THE INCIDENCE OF TUBERCULOUS INFECTION AND ITS RELATION TO CONTAGION IN CHILDREN UNDER 15

AN ANALYSIS OF 1,220 CHILDREN FROM THE BROMPTON HOSPITAL RESEARCH DEPARTMENT

BY

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Last year we published a report on tuberculosis mortality in children[1] which included the results of an investigation into the fate of 1,192 children born of parents who had attended the Brompton Hospital, London. This work has been followed by an investigation, also at the Brompton Hospital, into the incidence of tuberculous infection in children and its relation to contagion. The figures deal for the most part with families of an urban working-class population. All children under the age of 15 attending the hospital have been tested, together with a number of contact children.

The majority of workers in tuberculosis are of the opinion that, from the standpoint of accuracy, the quantitative intracutaneous test of Mantoux is the best for determining tuberculous infection. However, as extensive work has been recently done in America and Norway with the Pirquet test, we carried out a preliminary investigation on just over two hundred children with this method before going on to the main part of our work—that is, an investigation of one thousand cases with the Mantoux test. We have thus been able to give our opinion as regards the delicacy of the two tests.

THE PIRQUET TEST

The flexor surface of the left forearm was cleaned with ether; a drop of Old Tuberculin—Human (T)—was dropped on to the skin from a pipette and the skin under the drop was incised with a vaccination lancet. The size of the scratch and the amount of tuberculin used in each case was approximately the same. The arm was left exposed to the air for at least fifteen minutes. The child was seen in forty-eight hours and any reaction at the site of the test was noted. To begin with, a control was always done on the opposite arm, but as no reaction ever occurred with it this was given up as being unnecessary.

The results are given in five-year age groups in the following table.

TABLE I

Age.	Number of Cases	Number Positive	Per cent. Positive
0 5	52	7	13.5
5-10	130	34	26.2
10-15	35	18	51.4
0-15	217	59	27.2

Our figure of 27.2 per cent. agrees closely with that of Chadwick and Zacks,[2] who tested 101,118 school children and found that 28 per cent. gave a positive reaction. The above 217 cases were further divided into three classes: (1) Children who had lived or were living in contact with a person or persons suffering from pulmonary tuberculosis with positive sputum (Contact T.B.+). (2) Children who had lived or were living in contact with a person or persons suffering from pulmonary tuberculosis who had no sputum, or in whose sputum tubercle bacilli had never been found (Contact T.B.−). (3) Children who had never lived in contact with a tuberculous person as far as was known (No contact). Results are shown in Table II.

TABLE II

Age	1. Contact T.B. +			2. Contact T.B.−			3. No Contact with Tuberculosis		
	Number Tested	Number Positive	Per cent. Positive	Number Tested	Number Positive	Per cent. Positive	Number Tested	Number Positive	Per cent. Positive
0-5	20	5	25.0	15	2	13.3	17	0	0
5-10	53	23	43.4	27	3	11.1	50	8	16.0
10-15	7	4	57.1	11	5	45.5	17	9	52.9
0-15	80	32	40.0	53	10	18.9	84	17	20.2

It will be noted that twice as many children under the age of 15 are infected with tuberculosis when in contact with a person with positive sputum as compared with the other two groups. This fact will be dealt with more fully later

THE MANTOUX TEST

Having examined 217 children with the Pirquet test, we applied the intracutaneous test of Mantoux to 1,003 children. For this purpose a sufficient quantity of Old Tuberculin of one brew (T. 1586) was kindly supplied by Dr. O'Brien of the Wellcome Research Laboratory, to whom we are grateful for many suggestions. Dilutions of (*a*) 1 in 10,000 tuberculin, (*b*) 1 in 1,000 tuberculin, and (*c*) 1 in 100 tuberculin, were made in sterile water to which had been added 0.5 per cent. phenol. The dilutions were always freshly prepared.

A 1 c.cm. glass Record syringe fitted with a No. 214 needle (Burroughs Wellcome) was used, and 0.1 c.cm. of 1 in 10,000 tuberculin was injected into the skin of the flexor surface of the left forearm. The site of injection was examined after forty-eight hours, and any reaction was carefully noted. If no reaction had occurred, 0.1 c.cm. of 1 in 1,000 tuberculin was injected intracutaneously, and the arm was again examined in forty-eight hours. If this was still negative, a third

TABLE III

Age	Boys			Girls			Total		
	Number Tested	Number Positive	Per cent. Positive	Number Tested	Number Positive	Per cent. Positive	Number Tested	Number Positive	Per cent. Positive
Years 0-1	0	0	0	0	0	0	0	0	0
1-2	2	0	0	2	0	0	4	0	0
2-3	17	3	17.6	14	1	7.1	31	4	12.9
3-4	25	5	20.0	14	7	50.0	39	12	30.8
4-5	43	11	25.6	22	5	22.7	65	16	24.6
5-6	67	15	22.4	56	15	26.8	123	30	24.4
6-7	63	26	41.3	52	25	48.1	115	51	44.3
7-8	61	24	39.3	45	19	42.2	106	43	40.6
8-9	54	23	42.6	34	14	41.2	88	37	42.0
9-10	68	28	41.2	38	21	55.3	106	49	46.2
10-11	52	22	42.3	39	21	53.8	91	43	47.3
11-12	40	25	62.5	39	18	46.2	79	43	54.4
12-13	29	19	65.5	22	15	68.2	51	34	66.7
13-14	34	17	50.0	26	16	61.5	60	33	55.0
14-15	21	17	81.0	24	20	83.3	45	37	82.2
0-5	87	19	21.8	52	13	25.0	139	32	23.0
5-10	313	116	37.1	225	94	41.7	538	210	39.0
10-15	176	100	56.8	150	90	60.0	326	190	58.3
0-15	576	235	40.8	427	197	46.1	1,003	432	43.1

injection of 0.1 c.cm. of 1 in 100 tuberculin was made and examined in forty-eight hours, and any reaction noted.

Many workers, both in this country and abroad, regard 1 c.cm. of Old Tuberculin as being equal to 1,000 mg., and classify their results of the Mantoux test according to the reaction to:

0.01 mg. (0.1 c.cm. of 1 in 10,000 O.T.);
0.1 mg. (0.1 c.cm. of 1 in 1,000 O.T.); and
1 mg. (0.1 c.cm. of 1 in 100 O.T.).

We agree with Bandelier and Roepke[8] that the milligramme notation should be entirely dropped, and all results should be recorded according to the dilution of the O.T. used.

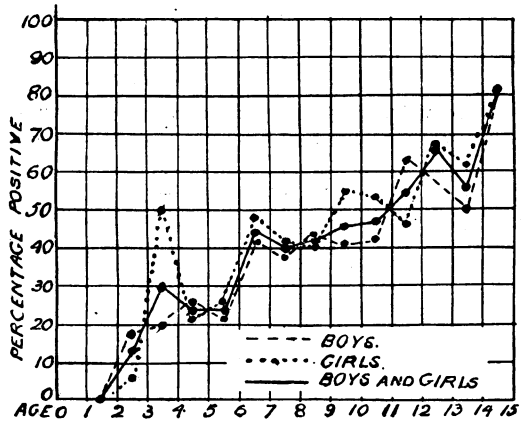

FIG. 1.—The percentage of children who reacted to the Mantoux test according to age and sex groups.

For various reasons it was not found possible to do the three tests in all the children. No difficulty was experienced in carrying out the tests even with the youngest; compared with the Pirquet method the technique of the Mantoux test is, if anything, simpler. The results are given in Table III and Fig. 1.

The foregoing graph, although somewhat irregular, shows that the incidence of tuberculous infection increases gradually from infancy to the age of 15. This irregularity of the graph becomes less obvious by grouping the children into larger age groups.

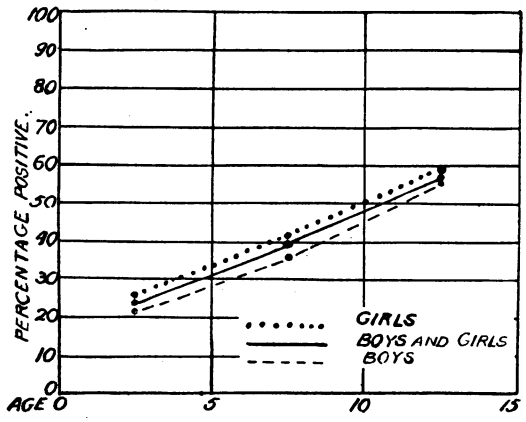

FIG. 2.—The percentage of children in different age groups who reacted to the Mantoux test.

From this it will be seen that 23 per cent. of children from birth to 5 years, 39 per cent. between 5 and 10 years, and 58 per cent. between 10 and 15 years old have been infected by the tubercle bacillus at some time or other. From our figures the incidence of tuberculous infection in children between the ages of 0 and 15 years is 43 per cent. It should be added that of the 1,003 children, 279 had been exposed to tuberculosis. Comparing these figures with those of other workers, we find that they are rather lower than those of Opie and McPhedran,[3] who based their results on a large number of school children in Philadelphia, while they are higher than those of Dickey and Seitz,[4] working in San Francisco (Fig. 3).

As already mentioned, we found it impossible to test every child with 1 in 100 tuberculin, and so it is not unreasonable to suggest that the number of positive reactions would have been somewhat higher if this had been done. Of the 1,003 Mantoux tests which were performed in children under 15 years of age, 268 children, or 26.7 per cent., were positive to 0.1 c.cm. of 1 in 10,000 tuberculin. Of the 735 who were negative, 668 were re-tested with 0.1 c.cm. of 1 in 1,000 tuberculin, and of these 122 were positive. This brings the number of positives up to 390,

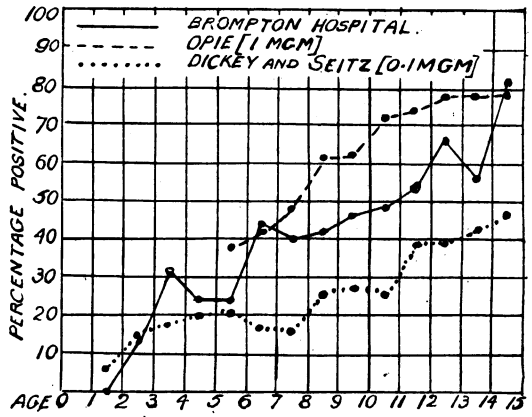

FIG. 3.—The percentage of children at different ages who reacted to the Mantoux test, as given by various workers.

or 38.9 per cent. Now if all the 735 who were negative to 0.1 c.cm. of 1 in 10,000 tuberculin had been re-tested, instead of only 668, the number of positives would presumably have been 402, or 40.1 per cent., an increase on our figures, so far, of 1.2 per cent. Of 421 tested a third time with 0.1 c.cm. of 1 in 100 tuberculin 42 were positive, making a total of 432, or 43.1 per cent.—the figure which we gave as showing the incidence of tuberculous infection in children up to the age of 15. If all the 601 who would have been so far negative to 0.1 c.cm. of 1 in 1,000 tuberculin had been tested with 0.1 c.cm. of 1 in 100

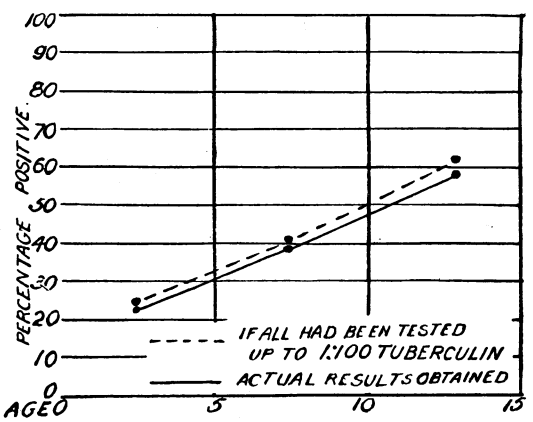

FIG. 4.—The percentage of children in different age groups who would presumably have reacted to the Mantoux test if all had been tested up to 1 in 100 tuberculin, compared with our actual findings.

tuberculin, 60 would presumably have been positive, making a total of 462, or 46.1 per cent. We may therefore say that the incidence of tuberculous infection in children up to the age of 15 attending the Brompton Hospital is somewhere in the region of 46 per cent. This figure may be adversely criticized as being too high for the general population of this age, because this is a special hospital for diseases of the chest, and for this

reason more children exposed to tuberculosis, or suspected of being tuberculous, are brought for examination.

It will be noted that the figure 26.7 per cent., which represents the percentage of children under 15 who are positive to 1 in 10,000 O.T., is practically the same as the 27.2 per cent. positive when the Pirquet method was used. This agrees with the conclusion reached by Happ and Casparis[5] about the two tests. By using 1 in 1,000 O.T. the number of positives was increased from 26.7 to 38.9 per cent., which makes a large difference in results, and by still further using 1 in 100 O.T. a further increase of 4.2 per cent. was obtained, making a total of 43.1 per cent., which would have been still higher (46.1 per cent.) if all had been tested up to this amount. From this it appears that by using the Mantoux test rather than the Pirquet, more accurate results are obtained in estimating the incidence of tuberculous infection, while the Mantoux test has also the advantage that a fixed amount of tuberculin is used in each case. Our figures show that the incidence of tuberculous infection in girls is slightly higher than in boys (see Figs. 1 and 2).

Analysis of Contact and Non-contact Groups

We have further subdivided our cases into the same three groups which were mentioned when dealing with the Pirquet test. The results for these three groups are given in Table IV and Fig. 5.

TABLE IV

Age	1. Contact T.B.+			2. Contact T.B.−			3. No Contact with Tuberculosis		
	Number of Cases	Number Positive	Per cent. Positive	Number of Cases	Number Positive	Per cent. Positive	Number of Cases	Number Positive	Per cent. Positive
0–5	21	15	71.4	15	3	20.0	103	14	13.6
5–10	87	66	75.9	47	18	38.3	404	126	31.2
10–15	76	58	76.3	33	14	42.4	217	118	54.4
0–15	184	139	75.5	95	35	36.8	724	258	35.6

The results show that up to the age of 15 twice as many children living in contact with a person suffering from pulmonary tuberculosis with positive sputum are

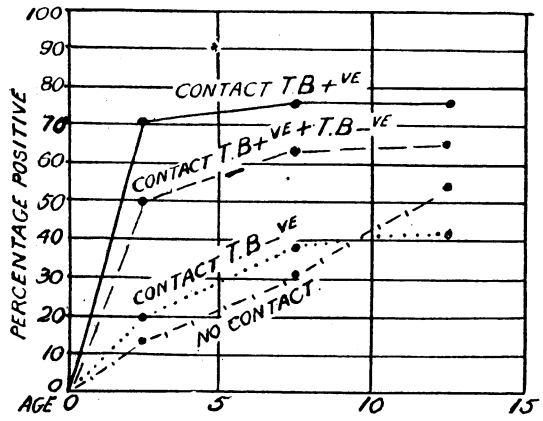

FIG. 5.—Percentage of contact and non-contact children who reacted to the Mantoux test, arranged in age groups.

infected with tuberculosis as compared with those children living in contact with a person with pulmonary tuberculosis with no sputum or negative sputum, or where there is no known contact with the disease, the figures being 75.5, 36.8, and 35.6 per cent. respectively. It is noteworthy that there is no marked difference between the curves of children in contact with parents diagnosed as suffering from pulmonary tuberculosis, but with negative sputum, as compared with the non-contact group.

In considering the three age groups 0–5, 5–10, and 10–15 years, a very striking difference in the graphs of the contact and non-contact cases will be observed. These show that the percentage of positive reactors in the children exposed to open tuberculosis is almost identical

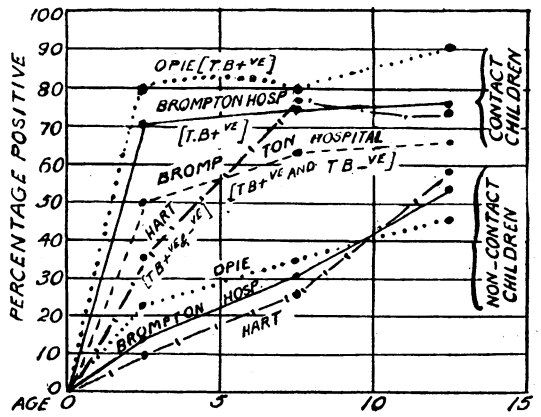

FIG. 6.—Percentage of children in contact and non-contact groups who reacted to the Mantoux test, as given by various workers.

in the three age groups, the average being about 75 per cent. On the other hand, the percentage of positive reactors in the non-contact children increases steadily with each age group. In the 0–5 year age group, the percentage of positive reactors is five times higher in children in contact with open tuberculosis than in the non-contact children.

These findings agree very closely with those of Opie and McPhedran[6] and Schlesinger and Hart[7] as is shown in Fig. 6. Opie included those children living in contact with open tuberculosis, while Hart included all children living in contact with all forms of pulmonary tuberculosis.

The group of children living in contact with a person with tubercle bacilli in the sputum was further analysed according to the relationship of the contact.

TABLE V

	Number of Cases	Number Positive	Per cent. Positive
1. Mother T.B.+ (father healthy) ...	50	34	68.0
2. Father T.B.+ (mother healthy) ...	74	57	77.0
3. Both parents T.B.+	4	4	100.0
4. Mother T.B.+ father T.B.− ...	2	2	100.0
5. Other contacts T.B.+	54	42	77.8

The above figures show that children exposed to a tuberculous father with positive sputum react more frequently than children exposed to a tuberculous mother with positive sputum. Although the difference is only slight, it is of interest to note that in our previous report[1] we found that the mortality rate from tuberculosis was greater in the children of fathers with positive sputum than of mothers with positive sputum.

Environment

We have found that the incidence of tuberculous infection is higher in children from homes in which there is a case of pulmonary tuberculosis with positive sputum. It may be that this increased tuberculization can be accounted for in part by the environmental conditions. It is difficult to classify home conditions in a really

satisfactory way, but an attempt has been made to divide homes into three groups—namely, " bad " homes, " fair " homes, and " good " homes. This was done after consideration of (*a*) total income, (*b*) locality, and (*c*) general hygienic conditions. In a series of 494 homes in which there was no tuberculous person living, 110 were classified as " bad," 154 as " fair," and 230 as " good." The incidence of tuberculous infection in each of these groups was practically the same, the figures being 30.9, 37.6, and 35 per cent. respectively. In 228 homes where there was a person suffering from tuberculosis, the corresponding figures were 86.4, 76.8, and 68.6 per cent. These figures would seem to show that where there is no known tuberculosis in the home, the incidence of tuberculous infection is much the same, whether the home conditions are " bad," " fair," or " good," while in the case of the tuberculous household there is a considerably lower percentage of tuberculous infection in the " good " home than in the " fair " home, and much more is this the case when comparing the " good " with the " bad " home.

Conclusions

1. The Mantoux test is more delicate than the Pirquet test. The Pirquet test is equivalent to 0.1 c.cm. of 1 in 10,000 tuberculin given intracutaneously.

2. The incidence of tuberculous infection in children increases gradually from infancy to puberty.

3. The incidence of tuberculous infection up to the age of 15 years is 43.1 per cent.—23.0 per cent. are infected between 0 and 5 years, 39.0 per cent. are infected between 5 and 10 years, 58.3 per cent. are infected between 10 and 15 years.

4. The incidence of tuberculous infection is slightly higher in girls than in boys.

5. The incidence of tuberculous infection in children between 0 and 15 is doubled when there is contact with open tuberculosis.

6. The incidence of tuberculous infection from birth to 5 years is five times greater when there is contact with open tuberculosis than when there is no contact with the disease.

7. The incidence of tuberculous infection in children of tuberculous fathers with positive sputum is slightly higher than in children whose mothers have positive sputum.

8. Our figures suggest that the incidence of tuberculous infection in contact children in " bad " homes is higher than in contact children in "good " homes.

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THE NEED OF EDUCATION IN QUESTIONS OF SEX *

BY

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It would be a mistake to suppose that education in sex matters refers solely to physiology. There is plenty of evidence that ignorance of the body may breed sex-mismanagement; but there is also evidence that physical knowledge, while, no doubt, protecting informed people from the worst physical consequences of sex-mismanagement, by no means ensures correctness of conduct. By sex-education I mean the physical, but also, the social, the moral, and the emotional (or what may be called the psychological) aspects. Again, while believing in the need of education in this more comprehensive sense, I do not believe that education alone, however complete in these ways, can be counted on to do more than point the way and ease the burden. As you would expect of me, I hold that as body must be directed by mind, so mind must be informed and empowered by God Himself. This recognition of man as what we clergy call a spiritual being does not, perhaps, concern doctors as a professional matter, but I should run the risk of being completely misunderstood if I omitted all reference to it. I put it now in the forefront because of its supreme importance; I do not propose to say more about it because it is my business to open a discussion on those other aspects of our subject which give common ground to us all.

The first of these to consider is the mind of the educator; and here we are faced with the difficulties which inevitably belong to a period of transition. The required instruction must often be given by those who have not completely escaped from the atmosphere of ignorance, negation, fear or disgust in which they themselves were brought up. When harm is alleged to result from education in sex we may suppose that it is nearly always due to the fact that the information is given in the wrong way. Wrong attitudes of mind in the educator may be briefly summarized: his own experience of life may lead him to over-emphasize dangers, sins, abnormalities; or he has escaped from the view that he is dealing with a dark and mysterious subject, but still keeps it in a water-tight compartment and deals with it in a highly specialized manner instead of as a universal part of life as a whole; or his approach is over-emotional, and he cannot speak of the physical side of sex in that matter-of-fact manner which we find and envy in those who profess the science of medicine. He is furtive where he means to be reverent, alarming when he means to be cautionary, and over-stimulating through his ardour for righteousness; or, worst of all, his own interest in the subject is morbid, obsessional.

The result of wrong attitudes in the educator must often be injurious to the boy or girl to be educated; the pupil is needlessly stimulated or frightened, and may, even after some instruction, regard sex-energy as a force to be suppressed rather than as a creative faculty to be directed aright and to be controlled for that end. Hence the need of emphasizing the importance of educating the educators. The Lambeth Conference indicated parents as the people directly responsible and the Church as the quarter to which parents should look for guidance and equipment. But it would be useless to ignore the fact that a majority of parents are incompetent for the task, and only a minority of clergy possess, at present, the knowledge required to provide the right guidance. During this transitional stage it may be necessary that certain people, men and women, chosen for the purpose, should be available as educators of educators, working to widen the area of competency.

Be that as it may I venture, as a father myself, to illustrate the part to be played by parents in very early stages. There is much to be said, which for lack of space must be here omitted, about the atmosphere of the home, the way in which father and mother treat each other, and

* Read in opening a discussion in the Section of Medical Sociology at the Annual Meeting of the British Medical Association, Eastbourne, 1931.