A Survey of Tuberculous Infection among 1092 Children attending Anti-Tuberculosis Dispensaries in Lanarkshire.

THIS study was initiated in 1928 in Bellshill and Shotts Dispensaries. The area served by those dispensaries extends to 83,500 acres and has a population of 150,000, including a number of Lithuanians and a large proportion of Irish. Coal-mining, Iron and Steel manufacture are the industries of the district, and in all three unemployment has reached its "peak" figures during the year under review. Living conditions, therefore, have been bad, and out of this distress has been established a more intimate relationship between the dispensaries and the community as a whole. The unemployed and poorer classes generally, also those more happily situated but feeling the pinch of long continued economic stress, now resort to the dispensaries in search of general medical advice, medical comforts or assistance in some other ways. The actual cases of tuberculosis are few amid a surfeit of minor ailments, nutritional and general medical disorders. The children among them are representative of the average family in a "depressed" area, but in so far as the investigation has been conducted entirely in dispensaries, the figures are still short of being typical of the district as a whole. They are capable of comparison only with figures obtained under similar conditions.

Throughout the investigation the routine dispensary procedure was adhered to, and no endeavour made to provide data in support of any preconceived hypothesis. Domestic particulars and weight in ordinary clothing were recorded by the clerkess in attendance. An enquiry into the previous and family history, and physical examination, either complete or with reference to the locus of disease as suggested by the symptoms, was undertaken by myself. Tuberculin skin tests were applied by myself or by the nurse assistant. The Von Pirquet and Moro tests were used in each case and every effort made to obtain uniform results by the employment of one simple technique. X-Ray photographs were taken by arrangement with the physician superintendent in the X-Ray department of the County Fever Hospital. An established diagnosis was reserved until all relative information was complete.

The Moro and Von Pirquet methods of applying the tests have been used throughout and have not been abandoned in favour of the more delicate intradermal method of Mantoux. Fishberg (1) uses the Von Pirquet test in preference to the quantitative method which, he holds, offers no advantages, but it is generally accepted that the Mantoux test is a more exact method where sensitivity is low. Hamburger and Monti (2) were the first to demonstrate discrepancies in results due to different technique, and more recently, Austrian (3) and Myers (4) and others have recorded positive reactions with the intra-dermal test in children whose Von Pirquet had

previously diminished to negative. However, the tests employed are simple and better suited to dispensary practice where scientific accuracy must of necessity be sacrificed for convenience. Moreover, these tests have been widely used in other similar surveys and their results will be more exactly comparable.

METHOD OF APPLYING TUBERCULIN SKIN TESTS.

Von Pirquet Test: Von Pirquet's idea of keeping the scarification soaked with tuberculin sufficiently long to allow absorption to take place was considered much too fundamental to ignore yet unsuitable for routine dispensary procedure. A modification of the original technique was devised. Koch's Old Tuberculin, human and undiluted, was used. The bovine type in addition was used for a short period at first, but later discontinued, as differences in reaction between the two were negligible.

The flexor surface of the left forearm was cleansed with methylated ether. A drop of tuberculin was placed at a point corresponding to the apex of the cubital fossa. About two or three inches distally the skin was scarified as a control—the scarification consisting of two strokes about 10 m.m. in length longitudinally and two transversely at right angles across the first two. There should be no bleeding and the scarification was considered to be applied correctly when each incision became visible in some seconds as a red stroke. An exactly similar scarification is done through the tuberculin with the same scarifier. Using a sterile finger cot the tuberculin is gently rubbed into the upper scarification—Fishberg (1) recommends that the tuberculin should be rubbed into the scarification vigorously with a toothpick. Thereafter a bandage is applied to the forearm and the child or its parents advised to leave it undisturbed for 48 hours. In Shotts dispensary where the nurse assistants were trained to apply the tests, the control scarification has been done through distilled water and gently rubbed so that the traumatic disturbance might be equalised.

Moro's Test: The technique observed here was as follows. A small portion of the tuberculin ointment was rubbed into the skin over the cranial end of the sternum. The skin was cleansed previously with methylated ether only if visible dirt was present, and some other portion of skin, usually over the abdomen, was used if any rash or abrasion existed at the site of choice.

INTERPRETATION AND DESIGNATION OF REACTIONS.

Reactions have been arbitrarily graded as follows:—

Von Pirquet Test:

(1) Negative—when there is no appreciable difference between the two areas.

(2) One plus (+)—when a definite though small areola of erythema occurred at the site of scarification through tuberculin and persists for a week.

(3) Two plus (++)—reactions varying in intensity between (+) and (+++).

(4) Three plus (+++)—when there was definite raised infiltration and a well-marked areola of erythema approximately 10 m.m. or more in diameter, frequently surrounded with a definite folliculitis—a percutaneous reaction due to inunction of tuberculin with finger, and corresponding to Moro's test.

(5) Four plus (++++)—when there is unusually marked infiltration over a wider area with vesiculation or pustulation or even central necrosis, usually accompanied by marked folliculitis and occasionally by lymphangitis of adjacent skin.

Moro's Test:

(1) Negative—when no change was noted.

(2) One plus (+)—when one or two minute papules appeared at the site of inunction. (For a positive test there must at least be papules.)

(3) Two plus (++)—between (+) and (+++).

(4) Three plus (+++)—when a definite folliculitis occurred with papules and vesicles and redness.

(5) Four plus (++++)—when the folliculitis was marked with vesicles and pustules dense over the actual area of inunction and extending beyond. (One very severe reaction recorded resembled a confluent smallpox involving the entire anterior surface of the trunk.)

The result of both tests in each child was recorded by the dispensary nurse 48 hours after when the bandage was removed, and again one week later interpreted, compared with the 48 hours record, and finally designated by myself. These intervals originally chosen for convenience have proved useful in the following respects, (1) the evanescent pseudo-reaction usually observed during the first 24 hours is avoided; (2) the characteristic residual pigmentation of the positive reaction, however faint, is well marked one week after; (3) delayed reactions occasionally encountered in both tests are never missed. Reactions delayed beyond seven days have not been observed.

Border-line Reactions:

The grading is arbitrary and difficulties have been overcome with experience. It is of advantage in such a study as this that the personal equation remains constant. Where difficulty in interpretation has existed between a negative and a one plus reaction, a reference to the other test has often determined the reading, or a final appeal might be made to the more

exact and delicate intradermal test described by Mantoux. A three plus reaction represents the common allergic response met with in dispensary practice, and with experience there has been no difficulty in recognising this grade of reaction. Diminution or increase of the common sensitivity to tuberculin has been measured by two plus or four plus. In most cases the recorded results by the Von Pirquet and Moro methods correspond, but discrepancies have occurred and provide material for a tabulated statement later of the relative merits of these tests.

MEANING OF THE TUBERCULIN SKIN TEST.

A positive skin reaction indicates an infection with tubercle bacilli and a negative reaction, with few exceptions, the absence of infection. Infection must be distinguished from tuberculous disease. More certain information may be obtained from the grade of the positive reaction. Von Pirquet (5) and Pottenger (6) believe " that marked sensitivity proves that the organism has recently come in contact with the tubercle bacilli or its poisons." Opie and McPhedran (7) and Myers and Atsatt (8) have found that the grade of reaction is important in the diagnosis of clinical disease, while McNeil (9) associates the severe reactions with scrofulous tuberculosis.

The usefulness of the test goes further. As an aid in the diagnosis of obscure cases among young children with tuberculous symptomatology a positive reaction is sufficient to decide the diagnosis, while a negative reaction for all practical purposes rules out tuberculosis. In this respect the test is comparable with the Widal in obscure cases of Paratyphoid. The younger the child, the more strictly true is this comparison. The significance of the positive reaction, however, as an indication of active disease, diminishes with age, but on the contrary in later childhood a negative reaction is of enhanced value in excluding tuberculous disease

The occasional failure of the test in the presence of tuberculosis, latent and manifest, is of relatively little importance. That it does fail under certain conditions is admitted, e.g. anergy during the eruptive phase of measles, or in the terminal stages of chronic phthisis, but these conditions obviously will not vitiate the results of the routine application of the test among dispensary children. Von Pirquet reported a negative reaction in 2-4% of tuberculous cases without any assignable reason. Fishberg (1), who quotes the above, states that in his experience the proportion is even higher. Again, the test being one of sensitivity, this acquired attribute of the body tissues in the absence of re-infection may die out completely as primary processes heal. Krause (10) discusses this occurrence in an article on resistance to tuberculosis at various ages. Austrian (11) and Myers (4) both cite groups of children who had reacted positively to the Von Pirquet test and later became negative.

In one or two instances during the present study the first test has been negative, but a second application a week later has been positive. It has been considered advisable, therefore, in all cases of suspected tuberculosis notified by general practitioners, to repeat the test before interpeting the result as unequivocally negative. It has been noted also in one child that a subcutaneous inoculation of .5 c.c. 1/100 tuberculin has produced an unusually intense secondary reaction at the areas of Moro and Von Pirquet tests which had been applied two weeks previously, and recorded, then, as positive.

GENERAL RESULTS OF TUBERCULIN REACTION.

In Table I. is set forth the incidence of infection among 1092 children examined in the manner described. Of this number 535 were boys and 557 girls. Clinical Tuberculosis of all types was diagnosed in 197 children and the incidence of infection among 895 children, in whom no clinical disease was apparent, is also given in this Table. It may be observed here that the term Hilum Tuberculosis has not been used throughout this series of cases in the belief that Hilum Tuberculosis—Hilum used in the topographical sense —can be much exaggerated as a type of intrathoracic tuberculosis in children. The diagnosis of Pulmonary Tuberculosis has been restricted to those children in whom frank parenchymatous infiltration has been observed clinically or by X-Ray. Where the clinical data conformed to the diagnosis of hilum tuberculosis the children have not been notified as tuberculous, but as " tuberculised with pulmonary symptoms."

The numbers at each age are probably insufficient to warrant definite conclusions as to incidence of infection at any given age, but it is apparent that a progressive increase occurs with increasing age, varying from 9.4 per cent. under 1 year to 73.8 per cent. at 15 years, an average of 53.8 per cent. all over. Among boys there is a higher incidence than among girls, and the increase is obvious at all ages under 7. Over 7 infection is still higher in the case of boys, 67.5 per cent. against 66.3 per cent., but at the individual years the higher incidence is as often among the girls as among the boys. The average incidence of infection among children with no clinical disease is fully 10 per cent. less than among all children and the diminution is most marked at all ages under 3 years, where children with clinical disease account for over 60 per cent. of all positive reactors. This latter fact suggests a very close relation between disease and the tuberculin reaction, and substantiates the clinical significance of a positive reaction in the very young.

A rather sharp increase in incidence of infection occurs between the age of 2 and 4 years. It is equally apparent in the total group, in boys, in girls and in all children with no clinical disease. The figures, of course, do not include those children who have already died of rapidly fatal tuberculous

disease and who form a considerable proportion of the positive reactors under 2 years, but, with this point in mind, it is probable that some other factor influences the incidence of infection about the age of 3 years. Children at this age seem to come suddenly into contact with an additional and common source of infection. Household contact with "open" cases and ingestion of infected milk apply with equal weight at each year of life. A view

TABLE I.

Incidence of infection among dispensary children in industrial Lanarkshire as revealed by the Von Pirquet test.

Age	All Children			Boys			Girls			Children with T.B. disease excluded		
	No.	No. +	%	No.	No. +	%	No.	No. +	%	No.	No. +	%
Under 1	32	3	9.4	17	3	17.7	15	0	0	30	1	3.3
,, 2	77	9	11.7	32	5	15.6	45	4	8.9	72	4	5.5
,, 3	76	27	35.5	45	20	44.4	31	7	22.6	60	9	15
,, 4	54	25	46.3	27	14	51.9	27	11	40.9	44	15	34.1
,, 5	66	29	44	30	14	26.6	36	15	41.7	53	17	32
,, 6	100	46	46	49	24	49	51	22	43.2	88	34	38.6
,, 7	110	62	56.3	58	34	58.6	52	28	53.8	88	40	45.5
,, 8	88	48	54.5	46	25	54.4	42	23	54.8	70	30	42.9
,, 9	88	52	59	42	24	57.1	46	28	60.9	69	33	47.8
,, 10	87	58	66.6	42	32	76.2	45	26	57.7	74	44	59.5
,, 11	62	42	67.7	31	20	64.5	31	22	70.9	51	31	60.8
,, 12	71	53	74.4	36	26	72.2	35	27	80	59	41	67.8
,, 13	72	53	73.6	36	24	66.6	36	29	80.6	57	36	63.2
,, 14	48	35	72.9	19	14	73.7	29	21	72.4	38	25	65.8
,, 15	61	45	73.8	25	22	88	36	23	63.9	42	27	64.3
Totals	1092	587	53.8	535	301	56	557	286	51.2	895	387	43.4

expressed by Austrian (11) in explanation of a slightly different aspect of infection, and again by Scott (27), may provide the explanation. At this time of life children have just learned to toddle about confidently by themselves and have passed out of the constant supervision of their mothers. They play about on the pavements and in the gutters, and their enjoyment is keenest when they are rolling about in the dust or mud. They are essentially "ground animals." Scott refers to the "dirty" age. Their hands become infected, they ingest or inhale infected material, and it is not improbable that the surface dirt of these pavements and streets are laden with tubercle bacilli. The habit of expectorating is still a promiscuous one about the street corners of industrial Lanarkshire—as perhaps in other similar areas—and every case of spit positive pulmonary tuberculosis is not on the tuberculosis list and provided with a sputum bottle. This view is consistent with the theories of the mode of dissemination of tuberculosis and recognises the universality of contact of all children over two with tuberculosis.

Published statistics concerning the incidence of infection elsewhere are not readily compared, one with one another. Different tuberculin, different methods of applying the test and different groups of children have been selected, and for true comparison it is deemed necessary only to cite those results obtained under similar conditions with similar methods and material. The classical observations of Von Pirquet (5) in Vienna show a slightly higher incidence generally, but the gradual increase with age and the sharp increase at 3 years correspond. Post-war figures for Vienna published by Stoloff (12) examining the poorer classes of the general population show the incidence ever higher than the figures of Von Pirquet.

Germaine Mioche (13) in Paris, 1920, reported the incidence to vary from 10.6 per cent. under one year to 82.7 per cent. from 12 to 15 years. Drolet (14) in a study of dispensary children in New York found that infection increased from 26 per cent. under one year to 78 per cent. at 14 years, coinciding with the figures given in this study among the older children, but considerably higher among the younger children. Austrian (11) found the incidence as high as 68 per cent. under two years and no definite increase thereafter. Myers and Magiera (15) studying infection among 2000 children at the Lymanhurst school for tuberculous children, Minneapolis, found the average incidence among all children to be 41.7 per cent. and observed no material difference in the incidence at each year of life. The same authors give exactly similar findings among the boys and girls separately.

Parisot and Saleur (16) at Nancy and Olbrechts (17) at Brussels, working under conditions closely corresponding to those pertaining in the present study, have found an incidence of infection which is almost an exact parallel to the incidence in Lanarkshire. At the Villemin dispensary in Nancy 13 per cent. of the children under 2 years and 71 per cent. of those between 12

and 15 years are infected. In Brussels the incidence is 40 per cent. at 5 years and 69.5 per cent. at 14 years, while the average of all children between 3 and 15 years is 54 per cent. In each of these two studies figures for each year are not given and prevent any closer analysis.

Kesava Pai and Venugopal (18) in Madras, Armstrong (19) at Massachussets, Pach (20) in Budapest, and Hetherington (21) in Philadelphia, using the intradermal test found that infection is more prevalent among the girls, while Harrington and Myers (22) and Slater (23) found the incidence equally distributed between boys and girls.

Among dispensary children suffering from other diseases than tuberculosis, Hoffman (24) in the industrial districts of Westphalia found that the incidence of infection was 47.5 per cent. In industrial Lanarkshire the incidence is 43 per cent. Kesava Pai and Venugopal (18) found a much higher incidence in Madras, while Veeder and Johnston (25), at St. Louis, observed that when they excluded their cases of clinical disease the percentage of positive reactions in the age group, 10 to 14 years, dropped from 44 to 36 per cent. Asserson (26) in New York found the number of positive reactions to be 4.5 per cent. among babies under two, who were under treatment at clinics for ailments other than tuberculosis. The corresponding figure in the present study is 4.9 per cent.

INFLUENCE OF FAMILY CONTACT WITH SPIT POSITIVE PULMONARY TUBERCULOSIS.

Of the total number of children examined, 140 were known to have lived in a home with an " open " case of pulmonary tuberculosis. The actual duration of exposure varied within wide limits. In some cases the consumptive relative had been resident for varying periods in a County Sanatorium, while in others tubercle bacilli may have been absent from the spit for some years before the child contact came under observation. These and other factors influencing the actual duration, constancy and intimacy of the exposure may render the effect of this exposure per se difficult to assess.

Table IIa gives the results of the investigation under this heading, and Table IIb the findings of different authors selected from the literature, as being most strictly comparable. Of these 140 known spit positive contacts, 106 gave positive reactions, or 75.2 per cent. against 481, or 50.5 per cent. among the 952 remaining children with no known contact. The effect of familial contact with " open " tuberculosis is here evident. The numbers at each age are small and this probably accounts for the haphazard variation in incidence, but it is noteworthy that with one exception among the 8 year olds, the incidence at each year is higher among the contacts than among the non-contacts. Further, while the incidence is definitely higher among the older contact children than among the younger, there is not the same gradual

increase from birth as among the non-contact children. The immediate source of infection among contacts is common to all ages, and the maximum incidence is speedily reached within the first few years. In other words, even in the very early years of childhood infection occurs much more frequently in a family environment of spit positive tuberculosis, while

TABLE IIa.

The incidence of infection among Dispensary Children exposed to family contact with spit-positive Pulmonary Tuberculosis and among children with no such exposure.

	Family Exposure to Spit positive Pulmonary Tuberculosis.		No known case of Spit positive Tuberculosis in family.	
Age	No.	Per Cent. Positive	No.	Per Cent. Positive
Under 1	6	16.6	26	7.7
,, 2	6	50	73	10.9
,, 3	7	71.4	69	30.4
,, 4	11	54.5	43	44.2
,, 5	9	55.5	57	42.1
,, 6	6	100	94	44.4
,, 7	16	75	94	53.2
,, 8	12	83.3	76	50
,, 9	9	55.5	79	59.5
,, 10	15	86.6	72	62.5
,, 11	4	75	57	68.4
,, 12	14	92.9	58	69
,, 13	9	100	63	69.9
,, 14	8	87.5	40	70
,, 15	10	90	51	70.6
Totals	140	75.2	952	50.5

children not so domiciled derive their infection later in life, presumably from the usual social and environmental sources of contact.

That such a high incidence as 50 per cent. can occur in this way before the age of 7 only emphasises the importance of these extrafamilial sources of infection, and in no way detracts from the greater danger of exposure in the home. Scott (27) in a recent Medical Research Council Report emphasises this point by saying that the " dominating factor is opportunity for infection, the greater the opportunity, the higher the rate of incidence."

TABLE IIb.

The incidence of infection among Contacts and non-Contacts according to different Authors.

Age	New York 1912-1916 Drolet (14)		Baltimore 1923 Austrian (11)		Minneapolis 1925 Myers & Magiera (15)		Nancy 1925 Parisot & Saleur (16)		Brussels 1925 Olbrechts (17)		New York 1930 Fishberg (1)	
	Pos. F.H.	Neg. F.H.	Pos. F.H.	Neg. F.H.	Pos. F.H.	Neg. F.H.	Pos. F.H.	Neg. F.H.	Pos. F.H.	Neg. F.H.	Pos. F.H.	Neg. F.H.
Under 1	24	30	33		41	0	42	0			15	10
,, 2	45	63	69		47	25					55	33
,, 3	52	40	75		60	40					69	38
,, 4	50	59	80		47	18	82.5	8.7			67	43
,, 5	57	46	63		43	23					65	48
,, 6	68	70	85		47	29					66	53
,, 7	70	55	58		54	19					72	60
,, 8	71	63	61		56	22					72	63
,, 9	70	76	70		58	26		31.6		94	71	67
,, 10	73	57	50		75	29	91.5				73	70
,, 11	78	67	62		70	36					74	63
,, 12	72	80	74		58	33					71	66
,, 13			77		67	34		57.4			78	77
,, 14	74	72	100		74	39					84	76
,, 15			50		67	21						

The results of different authors given in Table IIb differ somewhat in total incidence in each group, but coincide in the various points mentioned of comparative interest between the two groups. The New York figures by Drolet and Fishberg do not reveal a marked difference in incidence between the contact and non-contact children, but it must be remembered that the children examined by them lived in the poorer and densely populated portions of New York City, where extrafamilial sources of exposure are undoubtedly greater than in the County areas of Lanarkshire.

RELATION OF INFECTION TO NATURE OF EXPOSURE.

In Table III. the incidence of infection among spit-positive contacts is given in terms of the actual relative suffering from the disease and according to the intimacy of contact—such as is usual in family life. Exposure is regarded as contact with tubercle bacilli, but many factors influence exposure, e.g., duration of exposure, the co-operation of the patient after diagnosis, or the time which has elapsed since the date of last exposure, and these factors may create a fallacy in the results.

TABLE III.

The Incidence of Infection according to Nature of Exposure.

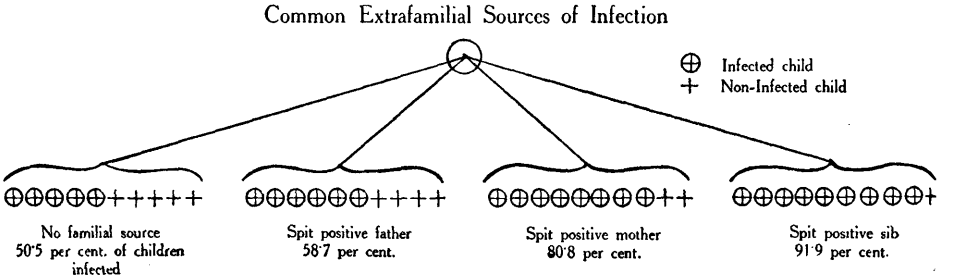
	Type of Disease.	Relative suffering from Disease.				Intimacy of Contact.		
	Spit positive Pulmonary T.B.	Father	Mother	Sibs	Others	Bed	Room	House
Total No. of Children	140	46	47	37	10	37	53	50
No. of Positive Reactors	106	27	38	34	7	34	41	31
Per centage	75.7	58.7	80.8	91.9	70	91.9	77.4	62

However, in the results given it will be observed that the most potent source of infection is among the sisters and brothers of the child under observation. Of all such children with a spit-positive sib 91.9 per cent. are infected. Close behind is the maternal source, when 80.8 per cent. of all children are infected. Both these figures are above the average incidence, 75.7 per cent., for all contacts.

Omitting from consideration " open " disease among others, grandparents or lodgers, etc., where the numbers are small, the paternal source of

infection would appear to be negligible in comparison. The incidence here, 58.7 per cent., is certainly higher than the average incidence among all non-contact children, but considerably lower than the average among all contacts. The relative unimportance of the father as compared with the mother or sib has been observed in other similar studies, and, mindful of the possible errors alluded to, these figures may be accepted as an index of the increase in infection, which may be attributed to these familial sources.

In the accompanying diagram an attempt has been made to illustrate the relative danger of these familial sources of infection.



Among non-contact children the average incidence of infection is 50.5 per cent. (Table IIa). In other words, in any hypothetical family of 10 children under 15 years with no familial source of infection, 5 may be presumed to become infected from extrafamilial sources. In any similar family if the father suffers from spit-positive pulmonary tuberculosis, the effect of this additional source of infection is to raise the incidence to 58.7 per cent., i.e., approximately 6 children in this family are infected. If the mother be the " open " case, then 80.8 per cent. or 8 of the children are infected. If the diseased relative be a sister or brother, 91.9 per cent. or 9 children are infected.

In Table IIIa is shown also the incidence of infection ascertained according to intimacy of contact. A child who sleeps with a spit-positive relative can hardly escape infection. The more effective the isolation of the patient, the less risk of others becoming infected, but even with the patient isolated in a room by himself at home, the children of that home are in greater danger of infection than children from homes with no family exposure. These figures amply substantiate the statement that the " dominating factor in infection is opportunity for infection."

THE RELATION BETWEEN SOCIAL CONDITIONS, OVERCROWDING AND INFECTION.

Overcrowding has been held to exist when there are more than two adults per room—two children under 12 years being reckoned as one adult. In the law of Scotland there is no single standard for the measurement of overcrowding. However, in the course of administrative development standards based on cubic space per adult have found their way into the statutes, but these have been solely for special purposes. The specific provisions of the Public Health Act permit of action being taken only when "overcrowding is such as to be dangerous to health." The report of the Royal Commission on the Housing of the Industrial Population of Scotland, 1918, adopted the standard of three persons per room, but the tendency of housing legislation within recent years has been to determine the standard with more stringency. The Departmental Memorandum on the Housing (Scotland) Act, 1930, appears to limit the number of occupants for the purpose of grant as follows: —A room and kitchen house will nominally be regarded as rendering accommodation available for 3 persons, a two room and kitchen house for 5 persons, a three room and kitchen house for 7 persons, and so on. Consequently, while the standard adopted here has no statutory authority in Scotland, it is the ideal for the future, and is similar to that used by the English Registrar General for census purposes.

The general results of this investigation in respect of the number of rooms and overcrowding are shown in Tables IVa and IVb. Infection increases from 45 per cent. in a one room house to 56 per cent. in a two room house and to 59 per cent. in houses of three or more rooms. An increase in the size of the house is associated with an increase in the incidence of infection. In respect of tuberculous *disease* published statistics disclose a uniform *decrease* in incidence and mortality, as the number of apartments increase. MacGregor (28) in 1914 found that the incidence of pulmonary tuberculosis in Glasgow diminished from 4.4 per 1000 of the general population in one apartment houses to 1.4 per 1000 of the general population in houses of four apartments and over. Wilson (29) in 1926, also in Glasgow, published figures which established a similar relationship and applicable at all ages. There is a general consensus of medical and lay opinion that inadequate housing is a potent indirect factor in the causation and spread of tuberculosis. The "Majority" findings of the Royal Commission of Housing, 1918, in relation to tuberculosis, strongly indict the smaller houses, and in a recent publication Bolton Tomson (30) has summarised the present day attitude on the same problem.

A very definite increase in tuberculous infection has already been established in the presence of "open" disease of the lungs, and the increase is greatest under overcrowded conditions (Table IVc). Consequently, in the smaller houses, where overcrowding may be held to be greatest and where

the incidence of pulmonary disease has been proved to be greatest, a higher incidence of infection might have been expected. The figures given in Table IVa indicate a contrary conclusion and can hardly be credited.

TABLE IVa.

The incidence of infection according to the number of rooms and the number of adults per room.

	Number of Rooms.			No. of Adults per Room.	
	One	Two	Three and over	Two	Over Two
No. of Children	310	543	239	371	721
Per Cent. Infected	45	56	59	53.4	58.9

The population in one and two room houses is normally a floating one, and this feature has been marked during the past decade. The provision of Housing Schemes and Slum Clearance Areas, by the Local Authority, has

TABLE IVb.

The relation between infection and overcrowding.

	One Room		Two Rooms		Three Rooms	
	Two Adults per room	Over Two Adults per room	Two Adults per room	Over Two Adults per room	Two Adults per room	Over Two Adults per room
No. of Children	7	303	193	350	176	63
Per Cent. Positive	14.3	46	50.8	58.8	61.4	58.7

accelerated the normal flow through these one and two room houses into the larger houses, and what has been recorded in the dispensary records as social conditions may not represent the actual domiciliary environment in which the children have been bred.

The same observation may apply to the question of overcrowding, where the figures do not reveal any deadly association between overcrowding and infection. Some increase in infection does occur in houses that are overcrowded in terms of the accepted standard, but the difference observed in either table is not sufficient to warrant any convincing conclusion.

Where infection does occur, with definitely greater frequency in respect of overcrowding, is in the homes of the spit-positive contacts, Table IVc.

In these homes of two rooms, where overcrowding exists, 86 per cent. of all the children examined are infected, while only 68 per cent. are infected in

TABLE IVc.

The relation between infection and overcrowding in spit-positive houses.

	One Room		Two Rooms		Three Rooms	
	Two Adults per room	Over Two Adults per room	Two Adults per room	Over Two Adults per room	Two Adults per room	Over Two Adults per room
No. of Children	—	32	28	51	18	11
Per Cent. Positive	—	62.5	68	96	72	91

similar homes with no overcrowding of the occupants. In homes of three rooms or more the corresponding figures are 91 per cent. and 72 per cent.

NUTRITION AND TUBERCULOUS INFECTION.

Most Tables dealing with the normal weight of any individual of a given age are based on relations between age, height and weight. Dreyer (31), however, has satisfactorily proved that such relations do not exist when individuals varying widely in size are examined, and that scientific accuracy in the assessment of the normal is only achieved when the measurements are considered in relation to the circumference of the chest. Therefore, in studying the state of nutrition in any individual, all the above measurements are required and the normal limits defined before any definite significance can be attached to deviations from the normal. The only data available in this study are the age and weight in ordinary clothing of each child and the nutrition or degree of malnutrition has been estimated in relation to the normal weight, which has been determined as follows:— The mean of the average weights of Lanarkshire school children at 6½ years, 9½ years and 12½ years has been accepted as the normal weight of children at these years. The Chart used in the Child Welfare Centres of the County for normal weights of babies under two years has been enlarged and the graph continued to pass through the accepted normals at 6½, 9½ and 12½ years respectively, the course of the graph at intervening ages following the curves of a similar graph based on the Anthropometric Table of Weights.

While no hard and fast line can be drawn between the normal and the abnormal, above or below, when the weight of the body is being considered, 10 per cent. has been fixed as the limits of the range within which a child

has been considered of normal weight and nutrition. The range is possibly wide, but may minimise the shortcomings of the methods applied here and must at least include all the normals. Similarly, children 20 per cent. or more underweight may be regarded as grossly undernourished.

TABLE Va.

Incidence of grades of nutrition among all children examined.

	Overweight	Normal Weight	10-20 per cent. Underweight	20 per cent. or more Underweight
No. of Children	73	585	255	179
Per Cent. of Total	6.7	53.5	24.3	16.4

It will be seen in Table Va that 434 children or approximately 40 per cent. of all children examined were underweight and that 179 or 16.4 per cent. were at least 20 per cent. underweight. These figures are high and reveal an unexpected incidence of malnutrition. Hetherington (32) examining 1,999 children during an investigation of Tuberculosis in Philadelphia recorded 35 per cent. over 10 per cent. underweight, but most of the published statistics reviewed vary between 20 and 30 per cent. The Annual Reports of the School Medical Service in Lanarkshire record with small annual variations about 3 per cent. of the school children under normal nutrition, but the figures here are based not on weight but on the personal opinion of the Medical Officers at the routine examination. The discrepancy between these figures is so marked that further investigation with more exact methods is necessary.

If malnutrition were a predisposing factor in the causation of infection, one would expect a greater number of undernourished children among the infected group. On the contrary, it will be observed in Table Vb, there is a slightly higher proportion of undernourished, even of the grossly undernourished, among the non-infected children. When the age groups are considered separately a similar finding is observed in the very young and in the older age groups, but in children between 5 and 10 years the balance is reversed—malnutrition occurring slightly oftener among the infected children of this group than among the non-infected.

Whether this variation in incidence at different ages among infected and non-infected children has any bearing on the question of cause and effect remains uncertain. The figures are not sufficiently convincing. That malnutrition among infected children is not significant seems the only safe conclusion.

TABLE Vb.

The grades of nutrition among infected and non-infected children, classified according to age groups.

Age Groups	INFECTED						NON-INFECTED					
	No.	Normal and overwt. Per cent		10 per cent underwt. No.	Per cent	20 per cent underwt. No.	Per cent	No.	Normal and overwt. Per cent		10 per cent underwt. No.	Per cent	20 per cent underwt. No.	Per cent
Years														
0- 5	93	57	61.3	21	23.7	15	16.1	212	110	51.9	62	29.2	40	18.8
5-10	266	159	59.8	66	25	41	15.4	207	129	62.3	51	24.6	27	13
10-15	228	151	66.2	38	16.6	39	17.1	86	52	60.4	17	19.8	17	19.8
Totals	587	367	62.5	125	21.3	95	16.2	505	291	57.6	130	25.7	84	16.6

In Table Vc the relationship is compared from a different angle. If infection were a factor in the causation of malnutrition, then undernourished children would give a larger proportion of positive reactions. Of the normal or overweight group 55.8 per cent., of the slightly under-

TABLE Vc.

The percentage incidence of infection among all children, normal or overweight children and undernourished children.

Age Groups	All Children	Percentage number infected. Normal & overwt.	10% underwt.	20% underwt.
0- 5 years	30.5	34.1	24	27.3
5-10 ,,	56.2	55.2	56.4	60.3
10-15 ,,	72.6	71.4	69	69.6
Totals	53.8	55.8	49	53

nourished group 49 per cent., and of the grossly undernourished group 53 per cent. are infected. That is, if the figures justify comparison, infection occurs more frequently in normal or overweight children than in undernourished children. Here again, as in Table Vb, in children between

5 and 10 years the general conclusion is reversed. The margin of difference is greatest among the children 0 to 5 years. Infection is very definitely less among the undernourished at these ages, where it may be calculated that the proportion of undernourished children is greatest, 45 per cent. as compared with 39 per cent. at 5 to 10 years, and 35 per cent. at 10 to 15 years.

In the first quinquenium of life good health would appear to be a more frequent concomitant of latent tuberculosis than malnutrition, and therefore the two cannot be associated as cause and effect. That malnutrition diminishes with age and tuberculous infection increases with age is convincing evidence that infection is not a factor in the production of malnutrition.

Nutrition and Infection Among Contacts and Non-contacts.—The relationship has been further studied among contacts and non-contacts, that is, among children exposed to a more certain and continuous infection and children exposed to the chance infection of social and environmental sources. Here the figures show a sufficient difference to appear to have

TABLE Vd.

The relation of nutrition to infection among contact and non-contact children.

Groups	Normal and overweight	10% underweight	20% underweight
Contacts	96	23	21
Per cent. infected	71.9	82.6	85.7
Non-Contacts	562	232	158
Per cent. infected	53	45.7	48.7

some significance contrary to the conclusions already established. Among the non-contact group infection bears the same relation to nutrition, even more certain, than among all children—a higher incidence occurring among the normal and overweights than among the undernourished. Among the contacts, however, the incidence is reversed. In the undernourished groups approximately 84 per cent. are infected, and it is noteworthy that the more severe the degree of malnutrition the greater is the infection.

All these contacts are equally exposed; the underweight children have just the same opportunities of infection as the normal or overweight children. While it may be contended that the underweight contact is more

exposed by reason perhaps of greater confinement in the home on account of his poor nutrition, the same argument should apply to girls. But there is actually a higher percentage among boys than among girls. The more obvious conclusion seems to be that the child's growth is retarded because of the infection, an infection which perhaps is unrecognisable, but forming an active focus somewhere in the body and deranging the normal metabolism produces a state of malnutrition. Undernourished infected contacts should therefore receive the full consideration that is extended to the case of clinical disease.

INCIDENCE OF COMMON PHYSICAL DEFECTS.

The common physical defects observed in dispensary children have been extracted from 299 records, in which the data represent a complete physical examination. The incidence of these defects and the amount of infection in respect of each are shown in Table VI. Ninety-six or approximately one third of all the children were considered unduly pale. The other defects are severally less frequent.

TABLE VI.

Incidence of common physical defects and the association of infection with each compared.

Number and Percentage	All Children examined	Pallor	Tonsils and for Adenoids	Dental caries	Palpable Cervical glands	Pigeon Chest	Other Chest deformities
Number of Children	299	96	77	66	46	40	13
Per Cent.		32.1	25.7	22	15.4	13.4	4.3
Per Cent. Infected	70.9	75	63.6	63.6	63	65	77

The amount of infection associated with each defect does not reveal any particular association. Pale children and children with flat, barrel or asymmetrical chests appear to be more frequently infected than the average child, but there is no evidence of any very close association. That enlarged tonsils, palpable glands and pigeon chests are quite independent of infection seems a more exact inference from the results.

RELATION OF INFECTION AND LESIONS RECORDED BY X-RAY.

This relationship has been studied in 299 children. The films, single exposures in each case, have been reviewed recently and the demonstrable

lesions have been classified under the following headings:—Calcified hilum glands, uncalcified hilum glands, peribronchial thickening, parenchyma positive and pleural thickening. The interpretation of the significance of X-Ray films is capable of rather wide divergence of opinion. It is difficult to define the normal chest or the normal hilum. Variations in linear markings and in hilum shadows are so extreme that exact description is impossible and is often a matter of personal opinion. It is possible to view films with a " tuberculosis complex " and interpret as pathological certain increased densities, which are quite normal to others. In the same way, where the appearances are admittedly abnormal, those which should be considered evidence of clinical disease and those which may occur in healthy children, are difficult to determine. Where such confusion exists there can be no standards whereby the normal can be recognised and X Ray shadows in themselves interpreted as pathognomonic. Their significance can only be interpreted after full consideration of all the available clinical data.

The films reviewed here have been approached in this attitude and read without reference to history or physical signs. A uniform translucency with no appreciable thickening of the bronchial tree and a crescentic shaped hilum less than one inch broad at its central and broadest portion, with a clearly defined interspace between it and the heart, is the accepted pattern of the normal chest. The degree of opacity has served to distinguish between calcified and uncalcified glands, while in the latter group has been included such descriptions as " hilum thickening " or increased " hilum density." These indefinite descriptions may probably record those small or even moderately enlarged caseous glands, which are not demonstrable in the hilum or even in the lung substance by X-Ray photography.

TABLE VIIa.

Comparison of the number of X-Ray lesions and the incidence of infection according to age groups.

Age Groups	Incidence of Infection	Number of Children X-Rayed	Normal Films.		Films with X-Ray lesions recorded.	
			No.	Per Cent.	No.	Per Cent.
0- 5 years	63.3	26	12	47	14	53
5-10 years	69	139	53	38	86	62
10-15 years	80	124	36	29	98	71
Total	70.9	299	101	34	198	66

In Table VIIa the total number of X-Ray lesions is compared with the incidence of infection in age groups. It will be seen that the number of recognisable X-Ray lesions lags behind the incidence of infection in each age group, but increases with age, parallel to the increase in infection. That X-Ray lesions are not necessarily tuberculous is shown in Table VIIb. Of all

TABLE VIIb.

Incidence of recorded X-Ray lesions among infected and non-infected children.

	Number of Children	Normal Films		Films with Lesions recorded	
		Number	Per Cent.	Number	Per Cent.
Infected	212	65	30.6	147	69.4
Non-infected	87	36	41.4	51	58.6
Total X-Rays	299	101	34	198	66

films with lesions recorded 51 were of non-infected children, while 65 of the infected children had no recognisable lesions. In other words, all X-Ray lesions are not tuberculous and all tuberculous lesions are not recognisable by X-Ray. That a greater number of these films with lesions recorded are of children who harbour the tubercle bacillus somewhere in the body can be expected. It is rather surprising that the difference is not even greater than revealed by the figures in the tables. A difference of approximately 10 per cent. does not appear to represent the true potentiality of the tubercle bacillus as a source of intrapulmonary mischief. On the other hand, the occurrence of X-Ray lesions in more than half the uninfected children serves to remind us of the large amount of residual damage to the lungs from non-tuberculous disease.

In Table VIIc the individual lesions have been considered in relation to infection and classified according to age groups. In analysing this table it must be borne in mind that X-Ray lesions occur in all manner of combinations. Every abnormality in each film has been separately recorded and the figures given are an accurate index of the total number of lesions that have been recognised. It is noteworthy that calcification of hilum glands has not been found in non-infected children under 5 years, that X-Ray lesions of any kind are conspicuously rare among these same children, and that among infected and non-infected children of all ages there is some constancy in the occurrence of hilum glands and peribronchial thickening. Recognisable changes in the lymphatic system, in the lung

TABLE VIIc.

Incidence of various types of X-Ray lesions among infected and non-infected children according to age groups.

X-RAY LESIONS	Infected No. = 212			Non-Infected No. = 87		
	Age Group 0-5 No. = 18	Age Group 5-10 No. = 88	Age Group 10-15 No. = 106	Age Group 0-5 No. = 8	Age Group 5-10 No. = 51	Age Group 10-15 No. = 28
Normal Films	5	34	26	7	19	10
Calcified hilum glands	4	15	34	—	15	7
Uncalcified hilum glands	7	28	25	1	14	7
Parenchyma positive	1	2	12	—	—	1
Peribronchial thickening	6	28	37	—	10	8
Pleural thickening	2	1	13	—	—	2
Total X-Ray Lesions	20	74	121	1	39	25

substance and in the root, are common evidence of infection not necessarily tuberculous, pathognomonic of none and possibly the residue in healthy children of long forgotten illnesses.

Of greater significance is pleural thickening and soft, diffuse and varying sized shadows in the lung field, grouped as parenchyma positive. These lesions are invariably accompanied by tuberculin reactions, occur in all age groups, but with much greater frequency among the older children. The parenchyma has been recorded as positive in one child of 10-15 years, in whom the tuberculin tests were negative. A reference back to the clinical records of this case confirms the general statement. The weight of clinical evidence is in favour of the diagnosis of pulmonary tuberculosis, probably quiescent with waning sensitivity. The actual test, however, has been given once only, and the occasional error here has already been observed.

Two further observations are worthy of note. Firstly, when the frequency of X-Ray lesions is compared with the grade of tuberculin

reaction it is found that in children with one plus reaction 84 per cent. showed X-Ray lesions, with a two plus reaction 53.5 per cent., with a three plus 71.6 per cent., and with a four plus reaction 77.7 per cent. The general conclusion may be that increasing intensity of reaction is associated with gradually mounting frequency of X-Ray lesions and that the anomalous figure of 84 per cent. in the one plus group included those X-Ray shadows which may represent the sclerotic termination of healed tuberculous processes, and that the body tissues have in the absence of re-infection practically lost their acquired attribute of specific sensitivity.

Secondly, it has already been pointed out in Table VIIb that X-Ray lesions are more common in infected children than in non-infected children. Confirmation of this is obtained when the incidence of these lesions is compared in spit-positive contact and non-contact children. Of the former 73 per cent. and of the latter 63 per cent. have X-Ray lesions recorded.

RELATION OF D'ESPINE'S SIGN TO HILUM GLANDS, AS RECORDED BY X-RAY, AND INFECTION.

The relationship has been studied in 212 dispensary records in which D'Espine's sign is recorded and an X-Ray obtained. The normal tracheal timbre is assumed to extend to the level of the 7th cervical spine in children under 6, to the 1st dorsal in children under 9, to the second dorsal in children under 12, and to the 3rd dorsal spine in children under 15. D'Espine's sign has been regarded as present when the tracheal timbre has been distinctly audible below these levels. For the purpose of comparison, calcified and uncalcified glands, as recorded in X-Ray films, have been slumped together.

TABLE VIIIa.

Relation of D'Espine's Sign to Hilum Glands as recorded in X-Ray film.

D'Espine's Sign.	No.	Hilum Glands recorded.		No Hilum Glands recorded.	
		Number	Per Cent.	Number	Per Cent.
Present	123	94	76.4	29	23.6
Absent	89	36	40.5	53	59.5
All Cases	212	130	61.3	82	38.7

In Table VIIIa it will be seen that in 94 children, or 76.4 per cent., D'Espine's sign coincided with X-Ray evidence of hilum glands, while in 29 children, or 23.6 per cent., the sign was elicited without any corroborative evidence on X-Ray examination. In a group of 89 children with D'Espine's sign absent 36, or 40.5 per cent., were found on X-Ray to have hilum glands. It is evident from these figures that no constant relationship exists between D'Espine's sign and hilum adenitis even in a negative sense, and that there must be an explanation other than hilum glands for the presence of the sign; but the sign does not occur indiscriminately and the relationship is sufficiently close to lend support to its value as indicative of enlarged glands at the root of the lungs. More certain conclusions cannot be observed when the relationship is studied according to the extent of audibility of D'Espine's sign beyond the normal limits.

Since D'Espine called attention to the sign in 1910 (33) its value has been the subject of continuous controversy. The weight of opinion is perhaps not enthusiastic about it and some authorities discredit the sign entirely. The Committee appointed by the National Tuberculosis Association of America (34) concluded that the sign was of doubtful value. At a meeting of the National Tuberculosis Association of this country in 1929 Dr. Agassiz stated that in his opinion D'Espine's sign was of little use. Fishberg (1), on the other hand, has tested D'Espine's sign in various ways and found it most satisfactory. The same author cites the opinion of some others, who strongly recommend it.

TABLE VIIIb.

Relation of D'Espine's Sign to Infection.

D'Espine's Sign.	No.	Infected Children.		Non-Infected Children.	
		Number	Per Cent.	Number	Per Cent.
Present	123	84	68.3	39	31.7
Absent	89	62	69.6	27	30.4
All Cases	212	146	68.8	66	31.2

TABLE VIIIc.

Relation of Hilum Glands to Infection.

X-Ray Films	No.	Infected Children.		Non-Infected Children.	
		Number	Per Cent.	Number	Per Cent.
Films with Hilum Glands recorded	130	93	71.5	37	28.5
Films with no Hilum Glands recorded	82	53	64.6	29	35.4
All Cases	212	146	68.8	66	31.2

In Table VIIIb D'Espine's sign is shown to occur more frequently among infected children, but the presence or absence of the sign occurs in much the same proportion in infected and non-infected children. In Table VIIIc hilum glands are compared with infection and are shown to be recorded in 93 or 71.5 per cent. of infected children and in 37 or 28.5 per cent. non-infected children. The relationship is closer than in respect of all X-Ray lesions as in Table VIIb. Calcification which has often been claimed to be pathognomonic of tuberculosis occurred 44 times among the infected group and 20 times among the non-infected group. Calcification cannot be recognised with certainty in the indirect manner of X-Ray examination, and the possibility of misinterpretation is readily admitted.

An attempt to correlate all three, D'Espine's sign, hilum glands and infection, has been made in Table VIIId. Here D'Espine's

TABLE VIIId.

Co-Relation of D'Espine's Sign, Infection and Hilum Glands.

D'Espine's Sign.	Hilum Glands.			No Hilum Glands.		
	No.	Infected	Non-Infected	No.	Infected	Non-Infected
Present	94	66	28	29	18	11
Absent	36	27	9	53	35	18
All Cases	130	93	37	82	53	29

sign is present when hilum glands are present in 94 children, 66 infected and 28 non-infected, and is absent when no hilum glands are recorded in 53 children (35+18), *i.e.*, the presence or absence of the sign corresponds with the presence or absence of hilum glands in 147 (94+53) children. Similarly, D'Espine's sign and hilum glands do *not* correspond whether present or absent, in 65 (36+29) children. In Table VIIIc infection is shown to correspond more frequently with hilum glands than (Table VIIIb) with D'Espine's sign. In Table VIIId, when the latter two factors correspond, whether present or absent, in 147 children, 101 (66+35) of these children are infected, while 46 (28+18) are not infected. When the same two factors do *not* correspond in 65 children, 45 (18+27) are infected and 20 (9+11) are not infected. The ratio in both cases, 101 to 46 and 45 to 20, is almost identical. That is, D'Espine's sign and hilum glands do or do not correspond, independent of whether the child is infected or not. D'Espine's sign may be regarded as a useful aid in the diagnosis of hilum glands and its value is uninfluenced by infection. It is indicative of hilum glands which may, or may not, be tuberculous.

INCIDENCE OF CLINICAL TUBERCULOSIS AMONG DISPENSARY CHILDREN.

The diagnosis of tuberculous disease in children is not always defined by certain standards. Much is left to the discretion of the physician, who finds himself often compelled to make the diagnosis on symptomatic evidence alone, or according to the necessity of the moment. Where the *locus* of disease is external, *e.g.*, in the cervical glands, the variation of the personal factor is not so frequent, but in the pulmonary and abdominal types doubt often persists even after full consideration of all available evidence. The diagnosis is established or rejected according to one's faith in the clinical value of symptom complexes, certain physical signs or other data.

It will be understood here that the initial consideration in the diagnosis of clinical disease has been that the child is infected as shown by a positive reaction to the Von Pirquet test. Where the clinical examination thereafter has failed to reveal conclusive evidence of active disease the child has been regarded as Tuberculised and reference made to the *locus* of disease as suggested by the symptoms and signs. Intrathoracic tuberculosis which does not conform to the adult type of parenchymatous infiltration has not been recognised. Evidence of initial childhood infection has not been detected with certainty and hilum disease confined to the root glands has been intentionally avoided. Tuberculous glands at the hilum may produce a tuberculous toxaemia, but readily undergo retrogression and are never fatal in themselves. Their significance is still enveloped in the mists of uncertainty and between this stage of pulmonary infection and the infiltra-

tive and exudative parenchymatous lesion of the adolescent there is a gap which has not been bridged. The existence of hilum glands does not appear to justify the stigma of pulmonary tuberculosis.

TABLE IXa.

Incidence of types of Clinical Tuberculosis according to age.

Age.	Clinical types of Tuberculous Disease				
	Pulmonary	Glandular	Abdominal	Bones & Joints	Others
less than 1 yr.	–	2	–	–	–
,, 2 yrs.	–	3	–	2	–
,, 3 ,,	–	4	3	3	–
,, 4 ,,	1	8	3	2	2
,, 5 ,,	–	7	3	3	–
,, 6 ,,	–	6	4	2	–
,, 7 ,,	–	15	4	2	1
,, 8 ,,	1	7	3	2	5
,, 9 ,,	1	9	5	3	1
,, 10 ,,	–	11	–	1	1
,, 11 ,,	–	6	3	1	1
,, 12 ,,	3	5	–	1	3
,, 13 ,,	1	11	–	1	2
,, 14 ,,	2	3	1	2	2
,, 15 ,,	8	8	–	3	–
Totals	17	105	29	28	18

With these reservations in mind clinical tuberculosis has been diagnosed in 197 children, or 18 per cent. of all children and 33.5 per cent. of all infected children. Of this total 105 or 53 per cent. are cases of superficial gland disease—the cervical glands being the usual site. Abdominal tuberculosis and tuberculosis of bones and joints come next in order of incidence,

accounting for 29 and 28 cases respectively. Other forms of tuberculosis were diagnosed in 18 children and pulmonary tuberculosis in 17. In Table IXa these types of disease are grouped according to the age of the children. While non-pulmonary disease occurs with equal frequency at all ages, frank parenchymatous disease of the lungs is only rarely diagnosed below the age of 12. Pulmonary tuberculosis has been diagnosed 17 times in all, and 14 of these cases occurred between the ages of 12 and 15, or 5.5. per cent. of children examined at these ages. Other figures, notably those of Hetherington (21) and Chadwick (35) indicate a much lower incidence, but their investigations were in school children and are therefore not strictly comparable.

TABLE IXb.

Incidence of clinical tuberculosis among Spit positive Contact and Non-Contact Children.

Types of Clinical Tuberculosis	Spit positive Contacts. No.—140		Non-Contacts No.—952	
	Number	Per Cent. of Total	Number	Per Cent. of Total
Pulmonary	7	5	10	1
Glandular	3	2.1	102	10.7
Abdominal	–	–	29	3
Bones & Joints	1	.7	27	2.8
Others	2	1.4	16	1.6
Totals	13	9.3	184	19.3

The incidence of all forms has been compared in children from homes in which one or more members of the family suffer from spit positive pulmonary tuberculosis and in children with no such exposure. (Table IXb.) Clinical tuberculosis is shown to occur in 9.3 per cent. of the contact group and in 19.3 per cent. of the non-contact group. Approximately 1 in 10 spit positive contacts become tuberculous. This is much the same incidence as found elsewhere. Opie and MacPhedran (7) found the incidence to be 1 in 11 and Schram's figures (36) corrected for hilum tuberculosis is 11.8 per cent. The high incidence of clinical disease in the non-contact group has no statistical or comparative value. It is a statement only of the amount of actual disease seen at tuberculosis dispensaries.

It is noteworthy, however, that pulmonary tuberculosis of the adult infiltrative type is more common than any other form of the disease among contact children and is five times more common among contact than among non-contact children. Pearson (37) estimated that the incidence of pulmonary tuberculosis at all ages in tuberculous families was over 3 to 1 of the general population. MacGregor (28) comparing the contact with the general population of Glasgow during the years 1910-1914 found that the case rate per 1000 in the former group was 5.2 as against 2.8 in the latter group, and within recent years Dr. MacCallum Lang (38) has shown that the annual death rate from phthisis among contacts of all ages is 5.7 to 1 of the general population in Lanarkshire. The similarity of the ratio among dispensary children is striking, but may be accidental. The figures must be considered with due regard to the material and paucity of numbers.

GRADE OF REACTION COMPARED IN LATENT AND CLINICAL DISEASE.

The grades of tuberculin reaction are held to be grades of specific sensitivity to the tuberculo-protein. It is unlikely that the grade of reaction is influenced by non-specific protein sensitivity, adding when present to the intensity of the specific reaction. Non-specific protein reactions do occur, but are pseudo and evanescent, and do not complicate the picture of the specific reaction on the seventh day, when these reactions have been finally interpreted. The very intense tuberculin reaction is an indication of specific hypersensitivity.

TABLE X.

Grades of Reaction in latent and clinical disease.

Von Pirquet Reactions.	Children with no evidence of clinical disease.		Children with clinical disease.						
			All forms.		Pulmonary	Glandular	Abdominal	Bones & Joints	Others
	No.	Per cent.	No.	Per cent.					
+	55	14	6	3	–	2	3	1	–
+ +	90	23	17	8.7	1	13	–	3	–
+ + +	237	60.5	160	81.2	14	85	23	22	16
+ + + +	10	2.5	12	6.1	1	5	2	2	2
Total Positive	392	100	195	99*	16*	105	28*	28	18

*The Von Pirquet reaction failed in one child with pulmonary tuberculosis and in another with abdominal tuberculosis.

In Table X the very intense or four plus reaction occurs in 6.1 per cent. of clinical cases against 2.5 per cent. of children with no clinical disease, and the ratio is approximately 7 to 3. The corresponding ratio for the three plus reaction is 4 to 3, for the two plus reaction 3 to 8, and for the one plus reaction 3 to 14. The more intense the reaction the more frequently it occurs among the clinical cases, and the increase in the ratio of frequency is strikingly uniform. The same observation is applicable irrespective of the type of disease. Intense reactions occur with approximately equal frequency whether the focus of disease is pulmonary, lymphatic, osseus or cutaneous. The factor common to all is not site or type, but activity of the tuberculous process. When the lesion is active the more intense tuberculin reactions are common. Conversely, when the reaction is marked, the lesion is probably active. That is, whether the lesion is such as to be recognised clinically or whether its presence may only be inferred by the fact of allergic response, it may be held to be active if the sensitivity of the response is marked.

Active lesions may be recent infection from without or reactivation of an already encapsulated focus with dissemination of bacilli or toxins, playing on the immunity mechanism.

COMPARISON OF THE VON PIRQUET AND MORO TESTS.

The incidence of infection has hitherto been based on the results of the Von Pirquet test, but in each case the Moro test was applied simultaneously in the manner described. In Table XI the results of both tests are com-

TABLE XI.

A comparison of the sensitivity of the Von Pirquet and Moro Tests.

Von Pirquet. Grade of Reaction	Total Numbers	Moro. Total Positive	Negative	+	+ +	+ + +	+ + + +
Total Positive	587	553	34	42	103	388	20
Negative	505	5	500	5	–	–	–
+	62	41	21	33	5	3	–
+ +	107	98	9	7	77	14	–
+ + +	396	392	4	2	21	364	5
+ + + +	22	22	–	–	–	7	15

pared. In 34 children the Von Pirquet test has been positive and the Moro test negative. In 5 children the Moro test is positive and the Von Pirquet negative. That is the reaction in both tests coincided in 1053 or 96 per cent. of all children tested, while in the remaining 39 the Von Pirquet is much more frequently positive and the Moro negative than the Moro positive and the Von Pirquet negative. The latter combination occurs 5 times, and it is interesting to note that the positive Moro reaction in each case is of the one plus grade.

When the grades of reaction are compared it will be seen that in each grade the tests correspond in the main, but a lesser grade of Moro reaction is recorded more often than a lesser grade of Von Pirquet reaction. The number of negative Moro reactions diminishes to nil as the intensity of Von Pirquet reactions increases. In 71 (21+9+7+4+2+21+7) children a less sensitive Moro reaction is recorded, while in 32 (5+5+17+5) children a less sensitive Von Pirquet reaction is recorded, and the difference generally amounts to one grade of reaction.

The Moro test appears to be a trifle less sensitive than the Von Pirquet test and fails but rarely to reveal infection, even in children in whom the allergic response is diminished. Its application is simple and suitable for babies and very young children, in whom the test will rarely fail, and the significance of a positive reaction is greatest. It might with advantage be used by the busy general practitioner as a valuable aid in the diagnosis of tuberculosis at these years.

CONCLUSIONS.

1. *Von Pirquet Test.*

The Von Pirquet test is suitable for routine application among children. Marked reactions are rare and no harmful results are observed.

As an aid in the diagnosis of obscure cases among young children with tuberculous symptomatology a positive reaction is sufficient to decide the diagnosis, while a negative reaction for all practical purposes rules out tuberculosis.

The significance of positive reactions diminishes with increasing age.

2. *Moro Test.*

The Moro test is only very slightly less reliable than the Von Pirquet test and is particularly suitable for tuberculin testing of babies and young children.

3. *Incidence of Infection in Industrial Lanarkshire.*

53.8 per cent. of all children are infected, the incidence gradually increasing from 9.4 per cent. under one year to 73.8 per cent. between the age of 14 and 15 years. The increase year by year is greatest about the age of 3 years.

The incidence is slightly higher in boys than in girls.

The exclusion of children with clinical disease lowers the general incidence by 10 per cent.

The incidence in Lanarkshire coincides closely with incidence in similar areas elsewhere.

4. *Incidence of Infection in Relation to Family Contact.*

A higher incidence of infection occurs in children living with a relative suffering from spit positive pulmonary tuberculosis, the actual ratio being 3 to 2, and the maximum incidence among contacts is speedily reached within the first few years of life.

5. *Infection in Relation to Source of Exposure.*

When the mother suffers from spit positive pulmonary tuberculosis infection occurs among her children in the ration of 4 in 5. Sisters and brothers appear to be an even more dangerous source, while the father is relatively unimportant. Even so, children of a spit positive father are more frequently infected than children with no such exposure.

6. *Infection in Relation to Intimacy of Exposure.*

The dominating factor in infection is the opportunity for infection. A child who sleeps with a spit positive relative cannot escape infection. The more effective the isolation of the patient, the less risk of others becoming infected, but even with the patient isolated at home the children of that home are in greater danger of infection than children from homes with no family exposure. The isolation of the " open " case is the essential problem in the eradication of tuberculous infection.

7. *Social and Environmental Sources of Infection.*

These are important, 1 in every 2 children being infected in this way.

8. *Social Conditions and Overcrowding.*

Infection bears no relation to the number of apartments in the house, and is only slightly increased when the number of occupants exceeds 2 adults per room.

9. *Overcrouding in " Spit Positive " Homes.*

If overcrowding exists in homes in which there is a member of the family with spit positive pulmonary tuberculosis, the incidence of infection is definitely increased irrespective of the number of apartments.

10. *Malnutrition and Infection.*

Of all children examined 40 per cent. were underweight, 16.4 were grossly underweight.

Malnutrition among all infected children is not significant. Probably in the first quinquennium of life normal weight or over is a more frequent concomitant of tuberculous infection than malnutrition.

When the source of infection is constant and continuous, *e.g.*, among contacts, the child's growth may be retarded as a result.

11. *Infection and Common Physical Defects.*

No relationship is observed here.

12. *Infection in Relation to Lesions Recognised by X-Ray.*

All X-Ray lesions are not tuberculous and all tuberculous lesions are not recognisable by X-Ray.

Hilum glands are not necessarily tuberculous and are often the residue in healthy children of long forgotten respiratory illnesses.

Increasing intensity of tuberculin reactions is associated with gradual mounting frequency of X-Ray lesions.

Calcification of hilum glands does not appear to be pathognomonic of tuberculosis.

13. *Value of D'Espine's Sign.*

D'Espine's sign is not constantly associated with hilum glands, but its value as an aid in the diagnosis of hilum glands has been confirmed. The sign is indicative of glands which may or may not be tuberculous.

14. *Incidence of Clinical Tuberculosis Among Dispensary Children.*

Less than one fifth of all dispensary children suffer from clinical tuberculosis.

Disease of the superficial glands is the most common type.

Non-pulmonary disease occurs at all ages.

Pulmonary disease of adult infiltrative type is rare below the age of 12, is diagnosed in 1 in every 10 spit positive contact children and is 5 times more frequent among these children than among non-contact children.

15. *Grades of Tuberculin Reaction in Latent and Clinical Disease.*

The more marked reactions occur more frequently in children with clinical disease, the ratio for the very intense or four plus reaction being 7 to 3.

Activity of the lesion irrespective of its site may be held to determine the intensity of the reaction.

When the reaction is very intense the lesion, recognised clinically or inferred by the fact of allergic response, may be held to be active.

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