the medium of the blood stream or otherwise.

These complications may make their appearance very early in the disease and might resemble concurrent lesions.

Foci appearing in the lungs including pleura and mediastinal glands, are more frequent than anywhere else, hence a rough classification may be made of pulmonary and non-pulmonary complications.

Of these two the pulmonary form is by far the more important, not only from the point of frequency but also in the gravity of the clinical picture presented.

The non-pulmonary complications may affect either the soft tissues or the osseous skeleton and the severity of the lesion presented may vary from a superficial tuberculide to multiple miliary lesions throughout spleen, kidney and other organs. However in most cases these complications are of minor significance.

In diagnosing pulmonary complications radiography is of the greatest value and in those cases where the

disease is limited to the mediastinal glands: but the activity may be estimated by films repeated at regular intervals.

To a certain extent there would appear to be a correlation between the character of the pulmonary lesion and the original focus in the abdomen. For example, in simple cases of tabes mesenterica the intra-thoracic lesions were limited most frequently to the mediastinal glands whereas when ascites was the prominent feature pleurisy with effusion was more commonly found as a complicating condition. Similarly the most acute pulmonary lesions occurred in cases with correspondingly acute peritoneal conditions.

When the tuberculous focus is limited to the mediastinal glands on one side only, the right is affected more frequently than the left, in this series the relation being seventeen of the former to two of the latter. When the condition is bilateral the disease is usually more pronounced in the right than in the left side.

(7) The Tuberculin Tests in Abdominal Tuberculosis.

In considering the various methods of investigating the reaction of individuals to tuberculin the choice lay between the cutaneous reaction of von Pirquet and the intra-cutaneous method of Mantoux. Other methods, at one time popular, have mostly gone out of favour. The subcutaneous test has now fallen into disuse and was considered unsuitable by the Medical Research Council Tuberculin Committee (1925-1928). Similarly the conjunctival test has been rendered obsolete on the grounds of being unreliable and painful on application. The percutaneous

test of Moro depending on a reaction following the inunction of a mixture of old tuberculin and anhydrous lanolin, has also largely fallen out of favour; even the recent modification of the test as suggested by Lovett[13] has not been hailed as a success.

The cutaneous and intra-cutaneous methods now hold the field of present-day mass investigation. The extensive works carried out by numerous authorities in the past twenty-five years have greatly favoured the value of the latter method both for accuracy of technique and reliability of results. The advantages of an intradermal injection over that of scarification when carried out in children can be readily appreciated. The intra-cutaneous method was first used in man by Mantoux in 1910 and when compared with the cutaneous method of von Priquet he found a discrepancy of 21 per cent in favour of his test.

Other varying percentages in favour of the test of Mantoux have been recorded by various investigators. Monti in 1912 working with 58 clinically tuberculous children and 316 patients clinically non-tuberculous or doubtful, found an equality in the first group but a discrepancy of 9 per cent in favour of the intra-cutaneous test in the second group.

Davidsohn in 1920 and Nehring in 1922 in their comparisons found percentages of 15 and 10 respectively in favour of the intra-cutaneous route.

Smith[14] in 1929 carried out comparisons in over 3000 cases, practically all being children under 13 years of age. Over the whole series there was a variance of 9 per cent in favour of the intra-cutaneous method. Hart[15] arrived at the conclusion that the intra-cutaneous or

Mantoux test used in doses of 0.1 c. of 1:1000 dilution is at least as sensitive as, and in bigger doses more sensitive than the von Pirquet or cutaneous test when the maximum concentration of tuberculin is used for the latter method. The intracutaneous test is thus one thousand or more times as sensitive, if concentration be compared with concentration.

Material and Technique employed in the Mantoux Test.

Human Old Tuberculin as supplied by Burrough Wellcome and Co. was made in dilutions of 1:100,000; 1:10,000; 1:1000 and 1:100. The dilutent employed was 0.5 per cent pheno-saline, 0.1c.c. of tuberculin was diluted in 10c.c. of pheno-saline giving a strength of 1:100, higher dilutions being derived from this original. The maximum period of time during which any quantity was retained was limited to fourteen days, fresh material being prepared after this time. Any sign of opalescence or deposit was sufficient reason for rejecting the batch. This material was stored in air-tight glass containers with a close-fitting rubber cap.

The syringe employed was an all-glass tuberculin syringe of capacity 1cc divided into ten major divisions of 0.1 cc and twenty minor divisions of 0.05 cc. Fine, short bevelled intra-dermal needles were employed for the actual injection. The area selected for injection was the flexor surface of the forearm which had previously been cleaned with methylated spirit. The success of the injection was judged by the appearance of a white circumscribed bleb in the skin. In doubtful cases or where use was made of weak dilutions, a control test was employed in the other arm, the control material being 0.5

per cent pheno-saline. The reaction was examined at the end of 48 and 72 hours. The degree of response was estimated by accurately measuring the diameter of the area of erythema, the maximum of the two consecutive readings being taken. The total area of erythema was considered more reliable than the area of central oedema which was found to be variable.

The response to dilutions of 1:100,000 was found to be inconclusive. In a group of 41 cases considered to be definitely tuberculous 24 (63.4 per cent) gave a positive reaction and 15 (36.6 per cent) a negative reaction. In a corresponding group of 12 cases definitely non-tuberculous 7 (58.3 per cent) were negative and five (41.7 per cent) doubtful. In many accepted as positive the reaction was vague and indefinite.

On testing the 41 definitely tuberculous cases with the next strength of tuberculin namely 1:10,000, 30 (72.2 per cent) gave a positive and 10 (22.8 per cent) a negative reaction, the remaining one not having been tested. Re-testing again immediately afterwards with dilutions of 1:1000, a total of 38 (92.5 per cent) gave a positive result and 3 (7.5 per cent) negative.

The significance of these three negative results will be considered later. Thus it was seen that from a practical point of view the value of dilutions of 1:100,000 was a strictly limited one and for that reason further investigation was concentrated on dilutions of 1:10,000 and 1:1000, particularly the latter strength.

As regards the reactions of the different clinical types to dilutions of 1:100,000, no distinction could be drawn between those showing glandular involvement and

those in whom the peritoneum was affected. Of the former 12 were positive and 6 negative while of the latter group 11 were positive and 5 negative.

An interesting observation was made regarding cases showing definite signs of ascites, that in three of this variety tested all gave a negative reaction to the dilution of 1:100,000.

The Value of a Positive Reaction.

In the consideration of the value of a positive reaction to the intra-cutaneous injection of tuberculin the problem must be considered from three aspects, firstly the question of diagnosis, secondly the prognosis of the case, and finally the estimation of the activity of the lesion. Hart in his conclusions stated that a positive tuberculin reaction indicated that tuberculous infection had taken place, whatever the age of the individual and also it had its chief clinical value in infancy where the phenomenon was more likely to be associated with active tuberculosis. The younger the age the worse the prognosis.

This last statement is borne out by comparing the maximum result obtained in three groups of 18 definitely tuberculous children, the groups consisting of children aged 0-5 years, 5-10 years and 10-15 years respectively. The 10-15 age group showed the highest readings with an average of 6.6 cms.; the 5-10 age group came next with an average of 5.2 cms., and the 0-5 age group lowest with an average of 3.6 cms. Comparisons were next made in the different age groups of apparently non-tuberculous children. This group of controls was composed mostly of orthopaedic cases, practically all suffering from

post infantile paralysis, the exceptions being one case of torticollis, one case of spina bifida, and one of genu valgum. The strength of tuberculin used was 1:1000. Of the group aged 0-5 years, four in number, all gave a negative reaction; of four in the 5-10 years group, one was positive; while a total of seven out of eleven in the 10-15 age group were positive.

It may be stated thetefore that the value of a positive reaction to tuberculin decreases as the age of the child advances, that is broadly speaking in the group below the age of five years a positive result is of the greatest significance; between five and ten years, of doubtful value; and over ten years of little importance.

Hypersensitiveness to Tuberculin as a Guide in Prognosis.

Lobban (16) making use of the changes of allergy produced by repeated tuberculin tests claimed to be able to estimate the gravity of any particular case and also the ultimate prognosis. An increasing reaction suggested a favourable degree of immunity, while a decreasing response indicated a corresponding failing resistance and a resultant poor prognosis. Hart however throws doubt on this conclusion and pointed out that he found an increased response on retesting clinically non-tuberculous individuals. He suggested that this discrepancy might be due to variations in the time interval between tests.

Adopting the quantitative method of measuring reactions, cases were retested at fortnightly intervals with similar dilutions of tuberculin and any increase or decrease in response was recorded in centimetres.

The observations were carried out in 56 cases, 28 males and 28 females; 43 of these were clinically

tuberculous and 13 clinically non-tuberculous. In the group of 43 tuberculous cases, 31 showed an increased response on retesting, 9 a decrease and 3 no change. Of the 13 non-tuberculous cases 5 gave an increased reaction, and one a decrease, the remaining 7 being unchanged, 6 of them giving a repeated negative result. In both groups the cases showing an increased reaction preponderated over those with a decrease. As will be mentioned later, a persistent negative result was found in those cases in the terminal stage of acute tuberculous peritonitis. Examination of the other results showed that no definite conclusions could be drawn. In the majority of these cases on a clinical basis the prognosis was good, this being judged by an absence of symptoms and an increase in weight. Correspondingly a high percentage of these gave an increasing response to tuberculin, thus favouring the prognostic value of the procedure. However, numerous exceptions were found, cases that were clinically making progress were found to give a diminishing reaction and others that were going steadily downhill with increasing toxaemia and loss of weight were found to give an increased response.

Response to Tuberculin as an Indication of Activity.

Luker (17) in 1920 supported the theory first put forward by Roemer and Joseph in 1909 that by means of the intra-cutaneous test a distinction could be made between active and inactive tuberculosis. Opie and M'Phedran concluded that the weaker the solution of tuberculin to which a child would respond or the more severe the reaction, the greater was the chance of the condition being an active one of grave significance. On the other

hand Monti was unable to make any correlation between activity and quantitative responses to tuberculin.

Estimations of activity were attempted in the group of cases last quoted. As already mentioned some of the most acutely ill cases with undoubted activity failed to give any response to intracutaneous tuberculin, while cases that did respond showed no parallelism with activity. These findings are illustrated by referring to two individual cases. J.H., female, aged 14 years, diagnosed as tabes mesenterica, showed the greatest reaction to 1:1000 tuberculin of any case tested, the area of erythema being about 10 cm. in diameter; clinically this child showed no signs of activity, progress being uneventful and accompanied by a satisfactory increase in weight. On the other hand, M.M., female, aged 8 years, also diagnosed as tabes mesenterica, gave only a slight response to the same strength of tuberculin, the area of erythema being 1 cm. in diameter. This child made good progress in hospital and was dismissed with no evidence of activity. However, one year later she developed evidence of acute peritonitis, laparotomy revealing an extensive active tuberculous invasion of the peritoneum. Thus it may be seen that the intensity of reaction in the Mantoux test cannot be accepted as a reliable indication of the extent of activity of the tuberculous focus.

The Value of a Negative Response to Tuberculin.

Although it can be assumed that a positive reaction to tuberculin indicates that the reacting individual has at some time developed an active focus of tuberculosis,

either extensive or otherwise, it does not however follow that a negative response eliminates the possibility of such an event having taken place. Yet, during his early work on the tuberculin test, Mantoux stressed the value of the negative reaction as follows: "A negative test, except in measles, meningitis, miliary tuberculosis and advanced cases with marked toxaemia, is an argument of the first order in excluding tuberculosis. Contrary to most clinical methods, the value of the intracutaneous test lies in negative results."

In the general estimation of negative responses to the tuberculin test, the factor to be considered is the strength of the dilution used. As already pointed out, negative responses to strengths of 1:100,000 and 1:10,000 are of little significance, errors of 36.6 per cent and 22.8 per cent were found respectively in each case in patients definitely suffering from tuberculosis. The majority of workers in this field have employed a dilution of 1:1000 as a standard one. Engel in 1911 suggested that dilutions of 1:10,000 and 1:1000 were too weak and advised that doubtful cases should be retested with concentrations of 1:100, 1:10 or even undiluted tuberculin, and considered this procedure of most value in patients with cachexia, miliary tuberculosis, meningitis and acute infections.

In the hundred cases under review, 19 what were negative to concentrations of 1:1000 were retested with 1:100 strength but the responses were indefinite. 5 gave what were considered positive results; three of these were advanced cases of tuberculous peritonitis and the other two were clinically doubtful.

The positive results were liable to be confused with atypical non-specific reactions attributed to anaphylactic sensitization.

Hart in his 1929 London Investigation of 1030 clinically tuberculous individuals found a 12 per cent failure to react to 1:10,000; 3.7 per cent to 1:1000; 2.75 per cent to 1:100; 2.3 per cent to 1:10, and a minimum error of 2.2 per cent with undiluted tuberculin. He admits however that the percentage error was higher (6 with 1:1000 and 3.5 with undiluted tuberculin) in children under the age of five years. Most of the cases tested were pulmonary, but he found cases suffering from pleural and peritoneal tuberculosis gave the greatest percentage of errors with strong concentrations.

It would appear therefore from the cases investigated that negative results with standard dilutions are derived from two groups of patients, firstly those that are clinically and otherwise non-tuberculous and secondly those with advanced lesions in the terminal stages and accompanied with marked toxaemia. It is chiefly the latter group that gives positive reactions with lower dilutions, which is of little value from a diagnostic point of view as the condition is manifest on clinical findings alone.

Some interesting points are noticeable when the degree of reaction to tuberculin is considered with reference to each clinical group. The conclusions have been drawn from the maximum results recorded with the standard 1:1000 dilution of tuberculin. On an average the greatest degree of reaction was obtained in the group tabes mesenterica, that is patients with only a

glandular involvement found on clinical examination. When measured, the results varied from .9 cms. to 12.4cms, the average being 5.2 cms. Those classified as chronic tuberculous peritonitis came next with readings varying between .9 cms. and 7 cms., the average being 4.3 cms. The sub-acute cases were in the next highest group with figures varying from 0 to 6.5 cms. and 0 to 6.3 cms. for the plastic and ascitic varieties respectively, the average being 4.6 cms. and 2.6 cms. respectively. Those showing acute tuberculous peritonitis gave the lowest readings, 0 to 1.8 cms., the average being 1.2 cms.

The quantity of reaction appears to be in direct proportion to the degree of immunity, Thus in the cases where the infection was limited to the mesenteric glands the greatest reactions are seen. The other extreme is found where the condition is clinically widespread and acute, with a correspondingly limited degree of resistance in the patient.

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E. THE DIAGNOSIS OF ABDOMINAL TUBERCULOSIS.

It has been repeated and stressed in each succeeding section of this work that in abdominal tuberculosis exactness of diagnosis in many cases presents a problem with many difficulties. The results of invasion of the tubercle bacillus may vary from an indetectable lesion quite compatible with apparently good health to a clinical picture presenting the extremes of toxaemia, cachexia and emaciation, at this stage a condition which has only one possible ending.

(1) Diagnosis on Clinical Findings.

Before considering the significance of clinical examination in individual cases it is essential that an accurate history of the case should be obtained. This should include not only a detailed account of the symptoms of onset but also all available information concerning any family history of tuberculosis, full details of environmental surroundings including housing conditions, nutrition and contact with active cases of pulmonary tuberculosis. These factors, although individually not of great significance, can be of considerable value when taken in conjunction with clinical findings. It has already been brought out in the section dealing with mode of onset that the symptoms ushering in the condition may vary widely within certain limits. The history supplied by parents may be divided into two sections, firstly facts relating to the general condition of the child and secondly facts relating to the local condition. In the former a history of gradual failing health accompanied by loss of weight

and lassitude is very characteristic. Although this loss of weight might be expected in any slow toxic condition it is feasible to assume that it is directly connected with nutritional disturbance resultant on impairment of the mesenteric lymph glands and the neighbouring lacteals, giving rise to delay and diminution of fat absorption. This results in the increase in the amount of fat found in the faeces. Morton (18) claims that this increase in faecal fat is of diagnostic value in cases of tuberculous mesenteric adenitis.

Other general symptoms such as loss of appetite and excessive night sweating were not considered of any importance, the latter condition in many cases being reported in the history of illness but was practically never noted after admission to hospital.

The second group of symptoms, that is those relating to the local condition, must rank as more important and as to the value of these symptoms there is a wide variety of opinion. Abdominal pain is often a prominent feature of these cases, its importance having been stressed by some writers. Referring to tuberculous glands in the mesentery, Carson wrote, "the condition can be diagnosed with moderate certainty, even though the glands were not palpable, by the history and the peculiar character of the pain. I am convinced that the pain is due to spasm of the circular muscular coat." Continuing he states, "The only symptom which is at all common except for the characteristic pain is vomiting. This has occurred in exactly half the cases and if it occurs it always comes with pain." Cassidy on the same subject put forward a

different view, "pain is a variable symptom and is more common in the plastic than the ascitic type: it is not so common in children." (19) Dretzka, discussing intra-abdominal tuberculosis, stated that "tuberculosis of the peritoneum is most common in children and young adults. In the early stages the disease has no characteristic symptoms. The initial symptoms are abdominal discomfort, loss of appetite and frequent attacks of colic. The presence of these symptoms with anaemia, loss of weight and the typically rounded abdomen should arouse the examiner's suspicion." This last view is more or less subscribed to by the present writer, that is no one symptom can be taken as in any way diagnostic, whether it be diarrhoea, pain or vomiting, but taken in combination with clinical and other findings, can be of great significance. On turning to the clinical examination of individual cases, the first point that must come under scrutiny is the general appearance of the patient, the presence or absence of the so-called tuberculous diathesis.

Thomas White in 1784 in his treatise on struma or scrofula made what must be one of the earliest references to personal characteristics and non-pulmonary tuberculosis. "Persons of red or light-coloured hair are said to be peculiarly subject to the disease, but that this complaint is not confined to the colour of the hair or the complexion is evident from the number of people who have dark hair and similar complexion being very frequently strumous." Andral in 1829 in his essay on pathological anatomy followed the same vein thus, "the colouring matter thus deficient in their skin is likewise so in their eyes, which retain the blue tint of infancy and in their

hair which is light-coloured and small in quantity."
Shrubrall (20) formed the opinion that although phthisical children were apt to be brunettes, yet in cases of joint or glandular tuberculosis fair traits dominated.

In the hundred cases reviewed in this series there was no apparent connection between the presence of abdominal tuberculosis and the colour and quantity of hair, complexion or other characteristics of appearance. In order to classify the appearance of individuals it was found that they fell into four groups, the extremes being "dark" and "fair", with two intermediate groups "medium dark" and "medium fair". The medium dark group were found to predominate with 44 per cent, the fair group being smaller with 4 per cent. The medium fair and dark groups were intermediate with 33 and 19 per cent respectively. Compared with normal children the proportions were not definite enough to lead to any conclusions. Not one child in the series could be described as having red hair. On the other hand Rivers (21) found in cases of bone and joint tuberculosis that red and reddish hair was nearly twice as frequent as in the ordinary population.

In the physical examination of the abdomen two conditions on which great importance was laid were the presence of palpable masses and the presence of free fluid. Referring to the presence of the former Morley stressed its importance as follows, "the diagnosis of tuberculous mesenteric glands is by no means difficult, for it may be laid down as a broad general rule that whenever a child presents a firm rounded mobile lump in the umbilical or right iliac zones of the abdomen, unassociated with

intestinal obstruction the case is one of tuberculous adenitis." Writing on the significance of free fluid in the peritoneal cavity, Marshall considered that "the occurrence of ascites and pyrexia in a young patient is almost diagnostic of tuberculous peritonitis; we must exclude heart failure, nephritis, cirrhosis of the liver, malignant disease and acute septic peritonitis."

Apart from these two conditions, abdominal distension was evident in many cases and frequently accompanied early peritonitis. In advanced stages of tuberculous peritonitis large masses were often palpable, these being either glandular or more frequently due to tuberculous infiltration of the mesentery. Localised collections of fluid were often found in these cases and an outstanding feature was the absence of pain in association with such massive pathological lesions in the abdominal cavity. Enlargement of the superficial veins, especially in the lower part of the abdomen, was noted in many cases, indicating some obstruction to the venous channels, but it cannot be considered as typical of tuberculous peritonitis, being found in other forms of surgical tuberculosis, especially when toxaemia was evident. Digital examination of the rectum was carried out as a routine procedure but in no case was any abnormality detected.

Temperature and Pulse Rates in Abdominal Tuberculosis.

In pulmonary tuberculosis it is generally accepted that records of temperatures and pulse rates are of the utmost value and in the clinical study of this condition they rank as one of the most important factors in diagnosis and estimation of activity in a confirmed case. .It would appear, however, that their signifi-

cance in abdominal tuberculosis is a much more limited one. Referring to this point Carson writing on tuberculous glands in the mesentery was of the opinion that "a rise of temperature is unusual, uncomplicated tuberculous glands in the mesentery do not cause a rise in temperature - in the absence of sepsis, pyrexia does not occur."

Study of the cases reviewed here showed that periods of febrility were common shortly after admission to hospital, usually a rise of one or two degrees in the evening with a corresponding fluctuation in the pulse rate, but following routine treatment a rapid return to normal limits was the rule although activity was undoubtedly present. Only in the cases with advanced lesions accompanied by evidence of toxaemia was the irregularity in temperature and pulse rate maintained for any length of time.

Thus it will be seen that the question of diagnosis in abdominal tuberculosis on clinical findings is not a simple one. However in some cases a rapidly ascertained diagnosis can be reached, these cases falling into two extreme groups. On the one hand, if a child is reported with a history of diarrhoea, abdominal pain and loss of weight which have proved refractory in the home surroundings and if such symptoms rapidly clear up when the child is brought under controlled treatment of an institution; if physical examination reveals no abnormality then it can be safely classified as showing no evidence of active tuberculosis. The other clinical extreme is represented by those cases in which the signs of a definite tuberculous infection are manifest, that is local evidence of

peritonitis associated with systemic changes indicating marked toxaemia.

It will be obvious however that a large number of cases must fall between these extremes mentioned. The history of illness may be significant while the clinical findings may not be in keeping or even themselves contradictory. Delayed recovery where the condition was thought to be a simple transient one might set up misgivings as to the real underlying cause of the condition. It is in this large group of doubtful cases where the clinical findings are nebulous or contradictory that further resources must be called upon to aid the eliciting of a definite diagnosis.

(2) The Value of Radiological Examination.

All cases in this series were X-rayed as a routine procedure. An antero-posterior exposure was taken of the chest and if suspicious areas were present in the hilum region a second lateral view was taken. Radiograms of the abdomen were not employed in routine work as it was soon discovered that they were of little or no value. Films taken shortly before death failed to reveal the presence of large glandular masses either caseous or partly calcified found at post-mortem examination. The great majority of films taken of the abdominal contents revealed nothing of any value and considerable doubt would be thrown on interpretations of calcified mesenteric glands. It would appear therefore that the value of radiology in abdominal tuberculosis is limited to the detection of pulmonary complications, and is not an important factor in diagnosis.

(3) Erythrocyte Sedimentation Test as a Diagnostic Factor.

The variation of erythrocyte sedimentation in health and disease is a phenomenon which has attracted the attention of physicians for several centuries. Numerous investigations have been carried out and the general consensus of opinion is that the test is non-specific and of limited clinical value.

Apparently Galen was the first authority to draw attention to the significance of the rapidity of blood sedimentation. Hewson in 1771 and Hunter in 1794 also drew attention to the column of fluid or crusta sanguinis which formed above the coagulum, but it was not until recent times following on the work carried out by Fahraeus (22) that the full value of the test has been considered, the resultant literature on the question being considerable. Fahraeus showed that the rate of sedimentation was largely independent of the red corpuscles but varied according to the fibrinogen content of the plasma, being more rapid when this protein constituent was increased. He at first used the test in pregnancy and showed that normally there is an increased rate in this state. The non-specific element in the test has been stressed repeatedly. Westergren (23) demonstrated that it was a non-specific response to any inflammatory condition and was dependent on cellular activity and tissue destruction. According to Fahraeus an increased rate could be expected in any of the infections fevers and in such diverse conditions as diabetes mellitus and malignant disease.

It would appear from the foregoing conclusions that one could not adopt this test as a factor in diagnosis with any degree of optimism, but it must be remembered

that blood sedimentation is still employed in routine sanatorium work in connection with pulmonary lesions and still has its enthusiastic supporters who consider it of no little value in both diagnosis and prognosis.

The view expressed in the works of Beaumont and Dodds (24) may be quoted as a rational one on the subject. Reference is made to Westergren's statement that normal sedimentation is never given in active tuberculosis. The text then goes on to say, "if the converse (a rapid reading indicating active tuberculosis) be shown to be true the test will obviously be of great value in the investigation of that large number of cases in which the patient is run down and doubtful signs are found at one apex of the lung, the sputum contains no tubercule bacilli, the temperature is within normal limits, the X-rays show increased root shadows with diminished translucency of one apex, and the complement fixation test is either positive or negative. Westergren suggests that with a normal stability reaction on active phthisis can probably be excluded."

It was the possible value of the sedimentation test in the diagnosis of doubtful cases of pulmonary tuberculosis which suggested to the writer that the same test might profitably be applied to the relatively equally large number of doubtful cases of abdominal tuberculosis. There is no lack of analogy between the foregoing description of a suspicious pulmonary infection and one where symptoms equally nebulous but not without real significance are related to the abdomen.

The investigation was carried out in considerable detail, an attempt being made to collect information that

would be of value in both diagnosis and prognosis. The tests were repeated in individual cases at regular intervals and in order to estimate the comparative value of the results a series of control tests was carried out in other forms of the disease both pulmonary and non-pulmonary as well as in a non-tuberculous group.

The test of course is dependent on the fact that when a known quantity of blood is mixed with a known quantity of standard anti-coagulant, such as sodium citrate, and allowed to settle in a suitably graded tube or container, a variation in the rate of settling is found in different individuals due to such factors as age, sex and the presence of pathological conditions. The methods of interpretation can thus be divided into two groups, firstly those in which time is the standard factor, the degree of sedimentation being indicated by the length of the column of clear plasma measured at regular intervals of time. The second group comprises these methods in which the length of the column of plasma forms the standard, the exact time in minutes being recorded for the descending column of red cells to reach the different levels cut on the tube.

The original method of Fahraeus depended on readings taken at regular intervals of time, the blood having been run directly into 2 cc. of 2 per cent sodium citrate in a tube 17 cm. in length, with a bore of 9 mm., the blood filling the tube to a mark denoting a content of 10 cc. After mixing, the tube stood vertically and the readings were taken at the end of one hour. The method of Linzimeir relied on the times taken for the sedimenting red cells to reach three levels of 6, 12, and 18 mm.

cut on a tube 6.5 cm. in length and of 1 cc. capacity.

The method of Westergren which is the most frequent method of choice both in this country and America, is a modification of the original method of Fahraeus. Here the receptable employed was a uniform glass tube 300 mm. in length divided into 100 divisions each of 2 mm. extending to the lower end. Westergren suggested that the bore of the tube should lie within the limits of 2.4 and 2.7 mm., preferably about 2.5 mm. The anti-coagulant used was a 3.8 per cent solution of sodium citrate, the proportion of blood to citrate being 4:1. The blood was drawn from the cubital vein by means of a record syringe of 1.2 cc. capacity and was transferred to a 2 cc. test tube before being drawn into the sedimentation tube. Westergren took readings at 1, 2 and 24 hours.

Westergren's method was the one adopted in this investigation, the reasons being that firstly more accuracy could be obtained by taking a reading at a certain definite time than by recording the elapse of time necessary for a definite level on the tube to be reached. Secondly, the requisite quantity of blood, about 1.5 cc., could be easily obtained by acupuncture.

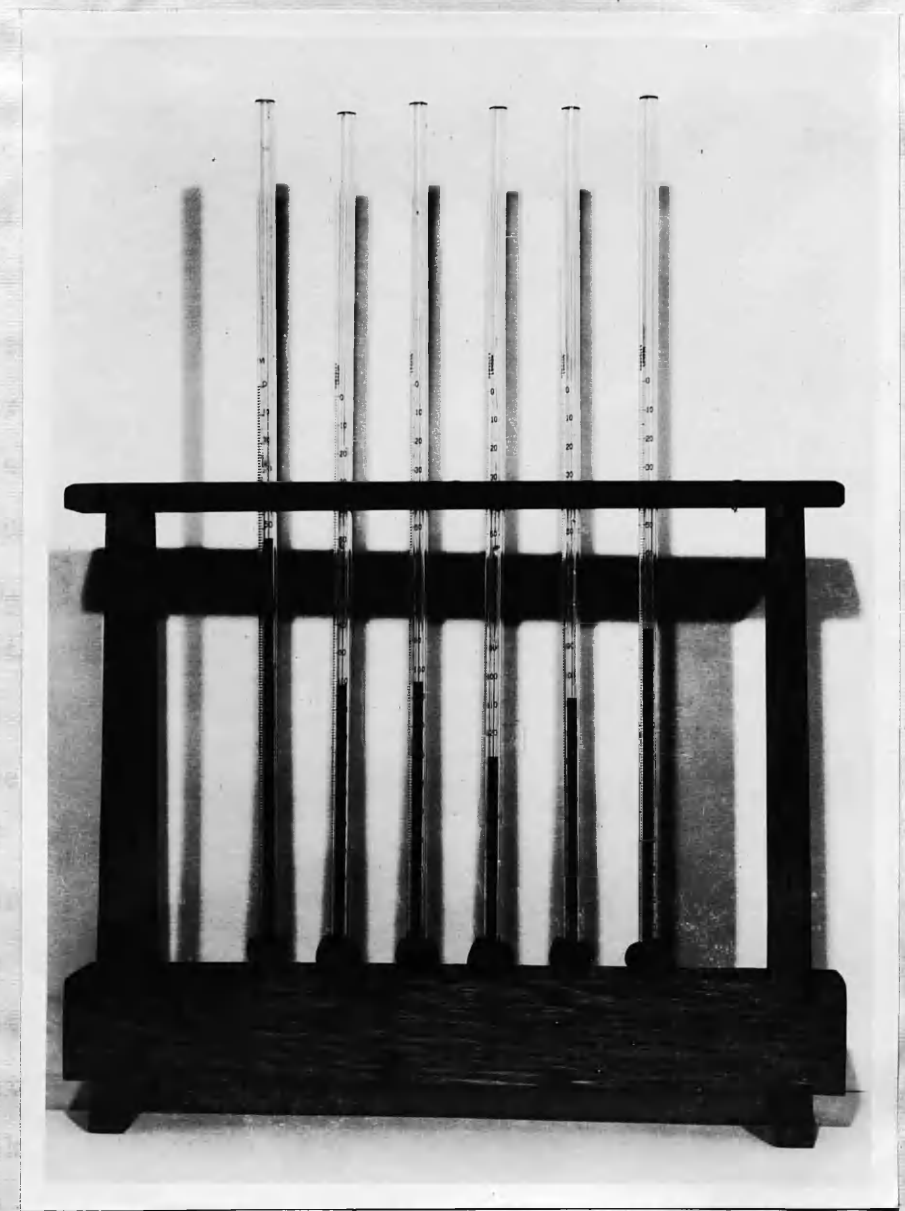
Technique Employed.

The apparatus employed and the technique used were based as closely as possible on that of Westergren, the essential details of which have already been described. The number of tubes in use was six, each being 300 mm. in length with a uniform bore of 2.5 mm. The tubes were graduated in a hundred divisions of 2 mm. each, the hundredth division coinciding with the lower end of the tube.

3.8 per cent sodium citrate was the anti-coagulant used. The proportion of blood to anti-coagulant was the same as employed by Westergren, namely 4:1. This proportion was obtained by employing a record syringe of capacity exactly 1.5 cc. .3 cc. 3.8 per cent sodium citrate was drawn into the syringe, the needle changed and the syringe completely filled with blood from the cubital vein. The contents were immediately transferred to a small test tube and thoroughly mixed. Westergren was of the opinion that the blood could be kept in the test tube from four to six hours without interfering with the sedimentation rate. In this series however the blood was immediately transferred to the sedimentation tube, the level being drawn up to exactly the zero mark on the scale; the tubes were then transferred to the wooden stand where an exact vertical position was obtained and the lower ends sealed with wax. Readings of the level of red cells were taken at intervals of 1, 2, 6 and 24 hours. As the sedimentation rate varies according to temperature, uniformity of this factor was obtained by carrying out all tests in a laboratory with a regulated temperature. Between consecutive tests the tubes were thoroughly cleaned, first by a stream of water under pressure, next with methylated spirit and finally with ether.

It has been mentioned in criticism of this method that the calibre of the tube is relatively large and therefore variations in size might be found in the one set of tubes capable of producing errors when final comparisons were made. However in the set of tubes used in this work the presence of such inaccuracies was

PLATE I.



Stand and Tubes used in Erythrocyte Sedimentation Tests

eliminated by comparing one tube with another using specimens of blood derived from the same patient at the same time. The error of variation was found to be negligible.

The site of acupuncture selected was the most accessible vein in the cubital fossa, the overlying skin having been cleaned with methylated spirit. As the tests were all carried out in children under sixteen years of age, in some cases difficulty was encountered in obtaining blood. It has been stated that the pressure of a tourniquet or other obstruction to the venous return should not be employed as the increased CO_2 tension of the blood increases the rate of sedimentation. In this series such constriction was produced in all cases by means of a rubber tourniquet applied to the upper arm. Without this assistance the obtaining of blood in some of the younger children would have been rendered very difficult or impossible. However in order to test the effect of congestion on the sedimentation rate a group of patients was selected whose veins were naturally prominent and two specimens of blood were taken from each at the same time, one from one arm with no compression above the acupuncture and one from the other arm where the CO_2 tension had been raised to a maximum by the application of a rubber tourniquet to the upper arm. Table VIII shows that the variation in the two sets of readings is negligible. The figures quoted represent the averages for four individual cases tested, the rate of sedimentation being recorded in centimetres.

TABLE VIII

COMPARISON OF READINGS TAKEN WITH AND WITHOUT TOURNIQUET.

Hours	1	2	3	6	24
No tourniquet	11	28	43	70	97
With tourniquet	12	30	46	70	97

Readings in cms.

Clinical Material Utilised.

The blood sedimentation test was carried out in 66 individual cases of abdominal tuberculosis, consecutive readings being taken at intervals of four weeks in as many cases as possible. In all 170 readings were taken. In order to estimate the relative value of the test, readings were obtained in four other groups of control cases, three tuberculous and one non-tuberculous. The first group was composed of 28 cases with pulmonary lesions including some with definite intrapulmonary disease and others with clinical and radiological evidence of hilum adenitis only. The second group also consisted of 28 cases but here the disease took the form of definite bone foci; a certain percentage of these were clinically inactive while others showed definite activity. The third group of 19 cases all suffered from tuberculous adenitis, the seat of the disease in each case being the cervical glands. The fourth or non-tuberculous group was made up of orthopaedic cases, practically all showing deformities which had followed as sequelae of anterior poliomyelitis. In these cases the general health of the child was good: they were afebrile and had no clinical evidence of active disease or tissue destruction.

The group contained 26 individuals. In these control groups consecutive readings were not taken.

The number in each group is given in Table IX.

TABLE IX.

CONTROL CASES USED IN BLOOD SEDIMENTATION TESTS.

PULMONARY GROUP:	28
Intrapulmonary disease	14
Pleurisy	7
Hilus disease	7
NON-PULMONARY GROUP:	
Bone and Joint tuberculosis	28
Glandular tuberculosis	19
NON-TUBERCULAR GROUP:	
Orthopaedic cases	26

The total number of readings taken in the whole series was 260.

Interpretation of Results in Blood Sedimentation Tests.

Westergren in his original method recorded readings at intervals of 1, 2 and 24 hours and for purposes of comparison accepted readings between 2 and 8 mm. within the first hour as normal. Krimphoff (25) using the same technique, accepted as normal rates 3-5 mm. in the first hour and 7-9 mm. in the second hour for healthy men and 3-8 mm and 8-15 mm for the same periods in healthy women. The rate for healthy children did not exceed 20 mm.

Banyai (26) recorded his results graphically with time indicated on the horizontal and the percentage reading of the red cells on the vertical. Comparisons were made by summing the readings in each of a series of so-called

normal cases and dividing to reduce the figure to 100. This was repeated with cases under investigation, the resultant figure being expressed as a percentage.

A useful formula has been quoted by Beaumont and Dodds from which is obtained the average hourly sedimentation for the first two hours. It is:- $\frac{S_1 + \frac{S_2}{2}}{2}$ where S_1 and S_2 equal the column of clear fluid in mm. at the end of one hour and two hours respectively. A column of clear fluid measuring 3 mm. was considered normal, 4 to 6 mm. as doubtful, 7 to 12 mm. probably pathological and over 12 mm. certainly pathological.

The chief difficulty in comparative work lies in the finding of a series of readings which can be accepted as definitely normal. In adopting normal readings used by other investigators there is always the fallacy of slight differences in technique which may be present, although the general principles are made to follow as closely as possible. As the chief aim of this work was to estimate the relative value of the sedimentation test in abdominal tuberculosis, main stress was laid on comparisons between the readings found in this group and in the other forms of tuberculosis, both pulmonary and non-pulmonary, where the diagnosis and the extent of the lesions had been established by other methods. The group of orthopaedic cases were taken as being a near approach to the normal.

The significance of the readings was interpreted by making use of the above formula suggested by Beaumont and Dodds, with any other information that might be derived from the final reading after 24 hours.

Blood Sedimentation in Various Clinical Groups of Abdominal Tuberculosis.

As might be expected, some of the lowest readings recorded were found in the group of cases notified as abdominal tuberculosis which finally proved to be definitely non-tuberculous. The lowest reading recorded in the series of one hundred belonged to this group, the average reading for the first two hours being 1 mm. with a total of 46 mm. for 24 hours. In this group of 10 cases 6 gave an average for the first two hours of 5 mm or under and none exceeded 87 mm. for 24 hours. However some relatively high readings were found in this group, the two highest being 20 mm. and 15 mm. for the first two hours and 113 and 99 mm. respectively for 24 hours. Although the cases were considered definitely non-tuberculous the high sedimentation readings were explained by the presence of other pathological conditions, marked bronchitis in the first case and acute rickets in the second.

Expressing results in the same manner, the average readings for the whole of this group were the lowest of any group, namely 8.1 mm. for the first two hours and 86 mm. for 24 hours.

The results obtained from the small group classified as doubtfully tuberculous are of little significance, the readings in individual cases showing a wide variation, the extremes being 2 mm and 23.5 mm for the first two hours and 57 and 102 respectively for 24 hours. Here again the presence of other pathological conditions was the determining factor in the high readings, the case with the highest reading in this group being complicated with a non-

tuberculous ascites.

In considering the remainder of the hundred cases, that is those considered to be definitely tuberculous, the results will be considered in relation to the clinical classification already tabulated.

Table X gives the average reading for each group, the first figure being the average for the first two hours and the second figure the total sedimentation for 24 hours.

TABLE X.

AVERAGE READING IN DIFFERENT CLINICAL GROUPS

Time	Tabes Mesenterica	Subacute Peritonitis		Chronic Peritonitis
		Ascitic	Plastic	
Av.1st 2 hrs	9 mm	14 mm	21 mm	13 mm.
24 hrs.	87 mm	106 mm	105 mm	102 mm.

Readings for the small number of cases comprising the group designated as acute tuberculous peritonitis have not been recorded.

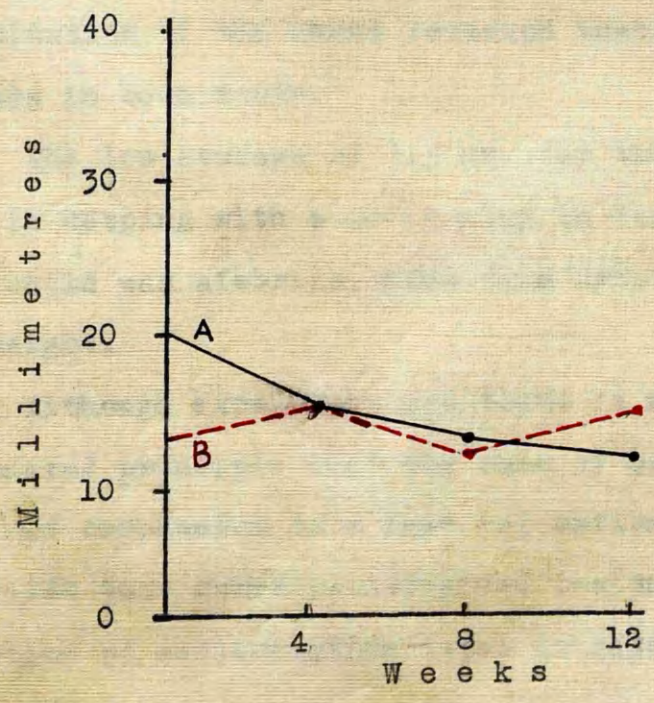
A direct comparison may be drawn between the rate of sedimentation and the amount of cellular activity associated with the lesion. The average is lowest for those with the involvement limited to the mesenteric glands while the highest readings are found in those cases of sub-acute plastic peritonitis where in practicallly all the abdominal lesions were extensive and the toxaemia marked. It will be noted that the sub-acute group, where ascites was the predominant feature, bears a close proximity to the group with chronic tuberculous peritonitis, both being intermediate between the tabes mesenterica group and the acute plastic group.

The significance of individual cases in the last of the various groups will now be considered.

In the tabes mesenterica group the highest readings 17 mm and 99 mm were recorded in M.K., female, aged 10 years, with a comparatively short history of illness of three months' duration, the main points of which were abdominal pain and loss of weight. The Mantoux reaction was positive to all dilutions used. Clinically and radiologically there was no involvement of the lungs, enlarged glands were palpable in both iliac fossae. Progress in hospital was satisfactory, the outstanding symptoms cleared up and the child increased in weight. There was no marked irregularity in temperature but a slight evening rise to a maximum of 99°F. was noted after admission with a pulse rate varying between 95 and 110. Concurrently with the clinical improvement consecutive readings of the blood sedimentation rate showed a steady decline.

Fig.I.A shows the decline in the sedimentation rate over a period of twelve weeks, the recorded figures being

Fig.I.



the average for the first two hours.

It will be seen that all the features of the case indicate active disease localised to the mesenteric glands undergoing cure with little or no constitutional disturbance. The blood sedimentation rates are in keeping with this picture.

Another comparatively high reading was obtained in J.H., female, aged 14 years, with a much longer history of illness. Glands were also palpable in the abdomen but in this case the clinical picture was complicated by the presence of another focus in the cervical glands. The blood sedimentation readings over a similar period, Fig.IB, shows no regular variation. At the other extreme, that is in cases with a uniformly low sedimentation rate, the results indicate lesions which have attained a degree of inactivity. This is illustrated in the case of J.P., female, aged 9 years, with a history of definite symptoms commencing only three months prior to admission but the general health of the child had always been poor. A few glands were palpable in the abdomen and radiological examination of the chest revealed inactive tuberculous glands in both roots.

The low average of 3.5 mm. for the first two hours was in keeping with a short stay in hospital during which the child was afebrile, free from symptoms and increased in weight.

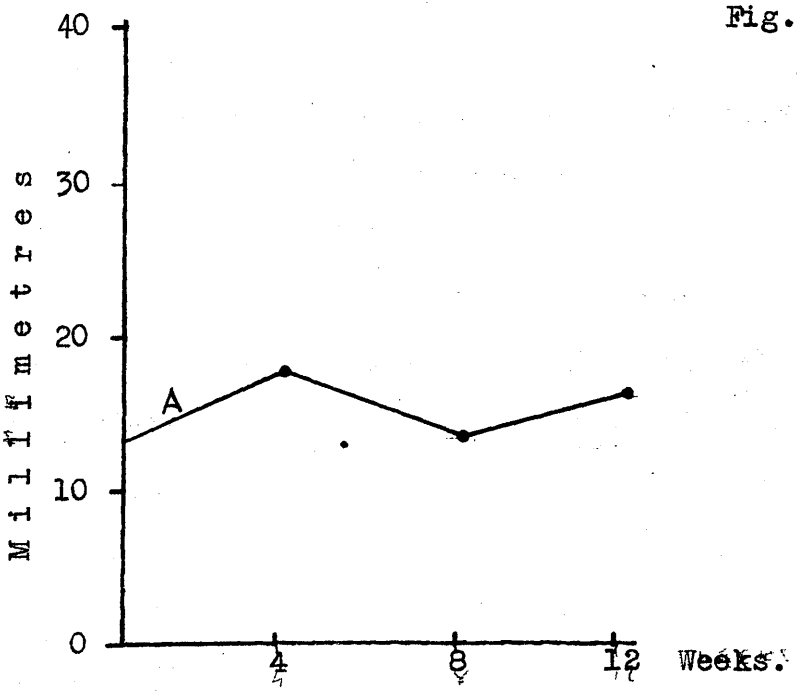
Although exceptions are found it may be stated as a general principle that the rate of sedimentation of the red corpuscles is a fair indication of local activity provided that other pathological lesions are absent. The question of sedimentation rates in cases where other

lesions were present as complications of the original abdominal focus will be considered under another heading.

Turning now to individual cases in the large group classified as chronic tuberculous peritonitis, the average sedimentation rate for the whole group is found to be higher than in the group with glandular lesions only. This is quite in keeping with the clinical aspect of the condition, the increased toxaemia and constitutional disturbance following naturally when the disease extends its borders to include the peritoneum. Of the three cases in this group with the most rapid sedimentation rate, two died and the other was removed by her parents in an extremely ill condition.

Fig.II shows the consecutive average two hourly rates for S.D., female aged 15 years, with a history of illness covering a period of 7 years. During a stay of about one year in hospital the child went steadily downhill with

Fig.II.



loss of weight, diarrhoea and vomiting in the terminal stages with a hectic swinging temperature. Post mortem

examination showed enlarged mesenteric glands with a generalised peritonitis, numerous small tubercles being present on the visceral peritoneum. Animal inoculation with glandular material gave a positive result. Although the average rates for the first two hours in this case were not excessively high, the total sedimentation in 24 hours varied between the high levels of 153 mm. and 173 mm.

The other fatal case, D.C., female aged 14 years, had a much shorter history of illness, approximately 15 months. This case showed no clinical improvement and had the characteristic symptoms of loss of weight and diarrhoea combined with a swinging temperature. Post mortem examination revealed a degree of peritoneal involvement which was not extensive but the mesenteric glands were enlarged and caseous. Tubercles were present in the sub-mucosa of the caecum and numerous necrotic tuberculous ulcers were located in the lower part of the ileum. The blood sedimentation rate in this case for the first two hours was very rapid, varying between 32 mm. and 36 mm.

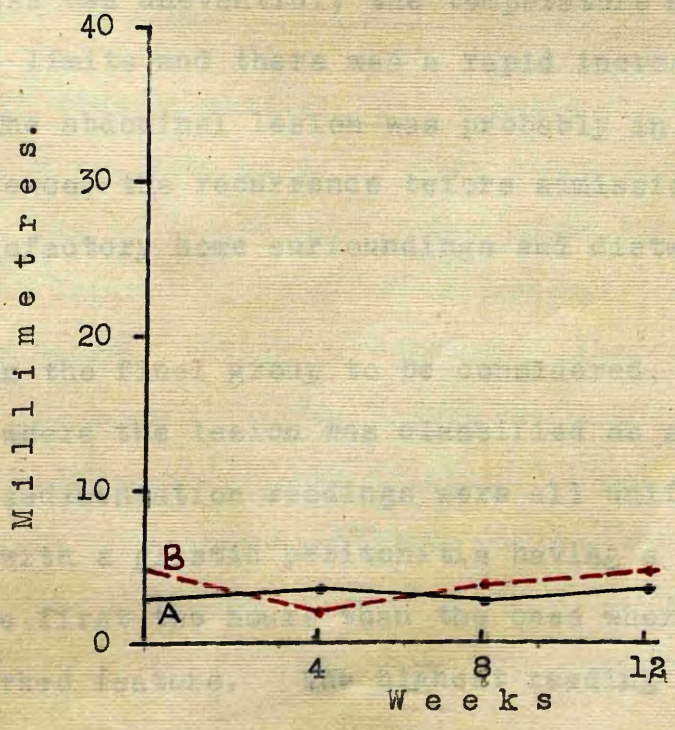
In the last two rates estimated before death accurate readings could not be obtained as lysis had occurred in the column of blood.

The third case remaining to be mentioned in the group related to M.M., female aged 13 years, who had a history of onset 14 months prior to admission; loss of weight and abdominal pain were the dominant symptoms but diarrhoea was absent. Palpation of the abdomen revealed a generalised resistance with extensive matting of the contents suggestive of a generalised peritonitis. A concurrent lesion was present in the form of an active tuberculous focus in the upper lobe of each lung, which

in the left side was partially calcified. Unfortunately this child was removed by her parents after a period of residence of two months in hospital. During that time a marked deterioration in the condition of the child was seen, temperature variations becoming more marked as the degree of toxaemia increased. During this time there was no great increase in the sedimentation rate for the first two hours, the figures being 21 mm. and 26 mm., but the total sedimentation rate for 24 hours had increased from 97 mm. to 148 mm.

The lowest sedimentation rate recorded in this group of chronic peritoneal lesions were found in cases where the clinical picture was proportionately mild and in these cases a marked improvement resulted following institutional treatment. Fig.III shows the rate of sedimentation for the first two hours in consecutive tests for two of the lowest recorded rates in this group. Fig. IIIA is the rate of J.P., male, aged 7 years, who had a short history of abdominal pain, diarrhoea and occasional

Fig.III



vomiting accompanied by marked loss of weight. Prior to this onset the general health of the child had been poor. The abdomen was scaphoid, generally resistant with definite pain on palpation. Progress was uneventful with little variation in temperature although the pulse rate showed a fairly wide excursion. The weight of the child increased steadily and it would appear that malnutrition played a part in the original symptoms. The sedimentation rate for the first two hours varied only between 2.5 mm. and 2.75 mm. for consecutive readings at intervals of four weeks the maximum sedimentation for 24 hours varying between 62 and 69 mm.

The other low reading recorded in this group, Fig. IIIB related to C.C., female aged 12 years, with a history of four years' illness, who had previously had seven months' treatment in hospital for the same condition. The symptoms were practically similar to those recorded in the last case. The child was thin and flushed with general matting of the abdominal contents. Here again progress was uneventful; the temperature stayed within normal limits and there was a rapid increase in weight.

The abdominal lesion was probably in a state of quiescence, the recurrence before admission being due to unsatisfactory home surroundings and dietetic indiscretions.

In the final group to be considered, that is those cases where the lesion was classified as sub-acute, the blood sedimentation readings were all uniformly high, those with a plastic peritonitis having a higher average for the first two hours than the ones where ascites was the marked feature. The highest reading in the former

group was found in M.G., female aged 11 years with abdominal distension and definite matting of the contents, the superficial veins of the abdomen being markedly prominent. This case was complicated by the presence of a unilateral pleurisy with some effusion and evidence of intrapulmonary disease. As seen in Fig.IVA, the sedimentation rate for the first two yours varied between 30 mm. and 41 mm. while the total for 24 hours lay between 126 mm. and 130 mm.

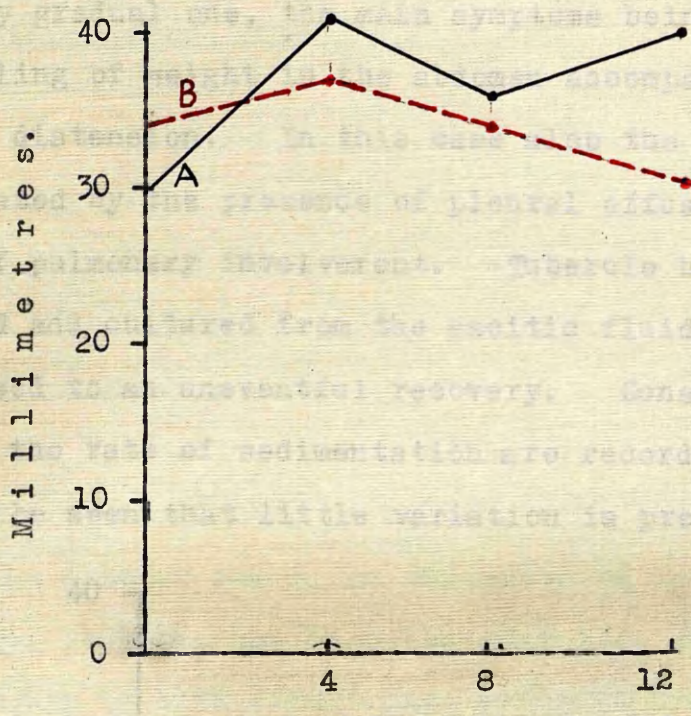


Fig IV.

Fig IVB records another high reading in this group. This child, W.A., male aged 7 years, had a history of sudden onset, the condition simulating acute appendicitis. Abdominal laparotomy revealed an acutely inflamed appendix with enlarged caseous mesenteric glands and a generalised tuberculous peritonitis. This child was in hospital for a period of 9 months and at first showed some improvement, the weight increasing although the abdominal wound continued to discharge. However the improvement was not maintained. Finally the child deteriorated rapidly, the

condition terminating in death. Post mortem examination showed considerable matting of the peritoneum with some glandular involvement. Multiple small tubercles were found in the lung suggestive of a miliary spread, while about a dozen small tuberculomata were located in the brain both in the cerebral and cerebellar tissue.

In those cases with sub-acute peritonitis accompanied by ascites the highest readings were recorded in the case of R.D., female, aged 7 years. The onset had been a fairly gradual one, the main symptoms being an increasing feeling of weight in the abdomen accompanied by visible distension. In this case also the condition was complicated by the presence of pleural effusion with evidence of pulmonary involvement. Tubercle bacilli were isolated and cultured from the ascitic fluid. The child progressed to an uneventful recovery. Consecutive readings of the rate of sedimentation are recorded in Fig.V; it will be seen that little variation is present and of

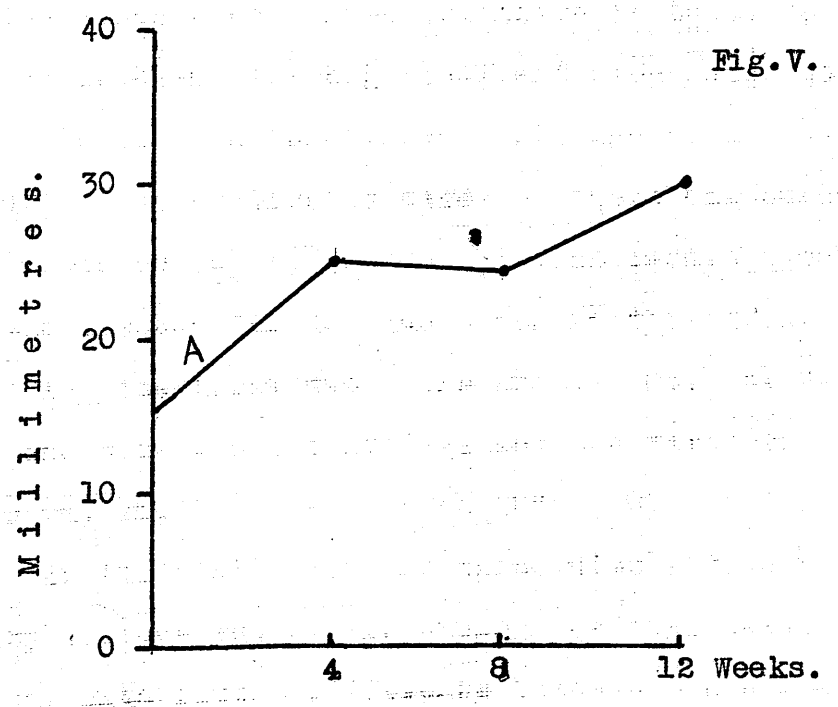


Fig.V.

the total sedimentation for 24 hours the extremes were

115 mm. and 125 mm.

From the records quoted above it would appear that there is some relationship between the rate of blood sedimentation and the clinical stage of the disease, the localised conditions giving the lowest rate and the widely disseminated lesions the highest. Even within each clinical group the readings are low for the mild cases and show a proportionate increase when more grave cases are considered.

Blood Sedimentation Rate in Cases with Active Complications.

It has been previously stated that other lesions present considered as complications were divided into two groups, those apparently active and those apparently inactive. As might be expected a significant elevation of the blood sedimentation figures is found only in the former, and this elevation is most marked where the complications are pulmonary in nature. In these cases of course the disease was often extensive in both the thorax and abdomen, the high sedimentation rates being attributable to both conditions, although high readings were found in uncomplicated cases. Where the pulmonary condition was an active one the highest readings were found, the average for the ten cases in this group being 19.6 mm. for the first two hours and 110 mm. for 24 hours. In only one case was the average for the first two hours under 10 mm. and in only 3 cases under 100 mm. for 24 hours. In the small group of cases with active non-pulmonary lesions the corresponding readings were 11 mm. and 92 mm. with little difference between the highest and

lowest. In the group of 11 cases with radiological evidence of inactive involvement of the root glands the readings were found to be lower still, the average being 9 mm. and 88 mm., the lowest being 4 mm. and 78 mm., and the highest 16 mm. and 100 mm.

Blood Sedimentation Rate in Control Cases.

The control cases investigated under this heading were the same cases employed as controls in the investigation of the Mantoux test, the numbers with their respective lesions having already been given. Table XI gives the average sedimentation rate for each group: column 1 shows the average for both the figures derived from the formula already used and for the final reading after 24 hours while the second and third columns show the minimum and maximum for each group.

TABLE XI.

AVERAGE SEDIMENTATION RATES IN CONTROL CASES.

CASES	Average		Minimum		Maximum	
	Av.1st 2 hrs	24 hrs.	Av.1st 2 hrs	24 hrs	Av.1st 2 hrs	24 hrs
Pulmonary Cases						
Intra-pulmonary lesions	41	128	8	125	73	138
Pleural lesions	20	108	5	87	37	120
Hilum disease	8	83	2	56	19	116
Non-pulmonary Cases.						
Bone & Joint lesions	24	108	2	74	80	111
Glandular lesions	18	97	1	70	88	111
Non-tuberculous Cases						
Orthopaedic cases	5	74	1	55	15	80

Examination will show that this table is self-explanatory

The highest readings are found in the active pulmonary group, there being a wide discrepancy between these and the readings from cases with hilum disease, the figures where pleurisy was a complication being intermediate. In the group with bone and joint lesions the readings occupy a similar level to the last-mentioned group with pleural lesions and slightly higher than the cases with cervical adenitis. As might be expected, the non-tuberculous group, that is the individuals most nearly approaching the normal, have the lowest readings of the whole series.

These results are in accord with the accepted views: that is, the phenomenon of sedimentation is most rapid in the active pulmonary lesions and varies in the other forms of the disease in proportion to the degree of tissue involvement. In the bone and joint cases there is a definite parallelism between the rate of sedimentation and the degree of activity estimated on clinical findings. In the cases where the clinical condition was found to be acutely active the sedimentation rates were much higher than those recorded in cases where the lesion was in the process of healing. If the 28 cases of surgical tuberculosis are divided into two such groups, the figures for columns I and II are 37 mm. and 123 mm. respectively for the active group and 16 mm and 93 mm. for the inactive group.

It now remains for a comparison to be drawn between the sedimentation rates in the control cases and the rates in the clinical types of abdominal tuberculosis. In Table XII the average for all abdominal cases is given

along with the average for the control groups which have not been subdivided; that is, pleural, intrapulmonary and hilum lesions have all been classified as pulmonary. It will be seen that the sedimentation rate for the abdominal cases is higher than those recorded in the orthopaedic group but is exceeded by all the other controls. These figures tend to minimise the importance of blood sedimentation as a factor of significance in abdominal tuberculosis.

TABLE XII

AVERAGE SEDIMENTATION RATES IN ABDOMINAL AND CONTROL CASES.

Cases	Average 1st 2hrs.	24 hours
Orthopaedic	5 mm.	74.5mm
Abdominal Tuberculosis	12 mm.	96 mm.
Cervical Adenitis	18 mm.	97 mm.
Bone & Joint Lesions	24 mm.	108 mm.
Pulmonary Lesions	29 mm.	114 mm.

If comparisons are made between Table XI and Table XII, it will be seen that of all the tuberculous lesions the sedimentation rates recorded in hilum disease are the only ones which fall below the readings in the various abdominal groups, and of these groups the sedimentation rates in plastic peritonitis are the only ones to exceed those in cervical adenitis and pleural lesions.

Relationship between Mantoux Test and Blood Sedimentation.

When it is considered that the intradermal reaction to tuberculin and the rate of sedimentation of the red cells may both be of value in the diagnosis of tuberculous

lesions, an investigation into the possibility of any connection between the two seems appropriate. This was done by comparing the maximum results obtained in the Mantoux test with the rate of sedimentation in individual cases. The figures utilised in the former represented the reactions to dilutions of 1:1000 tuberculin. As might be expected no correlation could be found between these two factors. The highest blood sedimentation rates were found in advanced cases of acute or sub-acute generalised peritonitis and owing to the extreme degree of toxaemia little or no response was given to the tuberculin test in these individuals.

The next greatest disproportion was found in the group classified as sub-acute peritonitis with ascites. Here as already mentioned, the blood sedimentation rate was relatively high while the intensity of the Mantoux reaction was below the figures for other groups.

No degree of parallelism was found to exist in the other groups: the more active the lesion the higher was the blood sedimentation rate, while a marked reaction to tuberculin was consistent with a high degree of resistance. The only group in which the two results resembled each other was that one composed of non-tuberculous or doubtful cases in which the reaction to tuberculin was negative or transient and the blood sedimentation rate much below that in the definitely tuberculous cases. This held, of course provided other gross pathological conditions were not present.

<u>The Value of the Blood Sedimentation Test</u>.

This problem will be considered from three aspects,

firstly in relation to diagnosis, secondly in the estimation of activity and thirdly in prognosis. Although the test is by no means specific in its action, it may be a factor of some value in diagnosis. This applies particularly to the relatively large class of cases where the clinical findings are doubtful and might well be due to malnutrition and defective housing conditions. A comparatively low sedimentation rate would here help to exclude the existence of an active tuberculous lesion. The significance of an abnormally rapid degree of sedimentation is more difficult to interpret, and the presence of concurrent lesions, tuberculous or otherwise, must be carefully eliminated. The question of age must also be remembered, a rapid rate being the accepted normal in infants and young children. Some difficulties present themselves when an attempt is made to find the true significance of actual figures, that is to state definitely what height of clear fluid constitutes a normal reading. Katz, employing Westergren's technique, in his classification quoted the average hourly reading for the first two hours and considered 3 mm to be normal, a figure between 4 and 6 mm. as doubtful, between 7 and 12 mm as probably pathological, and over 12 mm. certainly pathological. Westergren stated his normal for healthy men to be 3 mm to 5 mm in the first hour and 7 mm to 9 mm in the second hour, that is an average of approximately 3 mm to 5 mm and in normal children the figure lay between 2 mm. and 8 mm. Krimphoff gave a similar figure for males and 3.5 mm to 7.5 mm for healthy females. Rennebaum (27) investigated the sedimentation rate in 500 children

and found the readings to fall within Westergren's normal of 2 mm to 8 mm. Mathe (28) found no difference between the sexes in children but his accepted normal is high, between 2.75 mm and 17.75 mm.

The results found in this series did not exactly coincide with these standards, it being remembered that all the cases were under 15 years of age, which explains the divergence from some of these figures. An average hourly reading not exceeding 5 mm. was accepted as normal, 5 mm to 8 mm came under the category of doubtful, and over 8 mm as pathological. Under the age of two years these standards were not reliable.

In attempting to adopt a numerical standard it should be remembered that exceptions are liable to occur. As Westergren says, a rapid rate is suggestive of active tubercle; a normal rate on the other hand does not exclude the condition and adds that it may be of supplementary value in the diagnosis of peritonitis. Banyai recorded 128 cases out of 2000 who had definite active tubercle and a normal sedimentation rate. Conversely it is obvious that a rapid rate of sedimentation does not necessarily indicate tuberculosis. He also recorded 19 cases of hilum tuberculosis with an normal sedimentation rate.

In conclusion it may be stated that the rational view to be taken is that the sedimentation rate is only of supplementary value and not by any means diagnostic. However, in the large number of doubtful cases with nebulous clinical findings a decisive sedimentation reading may be of considerable value and in these cases it is always worthy of trial. The significance of the

test can be enhanced by interpreting it in conjunction with the Mantoux reaction.

A positive reaction to tuberculin combined with a rapid sedimentation rate indicates an active tuberculous lesion, while combined with a normal sedimentation rate it would point to a healed tuberculous focus. A rapid sedimentation rate with a negative Mantoux reaction provided the patient was not in the terminal stage of a severe tuberculous infection, would suggest that the clinical condition was non-tuberculous. A negative Mantoux reaction and a normal sedimentation rate would help to eliminate the possible presence of a pathological lesion of any significance.

In interpreting a high sedimentation rate in definitely tuberculous cases, two explanations must be kept in mind, firstly the local lesion is particularly active or extensive and secondly that some complication has developed, either pulmonary or otherwise.

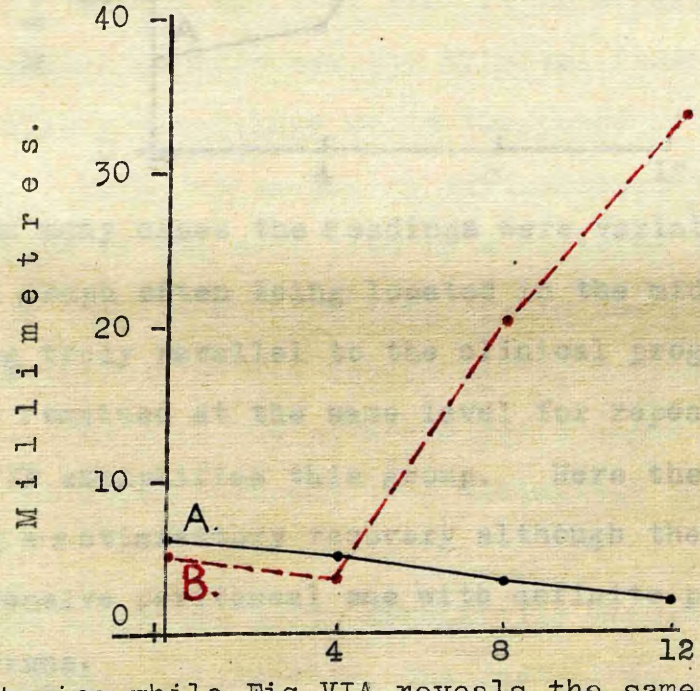
Blood Sedimentation in Prognosis.

It has been generally accepted by investigators of this question that the blood sedimentation rate is of little or no prognostic value in cases of non-pulmonary tuberculosis. Volker, referring to blood sedimentation, stated that "it may be of supplementary value in the diagnosis of tuberculous pleurisy and peritonitis but is very unreliable as regards the prognosis of surgical tuberculosis in children."

In investigating this question the significance of repeated sedimentation tests at regular intervals in individual cases came under scrutiny. These tests were

repeated at intervals of four weeks: if it were to be of value the anticipated result would be that an increasing rapidity pointed to an unfavourable prognosis while a diminishing rate might be taken as a favourable pointer. However this view was not borne out, and although in many cases the decline in rate of sedimentation coincided with improvement and an increasing rate was recorded in deteriorating cases, exceptions were by no means few. Unfortunately in most of the more severe cases, repeated readings were not available owing to a fatal termination resulting before an adequate time interval had elapsed. These points are illustrated by the graphical representations of individual cases. The first two show clinical improvement accompanied by a diminishing sedimentation rate. M.K., Fig.IA, illustrates this in a case of tabes

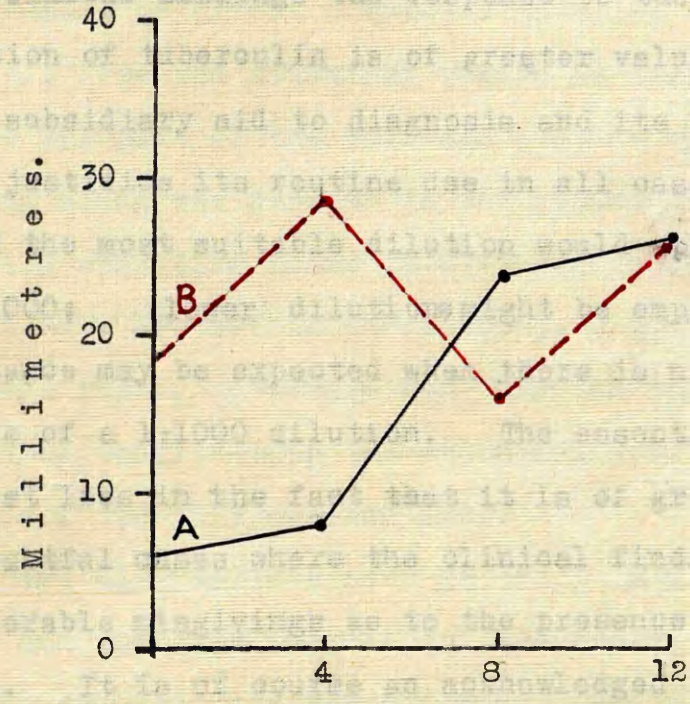
Fig.VI.



mesenterica while Fig.VIA reveals the same sequence of events in a case of chronic peritonitis which made a good recovery. Fig. VIB represents the converse, that is, an increasing rapidity with a progressive clinical condition. However, Fig. IVB is a direct contradiction of the preceding in as much as it shows a diminishing

sedimentation rate in a child who was going downhill with a sub-acute peritonitis which ultimately ended fatally. Fig.VIIA also fails to support the prognostic value of the sedimentation test; here the rate is seen to be increasing although the child was progressing satisfactorily.

Fig.VII



In many cases the readings were variable, the peak of the graph often being located in the middle and not running truly parallel to the clinical progress. Many others remained at the same level for repeated tests. Fig.VIIB exemplifies this group. Here the child was making a satisfactory recovery although the lesion was an extensive peritoneal one with definite pulmonary complications.

Thus it will be seen that the blood sedimentation test in prognosis is of little or no value and the results do not justify its routine employment. An increasing toxaemia without an actual extension of tissue involvement might furnish an explanation of the absence of an increased sedimentation rate in a case clinically deteriorating.

(4) Mantoux Reaction in the Diagnosis of Abdominal Tuberculosis.

The significance of this phenomenon has already been fully referred to in this section and the preceding one. It remains necessary only to summarise these results under the above heading. It may be stated that apart from clinical findings the response to the intradermal injection of tuberculin is of greater value than any other subsidiary aid to diagnosis and its undoubted value fully justifies its routine use in all cases. As already stated the most suitable dilution would appear to be one of 1:1000; lower dilutions might be employed but little assistance may be expected when there is no response to the use of a 1:1000 dilution. The essential value of the test lies in the fact that it is of greatest value in the doubtful cases where the clinical findings have left considerable misgivings as to the presence of a tuberculous lesion. It is of course an acknowledged fact that the true value of the test lies in a negative result, repeated negative results going a long way in the elimination of the possibility of the lesion having a tuberculous foundation. Only in the advanced toxic cases might one expect a negative response in a definitely tuberculous subject.

The technique being essentially simple and the results readily interpreted, the test lends itself as a most suitable one to be employed as a routine measure in all attempts to establish a diagnosis in these cases.

(5) The Value of Bacteriology in Diagnosis.

Owing to the nature of the lesions present in the majority of these cases the field for bacteriological

investigation was a strictly limited one. However an attempt was made to study the cultural characteristics of the bacillus where possible and to distinguish the bovine and human strains in the cultures isolated. As surgical interference was resorted to in only a few cases, mesenteric glands and other tissues were only occasionally obtained. However material was directly available from the abdominal lesion in these cases where ascites was part of the clinical picture or where a discharging sinus was present in the abdominal wall. Also where the condition ended fatally glandular and other tissues were accessible at necropsy. Apart from the abdominal focus, advantage was taken of the wide variety of lesions complicating the abdominal focus as potential sources of the tubercle bacillus.

There was utilised such material as pleural fluid, sputum and pus from superficial abscesses. Although not directly derived from the abdominal lesion, the results of these cultures are not without value and interest, it being assumed that the same type of organism was present in both the primary and secondary foci. In all, positive results were obtained in fourteen clinical cases, nine directly from the abdominal lesion and five from other lesions complicating the primary abdominal disease.

The source of the material is given in Table VII

TABLE VII

MATERIAL UTILISED IN POSITIVE CULTURES.

Ascitic fluid	3
Mesenteric glands (post mortem)	5
Pus from abdominal sinus	1
Others	5
(Pus from abscess 1 urine 1 sputum 1 cervical gland 1 pleural fluid 1)	

The individual results accruing from these various tissues will now be discussed.

Ascitic fluid was utilised in five cases, three of which returned positive cultures, the fluid being readily obtained by abdominal puncture under aseptic conditions. In two of the three cases the effusion was massive and considerable quantities were withdrawn on repeated occasions. The first case to be considered is R.D., female, aged 7 years; the effusion was well marked, a total quantity of over three pints being removed during a period of one month. Macroscopically the fluid was of a translucent green colour, the specific gravity being 1018; after standing in a sterile flask for 24 hours in the ice chest a definite pellicle had formed. Some of this pellicle was examined microscopically after staining with Ziehl-Neelsen carbol fuchsin but no tubercle bacilli were found.

Preparation for animal inoculation was made by transferring some of the pellicle by a platinum loop to a sterile sputum bottle to which was added ascitic fluid and 6 per cent sulphuric acid in the proportion of two parts of the former to one of the latter. The mixture was incubated at 37°C for thirty minutes, at the end of which time it had assumed an opalescent green colour. Centrifugalisation was then carried out at a high speed until a deposit was thrown down: the supernatant fluid was decanted, the deposit washed with sterile water, the acidity being neutralised by washing with a solution of sodium bicarbonate followed by a final washing with sterile water. Centrifugalisation was carried out between each successive washing. Part of the final de-

posit was distributed over the surface of a tube of Petragnani's medium, the tube being closed with a rubber cap and incubation carried out at 37°C. A second portion of the deposit was mixed with 1 cc. of peptone broth and inoculated into the peritoneal cavity of a guinea pig. This guinea pig was killed after a period of six weeks and generalised tuberculosis found. The disease was marked at the site of inoculation while the inguinal and post-sternal glands were also caseous and the spleen the site of multiple foci. A prominent feature was the presence of a considerable effusion in the peritoneal cavity. Cultures were made on Petragnani's medium from the post-sternal glands and from splenic tissue; a typical wrinkled growth resulted with slight pigmentation. Sub-culturing produced a profuse growth on all media; on 3, 6 and 9 per cent glycerin agar it was heaped in appearance without pigmentation. These was some pigmentation in the first growth on glycerin egg and glycerin potato; thereafter sub-cultures showed no pigmentation. The growths were markedly eugonic. As the strain was definitely a eugonic one a rabbit was not inoculated.

In the second case of ascites, S.H., female aged 14 years, the effusion was also considerable and greenish yellow in colour, the specific gravity being 1021; a pellicle also formed on standing and was treated as described above. The lesions produced in the guineapig were not so well marked, the site of inoculation being less affected. The post-sternal glands and spleen were found to be the chief seat of the disease. Cultures on Petragnani's medium were definitely wrinkled in appearance, and non-pigmented in all media and eugonic in nature. As the bacillus was obviously of a human strain, rabbit

inoculation was not considered necessary.

The quantity of acsitic fluid obtained in the third case of ascites, W.B., male aged 5 years, amounted to only 5 cc. As there was no pellicle formation the whole fluid was treated with 6 percent sulphuric acid. Inoculation of a guinea pig produced a modified spread of the disease, nodules being present in the spleen and liver.

Sub-cultures were pigmented with scanty growth on 9 per cent glycerin agar. Unfortunately the culture died out before rabbit inoculation was available. The appearance and cultural characteristics indicated that it was a bovine strain.

The same procedure was adopted in each of the five specimens obtained at post-mortem examination. The material in each case consisted of mesenteric lymph glands, some being markedly caseous in consistency while others were more fleshy or fibrous. The method of choice in the treatment of this material was a modification of the original antiformin method of Uhlenhuth. If the glands were definitely caseous they were found to disintegrate readily in the antiformin; if fleshy in consistency they were finely divided before being mixed with the antiformin. In each case interaction at 37°C was allowed for one hour, the sediment produced by centrifugalisation being washed three times in sterile water before implanting on Petragnis' medium or guinea pig inoculation. Of the five strains derived from such material three were definitely of the human type on cultural characteristics. The fourth strain, from the patient H.K., male aged 9 years, produced a moderately heaped growth on 3 and 6 per cent glycerin

agar, scanty on 9 per cent while on glycerin egg and glycerin potato pigment was present. .0012 mgm. of the culture were injected into the marginal ear vein of a rabbit weighing 1020 gm. The animal was killed two months later, when small retrogressive foci were found in the lung and a few minute cortical foci in the kidney. No other lesions were present - definitely a human strain.

The final culture in the series of five was derived from S.D., female aged 14 years: produced a growth which was not profuse in character and pigmented only in glycerin potato. The growth was also scanty in the first and third generations on subculturing, but moderate in the second generation. Rabbit inoculation was not carried out in this case. The culture was definitely dysgonic and probably of a bovine strain.

Turning now to the lesions found as complications of the primary abdominal condition; the specimen of urine produced a definite eugonic growth in all generations, heaped throughout, with no pigmentation. As it was definitely human in type, rabbit inoculation was not considered necessary.

A wrinkled non-pigmented growth on 3, 6 and 9 per cent glycerin agar was cultivated from the sputum after 35 days. On glycerin egg it was smooth and non-pigmented; pigmented on glycerin potato and a smooth growth on Dorset's egg medium. The growth tended to be scanty in the second and third generations. A rabbit weighing 1080 gms was injected with .018 mgm of culture into the marginal ear vein and killed after two months. Massive confluent lesions were found throughout both lungs with caseation but no cavitation. Numerous pin-point lesions, cortical

in distribution, were found in both kidneys, also on the upper surface of the liver. This was definitely a bovine s train.

Of the three remaining specimens the pleural fluid was also bovine in type while the cervical gland and the specimen of pus produced human strains.

Conclusions.

The number of positive cultures obtained is inadequate to provide data of any value. The outstanding feature is the high percentage of human strains derived directly from the abdominal lesions, s ix out of nine being definitely human in type; which is in excess of other findings. The English Royal Commission (29) in 29 cases found 13 human, 14 bovine and two mixed strains while the records of the Journal of Medical Research, (30) in a series of 22 cases in children under five years of age, quote 13 bovine strains and 9 human strains and in 15 cases aged 5 to 15 years, 8 human and 7 bovine strains. Blacklock records 13 bovine strains in 15 cases of abdominal tuberculosis aged 0-13 years.

As already stated, the significance of the cultural types cannot be estimated from this series owing to the difficulties presented in obtaining material necessary to carry out a proper investigation.

The Examination of Faeces.

Assuming the route of infection to be the oral one in abdominal tuberculosis, it is reasonable to conclude that in many of the affected individuals a varying number of bacilli will be present in the faeces. The value of this method of examination has been thoroughly established

in the diagnosis of pulmonary tuberculosis, particularly in young children. Here of course the swallowed sputum provides a more abundant supply of organisms than might be expected in a peritoneal or mesenteric glandular lesion, the number of bacilli found in the faeces bearing a direct relationship to the degree of cavitation in the pulmonary tissue. In this series investigated, the faeces in the great majority of cases were found to be apparently normal and only in the more advanced cases was diarrhoea a marked feature. Here the stools as well as being fluid in consistency tended to be light in colour owing to impaired digestion and in some mucus was present. The presence of blood was most unusual.

In selecting the most suitable method for detecting the presence of tubercle bacilli in faeces, those recommended by various authors were compared, using specimens of faeces known to contain numerous tubercle bacilli derived from patients with advanced pulmonary cavitation and intestinal ulceration. A factor which was constantly kept in mind was the frequent occurrence of acid fast-material in normal faeces.

In the method of Strasburger a bit of stool the size of a pea is mixed with 1 cc of water, centrifuged gently and to the supernatant fluid is added twice its volume of 96 per cent alcohol and centrifuged vigorously smears being made from the deposit.

Klose added 25 cc. of 50 per cent antiformin to a similar-sized mass of faeces, the mixture being repeatedly shaken during 24 hours; 60 cc. of water were added and 2 to 3 cc. ligroin, again shaken vigorously, smears being derived from the intermediate layer.

Petroff also employed a watery emulsion of faeces which had been roughly filtered to remove gross particles, then saturated with sodium chloride and allowed to stand for several hours. A collection was then made of the superficial scum and a mixture made with normal sodium hydroxide and incubated for 1 to 2 hours at 37°C. The process was completed by adding 3 to 4 drops HCl and centrifuging the mixture; smears were made from the deposit.

Engleson considered Reh's method better than any other for direct examination of faeces. Here a piece of faeces the size of a bean is mixed with enough water to make it half fluid. Ether is added and the whole shaken; the supernatant ether is poured into a tube and centrifuged. The sediment is then fixed on a slide and stained.

The method of choice in this work was the last-mentioned one. In accuracy of results it compared favourably with the others and could be carried out with greater ease and rapidity. The examination was carried out in all cases, the smears being stained by Ziehl-Neelsen carbol-fuchsin but in only three specimens were tubercle bacilli detected: in one they were particularly numerous. All three cases ended fatally. Post mortem examination in each subject revealed extensive advanced peritoneal lesions with numerous tuberculous ulcers present in the small intestine, particularly in the lower part of the ileum. One extraordinary feature noted in this routine procedure was the milky white appearance of the ethereal extract derived from clinically advanced cases, this being attributed to the excess of fat in the stools follow-

ing deficient absorption by the diseased lymphatic system of the small bowel. When the disease was of a mild variety the supernatant ether remained perfectly clear.

It would thus appear that routine examination of faeces by ordinary methodsis of little practical value in the diagnosis of abdominal tuberculosis. In those cases where the bacilli are readily demonstrated the diagnosis can be definitely ascertained on clinical findings.

Although the tubercle bacilli are almost certainly present in the stools of a far larger percentage of cases, their paucity of numbers would necessitate a much more elaborate technique to detect their presence including animal inoculation.

Conclusions.

In conclusion it may be stated that the diagnosis of abdominal tuberculosis in many cases presents difficulties which cannot be overcome with certainty, and the problem must be approached with a mind appreciative of the anomalous nature of the disease. Prolonged observation and investigation may be necessary before one can arrive at a definite decision, and the disease is one in which the early measures adopted must be viewed equally with reference to both diagnosis and treatment.

Regarding the methods of diagnosis, clinical findings must be accepted as the foundation on which are built up the results derived from subsidiary tests. Of these tests the reaction to tuberculin must be considered the most important, while to a limited extent the blood sedimentation test may be of value, especially when there

two are taken in conjunction. Other laboratory methods fill a very minor rôle, the scope of bacteriology is a strictly limited one, the isolation of organisms from the faeces or otherwise unfortunately is possible in only a few cases. The value of radiology also occupied an even more insignificant rôle, X-ray films of the abdomen being devoid of any useful information in practically all cases.

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F. ADMINISTRATIVE CONTROL.

In considering the measures necessary for the administrative control of abdominal tuberculosis, numerous problems present themselves, some of them being in many ways peculiar to this form of the disease.

Although in company with other forms of non-pulmonary tuberculosis it has shown a marked decline since notification, the condition still warrants the most careful supervision combined with the maximum resources of the community directed towards both cure and prevention.

The first outstanding feature is the anomalous nature of the disease, the extremes presenting clinical pictures so widely divergent that it becomes evident that from an administrative point of view one classification cannot be made to cover the whole field of the work. However, prior to this stage of investigation the very important question of diagnosis must come under review. Here again owing to the indefinite nature of the clinical features and the history of onset, in the vast majority of cases a certain diagnosis cannot be ascertained with any degree of rapidity. From a practical point of view the preliminary observation of every case should have a twofold purpose: firstly the diagnosis of the condition, and secondly a classification into one of several groups whereby appropriate treatment could be carried out.

The first point where observation becomes possibly is at the outdoor clinic or dispensary. It can be assumed that the child has been brought there by the parents following advice given by the family physician, the school medical officer, or some similar authority.

At this stage of the proceedings many factors can be ascertained concerning the case, a superficial examination can be carried out and information obtained as to the nature of the onset, the previous health of the child, and also information about nutrition. Other important points requiring investigation which might be elicited at this stage concern housing conditions and the economic status of the household and finally the important question of the family history with reference to tuberculosis, both pulmonary and non-pulmonary. Statements relating to contact with such individuals of course are most important. Apart from this form of superficial survey of the case, it will be seen that the further value of the outdoor clinic is a strictly limited one and does not compare favourably with the corresponding unit in the control of pulmonary tuberculosis. Here the information obtained by physical examination and through the medium of X-ray films makes diagnosis and classification much more rapid and accurate. If adequate observations at the outdoor clinic are not feasible it naturally follows that the home plays an even smaller part in the administrative scheme. As a large percentage of the cases are derived from that section of the population known as slum dwellers, it follows that any attempted co-operation, including therapeutic measures, would be carried out under numerous difficulties, economic and otherwise. Therefore as a broad principle it may be stated that when suspected cases of abdominal tuberculosis first come under control, accurate observation and diagnosis in the majority of cases is impossible without the facilities offered by an institution. One of the main

advantages gained by this procedure is the observation of the response made by the patient to routine treatment, including regulated diet and standards of hygiene vastly superior to the environment usually enjoyed by the individual. Then it will be seen that in many cases the symptoms are of a transitory nature, such symptoms as abdominal pain and distension disappearing with a remarkable rapidity, indicating that the underlying cause is principally dietetic deficiency combined with the evils resultant on bad housing.

Increase in weight and a stability in the temperature and pulse rate are other features that are commonly associated with this type of case.

During this early residence in hospital conditions are most suitable for the carrying out of accessory aids to diagnosis, the response to varying dilutions of tubercules can be recorded, the blood sedimentation rates estimated and where possible material collected for bacteriological examination. At this juncture the possible question of subsidiary lesions being present is an important one: this refers particularly to involvement of the thoracic contents. Radiograms of the lungs would be a routine procedure in all cases where there arose the slightest possibility of pulmonary involvement.

Following on this preliminary examination it would be found that from the aspect of future administration any case could be placed in one of two main sub-divisions. Firstly those in which the condition was so grave and the clinical manifestations so marked that further hospitalisation became a necessity. The presence of any complication would suggest inclusion in the group. In

the second group would be found those cases which presented few or no symptoms but where the general condition of the child was below normal or where the history of illness had been quite definite. It is in this type of case that there is less need for strict medical supervision. The apparent absence of any active pathological lesions such as the crippling deformities of surgical tuberculosis or the progressive pulmonary destruction of phthisis with its train of potential complications renders further control being adequately met by supervision combined with hygienic surroundings.

The essential difference between these two groups is one of cost of maintenance. In the first, treatment would have to be carried out in a modern hospital fully equipped in order that any possible emergency could receive prompt and adequate treatment. This would necessitate a centrally situated institution equipped with operating theatre, X-ray plant and an appropriately trained staff.

In the second group however these adjuncts would be unnecessary, the requisite amount of supervision, fresh air and suitable nourishment being easily supplied by locating the children in a country home. Under these circumstances of course the cost per patient would fall much below that required for a fully equipped modern hospital. It would be found that most of the cases coming under observation in any large community could be easily classified in the second group. The dividing line cannot be laid down as a definite one, and considerable detail in investigation would require to be carried out. A point to be kept in mind is the rapidity with which an

apparently quiescent case can assume urgent symptoms necessitating prompt surgical interference; intestinal obstruction may be quoted as an outstanding example of this form of emergency.

The final unit in the administrative control would take the form of continued supervision after the child had returned home, by which time the diagnosis and nature of the lesion would be fully understood. Enforced regular attendance at the outdoor clinic or regular inspection by a health visitor would enable records to be kept of the home surroundings and any deficiency corrected. This system would to a large extent eliminate the often unaccountable relapses to which these patients are subject.

In infants and very young children the proportion of suspected cases turning out to be non-tuberculous appears to be greater than in older boys and girls. This is accounted for by the greater prevalence of the simpler forms of enteritis, including summer diarrhoea, found in young children. Many of these cases, however, although apparently non-tuberculous, are most resistant to treatment and very liable to suffer relapse. Owing to the intractable nature of these cases, the question of a tuberculous basis is of the utmost importance and requires the fullest investigation.

When the problem is viewed from the widest angle it will be observed that at present there is a satisfactory decline in the incidence of abdominal tuberculosis. What is the cause of this decline, and how can the elements underlying it be utilised to bring about an even more rapid diminution? This decline cannot be attributed to any one factor but is a response to an improved stan-

dard of living in that section of the community where the disease is most prevalent. Elimination of the effects of poverty and evil housing combined with the assurance of adequate nutrition provides a suitable foundation for any administrative scheme designed to combat the problem. The value of pasteurisation of milk supply must be considerable, but at the same time difficult to assess accurately. Inquiry into the history of individual cases is liable to provide vague results as both pasteurised and unpasteurised milk in many cases have been component parts of the diet of these individuals.

It would appear to be reasonable to conclude that the present improvement should continue to keep pace with the improved standards of living and increased amenities available among the more distressed members of the community. Employment of adequate hospital facilities and supervision both during and after institutional treatment would not only shorten the duration of the illness, but help to eliminate the possibility of relapses which are so frequent.

Turning again to the question of preventitive measures, particular stress must be laid on the importance of the segregation of active cases of pulmonary tuberculosis. The dissemination of tubercle bacilli from such cases in small overcrowded houses must form a menace of the first magnitude to the health of any child coming into such association. The occurrence of human strains of the bacillus in abdominal tuberculosis can be readily attributed to the ingestion of bacilli derived from these ever active reservoirs of infection. Although

the Grancher system has not been adopted in this country, the obvious alternative is to ensure that all active cases of pulmonary tuberculosis are controlled as far as possible in overcrowded dwellings, thus eliminating active sources of infection.

Before leaving the question of prophylaxis, reference must be made to specific immunisation. At present there would appear to be no practical scope for the various forms of preventive inoculation. Although first tried in 1911 (Webb and Williams), the results of inoculation with living tubercle bacilli have not substantiated the claims made. The more recent use of attenuated non-virulent cultures or "B.C.G." employed by Calmette has also failed to establish the procedure as a unit in the practical prevention of the disease.

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G. SUMMARY AND CONCLUSIONS.

Although the number of individual cases under review in this series has been limited to one hundred, this figure has been sufficient to illustrate the different clinical types presented and the preponderance of any one type over the others. The various points of interest both clinical and otherwise, found in this series, have been fully investigated and the results obtained applied to the whole problem of abdominal tuberculosis.

Owing to the nature of the conditions, the problem of abdominal tuberculosis is not one which lends itself to dramatic changes in the direction of either cure or prevention such as have been prominently brought out in other maladies. A gradual diminution in the incidence of the disease has been maintained within recent decades and a continuance of this state of affairs would provide a satisfactory feature, but following on adequate measures it seems possible to bring about a speeding [illegible] this improvement associated with a practical form of administration combining efficiency with economy. The first obstacle to be overcome is the question of diagnosis. It is essential that an accurate diagnosis should be arrived at as soon as possible after the case comes under observation. At present there is a tendency to classify a large number of cases as of doubtful tuberculous nature. Many of these cases are not suffering from tuberculosis and if this were rapidly ascertained the expense of treatment in a fully equipped hospital might well be avoided. It is round this question of

diagnosis that the real problems present themselves. In a certain percentage the clinical manifestations are marked and little difficulty is experienced in making a definite diagnosis of abdominal tuberculosis. However in another large group the physician may have considerable misgivings in making such a diagnosis on clinical findings alone. In these circumstances resort must be made to accessory aids and it is in this province that the response to the intradermal injection of tuberculin and the blood sedimentation rate may be of considerable value. Following on a provisional diagnosis it is important to note the response made to careful nursing and regulated nutrition and to detect the presence of other tuberculous lesions, pulmonary or non-pulmonary. It should be kept in mind that cases apparently quiescent with no signs of activity may develop an acute surgical emergency.

The question of the treatment of abdominal tuberculosis does not lend itself to extensive discussion. There is no therapeutic measure which can be claimed to be in any way specific in nature. In the majority of cases the greatest benefit is obtained by adopting corrective measures, by the elimination of previous errors and deficiencies in nutrition. The advantages of fresh air and sunlight are also considerable. Surgical measures are limited to certain emergencies such as intestinal obstruction. Where there is a massive ascites, repeated withdrawal of fluid by abdominal paracentesis is of considerable benefit.

In considering measures to be adopted which might possibly hasten the present improvement, it would seem

appropriate to review briefly the factors responsible for the present decline. Probably the most important cause is found in the improved standard of living in the poorer section of the community, higher standards of nutrition and housing producing conditions more approaching institutional environment, under which most of these cases show rapid improvement.

In infancy and the early years of life the benefits of these improved standards cannot be over-estimated and it is in connection with this age of infancy that the supervision and advice of the numerous Welfare Clinics must be of considerable value. Another factor coming under scrutiny is the use of pasteurised milk.

Milk undoubtedly is an important vehicle of infection and any measure which diminishes the number of tubercle bacilli present must be a potent factor in the prevention of infection.

As yet the maximum benefit has not been obtained from these various improvements. Each succeeding year sees further progress in municipal schemes designed to better the welfare of the poorer classes and it may be confidently expected that the decline in the incidence of abdominal tuberculosis in the future will keep pace with the advancing standards of living.

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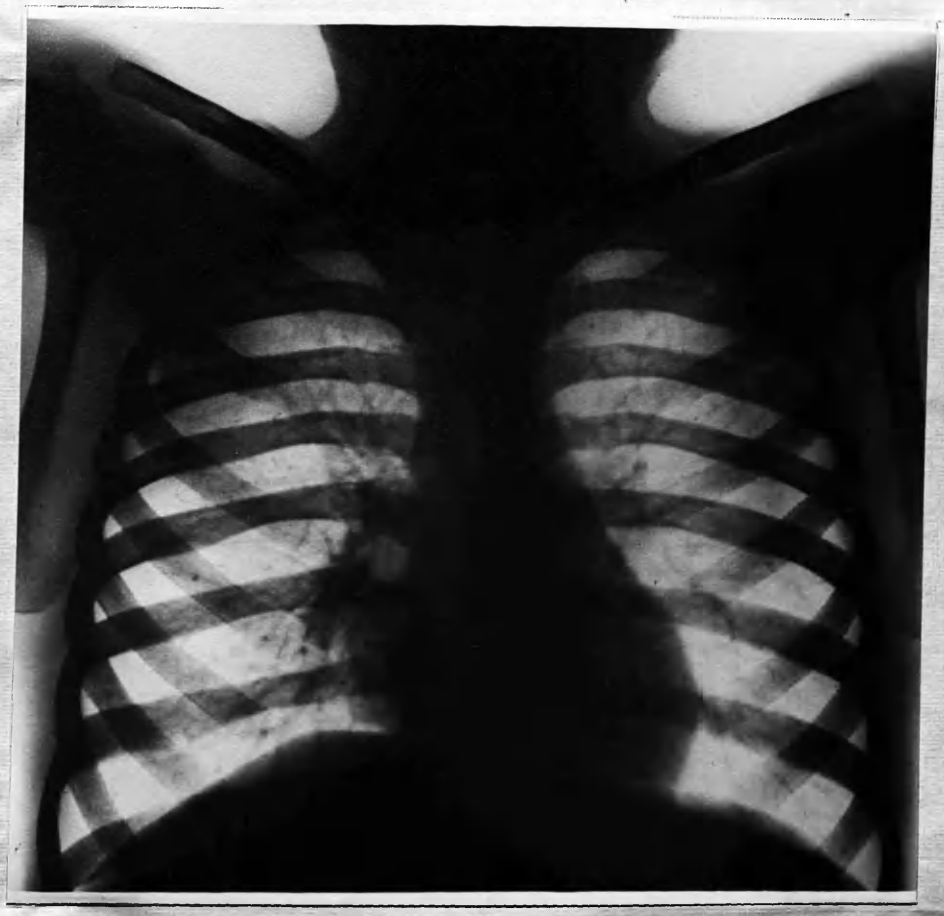
PLATE II.

D.G., Female, aet. 14 years.

Hilum tuberculosis.

Unilateral extension of hilum shadow right side.

PLATE III.

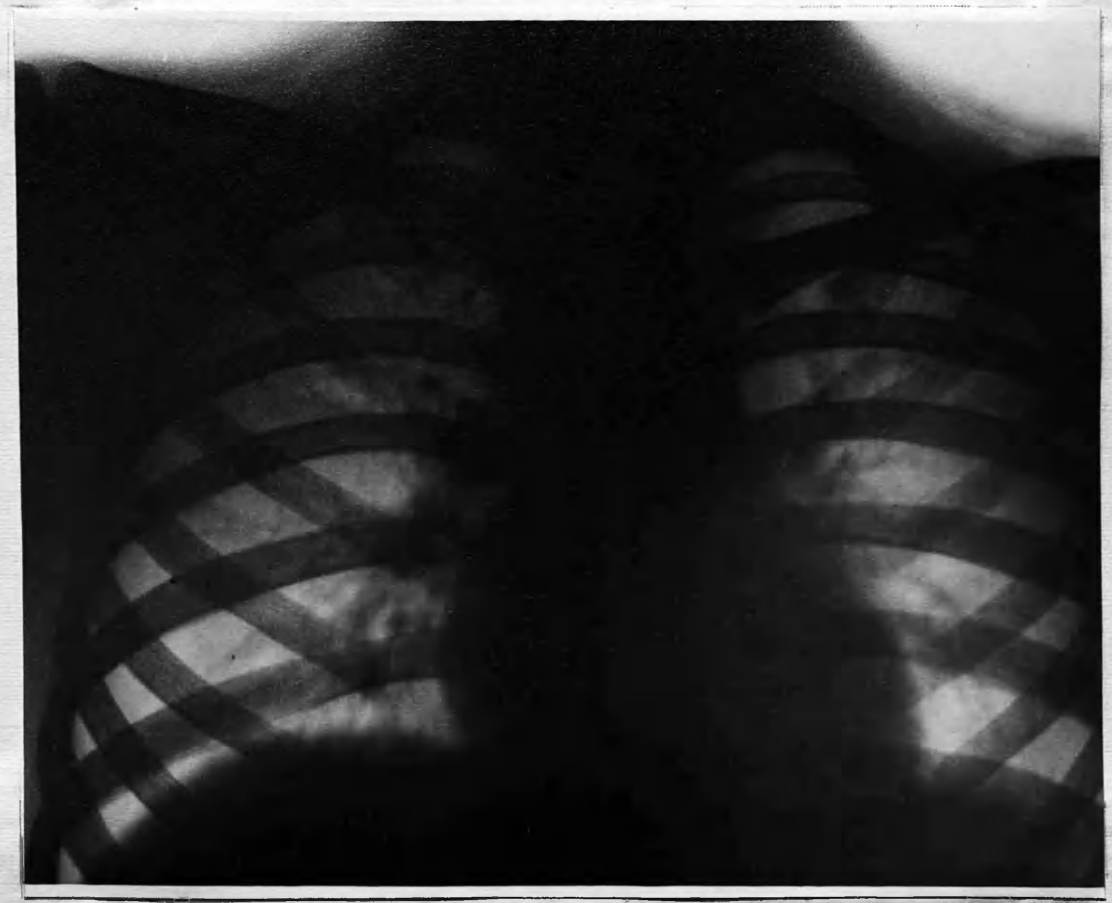


R.F., Male, aet.8 years.

Hilum tuberculosis.

Extension of hilum shadows. Calcification beginning.

PLATE IV.

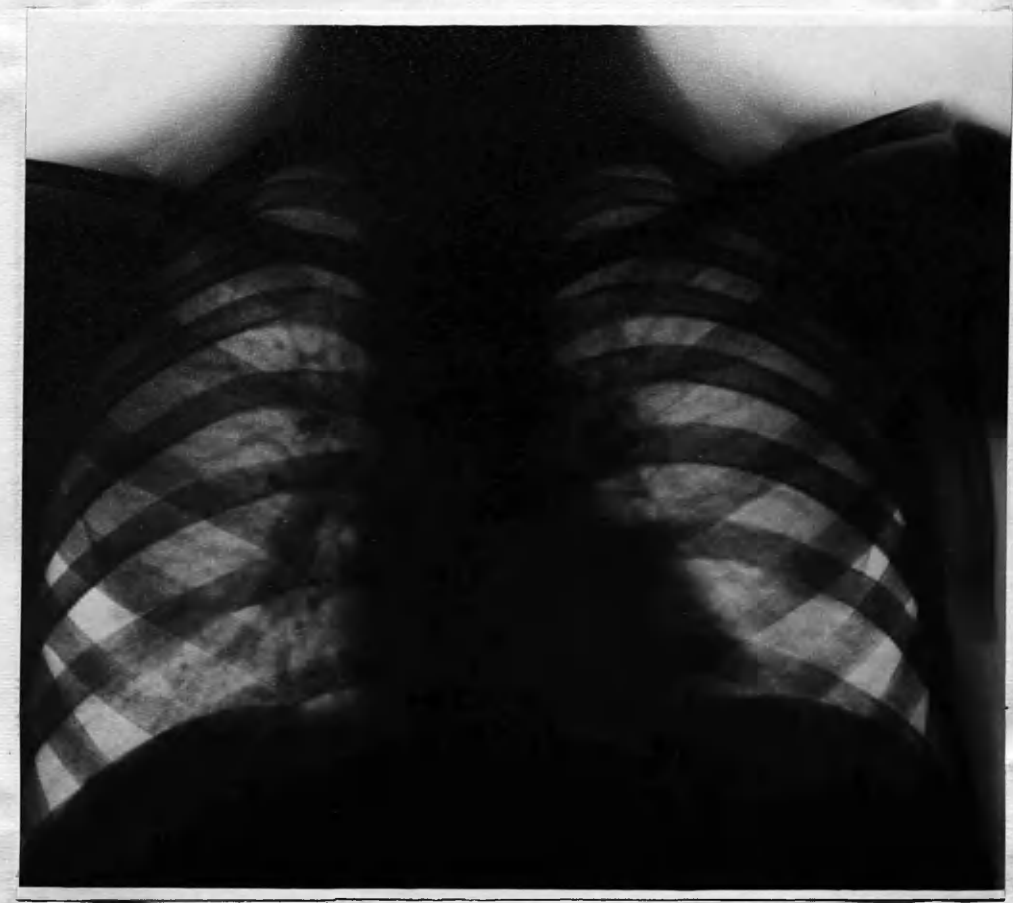


J.J., Female, aet.9 years.

Hilum tuberculosis.

Enlarged glands. Calcification more marked.

PLATE V.

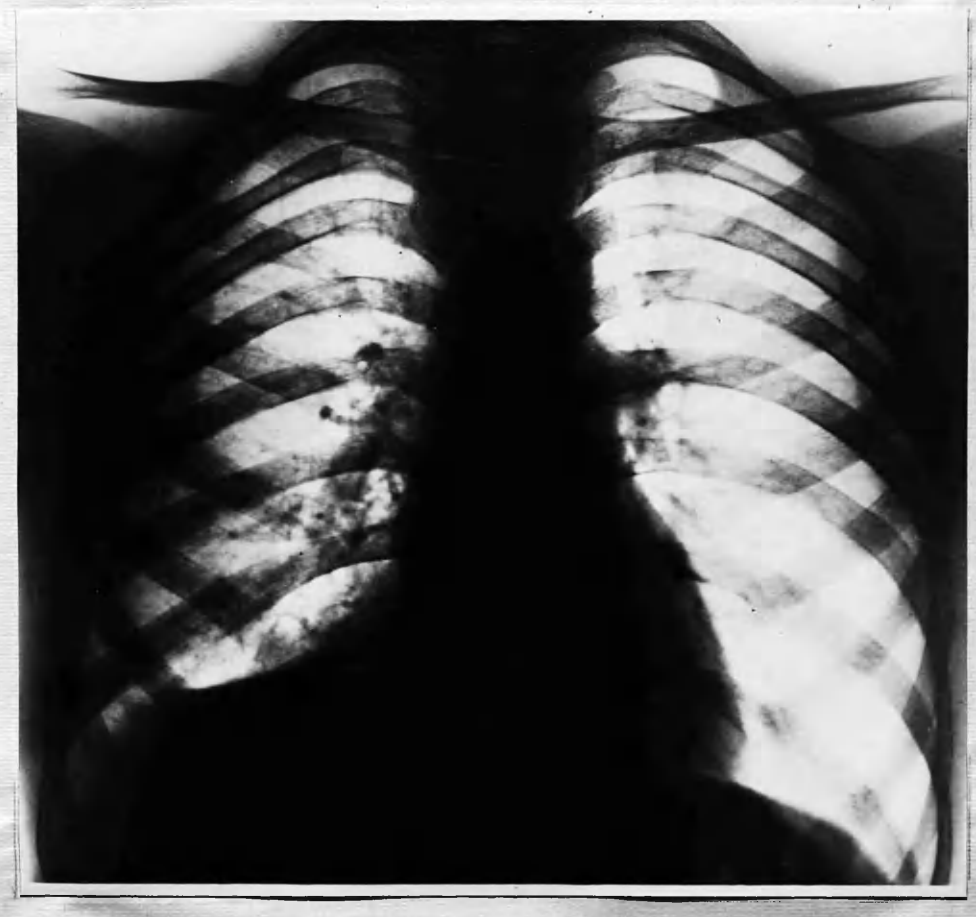


J.M., Male, aet.13 years.

Hilum tuberculosis.

Enlargement of hilum glands. No calcification.

PLATE VI.

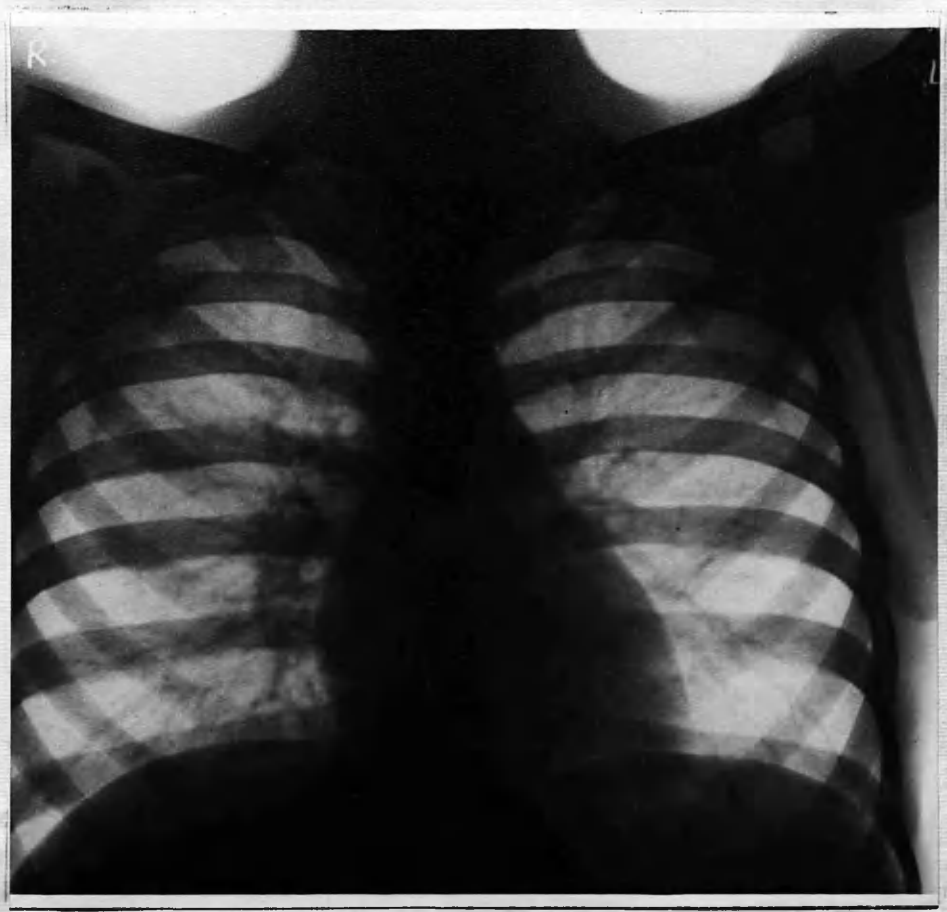


J.M. Same as Plate V. 6 months later.

Hilum shadows more dense.

Right basal pleurisy.

PLATE VII.

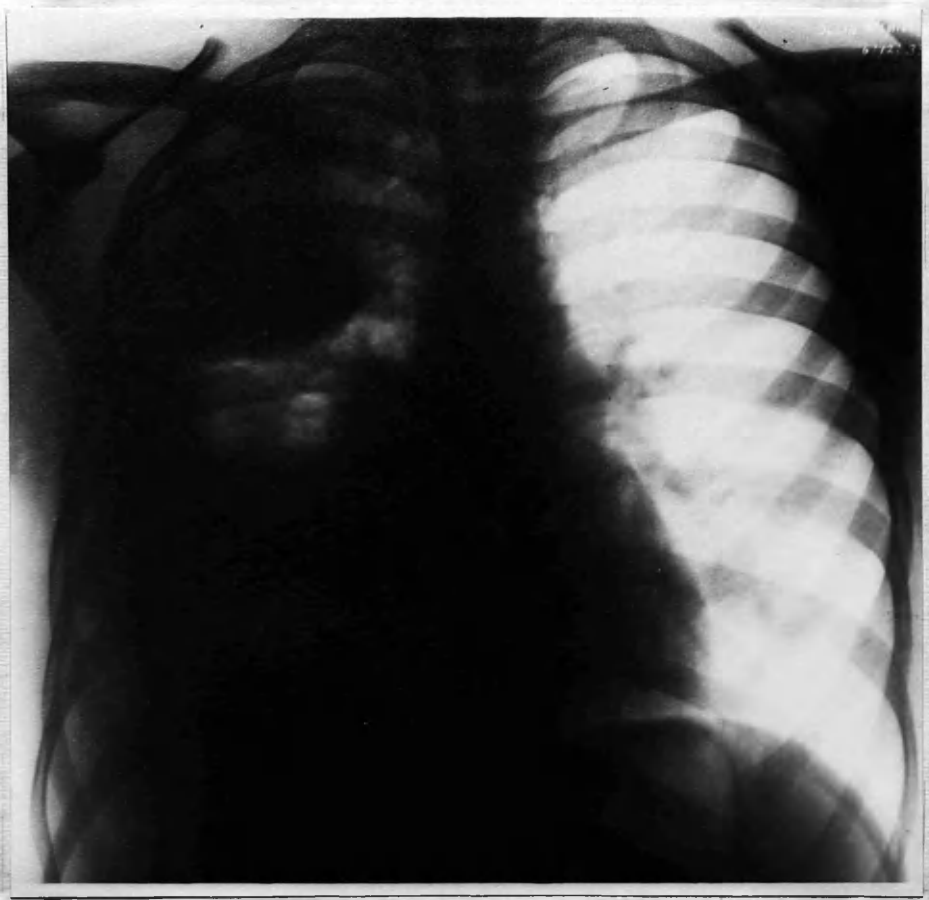


S.H., Female, aet.14 years.

Hilum tuberculosis.

Enlarged hilar shadows. No calcification.

PLATE VIII.

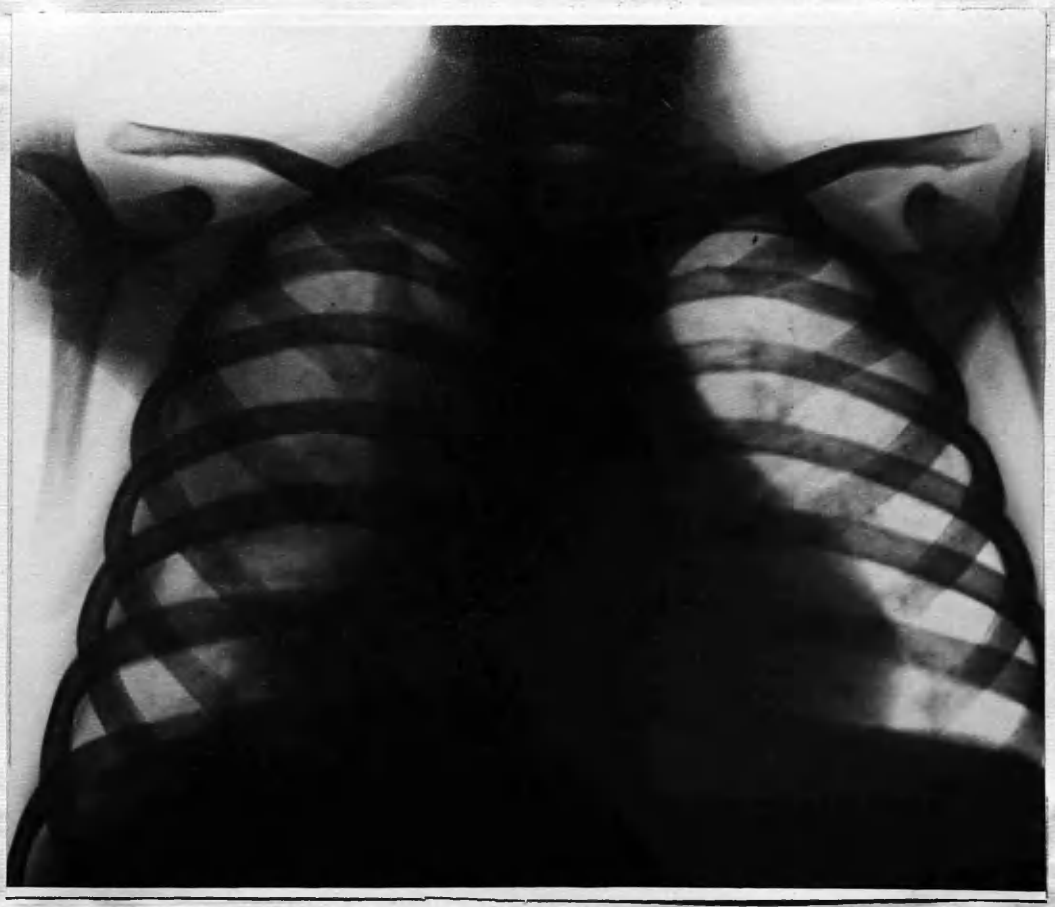


S.H. Same as Plate VII. 6 months later.

Extensive pleural lesion, right side.

Localised collection of fluid in upper zone.

PLATE IX.



R.D., Female. aet.6 years.

Hilum tuberculosis with r.basal pleurisy.

PLATE X.

R.D. Same as Plate IX. 10 months later.

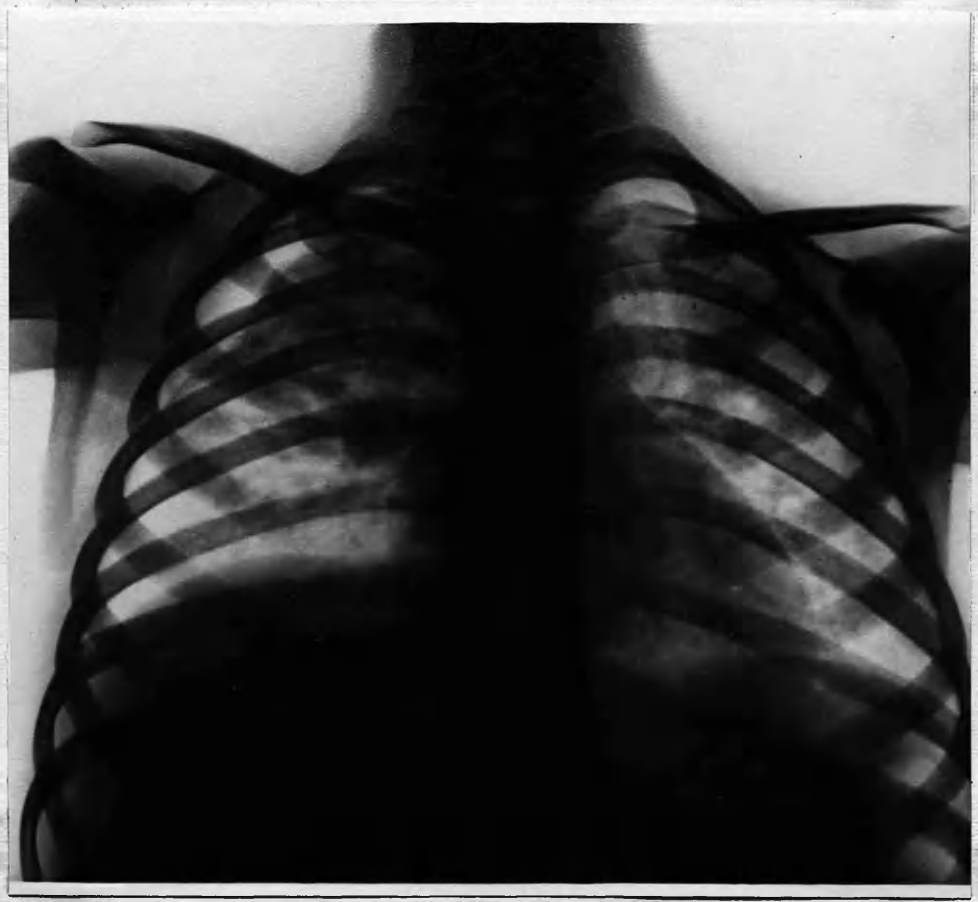
Lesion has cleared considerably.

PLATE XI.

M.G., Female, aet.11 years.

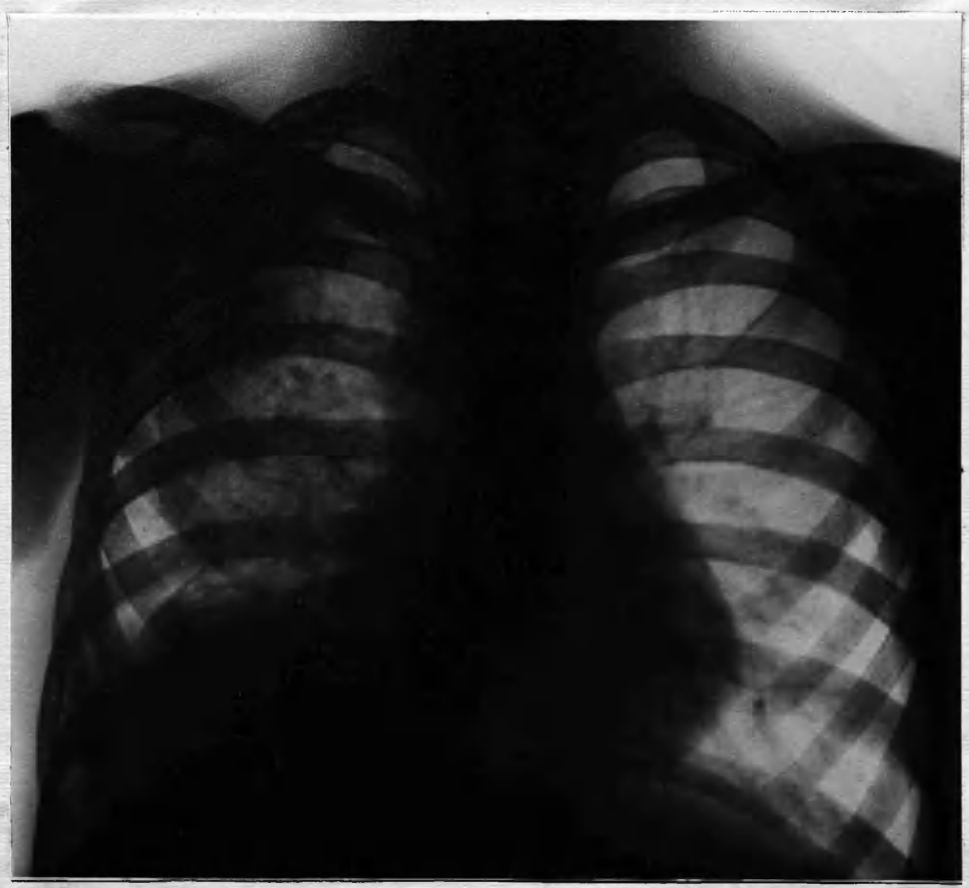
Hilum tuberculosis and right basal pleurisy.

PLATE XII.



J.B., Male, aet.9 years.
Intrapulmonary tuberculosis.
Active tuberculous disease spreading from right hilum into right lung.

PLATE XIII.

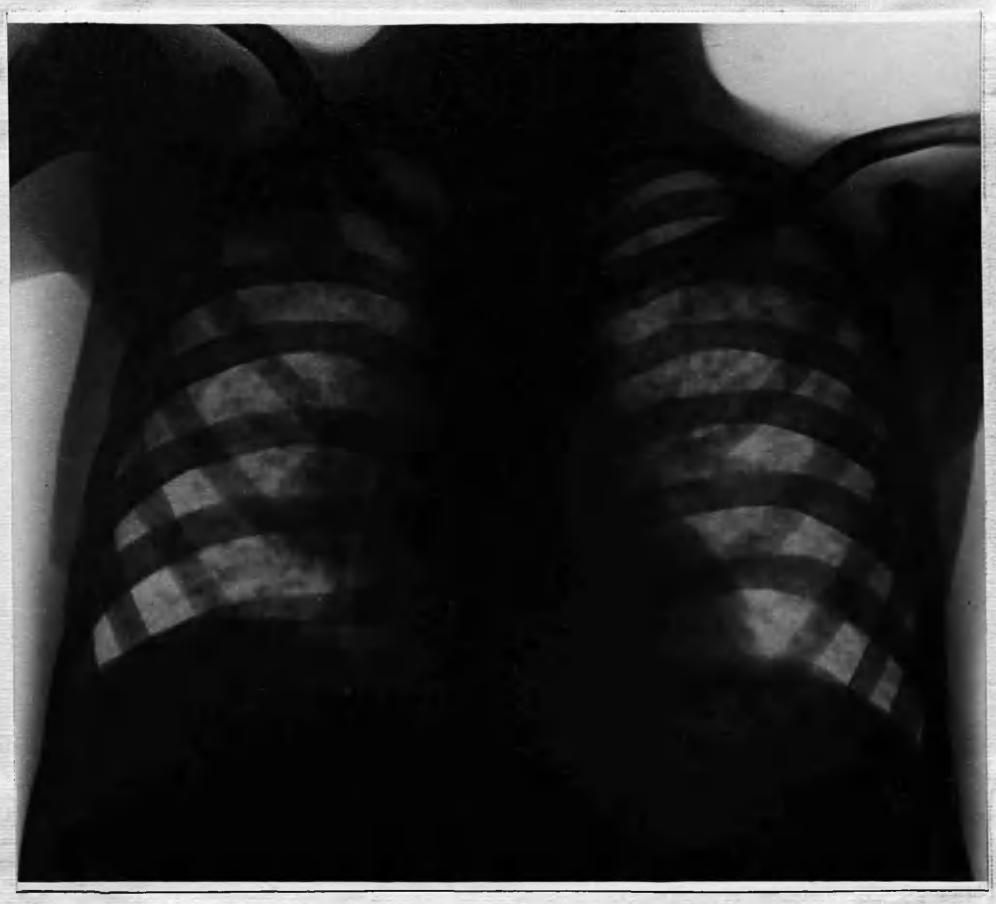


H.G., Male, aet.11 years.
Intrapulmonary tuberculosis.
Active disease right lung with
partial pneumothorax.

PLATE XIV.

D.M., Male, aet.1 year.
Intrapulmonary tuberculosis
Broncho-pneumonic tuberculosis,
right lung.

PLATE XV.

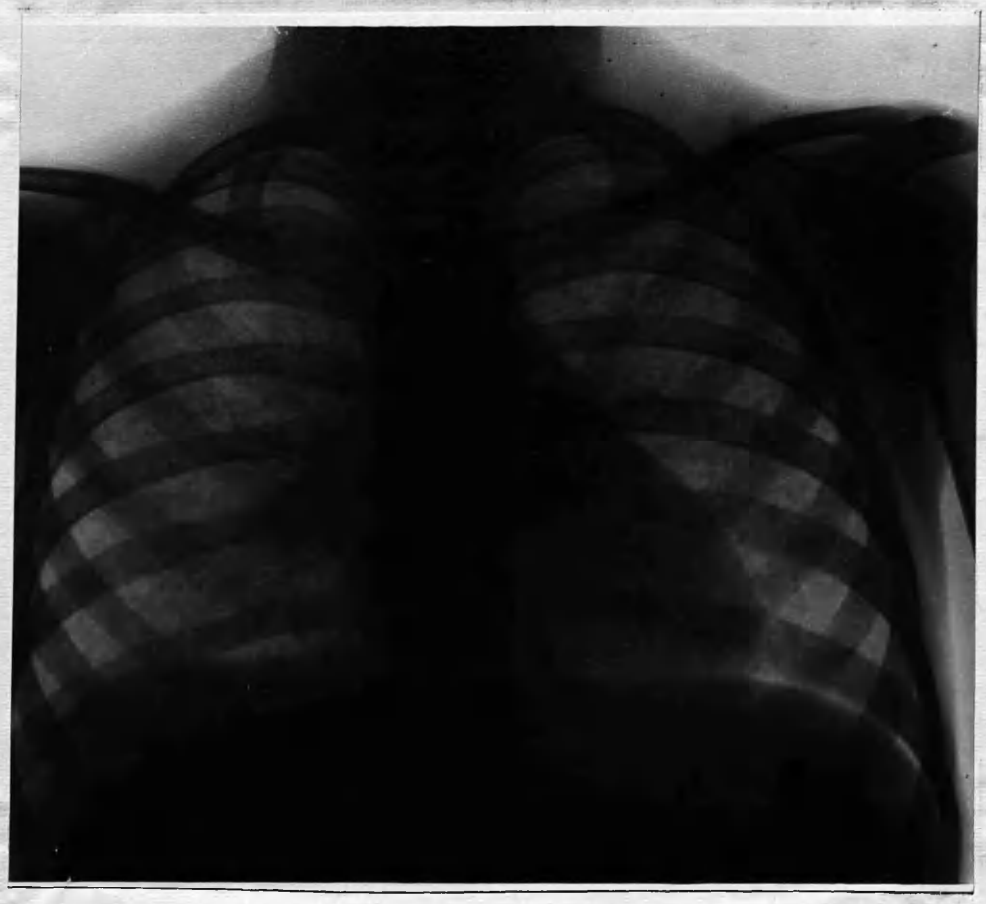


J.B., Male, aet.9 years.

Intrapulmonary tuberculosis

Broncho-pneumonic tuberculosis.

PLATE XVI.



S.P., Male, aet.10 years.
Intrapulmonary tuberculosis
Miliary tuberculosis.

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