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Prevalence of Tuberculosis among Close Family Contacts of Tuberculous Patients in South India, and Influence of Segregation of the Patient on the Early Attack Rate *

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The results of a study by the Tuberculosis Chemotherapy Centre, Madras, of the merits of home as compared with sanatorium treatment for pulmonary tuberculosis have indicated that treatment at home is satisfactory in the majority of cases. Before domiciliary chemotherapy can be introduced on a large scale, however, it must be established that it does not expose the patient's contacts to a special risk of infection, avoided by his isolation in a sanatorium. Accordingly, a further study was undertaken by the Centre to determine (a) the prevalence of tuberculosis among the family contacts of patients, and (b) the incidence of clinical tuberculosis and of tuberculous infections in the family contacts of the home and sanatorium groups of patients during the first year of treatment. The findings of this study indicate that the major risk for contacts lies in exposure to the infectious case before diagnosis, whether the patient subsequently remains at home or is isolated in a sanatorium appearing to have little importance, if the patients at home are treated with effective chemotherapy. Children under seven years of age proved to be particularly vulnerable to infection. The management of young contacts by chemoprophylaxis or by BCG vaccination, or by both measures, has been discussed.

A controlled comparison of the results of treatment of pulmonary tuberculosis with standard antituberculosis chemotherapy for 12 months at home with the results of the same treatment in sanatorium was described in a report from the Tuberculosis Chemotherapy Centre, Madras (Tuberculosis Chemotherapy Centre, 1959). The main conclusion of the report was " that the results of domiciliary chemotherapy, as carried out in this study, approach sufficiently closely the results of sanatorium treatment to suggest that it is appropriate to treat the majority of patients at home. In formulating this conclusion, consideration has been given to the manifest advantages of sanatorium treatment—namely, rest, diet, nursing and supervised medicine-taking—on the one hand, and the social disadvantages, as represented by the disruption to family life and the difficulty of persuading patients to remain in sanatorium, on the other ". Since this conclusion is encouraging to the introduction of mass domiciliary treatment of tuberculosis in underdeveloped countries, it is of particular importance to know in addition whether the treatment of tuberculous patients at home exposes their contacts to a special risk of infection which is avoided by treating the patients in sanatorium. It is only when this risk to contacts has been assessed that the role of domiciliary treatment can be fully evaluated.

The patients in the chemotherapy study were drawn from the lower income groups or the unemployed in Madras City, which is the largest urban community in South India. Living conditions were, with few exceptions, poor, the majority of families being overcrowded and the nutritional standards low. It was under such conditions (outlined below and described more fully in the 1959 report) that the patients in the home series were treated and their family contacts exposed to the risk of infection.

The object of the present report is to study:

(1) the prevalence of tuberculosis in close family contacts at the time of diagnosis of tuberculosis in the patients in the chemotherapy study; and

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(2) the incidence of clinical tuberculosis and of tuberculous infection in the close family contacts during the course of the first year of treatment of the patient.

The organization of the Centre, which is under the joint auspices of the Indian Council of Medical Research (ICMR), the Madras State Government, the World Health Organization (WHO) and the Medical Research Council of Great Britain (MRC), was described in detail in the first report (Tuberculosis Chemotherapy Centre, 1959). The research of the Centre is guided by a Project Committee consisting of three ICMR representatives (Dr P. V. Benjamin, Convenor, Dr J. Frimodt-Møller and Dr K. S. Sanjivi), the Director of the ICMR (Dr C. G. Pandit), the Director of Medical Services, Madras State (first Lieut.-Col. Sangham Lal and then Dr V. R. Thayumanaswamy), a WHO representative (appointed for each meeting), an MRC representative (appointed for each meeting) and the Senior Medical Officer of the Centre (Dr Wallace Fox). The joint secretaries are Mrs K. Daniels and Mr B. S. Verma. The MRC, through its Tuberculosis Research Unit, is responsible for the scientific direction of research, in accordance with plans prepared by the Project Committee, and Dr Wallace Fox of that Unit has been seconded to WHO to serve as the Senior Medical Officer and the Director of Research at the Centre. Dr Ian Sutherland of the MRC Statistical Research Unit gave much valuable advice in the planning of the study, and assistance in the presentation of the findings and the preparation of the report during a visit to the Centre. Dr J. Frimodt-Møller acted as an independent assessor of all the radiographic series and generously made available his punched-card machines and his staff for the analysis of the data.

I. PLAN AND CONDUCT OF THE CONTACT STUDY

The plan of the study was to examine all the close family contacts by radiography and by tuberculin testing at the time of diagnosis of each patient accepted for the chemotherapy study, in order to obtain information on the prevalence of clinical tuberculosis and of tuberculous infection in such contacts. In addition, all these contacts were to be followed intensively by serial radiography and, if indicated, by serial tuberculin testing, to detect the cases of clinical tuberculosis and the tuberculous infections developing among them. This would permit a comparison of the attack rate of tuberculosis, and the incidence of tuberculous infection, in the close family contacts of the patients treated at home with the corresponding rates in the close contacts of the patients treated in sanatorium. The follow-up was planned to continue for five years.

DEFINITIONS OF " INDEX CASE " AND " CONTACT "

For the purpose of this study the " index case " was defined as the first member of a family suffering from pulmonary tuberculosis to be registered in the Centre. All other members of the family were designated " contacts " of the index case. These definitions were strictly adhered to even if one or more of the contacts was found to have pulmonary tuberculosis believed to be of longer duration than the disease in the index case. In this report the contacts of the patients treated at home will be referred to as " home contacts " and those of the patients treated in sanatorium as " sanatorium contacts ".

CLASSIFICATION OF THE FAMILY CONTACTS

Before an index case was accepted for treatment every effort was made to interview and examine in the Centre, by radiography and by tuberculin testing, *all* the family members (by blood or marriage) living in the patient's household. In addition, family members living elsewhere were sometimes interviewed and examined, either because they had attended with the patient or because they had come at the request of the medical staff to assist in the assessment of the co-operation to be expected from the patient and the immediate family. Although a number of contacts who were unrelated to the index case also attended and were examined, the present report is confined to a study of the *family* contacts.

At the first and at each subsequent visit of a contact a record was made of the then current proximity of the contact to the index case, according to the following classification based on the family's cooking and accommodation arrangements:

	Degree of contact	*Accommodation arrangement*
Cooking and feeding with the index case	5	Living in the same room
	4	Living in a different room in the same house
Cooking and feeding separately from the index case	3	Living in a different room in the same house
	2	Living in a different dwelling in the same courtyard
	1	Living in a different house in the same neighbourhood
	0	Living in a different neigh bourhood

In addition, the duration of contact during the previous five years, and the period over which it had occurred, were recorded. The data so obtained were checked on several occasions during the first year of the follow-up, and before undertaking the present analysis they were systematically verified. All the family contacts were then classified as:

(1) " *close contacts* "—namely, those living, cooking and feeding in the same house as the index case (degree of contact 5 or 4) for the period of three months immediately preceding the start of treatment for the index case (including infants less than three months old); or

(2) " *remote contacts* "—namely, all those 5 or 4 degree family contacts who had not been in this degree of contact throughout the three months immediately prior to the start of treatment for the index case, and all the 3, 2, 1 or 0 degree family contacts. (These remote contacts numbered 203 and are not considered further in this report.)

Thus, except for very young infants, all " close contacts " had had a minimum of three months of recent close exposure to the index case, at a time when these cases were, in all probability, infectious. The analyses in this report relate to the total of 693 family contacts who were in close contact, as defined above, with 191 index cases. (There were 193 patients in the chemotherapy study, but these belonged to 191 families.) In the subsequent sections of this report the term " family contacts " refers to these close family contacts.

Although the three months immediately preceding the start of treatment for the index case was the minimum period of 5 or 4 degree contact stipulated for eligibility in this study, the great majority had been in this degree of contact for a very much longer period. Of the 693 close contacts, all except 23 (3.3%) had been living, cooking and feeding in the same house as the index case for at least one year immediately prior to the start of treatment of the index case (or throughout their life). The great majority had done so for at least five years, or, for children under the age of five years, for their whole life. Thus, the contacts under study had had a long period of close contact with the index case.

In order to enumerate all the close family contacts, the index cases and other family members were interrogated frequently in the clinic by the doctors, health visitors and social workers. It must be emphasized that every known close family contact has been included in this study, whether or not he or she ever attended the Centre.

FIRST EXAMINATION OF CONTACTS

At the time of admission of the index case to treatment each contact was given the following standard examination:

(*a*) A full-plate postero-anterior radiograph of the chest was taken (a few contacts had a 70-mm chest radiograph only) ; this was read by two clinic doctors independently.

(*b*) An intracutaneous tuberculin (Mantoux) test was made on the flexor aspect of the left forearm with 5 tuberculin units (TU) of a purified protein derivative (PPD) in 0.1 ml of solution. The greatest diameter of palpable induration after 48 or 72 (occasionally 96) hours was measured in millimetres, using a transparent ruler or a caliper gauge, according to the preference of the reader. If there was no induration, or if its maximum diameter was less than 5 mm, a further intracutaneous test with 100 TU of PPD in 0.1 ml of solution was performed on the right forearm. The greatest diameter of induration after 48 or 72 (occasionally 96) hours was again recorded in millimetres. (For the first six months of the intake for this study 50 TU was given instead of 100 TU.)

The tuberculin dilutions used were prepared in the BCG Laboratory, Guindy, Madras (Director: Dr K. S. Ranganathan) from PPD batch RT22, supplied as powder by the Statens Seruminstitut, Copenhagen, Denmark. The diluent was phosphate buffer and Chinosol and did not contain Tween 80 (Magnusson et al., 1958). Fresh solutions were made every two weeks and were stored in a refrigerator when not in use. All the tuberculin syringes had been tested for leakage (Guld & Rud, 1953),

and separate and distinctive series of syringes were used throughout for the 5 TU tests and for the 50 or 100 TU tests.

All the tuberculin tests were given in the Centre by the clinic nurses, and the great majority were also read in the Centre by them. Occasionally tests were read in the home by health visitors. In the early stages of the study one nurse read the test and another recorded the result on the contact's record sheet. This procedure was modified so that the result of each test was recorded on a separate card and transferred subsequently to the contact's record sheet, which was not available to the clinic nurse at the time of reading the test. The nurses were trained to read carefully but, to avoid bias, no explanation was given to them or to the health visitors about the special comparison that was in progress between the contact groups.

(The interpretation of these and the subsequent investigations of the contacts was not complicated by previous BCG vaccinations, since the Madras Government's mass vaccination campaign has not yet included Madras City, and the vaccine has scarcely been used there. BCG vaccine was not given to any of the contacts since one of the objects of the study was to discover whether there was any special risk to home contacts which might indicate the use of chemoprophylaxis or BCG vaccine, and since the contacts were all under intensive supervision.)

The age of each contact was obtained or estimated at the time of admission of the index case to treatment, and these are the ages quoted throughout this report.

Procedure when an abnormality was found at the initial examination

Although precise rules were not laid down, each contact found to have a radiographic abnormality at the initial examination was carefully investigated. The contact was asked to re-attend and was examined clinically, and bacteriologically by direct microscopy and culture of the sputum or by culture of laryngeal swabs, for tubercle bacilli. The number of cultures ordered was at the discretion of the individual clinician. The course of the lesion was followed by means of serial full-plate radiographs, taken usually monthly but more frequently if necessary. If indicated, further 5 TU and 100 TU tests were ordered. Courses of non-tuberculous chemotherapy were given on clinical grounds, if indicated, or as a diagnostic measure.

A special procedure was followed for any child under the age of three years with an initial induration to 5 TU of 5 mm or more, even if the radiograph was normal: a clinical examination was performed, one or more pairs of laryngeal swabs were often examined, and another full-plate radiograph was ordered after an interval of, at most, four to six weeks. The health visitor was usually asked to see the child at least weekly, especially if an infant or frail, and to report any untoward symptoms; the parents were advised to bring the child to the Centre if it became suddenly ill.

FOLLOW-UP EXAMINATIONS OF CONTACTS

At three, six and nine months and at one year each contact was given the following standard examination:

(*a*) A 70-mm radiograph (read independently by two of the Centre's doctors); if there was any doubt as to its normality, a full-plate radiograph was taken. For children under the age of five years, only full-plate radiographs were taken.

(*b*) If the indurations to 5 TU at all previous tests had been less than 20 mm an intracutaneous test was made with 5 TU and read as at the first examination. If the maximum diameter of induration to this test was less than 5 mm a 100 TU test was performed (a 50 TU test in the early stages).

At first, testing with 5 TU was stopped after a reaction of 5 mm or more had been obtained. This procedure was later modified, however, and 5 TU tests were performed at each examination until an induration of 10 mm or more was obtained. This procedure was soon modified again to that under (*b*) above. The modifications were introduced as the study developed in order to give a more complete picture of changes in tuberculin sensitivity, when it became evident that a high proportion of contacts of all ages could be persuaded to attend regularly and submit to repeated tuberculin tests—a situation which could not be foreseen when the study began. For much of the study the rule was to stop all tuberculin testing only when an induration of 20 mm or more to 5 TU had been obtained. The modifications led to progressively more results being available at three, six and nine months and at one year.

A radiograph was accepted as a 3-, 6- or 9-month film only if it was taken within six weeks of the set date, this date always being calculated from the date of the start of treatment for the index case. A radiograph was accepted as a 1-year film only if it was

taken within the period from six weeks before to three months after the set date. In fact, the great majority of radiographs lay within one month of the set date, and of these, most were within two weeks of the set date. Tuberculin tests with 5 TU were accepted according to the same criteria; a 100 TU test was accepted as a part of the same tuberculin investigation if performed within 15 days after a 5 TU test.

While the above routine investigations represented four set examinations of each contact during the year, there were, in fact, many more opportunities for the staff to observe the contacts. Regular visits were paid to each family by the health visitors, doctors or social workers, whether the index case was treated at home or in sanatorium. For home patients visits were made at least weekly during the early months of treatment. In addition, home patients (apart from a few who were too ill) attended the Centre weekly to collect a supply of medicine, and were often accompanied by contacts, both healthy and ill. This provided frequent opportunities for illness in other family members to be reported. Routine visits were paid to the homes of the sanatorium patients also at least once a month; moreover, a proportion of the sanatorium contacts attended weekly for financial assistance (Tuberculosis Chemotherapy Centre, 1959), and the families were quick to report illness or domestic difficulties. Patients in sanatorium frequently informed the Centre's staff of difficulties at home, at one of the bi-weekly visits of the latter to the sanatorium.

Although the contacts of home patients were probably seen more often there is no reason to think that illness in the contacts of the home patients more commonly came to the attention of the staff than illness in the contacts of the sanatorium patients. As with the index case, all treatment was free, and contacts therefore tended to seek medical advice in the Centre rather than from hospitals or private practitioners. Many contacts, especially children, came with ailments of all types. Whenever possible, these ailments, the commonest of which were feeding difficulties, malnutrition, skin infections, non-tuberculous respiratory infections, gastroenteritis and intestinal helminthiasis, were treated in the Centre. The Centre had facilities for the performance of routine blood examinations and urine investigations; when necessary, contacts were referred to hospital for specialist advice or other investigations, and details of the findings were obtained whenever possible.

Procedure when an abnormality was found at a follow-up examination

When a radiographic abnormality appeared for the first time, whether this was at one of the four set examinations or at an extra examination, a culture of at least one sputum specimen or a pair of laryngeal swabs was taken. Further full-plate radiographs were ordered as indicated, but seldom at intervals of more than a month. Sometimes extra 5 TU and 100 TU tests were also requested. If indicated, a course of non-tuberculous chemotherapy was given.

After the study had been in progress for a few months, it became a matter of routine when contacts with a normal radiograph, especially infants and children, showed changes in tuberculin sensitivity suggesting that a recent infection might have taken place, to take a full-plate radiograph four to six weeks later, and at similar intervals for several months before returning to the 3-monthly routine. In addition, at least one pair of laryngeal swabs was examined. In the case of infants and young children, the health visitor was instructed to see the contact weekly, or the parents were asked to bring the contact to the Centre weekly.

SPECIFIC ANTITUBERCULOSIS TREATMENT

The general policy was to observe lesions for evidence of progression before initiating treatment, especially for primary tuberculosis. (There is very little information on the natural history of primary tuberculosis in Indian patients, and the current general shortage of chemotherapeutic agents in India makes it important to define which are the most urgent and necessitous cases for treatment.) Active lesions were therefore not always treated immediately, and, in the event, it often did not prove necessary to do so during the year.

Specific antituberculosis chemotherapy was usually not started in any contact unless bacteriological confirmation of tuberculosis had been obtained. Exceptions to this general practice were made, however, in the case of young children who were ill, or where the lesion showed rapid progression radiographically or was large or disseminate (as in two examples of miliary pulmonary tuberculosis). For all contacts it was the standard practice at the start of treatment to set up at least four cultures to obtain, if possible, laboratory confirmation of the diagnosis as well as results of drug-sensitivity tests.

ENVIRONMENTAL BACKGROUND OF THE FAMILIES

Some aspects of the socio-economic background of the families under study were referred to in the earlier report (Tuberculosis Chemotherapy Centre, 1959), but the salient features are as follows: The majority of the families were from the poorest section of the community; the highest monthly income of the male patients in the chemotherapy study in the six months prior to the start of treatment was on the average Rs 47.78,[1] and only 26% of the *families* had a total income of Rs 100.00 or more per month. In assessing the purchasing power of such incomes, reference may be made to Chaudhuri's (1959) estimate that, at the current cost of living in India, the basic income requirement for *one adult* was Rs 60.00 to Rs 70.00 per month. As a further basis of comparison, the dietary alone of each sanatorium patient in the chemotherapy study cost approximately Rs 50.00 per month.

The accommodation in which the families lived was very overcrowded. About three-quarters of the families with index cases treated at home had less than 45 square feet (about 4 m^2) of floor area per person, and so were overcrowded according to the minimum standards laid down by the Environmental Hygiene Committee of the Government of India (India, Ministry of Health, 1950); many families had only one room. It will be appreciated that under such conditions segregation of the index case, if treated at home, was rarely practicable or efficient and was often physically impossible; the average size of these " home " families was 4.5 members.

The patients treated at home were instructed in the need for care in coughing and in the disposal of sputum, and were provided with an aluminium sputum mug and a small earthenware stove on which to heat it. Apart from such simple advice regarding hygiene and, where possible, segregation, no special attempt was made to alter the normal living conditions of the family. Where the illness of a wage earner meant total loss or serious reduction of the family income, a minimal amount of financial assistance was given (Tuberculosis Chemotherapy Centre, 1959). This, however, rarely raised the family to its usual income level.

No direct observations were made regarding the diet of the contacts, but a survey of the diet of the index cases treated at home revealed that half of them had a daily intake of less than 2000 calories and a protein intake of less than 50 g, and that about 90% had less than 30 g of animal protein per day. There is no reason to believe that the standard of diet for the contacts was better than that for the index cases. Further, direct evidence of malnutrition was not uncommon in the contacts, especially among the children.

Although it had not been intended to give any dietary supplements, during the course of the study a free supply of powdered milk was made available by a relief organization for all tuberculous patients and their families in Madras. A regular issue of this, amounting to not more than half a pound (225 g) per household member per month was thereafter given to each family. This powdered milk was included in the dietary calculations referred to above. Occasionally, protein concentrates and vitamins were given to contacts for clinical malnutrition.

INDEPENDENT ASSESSMENT OF THE FINDINGS

Since there was a possibility that the observations made by the Centre's staff in respect of the interpretation of radiographic appearances might be biased by knowledge of whether the index case was being treated at home or in sanatorium, it was decided to obtain an independent assessment for each of the 693 contacts. Dr J. Frimodt-Møller was the independent assessor, and he proceeded in the following manner.

At a first session he reviewed the full radiographic series of each contact, being unaware (as for all his subsequent assessments) whether the series was for a contact of a patient under treatment at home or in sanatorium. He scrutinized the series and reported any abnormality he saw on any of the films.

He subsequently reviewed all the series in which he had originally noted an abnormality and classified them as follows on the radiographic appearances only:

(1) normal;

(2) non-tuberculous abnormality;

(3) doubtfully tuberculous abnormality;

(4) active tuberculosis;

(5) tuberculosis of doubtful activity;

(6) inactive tuberculosis; or

(7) tuberculous calcification.

[1] Rs 4.80 = US$1.00.

Having thus made a radiographic assessment for every contact, the observer was presented with certain series for reassessment in the light of relevant bacteriological, tuberculin-test, clinical or pathological data. The contacts whose series were reassessed fell into eight clearly defined groups:

(1) those from whom tubercle bacilli were isolated on culture during the course of the year, if the assessor had made any assessment other than active tuberculosis (four contacts);

(2) those who had been examined bacteriologically and who had yielded only negative cultures during the year, if the purely radiographic assessment had been a doubtfully tuberculous abnormality, active tuberculosis or tuberculosis of doubtful activity (45 contacts);

(3) those for whom the assessor's classification had been a doubtfully tuberculous abnormality, active tuberculosis, tuberculosis of doubtful activity, inactive tuberculosis or tuberculous calcification, if all the 5 TU indurations during the year had been less than 5 mm (11 contacts);

(4) those under the age of three years whose radiographic series had been classified by the assessor as normal, a non-tuberculous abnormality or a doubtfully tuberculous abnormality, if the initial 5 TU induration was 5 mm or more (14 contacts);

(5) those who had shown evidence of tuberculin conversion during the year, that is, all contacts whose indurations to 5 TU were less than 5 mm at the initial examination and in whom a subsequent induration to 5 TU was at least 10 mm larger, if the purely radiographic assessment had been normal, a non-tuberculous abnormality or a doubtfully tuberculous abnormality (39 contacts);

(6) those in whom an initial 5 TU induration of 5, 6 or 7 mm had been enhanced in a subsequent 5 TU test by at least 10 mm, if the purely radiographic assessment had been normal, a non-tuberculous abnormality or a doubtfully tuberculous abnormality (28 contacts);

(7) those in whom there were relevant clinical data, including evidence of extrapulmonary tuberculosis, which might alter the assessment based only on the radiographic series (10 contacts);

(8) those who died from any cause during the year (16 contacts).

Some contacts fell into more than one of these groups. When making this reassessment the assessor was given all the bacteriological and tuberculin-test results during the year and all the available clinical data, including pathological reports. In all, reassessments were made for 142 of the 693 contacts; the assessor altered the classification for only 15.

It was not considered necessary for the assessor to review the series for the other 551 contacts—for example, those in whom he had diagnosed active tuberculosis and in whom a confirmatory positive bacteriological finding was available; those in whom he had diagnosed inactive tuberculosis and in whom all the culture results were negative; or the large group of contacts classified as normal, in whom the investigations and clinical records had been completely uneventful from the point of view of tuberculous infection.

In addition to classifying the abnormalities, the assessor divided them all into those present initially and those developing during the year, noting for the latter the date when the abnormality first became manifest. The abnormalities present initially are reported in section II of this report, which deals with the prevalence of clinical tuberculosis and of tuberculous infection in the contacts; those developing during the course of the year are reported in section III, which deals with the incidence of clinical tuberculosis and of tuberculous infection in the contacts.

Finally, the assessor carefully reviewed:

(1) all the cases of active tuberculosis, tuberculosis of doubtful activity and inactive tuberculosis present initially, describing the extent and the character of the lesion; and

(2) all the cases of active tuberculosis and the doubtfully tuberculous abnormalities which first became apparent in the course of the year. For these cases he described the first lesion, the date of each subsequent abnormality and the date the lesion attained its maximal extent. He briefly summarized the course of each case during the year.

II. PREVALENCE OF TUBERCULOSIS AMONG THE CONTACTS

Patients from 191 families were admitted to the study of chemotherapy at home and in sanatorium, the period of intake being from September 1956 to September 1957, and 97.0% of their 693 close family contacts were also examined within six weeks of the patient's admission, a further 2.5% being examined subsequently. Table 1 shows the distribution of these contacts by sex and estimated age. Of the 693 contacts, 347 were male and 346 female. Considering the sexes together, 19.0% were under five years of age and nearly half, namely, 48.5%, were under 15 years; only 6.1% were aged 55 years or more. The age distributions for the two sexes were broadly similar, although there were more males in the 10-14 age-group and more females aged 35 years or more.

Table 2 gives the distribution of the 191 families according to the numbers of close family contacts. Fifteen (7.9%) of the index cases had no family contacts. The majority of the families, namely 81.2%, had five or fewer contact members, and there were comparatively few large families, although three families had 14 contacts each. The average number of contacts for all 191 families was 3.6. Thus, including the index case, the average family consisted of 4.6 members. (This figure comes close to the latest census figure for urban communities in Madras State, which was 4.7 members per family (Venkateswaran, 1953).)

It did not prove possible to examine all the 693 contacts both by radiography and tuberculin testing at the time when treatment for the index case was started (Table 3). In all, 672 (97.0%) of the contacts were examined by radiography, and 647 (93.4%)

TABLE 1
DISTRIBUTION OF THE CONTACTS ACCORDING TO AGE AND SEX

Estimated age	Male contacts	Female contacts	Total contacts	
			No.	%
Under 6 months	9	8	17	*2.5*
6-12 months	9	11	20	*2.9*
1 year -	11	9	20	*2.9*
2 years -	13	15	28	*4.0*
3 ,, -	14	9	23	*3.3*
4 ,, -	12	12	24	*3.5*
5- 9 ,,	57	60	117	*16.9*
10-14 ,,	54	33	87	*12.6*
15-19 ,,	33	29	62	*8.9*
20-24 ,,	27	24	51	*7.4*
25-34 ,,	46	47	93	*13.4*
35-44 ,,	25	35	60	*8.7*
45-54 ,,	18	31	49	*7.1*
55-64 ,,	11	20	31	*4.5*
65 years or more	8	3	11	*1.6*
Total	347	346	693	*100.2*

TABLE 2
DISTRIBUTION OF THE FAMILIES ACCORDING TO THE NUMBER OF CONTACTS

Number of close family contacts	Families	
	No.	%
0	15	*7.9*
1	21	*11.0*
2	38	*19.9*
3	24	*12.6*
4	35	*18.3*
5	22	*11.5*
6	14	*7.3*
7	12	*6.3*
8	3	*5.2*
9	1	
10	2	
11	1	
12	0	
13	0	
14	3	
Total	191 *	*100.0*
Average number of contacts per family	3.6	

* There were 193 patients in the chemotherapy study, but these belonged to 191 families.

TABLE 3

INVESTIGATION OF THE CONTACTS BY RADIOGRAPHY AND TUBERCULIN TESTING AT THE START OF TREATMENT OF THE INDEX CASE

Investigations	Male contacts	Female contacts	Total contacts	
			No.	%
Radiograph plus acceptable 5 TU test (read two, three or four days later)	321	325	646	*93.2*
Radiograph plus unacceptable 5 TU test (read one day or more than four days later)	9	8	17	*2.5*
Radiograph but no 5 TU test	8	1	9	*1.3*
Acceptable 5 TU test but no radiograph	0	1	1	*0.1*
No radiograph and no 5 TU test	9	11	20	*2.9*
Total	347	346	693	*100.0*

had an acceptable 5 TU test (read two, three or four days after the test). Seventeen contacts had unacceptable 5 TU tests (read one day, or more than four days, after the test) and 20 contacts had neither a radiograph nor a tuberculin test. It must be emphasized that none of these initial radiographs or tuberculin tests were dated more than six weeks before or after the start of treatment of the index case, and that the great majority were performed within a few days of the appropriate date.

The prevalence survey is based on the 672 contacts with an initial radiograph (Table 3). Twenty-one contacts (3.0%) did not have a radiograph taken within six weeks of the start of treatment of the index case and so were excluded. Of these, only three were not radiographed at any time. One had a radiograph taken two months before the start of treatment of the index case; 10 were first radiographed during the first quarter after treatment, two in the second quarter, three in the third quarter, one in the last quarter and one in the thirteenth month. All except two of these 18 first radiographs were normal: a female who was first examined in the third month had an effusion with considerable pleural thickening, and pulmonary calcification was present in a male in the thirteenth month. In summary, three of the 21 contacts were never examined radiographically, and it is considered likely that two of the remaining 18 had tuberculous abnormalities present at the start of treatment of the index case.

The assessor decided that a contact had tuberculosis at the start of treatment of the index case, and assessed its activity, not just from the initial abnormal radiograph, but on the basis of the full radiographic series, and all the tuberculin-test results, bacteriological data, and clinical and pathological findings for the year. These data give greater precision to the assessment of the prevalence of tuberculosis than would be obtained from a survey based on observations more restricted in number or time.

RADIOGRAPHIC FINDINGS

Table 4 presents the independent assessor's final decision on the initial *radiographic* status of the 672 contacts. In all, 82.9% had a normal radiograph and a further 4.3% had a non-tuberculous abnormality. Definite tuberculous abnormalities were present in 12.2% of the contacts, 6.7% being classified as active tuberculosis, 0.3% as tuberculosis of doubtful activity, 1.6% as inactive tuberculosis and 3.6% as tuberculous calcification. Considering the sexes separately, 86.1% of the male contacts had normal radiographs, compared with 79.6% of the female contacts, the major part of this difference being due to the more frequent occurrence of non-

TABLE 4

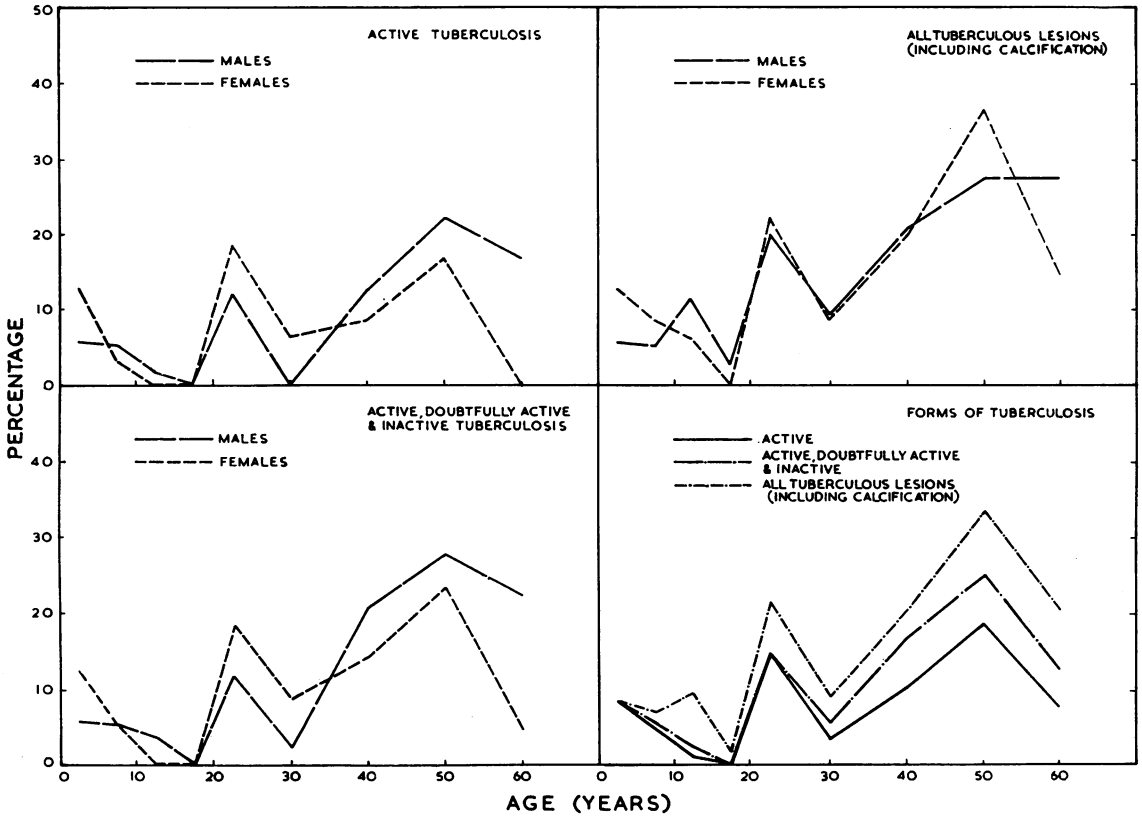
INITIAL RADIOGRAPHIC STATUS OF THE CONTACTS
(Final Decision of the Independent Assessor)

Initial radiographic status	Male contacts		Female contacts		All contacts	
	No.	%	No.	%	No.	%
Normal	291*	*86.1*	266	*79.6*	557	*82.9*
Non-tuberculous abnormality	9	*2.7*	20	*6.0*	29	*4.3*
Doubtfully tuberculous abnormality	1	*0.3*	3	*0.9*	4	*0.6*
Active tuberculosis	20	*5.9*	25	*7.5*	45	*6.7*
Tuberculosis of doubtful activity	1	*0.3*	1	*0.3*	2	*0.3*
Inactive tuberculosis	5	*1.5*	6	*1.8*	11	*1.6*
Tuberculous calcification	11	*3.3*	13	*3.9*	24	*3.6*
Total	338	*100.1*	334	*100.0*	672	*100.0*

* Includes one contact who had tuberculous cervical adenitis and a positive laryngeal swab culture.

FIG. 1

PREVALENCE OF TUBERCULOSIS IN THE CONTACTS, ACCORDING TO ACTIVITY, AGE AND SEX



tuberculous abnormalities in the females (6.0%) than in the males (2.7%), and of active tuberculosis in the females (7.5%) than in the males (5.9%).

The prevalence of all the tuberculous abnormalities in relation to age and sex is set out in the right-hand section of Table 5 and in Fig. 1. (The figures include one case of tuberculous cervical adenitis with a normal radiograph and a positive laryngeal swab culture.) The prevalence of active tuberculosis for the whole group was 6.8%. There were 12 cases of active tuberculosis among the 131 children under the age of five years (9.2%), whereas there was only one case (0.7%) in 145 contacts between the ages of 10 and 19 years. In the 20-24 age-group no less than 14.9% of the contacts had active tuberculosis and in the 45-54 age-group the proportion was 18.8%. Considering the sexes separately, the prevalence of active tuberculosis at all ages was 6.2% for males and 7.5% for females. It will be noted that in those aged 20-34 years, 4.4% of 68 males and 10.3% of the same number of females had active tuberculosis. However, among those aged 35 years or more the position was reversed, 16.7% of 60 males having active tuberculosis compared with 9.3% of 86 females. Neither of these differences attains statistical significance.

There were 11 contacts with inactive tuberculosis (not shown separately in Table 5) and of these 10 were aged 25 years or more. Amalgamating the findings for active tuberculosis, tuberculosis of doubtful activity and inactive tuberculosis, the 10-19 age-group yielded only two cases amongst 145 contacts (1.4%). Such lesions were more prevalent in males aged 35 years or more than in the females, there being 14 cases in 60 males (23.3%) compared with 13 in 86 females (15.1%).

The last columns of Table 5 present the findings for all tuberculous abnormalities, including calcifica-

TABLE 5

PREVALENCE OF TUBERCULOSIS IN THE CONTACTS, ACCORDING TO AGE AND SEX

Estimated age (years)	Number of contacts with initial radiograph			Bacteriological findings				Radiographic findings															
				contacts excreting tubercle bacilli				contacts with active tuberculosis						contacts with active, inactive or doubtfully active tuberculosis						all contacts with tuberculous lesions (including calcification)					
	male	female	total	male	female	total		male		female		total		male		female		total		male		female		total	
						No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0- 4	68	63	131	2	5	7	*5*	4*	*6*	8	*13*	12	*9*	4	*6*	8	*13*	12	*9*	4	*6*	8	*13*	12	*9*
5- 9	56	58	114	1	0	1	*1*	3	*5*	2	*3*	5	*4*	3	*5*	3	*5*	6	*5*	3	*5*	5	*9*	8	*7*
10-14	53	32	85	0	0	0	*0*	1	*2*	0	*0*	1	*1*	2	*4*	0	*0*	2	*2*	6	*11*	2	*6*	8	*9*
15-19	33	27	60	0	0	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*	1	*3*	0	*0*	1	*2*
20-24	25	22	47	2	3	5	*11*	3	*12*	4	*(18)***	7	*15*	3	*12*	4	*(18)*	7	*15*	5	*20*	5	*(23)*	10	*21*
25-34	43	46	89	0	2	2	*2*	0	*0*	3	*7*	3	*3*	1	*2*	4	*9*	5	*6*	4	*9*	4	*9*	8	*9*
35-44	24	35	59	3	1	4	*7*	3	*(12)*	3	*9*	6	*10*	5	*(21)*	5	*14*	10	*17*	5	*(21)*	7	*20*	12	*20*
45-54	18	30	48	3	4	7	*15*	4	*(22)*	5	*17*	9	*19*	5	*(28)*	7	*23*	12	*25*	5	*(28)*	11	*37*	16	*33*
55 or more	18	21	39	2	0	2	*5*	3	*(17)*	0	*(0)*	3	*8*	4	*(22)*	1	*(5)*	5	*13*	5	*(28)*	3	*(14)*	8	*21*
All ages	338	334	672	13	15	28	*4.2*	21	*6.2*	25	*7.5*	46	*6.8*	27	*8.0*	32	*9.6*	59	*8.8*	38	*11.2*	45	*13.5*	83	*12.4*

* Includes one contact with a normal radiograph who had tuberculous cervical adenitis and a positive laryngeal swab culture.

** Percentages based on fewer than 25 observations are enclosed in parentheses, as an indication of the small totals.

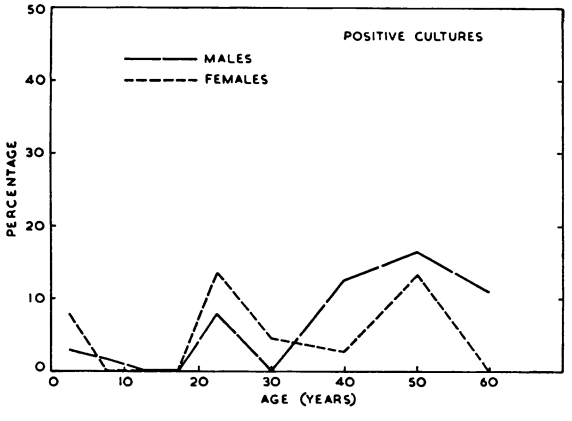
tion. The total prevalence of tuberculous abnormalities in the group was 12.4%. With the addition of the tuberculous calcifications, the differences in prevalence between the sexes in those contacts aged 20 years or more practically disappeared.

BACTERIOLOGICAL FINDINGS

The left-hand section of Table 5 and Fig. 2 show the prevalence of infectious tuberculosis according to age and sex, that is, the proportions of contacts with active tuberculosis initially who also had positive cultures, either initially (from specimens taken within six weeks of the start of treatment for the index case) or later. It will be seen that 13 (3.8%) of the 338 male and 15 (4.5%) of the 334 female contacts yielded positive cultures at some time during the year. No positive cultures were obtained from contacts between the ages of 10 and 19 years; but at ages 20-34 years two of 68 males (2.9%) and five of the same number of females (7.4%) had positive cultures. Bacteriologically confirmed tuberculosis was more prevalent among the males than among the females aged 35 years or more, eight of 60 males (13.3%) yielding a positive culture, compared with five of 86 females (5.8%). Of the total of 28 contacts who yielded positive cultures, 18 did so initially and 10 later. Seven were positive on laryngeal swab culture; the remaining 21 had positive sputum findings, 10 both on smear and on culture and 11 on culture only.

FIG. 2

PREVALENCE OF ACTIVE TUBERCULOSIS WITH POSITIVE CULTURES IN THE CONTACTS, ACCORDING TO AGE AND SEX



FORMS OF THE INITIAL TUBERCULOUS LESIONS

There was initially a total of 46 cases of active tuberculosis, two cases of tuberculosis of doubtful activity and 11 cases of inactive tuberculosis. The assessor classified all 11 cases of inactive tuberculosis and one of the two cases of tuberculosis of doubtful activity as adult-type pulmonary disease (Table 6). Of the 46 cases of active tuberculosis, 27

TABLE 6

FORMS OF THE INITIAL TUBERCULOUS LESIONS (EXCLUDING TUBERCULOUS CALCIFICATION)

Independent assessment of initial radiographic status	All tuberculous lesions	Adult-type disease (pulmonary)	Primary and post-primary type disease	Form of primary or post-primary type disease					
				miliary pulmonary tuberculosis	pleural effusion	hilar gland enlargement plus a pulmonary lesion	pulmonary lesion	hilar gland enlargement	tuberculous cervical adenitis
Active tuberculosis	46	27	19	1	1	10 *	3	3	1 **
Tuberculosis of doubtful activity	2	1	1	0	0	0	0	1	0
Inactive tuberculosis	11	11	0	0	0	0	0	0	0
Total	59	39	20	1	1	10	3	4	1

* Includes one contact who also had tuberculous cervical adenitis.

** This contact had a normal radiograph and a positive laryngeal swab culture.

TABLE 7

COURSE OF THE INITIAL ACTIVE TUBERCULOUS LESIONS

Type of tuberculous disease	All active tuberculous lesions	Progressive	Stationary	Regressive without treatment	Currently or recently under treatment	Inadequate data
Adult	27	17	3	2	5	0
Primary and post-primary	19	12 *	1	4	1	1 **
Total	46	29	4	6	6	1

* Includes one contact with a normal radiograph who had tuberculous cervical adenitis and a positive laryngeal swab culture.

** This contact was a child aged four years, who had only one radiograph taken and died in the first month; the cause of death could not be ascertained.

were classified as adult-type pulmonary disease and the remaining 19 as primary or post-primary type disease, only three of these being simple hilar gland enlargement.

The assessor also classified the active tuberculous lesions as progressive, stationary or regressive (Table 7). He based his opinion on the type of lesion present initially, and also on the course, taking into account any antituberculosis chemotherapy which was given. Of the 27 adult-type lesions, 17 were classified as progressive, compared with 12 of the 19 primary and post-primary lesions. Seven cases were not assessed; six had either recently been or were currently under treatment when the initial radiograph was taken, and one had inadequate data. It may be concluded that the majority (74.4%) of the 39 lesions for which an assessment was possible were progressive in character, whether primary, post-primary or adult-type.

The assessor classified the extent of the active intrapulmonary lesions (not tabulated here). Of the 27 adult-type lesions, 10 were bilateral, 10 were cavitated (two extensively so) and 16 occupied an area greater than two posterior rib interspaces.[1] Of 14 primary or post-primary intrapulmonary lesions, all except one were unilateral and none was cavitated, but five occupied an area greater than two posterior rib interspaces.

Of the 27 contacts with adult-type disease, 19 yielded a positive culture, representing 2.8% of the 672 contacts with an initial radiograph. A positive culture was also obtained in nine of the 19 contacts with primary or post-primary disease, i.e., 1.3% of the contacts radiographed initially.

An analysis (not tabulated here) was also made of the type of the disease in relation to age. Of the 27 contacts with adult-type disease, all except one, a child aged nine years, were at least 20 years old. Of the 19 with primary or post-primary type disease, 12 were less than five years old and four were between five and nine years; the remaining three were aged 10, 20 and 20 years, respectively.

As already explained (see page 467), the cases of active tuberculosis among the contacts were not automatically given antituberculosis chemotherapy. Of the 46 cases of initial active tuberculosis, six had already recently received antituberculosis chemotherapy, and a further 22 did so at some time during the year. Of these 28 treated cases, 18 had adult and 10 primary or post-primary type disease.

It may be concluded from this analysis that the majority of the tuberculous lesions detected in the prevalence survey were progressive and that many were in need of treatment.

RESULTS OF DRUG-SENSITIVITY TESTS

Tests of sensitivity to streptomycin, *p*-aminosalicylic acid (PAS) and isoniazid were performed as a matter of routine on any positive diagnostic culture from the contacts. Of the 28 contacts with a positive sputum, results of streptomycin-sensitivity tests were available for 23, all of which were sensitive.

[1] Defined as the area represented by the fourth and fifth posterior interspaces and the intervening rib, as seen on a postero-anterior radiograph.

PAS-sensitivity tests were performed on cultures from the same number of contacts; 22 were sensitive and one was resistant, the latter result being obtained in a contact with newly diagnosed disease (the index case had PAS-sensitive organisms). Isoniazid-sensitivity tests were performed on cultures from 22 contacts and two were resistant; one of these was in a contact who had previously received chemotherapy which included isoniazid; the other contact was newly diagnosed and had no history of previous treatment, and her index case also had primarily isoniazid-resistant organisms.

FAMILIES WITH TUBERCULOUS CONTACTS INITIALLY IN ADDITION TO THE INDEX CASE

There were 176 families with one or more contacts in this study, their average size being 4.9 members, including the index case. Forty-seven of these families (26.7%) had initially (in addition to the index case) at least one contact with active, inactive or doubtfully active tuberculosis. Of these 47 families, four had two such contacts and two had three such contacts ; one family had four tuberculous contacts. A total of 37 families (21.0%) had one or more contacts with *active* tuberculosis, in addition to the index case. Of these, four had two contacts with active disease and one had three such contacts; one family had four contacts with active tuberculosis.

TUBERCULIN SENSITIVITY TO 5 TU IN THE INDEX CASES

In determining, for any community, the minimum diameter of induration which indicates tuberculous infection, a useful approach is to study the results of tuberculin tests on a group of tuberculous patients in the same community (Edwards & Guld, 1951; WHO Tuberculosis Research Office, 1955a; Edwards, Edwards & Palmer, 1959). Such results are available for the patients in the chemotherapy study (all excreting tubercle bacilli), on whom a 5 TU test was performed as a matter of routine during their pre-treatment investigations, concurrently with the initial examinations of their close family contacts. The findings for the index cases are set out in Table 8 and Fig. 3 for males and females separately and combined. Very few patients had indurations of less than 5 mm. The distribution suggests that an

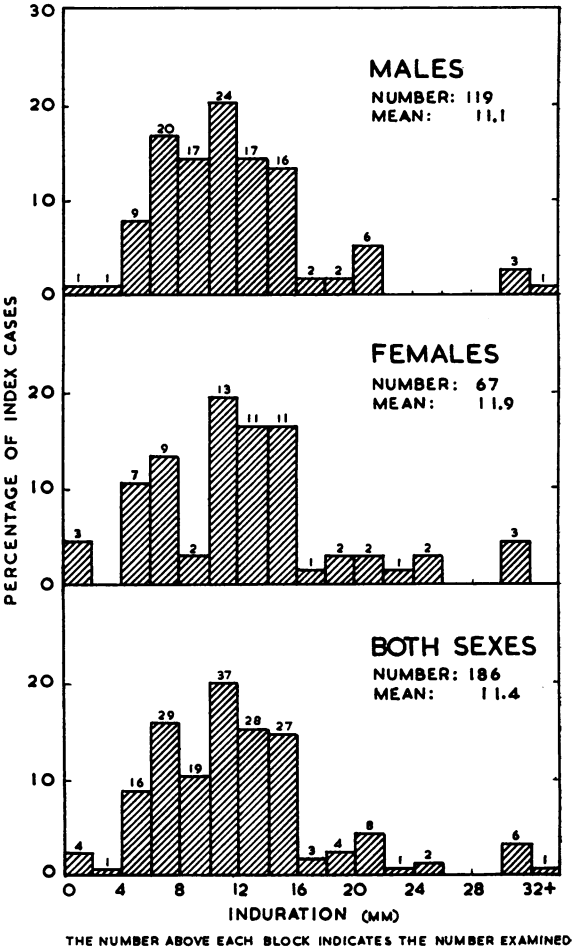
TABLE 8

RESULTS OF INITIAL 5 TU TESTS IN THE INDEX CASES, ALL EXCRETING TUBERCLE BACILLI, ACCORDING TO SEX

Diameter of induration (mm)	Male index cases		Female index cases		All index cases	
	No.	%	No.	%	No.	%
0- 4	3	*2.5*	3	*4.5*	6	*3.2*
5- 9	45	*37.8*	18	*26.9*	63	*33.9*
10-14	42	*35.3*	24	*35.8*	66	*35.5*
15-19	19	*16.0*	14	*20.9*	33	*17.7*
20-24	6	*5.0*	3	*4.5*	9	*4.8*
25 or more	4	*3.4*	5	*7.5*	9	*4.8*
Total	119	*100.0*	67	*100.1*	186	*99.9*

FIG. 3

DISTRIBUTION OF INDURATIONS TO THE INITIAL 5 TU TEST IN THE *INDEX CASES*, ACCORDING TO SEX



THE NUMBER ABOVE EACH BLOCK INDICATES THE NUMBER EXAMINED

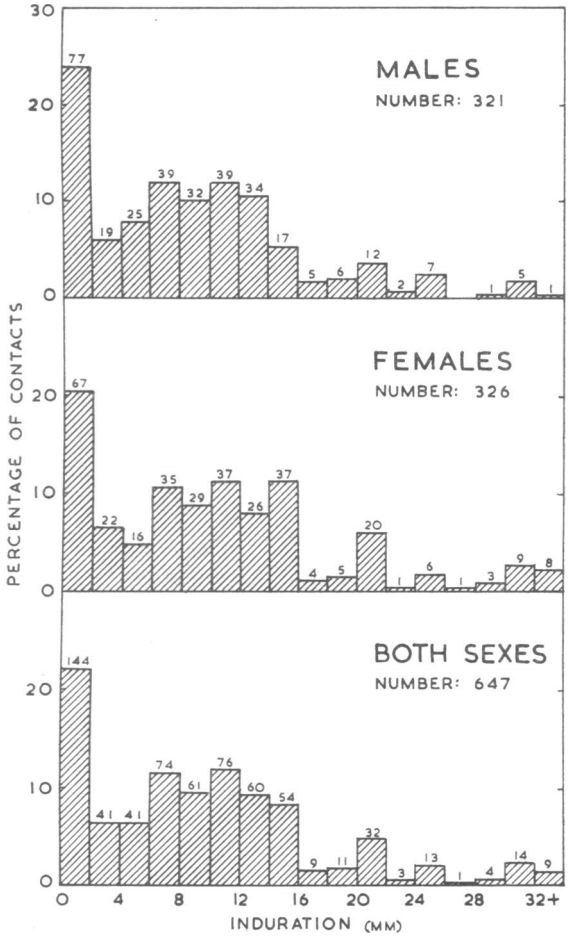
induration of 5 mm or more indicates tuberculous infection.

TUBERCULIN SENSITIVITY TO 5 TU IN THE CONTACTS

Of the 693 close family contacts, 647 had an initial 5 TU test read two, three or four days later. Table 9 and Fig. 4 show the distribution of the size of induration to 5 TU for the males and females, separately and combined. Considering both sexes, 29.7% had indurations of less than 5 mm, 46.4% had indurations of less than 8 mm, and 55.8% had indurations of less than 10 mm. These percentages were slightly higher for males than for females. Table 10 and Fig. 5 show the distribution of the

FIG. 4

DISTRIBUTION OF INDURATIONS TO THE INITIAL 5 TU TEST IN THE CONTACTS, ACCORDING TO SEX



THE NUMBER ABOVE EACH BLOCK INDICATES THE NUMBER EXAMINED

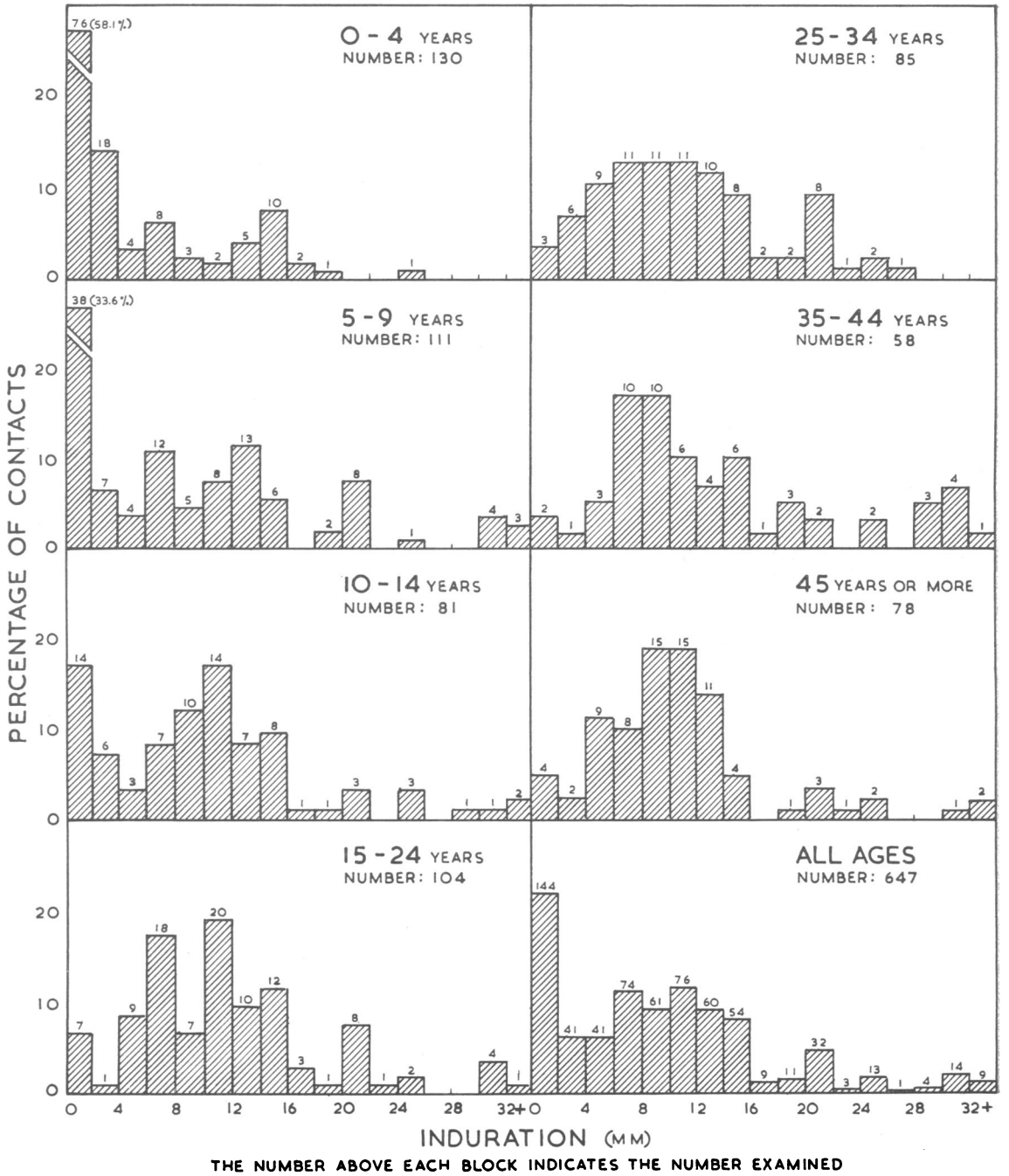
TABLE 9

RESULTS OF INITIAL 5 TU TESTS IN THE CONTACTS, ACCORDING TO SEX

Diameter of induration (mm)	Male contacts		Female contacts		All contacts	
	No.	%	No.	%	No.	%
0	76		67		143	
1	1		0		1	
2	13	*31.5*	13	*27.9*	26	*29.7*
3	6		9		15	
4	5		2		7	
5	20		14		34	
6	18	*18.4*	20	*15.0*	38	*16.7*
7	21		15		36	
8	31	*10.0*	27	*8.9*	58	*9.4*
9	1		2		3	
10	37		34		71	
11	2		3		5	
12	32		20		52	
13	2		6		8	
14	1		3		4	
15	16		34		50	
16	2		2		4	
17	3		2		5	
18	6		5		11	
19	0		0		0	
20	12		20		32	
21	0	*40.2*	0	*48.2*	0	*44.2*
22	2		1		3	
23	0		0		0	
24	2		1		3	
25	5		5		10	
26	0		1		1	
27	0		0		0	
28	1		3		4	
29	0		0		0	
30	5		9		14	
31	0		0		0	
32 or more	1		8		9	
Total	321	*100.1*	326	*100.0*	647	*100.0*

FIG. 5

DISTRIBUTION OF INDURATIONS TO THE INITIAL 5 TU TEST IN THE CONTACTS, ACCORDING TO AGE



THE NUMBER ABOVE EACH BLOCK INDICATES THE NUMBER EXAMINED

TABLE 10

RESULTS OF INITIAL 5 TU TESTS IN THE CONTACTS, ACCORDING TO AGE

Diameter of induration (mm)	Age of contact (years)															
	0-4		5-9		10-14		15-24		25-34		35-44		45 or more		all ages	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0	75		38		14		7		3		2		4		143	
1	1		0		0		0		0		0		0		1	
2	13	*73*	5	*42*	2	*26*	1	*10*	4	*12*	1	*5*	0	*8*	26	*30*
3	5		2		4		0		2		0		2		15	
4	1		2		1		2		1		0		0		7	
5	3		2		2		7		8		3		9		34	
6	6	*8*	9	*13*	2	*11*	8	*24*	5	*22*	5	*22*	3	*22*	38	*17*
7	2		3		5		10		6		5		5		36	
8	3	*2*	3	*5*	10	*12*	7	*7*	11	*13*	10	*17*	14	*19*	58	*9*
9	0		2		0		0		0		0		1		3	
10	2		8		14		18		10		6		13		71	
11	0		0		0		2		1		0		2		5	
12	4		10		7		8		9		4		10		52	
13	1		3		0		2		1		0		1		8	
14	1		2		0		0		0		0		1		4	
15	9		4		8		12		8		6		3		50	
16	0		0		0		3		1		0		0		4	
17	2		0		1		0		1		1		0		5	
18	1		2		1		1		2		3		1		11	
19	0		0		0		0		0		0		0		0	
20	0		8		3		8		8		2		3		32	
21	0	*16*	0	*41*	0	*51*	0	*60*	0	*53*	0	*55*	0	*51*	0	*44*
22	0		0		0		1		1		0		1		3	
23	0		0		0		0		0		0		0		0	
24	0		0		1		0		1		1		0		3	
25	1		1		2		2		1		1		2		10	
26	0		0		0		0		1		0		0		1	
27	0		0		0		0		0		0		0		0	
28	0		0		1		0		0		3		0		4	
29	0		0		0		0		0		0		0		0	
30	0		4		1		4		0		4		1		14	
31	0		0		0		0		0		0		0		0	
32 or more	0		3		2		1		0		1		2		9	
Total	130	*99*	111	*101*	81	*100*	104	*101*	85	*100*	58	*99*	78	*100*	647	*100*

TABLE 11

RESULTS OF INITIAL 5 TU TESTS IN THE CONTACTS UNDER FIVE YEARS OF AGE

Diameter of induration (mm)	Age-group of contact											
	under 6 months		6-12 months		1 year -		2 years -		3 years -		4 years -	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0-4	17	(100)*	13	(68)	15	(79)	21	75	15	(65)	14	(58)
5-7	0	(0)	4	(21)	0	(0)	2	7	1	(4)	4	(17)
8-9	0	(0)	1	(5)	0	(0)	0	0	1	(4)	1	(4)
10-14	0	(0)	0	(5)	2	(21)	2	18	2	(26)	2	(21)
15 or more	0		1		2		3		4		3	
Total	17	100	19	99	19	100	28	100	23	99	24	100

* Percentages based on fewer than 25 observations are enclosed in parentheses, as an indication of the small totals.

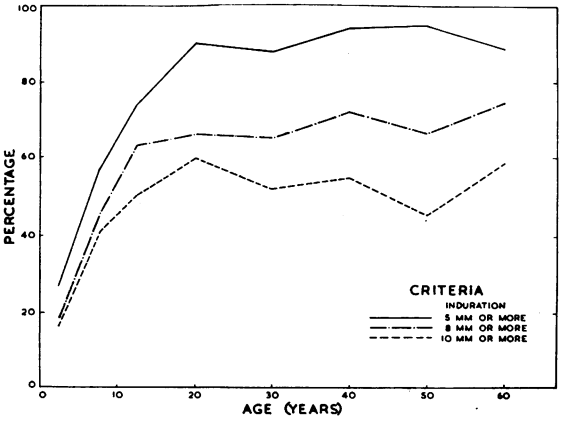
size of the indurations to 5 TU according to age. In the 130 contacts under five years of age the majority of indurations, namely 73%, were 4 mm or less; there was a progressive decrease in the proportion of contacts with indurations of 0-4 mm with increasing age to 42% at ages 5-9, 26% at ages 10-14 and 10% at ages 15-24 years. This proportion showed little further change at higher ages. There were relatively few indurations in the 1-4 mm range at any age. Considering Table 10 and the shape of the distributions in Fig. 5, and comparing them with that for the index cases (see Fig. 3), it seems likely that in this group of contacts, as with the index cases, an induration of 5 mm or more to the 5 TU test was indicative of tuberculous infection.

In Table 11 the results of the initial 5 TU test in the contacts under five years of age are considered in further detail. All 17 contacts less than six months old had indurations of 0-4 mm. The corresponding proportion for the 19 contacts aged 6-12 months was 68%. The proportion with induration of 0-4 mm in the second year was 79%, and decreased to 58% in the fifth year. Conversely, the proportion with induration of 10 mm or more increased after the first year; only one of 36 contacts under 12 months of age had such an induration, compared with approximately 20% in each of the subsequent four years. Thus, whereas none of the very young contacts showed evidence of tuberculous infection, there was evidence of its occurrence from the age of six months upwards.

Fig. 6 presents graphically the percentage of contacts positive initially according to three different criteria for a positive reaction—namely, induration of 5 mm or more (the level indicated by the above distributions and used as a standard in some BCG campaigns); 8 mm or more (the standard used in the mass BCG vaccination campaigns in India: P. V. Benjamin, personal communication); and 10 mm or more (the standard now used in the mass BCG campaigns in many other countries). With the criterion of 5 mm or more of induration, the graph

FIG. 6

PERCENTAGE OF CONTACTS WHO WERE POSITIVE TO THE INITIAL 5 TU TEST, BY AGE, ACCORDING TO THREE DIFFERENT CRITERIA FOR A POSITIVE REACTION



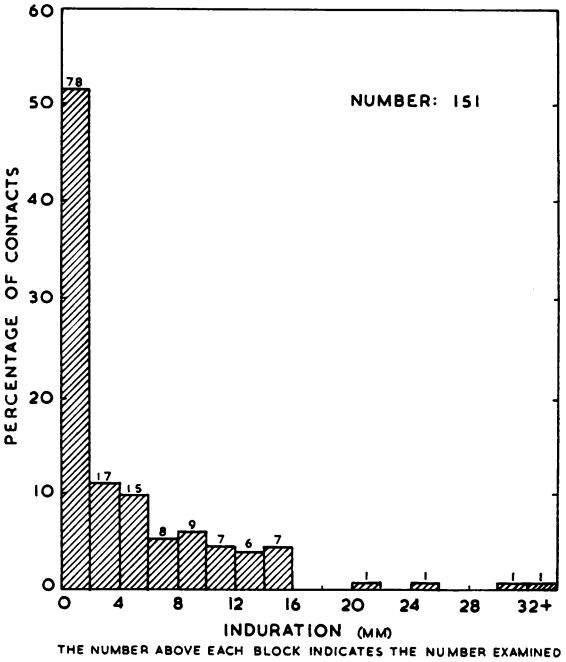
ascends very steeply; from the age of 20 years upwards, about 90% of the contacts gave a positive reaction. The graph for 8 mm induration or more also shows a rapid increase, reaching 66% positive at the age of 20 years with a tendency to rise further in the older age-groups, the highest level reached being 75%. The graph for the criterion of 10 mm or more induration also shows a steep increase to 60% at 20 years, but then flattens out, with some slight evidence of a decline in the percentage positive in the older age-groups.

It should be observed that RT 22, the batch of tuberculin PPD used in this study, is known to be rather weaker than the International Standard PPD (Guld et al., 1958); in this Centre, also, the indurations obtained with 5 TU of RT 22 were found to be about 1.5 mm smaller on the average than those obtained in a simultaneous blind comparison with 5 TU of RT 19-21 tuberculin. For a contact group with a prevalence of 7% of active tuberculosis, the criterion of 5 mm or more, according to which 90% of the group were positive at the age of 20, appears to represent a more likely indicator of tuberculous infection than the 66% represented by the 8 mm criterion or the 60% of the 10 mm criterion.

TUBERCULIN SENSITIVITY TO 50 OR 100 TU IN THE CONTACTS

It remains to consider the findings of the 50 and 100 TU tests in those contacts who had indurations of less than 5 mm to the 5 TU test. Of 151 contacts tested with 50 or 100 TU (Table 12 and Fig. 7),

FIG. 7
DISTRIBUTION OF INDURATIONS TO THE INITIAL 100 (or 50) TU TEST IN THE CONTACTS, AMONG THOSE WITH 0-4 MM INDURATION TO THE 5 TU TEST



THE NUMBER ABOVE EACH BLOCK INDICATES THE NUMBER EXAMINED

TABLE 12
RESULTS OF INITIAL 50 TU AND 100 TU TESTS IN THE CONTACTS WITH INDURATION OF LESS THAN 5 MM TO THE 5 TU TEST

Results of 50 TU tests					Results of 100 TU tests				
induration to 50 TU test (mm)	0-1 mm to 5 TU test	2-4 mm to 5 TU test	0-4 mm to 5 TU test		induration to 100 TU test (mm)	0-1 mm to 5 TU test	2-4 mm to 5 TU test	0-4 mm to 5 TU test	
			No.	%				No.	%
0-4	35	9	44	*65.7*	0-4	48	10	58	*69.0*
5-7	7	0	7	*10.4*	5-7	4	5	9	*10.7*
8-9	4	2	6	*9.0*	8-9	2	1	3	*3.6*
10-14	1	4	5	*7.5*	10-14	6	2	8	*9.5*
15-19	2	1	3	*4.5*	15-19	3	1	4	*4.8*
20 or more	1	1	2	*3.0*	20 or more	2	0	2	*2.4*
Total	50	17	67	*100.1*	Total	65	19	84	*100.0*

102 (67.5%) had an induration of less than 5 mm and only 24 (15.9%) had an induration of 10 mm or more. The indurations were, in general, small, although a proportion of the contacts reacted with indurations of large diameter to these strong doses of tuberculin. These findings suggest that positive tuberculin reactions due to infections other than tuberculosis were not frequent in this group of close family contacts.

III. ATTACK RATE OF TUBERCULOSIS IN CONTACTS OF PATIENTS TREATED AT HOME AND IN SANATORIUM

A total of 693 close family contacts of patients in the chemotherapy study was surveyed in section II of this report, to determine the prevalence of tuberculosis and tuberculous infection among them. Of these 693 close contacts, 335 were contacts of patients treated at home (" home " contacts) and 358 were contacts of patients treated in sanatorium (" sanatorium " contacts). It was necessary, however, to exclude a number of the contacts from each group so that the attack rates of tuberculosis in the two groups could be satisfactorily compared.

First, the 21 contacts (six home, 15 sanatorium) with no initial radiographic examination were excluded, since it could not be assumed that their radiographic appearances were normal at the time of the start of treatment for the index case. Secondly, 63 contacts (32 home, 31 sanatorium) were excluded because they had an abnormal initial radiograph which was classified as active tuberculosis, tuberculosis of doubtful activity, inactive tuberculosis or a doubtfully tuberculous abnormality by the assessor, and so could not contribute to the attack rate of tuberculosis. Thirdly, it was of particular importance to have a sharp contrast between the home and sanatorium groups in terms of exposure to infectious tuberculosis. It was therefore decided to exclude from the comparison all the families which were shown in the prevalence survey to have one or more members excreting tubercle bacilli, in addition to the index case. A further 77 contacts (40 home, 37 sanatorium) with no initial evidence of tuberculosis (apart from calcification) in 23 families (11 home, 12 sanatorium) were excluded for this reason; the findings for these 77 contacts will be considered separately below (see page 495). As a result of these exclusions, the comparison was between the close family contacts of an infectious index case who had not been segregated from the family, and the close family contacts whose infectious index case had been segregated in sanatorium.

After all these exclusions there remain 532 close family contacts, from 148 families, who contribute to the comparison—namely, 257 contacts of 75 patients treated at home and 275 contacts of 73 patients treated in sanatorium.

The treatment of the index case at home or in sanatorium had been determined by random allocation (Tuberculosis Chemotherapy Centre, 1959) and so the contacts were divided into the two groups under study as a consequence of this random process.

CONTACT WITH THE INDEX CASE DURING THE YEAR

The proximity and duration of contact with the index case in the course of the year was studied. Of the 257 close contacts in the home series, 201 (78.2%) continued in close contact throughout the year (that is, continued to live, cook and feed with the index case) and were not known to have been away from the family at all, or to have been away for at most a total period of one month. The remaining 56 contacts (21.8%) had reduced contact with the index case for at least one month, owing in most instances to the contacts being away from the family, but in a small number to the death of the index case or his admission to hospital. Of these 56 home contacts, 16 (6.2% of the 257) had been in close contact for the whole of the first three months, including nine (3.5%) who had been in close contact for the whole of the first six months. Considering the 275 sanatorium contacts, a very high proportion (94.9%) had, for all practical purposes, no contact with the index case. The remaining 14 contacts (5.1%) had renewed contact since their five index cases were prematurely discharged from sanatorium between the third and the seventh month. Although the patients in sanatorium were allowed visitors, few contacts could afford to visit frequently, as the sanatorium is situated 16 miles (25 km) from Madras City. In the second six months of treatment, sanatorium patients were

permitted to go home for 12 hours once a month, but by this time very few were infectious (Tuberculosis Chemotherapy Centre, 1959). These deviations in degree of contact are unlikely to have affected the major difference between the exposure of the home and the sanatorium groups to the index case during the year.

COMPARISON OF THE TWO GROUPS

Before comparing the attack rate of tuberculosis in the two groups of contacts in the course of the year it is necessary:

(1) to verify that as a result of the random allocation process the two groups were similar initially; and

(2) to determine whether the two groups were investigated with equal intensity by radiography, tuberculin testing and bacteriology during the year.

It will be appreciated from the description of the procedures for investigation already given (see page 467) that the frequency of investigation of the groups was to some extent dependent on the number of radiographic abnormalities which the clinic doctors observed, and on the number of instances of major changes in tuberculin sensitivity, as well as on the clinical features. A consistent tendency to over-read (or under-read) the radiographs in one of the contact groups, or greater concern about clinical features in one group than in the other, could have introduced differences in the intensity of investigation. On the other hand, the occurrence of more abnormalities in one group than in the other could also lead to such differences.

Age distribution of the contacts

There were 130 males among the home contacts and 141 among the sanatorium contacts; the corresponding figures for females were 127 and 134. Table 13 shows the age distribution for the two groups of contacts: 20.6% of the home contacts were under five years of age, compared with 17.5% of the sanatorium contacts; 51.4% of the home and 48.4% of the sanatorium contacts were children under 15 years old. At the other end of the age-scale 10.5% of home contacts were 45 years old or more, compared with 11.6% of sanatorium contacts. The age distributions were very similar for the two groups.

Size of the home and sanatorium family contact groups

The final section of Table 13 shows the distribution of the 75 home and 73 sanatorium families according to the number of close family contacts contributing to the comparison. There was only one such contact in 17.3% of the home families, compared with 11.0% of the sanatorium families; 17.3% of the home families had two close contacts in the comparison, compared with 26.0% of the sanatorium families; and there were six (8.0%) home families and 15 (20.5%) sanatorium families with more than five

TABLE 13

INITIAL COMPARISON OF THE HOME AND SANATORIUM CONTACTS AND FAMILY GROUPS

		Home contacts		Sanatorium contacts	
		No.	%	No.	%
Estimated age (years)	0-4	53	*20.6*	48	*17.5*
	5-14	79	*30.7*	85	*30.9*
	15-24	35	*13.6*	52	*18.9*
	25-34	37	*14.4*	37	*13.5*
	35-44	26	*10.1*	21	*7.6*
	45 or more	27	*10.5*	32	*11.6*
	Total	257	*99.9*	275	*100.0*
Diameter of induration to initial 5 TU test (mm)	0-4	86	*35.0*	87	*32.7*
	5-7	46	*18.7*	39	*14.7*
	8-9	24	*9.8*	24	*9.0*
	10-14	39	*15.9*	56	*21.1*
	15-19	24	*9.8*	24	*9.0*
	20-24	13	*5.3*	21	*7.9*
	25 or more	14	*5.7*	15	*5.6*
	Total tested	246	*100.2*	266	*100.0*
		Home families		Sanatorium families	
		No.	%	No.	%
Number of close family contacts in the comparison	1	13	*17.3*	8	*11.0*
	2	13	*17.3*	19	*26.0*
	3	17	*22.7*	9	*12.3*
	4	13	*17.3*	14	*19.2*
	5	13	*17.3*	8	*11.0*
	6 or 7	2	*2.7*	12	*16.4*
	8 or more	4	*5.3*	3	*4.1*
	Total	75	*99.9*	73	*100.0*

contacts in the comparison. There were thus irregularities in the distributions, but no consistent differences. The average number of contacts in the home families was 3.4 and in the sanatorium families 3.8. Since the home contacts also had the index case living with them, their total family size was increased by 1.

Results of the initial radiographic examination

The prevalence of non-tuberculous abnormalities and of tuberculous calcifications on the initial radiographs (not tabulated here) can be used as points of initial comparison of the home and sanatorium contacts. Of the 257 home contacts, 11 (4.3%) had a non-tuberculous abnormality and a further 10 (3.9%) had tuberculous calcification on the initial radiograph. The corresponding figures for the 275 sanatorium contacts were 13 (4.7%) and 10 (3.6%). Thus, the two groups were similar in these respects.

Results of initial tuberculin tests

The middle section of Table 13 shows the results of the initial 5 TU tests. Indurations of 0-4 mm were shown by 35.0% of the home contacts and 32.7% of the sanatorium contacts. The corresponding figures for indurations of 5-7 mm were 18.7% and 14.7%, and for 8-9 mm 9.8% and 9.0%. At the other extreme 5.7% and 5.6%, respectively, had indurations of 25 mm or more. Thus, the two distributions were similar.

The distributions of the initial 50 or 100 TU test results, in 76 home and 77 sanatorium contacts with indurations of 0-4 mm to 5 TU, were similar and have not been tabulated here.

Intensity of radiographic examination during the year

Table 14 sets out the numbers of home and sanatorium contacts who had radiographs taken at each of the four set examinations during the year—namely, at three, six and nine months and at one year. At three months 91.7% of the home and 90.9% of the sanatorium contacts were radiographed. The proportions at six and nine months fell just below 90%, but were similar in the two groups. Special efforts were made to get the contacts to attend at the end of the year, a number coming from their villages, with the result that 92.8% of the surviving home and 94.9% of the surviving sanatorium contacts were radiographed at one year. There was thus very little difference between the intensity of the set radiographic investigations of the home and sanatorium contacts, and very high proportions of both groups were radiographed at the end of the period.

TABLE 14
NUMBERS OF HOME AND SANATORIUM CONTACTS WITH RADIOGRAPHS TAKEN AT THE FOUR SET EXAMINATIONS DURING THE YEAR

Months after initial examination	Home contacts			Sanatorium contacts		
	total surviving contacts	radiographed		total surviving contacts	radiographed	
		No.	%		No.	%
3	253	232	*91.7*	275	250	*90.9*
6	251	220	*87.6*	274	237	*86.5*
9	251	218	*86.9*	272	241	*88.6*
12	250	232	*92.8*	272	258	*94.9*

The first section of Table 15 sets out, for the contacts in the home and sanatorium groups, the total number of radiographs taken during the course of the year (apart from the initial radiograph), whether these were taken at the four set examinations or were extra radiographs. The contacts who developed tuberculosis and were admitted to treatment during the year are classified according to the number of radiographs taken up to the date of the start of treatment only, since from then on a prescribed routine of investigation was followed. The majority, namely 80.9% of the home and 82.2% of the sanatorium contacts, had from three to six radiographs; less than 10% of each group had fewer than three radiographs, and a similar proportion of each group had more than six. The average number of radiographs was 4.2 for the home and 4.5 for the sanatorium contacts. It may be concluded that the general intensity of radiographic examination during the year was very similar for the two groups.

Intensity of bacteriological investigation during the year

The numbers of cultures for tubercle bacilli are also set out for the two groups in Table 15. Again, the investigations performed after the start of treatment on contacts who developed tuberculosis and were treated during the year have not been included. The majority in both groups, namely 79.0% of the home and 80.0% of the sanatorium contacts, had no bacteriological investigations in the course of the year. A further 10.9% of the home contacts and 10.5% of the sanatorium contacts had one or two

TABLE 15
INTENSITY OF EXAMINATION OF THE HOME AND SANATORIUM CONTACTS DURING THE YEAR

		Home contacts		Sanatorium contacts	
		No.	%	No.	%
Number of radiographic examinations *	0-2	25	9.7	22	8.0
	3	26	10.1	30	10.9
	4	117	45.5	112	40.7
	5	45	17.5	49	17.8
	6	20	7.8	35	12.7
	7 or more	24	9.3	27	9.8
Average number of radiographs		4.2		4.5	
Number of culture examinations	0	203	79.0	220	80.0
	1-2	28	10.9	29	10.5
	3-4	11	4.3	13	4.7
	5-7	10	3.9	9	3.3
	8 or more	5	1.9	4	1.5
Average number of cultures **		3.4		3.2	
Number of 5 TU tests *	0	43	16.7	63	22.9
	1	69	26.8	62	22.5
	2	52	20.2	59	21.5
	3	45	17.5	44	16.0
	4	35	13.6	30	10.9
	5 or more	13	5.1	17	6.2
Average number of tests		2.0		1.9	
Total		257	100.0	275	100.0

* Excluding the initial examination
** For those contacts with one or more examinations

cultures examined. At the other extreme, 1.9% of the home and 1.5% of the sanatorium contacts had eight or more cultures examined. The average numbers of examinations for those contacts who had one or more cultures were 3.4 and 3.2, respectively. Further analyses (not tabulated here) showed that the numbers of sputum cultures and of laryngeal swab cultures in the two groups were also similar.

Intensity of tuberculin testing during the year

The numbers of 5 TU tests (apart from the initial test) that were performed in the two groups in the course of the year are set out in the final section of Table 15. Of the home contacts 63.8% and of the sanatorium contacts 66.9% had no tuberculin test or one or two tests during the year; 18.7% of the home and 17.1% of the sanatorium contacts had four tests or more. The average number of tests was 2.0 for the home contacts and 1.9 for the sanatorium contacts. The distributions were thus similar. An analysis of the 50 and 100 TU tests (not tabulated here) also showed a very similar intensity of investigation of the two groups.

In summary, the groups of home and sanatorium contacts were similar not only initially, but also in the intensity with which they were studied in the course of the year.

ATTACK RATE OF TUBERCULOSIS AMONG THE CONTACTS

Table 16 shows the results of the independent assessment of the *radiographic* abnormalities which first became apparent during the year among the 257 home and 275 sanatorium contacts. There were 15 (5.8%) non-tuberculous abnormalities among the home contacts and 15 (5.5%) among the sanatorium contacts; doubtfully tuberculous abnormalities occurred in five (1.9%) and in one (0.4%), respectively. Radiographically, active tuberculosis developed during the course of the year in eight home contacts (3.1%) and in 17 sanatorium contacts (6.2%).

TABLE 16
INCIDENCE OF NEW RADIOGRAPHIC ABNORMALITIES DURING THE YEAR IN THE HOME AND SANATORIUM CONTACTS WITH NORMAL RADIOGRAPHS, NON-TUBERCULOUS ABNORMALITIES OR TUBERCULOUS CALCIFICATION INITIALLY

Type of abnormality	Home contacts		Sanatorium contacts	
	No.	%	No.	%
No new abnormality	229	89.1	242	88.0
New non-tuberculous abnormality	15	5.8	15	5.5
Doubtfully tuberculous abnormality	5 *	1.9	1	0.4
Active tuberculosis	8	3.1	17	6.2
Total	257	99.9	275	100.1

* Includes one contact who had active tuberculosis confirmed by a positive sputum culture. This contact is classified as having active tuberculosis in Tables 17 to 20.

TABLE 17

ATTACK RATE OF TUBERCULOSIS DURING THE YEAR IN THE HOME AND SANATORIUM CONTACTS, ACCORDING TO AGE AND SEX

Sex	Estimated age (years)	Number of contacts with normal radiograph (or non-tuberculous abnormality) initially		Contacts who developed active tuberculosis				Contacts who developed active or doubtful tuberculosis			
				home		sanatorium		home		sanatorium	
		home	sanatorium	No.	%	No.	%	No.	%	No.	%
Both sexes	0-4	53	48	5	*9.4*	10	*20.8*	7	*13.2*	11	*22.9*
	5-9	47	47	3	*6.4*	3	*6.4*	4	*8.5*	3	*6.4*
	10-14	32	38	0	*0.0*	0	*0.0*	1	*3.1*	0	*0.0*
	15-19	20	32	1	*(5.0)**	2	*6.2*	1	*(5.0)*	2	*6.2*
	20-24	15	20	0	*(0.0)*	0	*(0.0)*	0	*(0.0)*	0	*(0.0)*
	25-34	37	37	0	*0.0*	0	*0.0*	0	*0.0*	0	*0.0*
	35 or more	53	53	0	*0.0*	2	*3.8*	0	*0.0*	2	*3.8*
	Total	257	275	9	*3.5*	17	*6.2*	13	*5.1*	18	*6.5*
Male	0-4	34	20	4	*11.8*	2	*(10.0)*	5	*14.7*	2	*(10.0)*
	5-9	22	23	2	*(9.1)*	2	*(8.7)*	3	*(13.6)*	2	*(8.7)*
	10 or more	74	92	0	*0.0*	3	*3.3*	1	*1.4*	3	*3.3*
Female	0-4	19	28	1	*(5.3)*	8	*28.6*	2	*(10.5)*	9	*32.1*
	5-9	25	24	1	*4.0*	1	*(4.2)*	1	*4.0*	1	*(4.2)*
	10 or more	83	88	1	*1.2*	1	*1.1*	1	*1.2*	1	*1.1*

* Percentages based on fewer than 25 observations are enclosed in parentheses, as an indication of the small totals.

The distribution of *all* the cases of active tuberculosis by sex and age is shown in Table 17. Fig. 8 gives the findings for the home and the sanatorium contacts separately and Fig. 9 for the males and the females separately. (The totals include one case with a positive sputum culture whose radiograph was classified as showing a doubtfully tuberculous abnormality.) Five of the cases in the home contacts and 10 of those in the sanatorium contacts were children under five years of age, representing an attack rate of 9.4% for the 53 home contacts and 20.8% for the 48 sanatorium contacts in this age-group. At ages 5-9 years three of the 47 home contacts (6.4%) and three of the same number of sanatorium contacts (6.4%) developed active tuberculosis during the year, only one of these cases being aged seven years or more. There were three cases aged 15-19 years (one home, two sanatorium contacts) and two (both sanatorium contacts) aged 35 years or more. Thus in both groups the attack mainly involved infants and young children. Six of the nine cases in home contacts and seven of the 17 in sanatorium contacts were males.

The incidence of active tuberculosis according to the diameter of induration to the initial 5 TU test is given in Table 18 and Fig. 10. Of those contacts with induration of 0-4 mm initially (regarded as a negative tuberculin reaction in this study), seven of the 86 home contacts (8.1%) and five of the 87 sanatorium contacts (5.7%) developed active tuberculosis during the year. In the 5-7 mm group (regarded as weak positive reactions), there was one case in 46 home contacts (2.2%) and two cases in 39 sanatorium contacts (5.1%). Among those with indurations of

TABLE 18

ATTACK RATE OF TUBERCULOSIS DURING THE YEAR IN THE HOME AND SANATORIUM CONTACTS, ACCORDING TO INDURATION TO THE INITIAL 5 TU TEST

Diameter of induration to initial 5 TU test (mm)	Number of contacts with normal radiograph (or non-tuberculous abnormality) initially		Contacts who developed active tuberculosis				Contacts who developed active or doubtful tuberculosis			
			home		sanatorium		home		sanatorium	
	home	sanatorium	No.	%	No.	%	No.	%	No.	%
0-4	86	87	7	*8.1*	5	*5.7*	9	*10.5*	6	*6.9*
5-7	46	39	1	*2.2*	2	*5.1*	2	*4.3*	2	*5.1*
8-9	24	24	0	*(0.0)**	3	*(12.5)*	0	*(0.0)*	3	*(12.5)*
10-14	39	56	0	*0.0*	6	*10.7*	1	*2.6*	6	*10.7*
15-19	24	24	0	*(0.0)*	1	*(4.2)*	0	*(0.0)*	1	*(4.2)*
20 or more	27	36	1	*3.7*	0	*0.0*	1	*3.7*	0	*0.0*
Total	246	266	9	*3.7*	17	*6.4*	13	*5.3*	18	*6.8*

* Percentages based on fewer than 25 observations are enclosed in parentheses, as an indication of the small totals.

8 mm or more to the initial 5 TU test, one of 114 home contacts (0.9%) and 10 of 140 sanatorium contacts (7.1%) developed active tuberculosis. The incidence in the contact groups was thus similar for those with indurations of 0-4 mm to the initial 5 TU test, but was higher among the sanatorium contacts with indurations of 5 mm or more than among the corresponding home contacts. The difference, which attains statistical significance at the 5% level, is a surprising finding and, presumably, is due to chance. This is especially so since the index cases of the home contacts, as a group, had *more extensive* disease

FIG. 8

ATTACK RATE OF TUBERCULOSIS IN THE HOME AND THE SANATORIUM CONTACTS, ACCORDING TO AGE

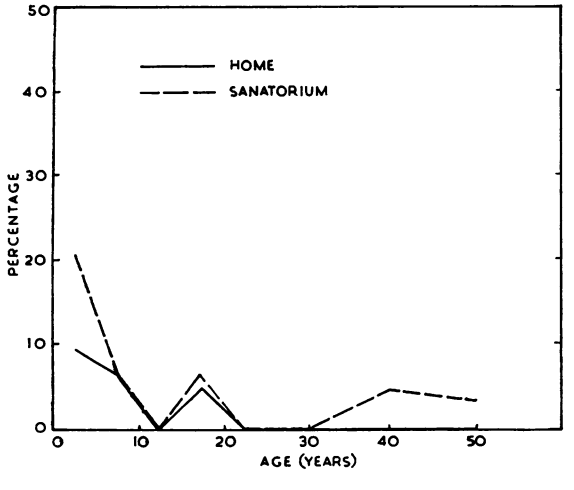


FIG. 9

ATTACK RATE OF TUBERCULOSIS IN THE CONTACTS, ACCORDING TO SEX AND AGE

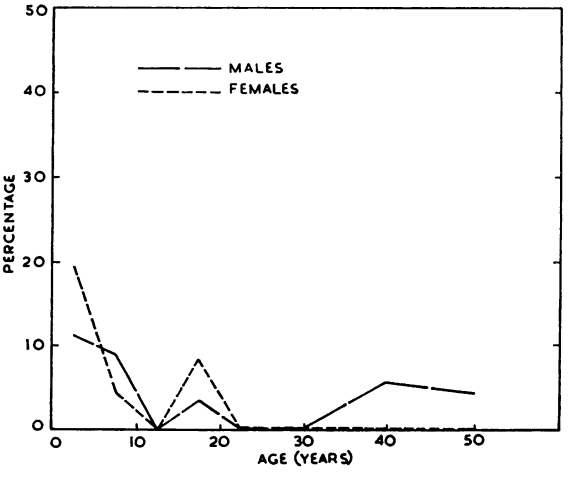
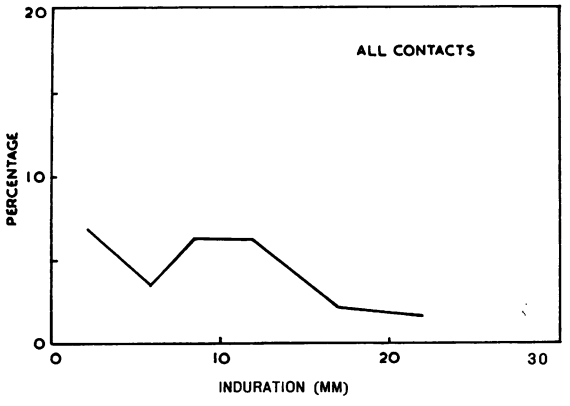


FIG. 10

ATTACK RATE OF TUBERCULOSIS IN THE CONTACTS, ACCORDING TO INDURATION TO THE INITIAL 5 TU TEST



radiographically at the start of treatment than the index cases admitted to sanatorium (Tuberculosis Chemotherapy Centre, 1959). In summary, cases occurred with similar frequency in home and sanatorium contacts with initially negative tuberculin reactions, but for those with initially positive reactions were largely confined to the sanatorium contacts. This difference is referred to again later (see footnote, page 489).

The forms of the active tuberculous lesions developing during the year are analysed in Table 19. All nine active tuberculous lesions in the home contacts were primary or post-primary in type, one being a pleural effusion, four progressive primary disease, two glandular (simple primary) disease, one a transient segmental lesion, presumed to be primary in type, and one a case of tuberculin "conversion" (induration of 20 mm at the 3-month 5 TU test, compared with no induration to the initial 5 TU test) with a positive culture. For this last case the assessor classified the radiographic abnormality as doubtfully tuberculous. Of the 17 cases of active tuberculous lesions among the sanatorium contacts, three had adult-type disease and 14 primary or post-primary disease. These 14 included one case of tuberculous meningitis, two cases of miliary pulmonary tuberculosis and one case of progressive primary pulmonary disease with spinal tuberculosis.

It was possible to date the appearance of the lesions with considerable precision. For the 26 lesions in the home and sanatorium contacts combined, the interval between the last normal and the first abnormal radiograph was one month or less for eight, two months for seven and three months for 10. In only one contact was the interval longer, namely six months (see Appendix 1, Tables A to D). Table 20 shows the cases of active tuberculosis according to the month at which the first abnormal radiograph was obtained. Among negative reactors to 5 TU initially, three of the seven cases in the home contacts and all five in the sanatorium contacts developed lesions within three months. In spite of the negative initial tuberculin tests, it is very likely that all these eight contacts had already been infected before their index cases had started treatment, especially since the sanatorium contacts had been removed from contact when treatment started. The

TABLE 19

FORMS OF THE ACTIVE TUBERCULOUS LESIONS DEVELOPING DURING THE YEAR IN THE HOME AND SANATORIUM CONTACTS

	All active tuber-culous lesions	Adult-type disease (pulmonary)	Primary and post-primary type disease	Form of primary or post-primary type disease					
				tuber-culous meningitis	miliary pulmonary tuber-culosis	pleural effusion	progres-sive primary	simple primary	other
Home contacts	9	0	9	0	0	1	4	2	2*
Sanatorium contacts	17	3**	14	1†	2	0	9††	2	0

* One transient segmental lesion; one tuberculin conversion with positive sputum culture and a doubtfully tuberculous abnormality on radiography.

** Includes one case with an intrapulmonary lesion and a pleural effusion.

† With a pulmonary lesion.

†† Includes one case with spinal tuberculosis and one with a lobar lesion and pleural effusion.

TABLE 20

CASES OF ACTIVE TUBERCULOSIS IN THE HOME AND SANATORIUM CONTACTS, ACCORDING TO THE MONTH OF THE FIRST ABNORMAL RADIOGRAPH

Diameter of induration to initial 5 TU test (mm)	Contact group	Total cases	Month of the first abnormal radiograph											
			1	2	3	4	5	6	7	8	9	10	11	12
0-4	Home	7	0	0	3	0	0	0	1	0	2*	1	0	0
	Sanatorium	5	1	2	2	0	0	0	0	0	0	0	0	0
5 or more	Home	2	0	0	1	0	0	1**	0	0	0	0	0	0
	Sanatorium	12	3	4*	1**	0	1	1**	0	0	0	0	1**	1

* Includes one aged seven years or more.
** Aged seven years or more.

remaining four cases, all in home contacts, developed lesions in the second six months. Among the contacts with positive reactions to 5 TU initially, one home and eight sanatorium contacts developed lesions in the first three months. Again, these contacts were, in all probability, already incubating the disease when the index case started treatment.[1] One home and four sanatorium contacts developed the disease after the first three months.

In the home and sanatorium groups combined, 20 of the 26 contacts who developed radiographic lesions were under seven years of age, 14 being under three years.

The details of all the cases of active tuberculosis have been summarized in Appendix 1, Tables A to D. In six families (two home, four sanatorium) two cases of active tuberculosis occurred during the year, and in one home family one case of active tuberculosis (T1989) and one doubtfully tuberculous abnormality occurred. Of particular interest are contacts T0605 and T0606, a boy aged two years and his sister aged two months. Neither had any induration to 5 TU or to 50 TU when the index case was admitted to sanatorium. The boy developed a parenchymal lesion at three months, and a thoracic vertebral lesion by six months. His sister had a pulmonary lesion at three months; 11 days later a radiograph showed miliary mottling, and bacteriological confirmation of tuberculosis was obtained. Another contact of particular interest is a female child (T1428) who had a normal radiograph at one month, but because she was fretful and ill, a further radiograph was taken seven days later and revealed miliary tuberculosis. Thus, considering the two cases of miliary tuberculosis, one became apparent seven days after a normal radiograph, the other 11 days after the first abnormal radiograph. In some of the young contacts, therefore, the disease progressed with striking rapidity; with less intensive supervision some contacts might well have passed from radiographic normality to death in a few weeks, the diagnosis of tuberculosis never being made. In all, two of the nine cases in home contacts and six of the 17 in sanatorium contacts were treated in the Centre during the year under review, in accordance with the policy of keeping the lesions under close observation and of starting chemotherapy only if there was a clear indication to do so (see page 467). The two cases of miliary tuberculosis were treated with chemotherapy under domiciliary conditions, and complete radiographic resolution had occurred in both by the end of the year.

There were four contacts who yielded positive cultures before or within a matter of a few days of

[1] In the 75 home and 73 sanatorium families contributing to this comparison (see page 482), there were 10 home and three sanatorium contacts who had active tuberculosis at the prevalence survey. They were excluded from this comparison because they could not contribute to the attack rate of tuberculosis. If these cases (apart from the one home contact who was initially tuberculin-negative) are added to those developing in the first three months, there were 10 home and 11 sanatorium contacts with positive reactions to 5 TU initially, who were either found to have active tuberculosis when the index case started treatment or else manifested the disease within three months. Thus the disparity between the home and sanatorium contacts disappears. This supports the view that all the cases developing during the first three months can be referred to the period before the index case started treatment.

the start of their treatment. Three had results of tests for sensitivity to streptomycin, PAS and isoniazid. All three strains were sensitive to streptomycin and PAS, but one was resistant to isoniazid (growth on 0.2 μg/ml isoniazid, inhibited by 1 μg/ml, confirmed by a repeat test); the strain from the index case had the same level of isoniazid resistance.

In summary, nine cases of active tuberculosis developed in home contacts and 17 in sanatorium contacts during the year. The attack rate of tuberculosis was greatest in the first three months, both for the home and for the sanatorium contacts, and predominantly involved infants and children under the age of seven years. There were four initially tuberculin-negative home contacts who developed lesions after the first three months, but none in the initially negative sanatorium contacts. None of the lesions in the home contacts, and only three of those in the sanatorium contacts, were of adult type. There were two cases of miliary tuberculosis, one initially tuberculin-negative, the other tuberculin-positive, and one case of tuberculous meningitis, initially tuberculin-positive, all in sanatorium contacts.

DOUBTFULLY TUBERCULOUS LESIONS

The independent assessor classified five contacts (four home, one sanatorium) as having doubtfully tuberculous lesions. (A longer period of follow-up may help to clarify the diagnoses.) Among the home contacts, a female, aged one year, developed a transient pulmonary lesion in the tenth month of observation; she had had no induration to the initial 5 TU test and 8 mm to an initial 50 TU test, and at one year she had 5 mm induration to a 5 TU test; a culture for tubercle bacilli was negative. A male, aged four years, developed a transient pulmonary lesion in the seventh month; the indurations to 5 TU tests were 5, 20 and 7 mm at the initial, 3-month and 1-year examinations, respectively; no cultures were examined. A male, aged 11 years, had a calcified pulmonary focus on all films and developed a transient pulmonary lesion in the seventh month; the indurations to 5 TU tests were 10 and 12 mm at the initial and 9-month examinations, respectively; two laryngeal swab specimens were culture-negative. A male, aged nine years, showed enlargement of the left hilar shadow in the seventh month which persisted; the indurations to 5 TU tests were 0 mm initially, and 15, 5, 5 and 13 mm at the four set examinations; two laryngeal swab specimens were culture-negative.

The contact in the sanatorium series classified as having a doubtfully tuberculous lesion was a female (aged 11 months when the index case started treatment) who developed a transient pulmonary lesion in the ninth month; the indurations to 5 TU tests were 0 mm initially and 0, 0, 3 and 3 mm at the four set examinations; a pair of laryngeal swabs was culture-negative.

In summary, four home and one sanatorium contact developed doubtfully tuberculous lesions, all during the second six months, four with transient lesions. Three were tuberculin-negative initially and one of these (a home contact) showed an increase of 10 mm induration or more at a subsequent 5 TU test. If these five cases are added to those of active tuberculosis during the second six months, although the general picture is unchanged, there are now eight cases among the home contacts in the second six months and three in the sanatorium contacts, six of the cases in home contacts and one in a sanatorium contact having been tuberculin-negative initially.

NON-TUBERCULOUS PULMONARY LESIONS DEVELOPING DURING THE YEAR

The independent assessor classified 15 radiographic abnormalities arising among the home contacts, and 15 in the sanatorium contacts, as being non-tuberculous. The majority—namely, 11 of the lesions in the home contacts and 10 of those in the sanatorium contacts—were diagnosed as pneumonic episodes.

CRITERIA OF TUBERCULIN CONVERSION DURING THE YEAR

Since the results of tuberculin tests show many technical variations, it is difficult to determine for certain from the findings of serial tuberculin testing whether conversion from tuberculin insensitivity to tuberculin sensitivity has occurred. The main approach adopted in the present analysis has therefore been to identify the contacts who, following a small diameter of induration to a 5 TU test, showed a large increase of induration on a subsequent test which seemed particularly likely to indicate that a recent tuberculous infection had occurred. An induration of 0-4 mm to the 5 TU test in the present study indicates that the contact has not acquired sensitivity to tuberculin as a result of tuberculous infection (see page 476 et seq.). The principal definition of conversion from tuberculin insensitivity to sensitivity used in this study is an increase in

induration of at least 10 mm in any 5 TU test during the year, from an initial induration of 0-4 mm. A second slightly less restrictive definition is an increase in induration of 8 mm or more at any subsequent 5 TU test, also from an initial induration of 0-4 mm. A subsidiary approach adopted has been to identify the two groups of contacts who had an induration of 5-7 mm to the initial 5 TU test and who showed either an increase of induration of 10 mm or more, or an increase of 8 mm or more, to any later 5 TU test.

Further, three more groups showing rather smaller increases in induration were identified—namely, those contacts showing an increase of induration from 0-4 mm to 5 mm or more, to 8 mm or more or to 10 mm or more; the findings for these groups add little to the general conclusions and are not presented in detail.

INCIDENCE OF TUBERCULIN CONVERSION AMONG THE CONTACTS

Table 21 shows the numbers of conversions among the home and sanatorium contacts, according to the first four definitions given above. The upper half of the table relates to the contacts who had initially shown an induration of 0-4 mm to 5 TU. Of 86 home contacts, 20 (23.3%) showed an increase of 10 mm induration or more at some time during the year, compared with 19 (21.8%) of 87 sanatorium contacts. Four home and four sanatorium contacts showed an increase of 8 or 9 mm, giving totals of 27.9% and 26.4%, respectively, for conversion by the 8 mm criterion. The incidence of tuberculin conversion, as indicated by these criteria, was thus very similar in the two groups.

The lower half of the table shows the corresponding figures for those with an induration of 5-7 mm to the initial 5 TU test. Of the 46 home contacts, 15 (32.6%) showed an increase of 10 mm or more in induration compared with 13 (33.3%) of the 39 sanatorium contacts. The corresponding percentages for an increase of 8 mm or more were 45.7% and 46.2%. The experience of the two groups was very similar. Although the numbers in the separate age-groups are small, they suggest that the conversions were not confined to the younger age-groups.

As already described (see page 466) the decision whether to perform a 5 TU test on a contact during the year depended upon the induration found at

TABLE 21
INCIDENCE OF TUBERCULIN CONVERSION DURING THE YEAR IN THE HOME AND SANATORIUM CONTACTS, ACCORDING TO AGE

Diameter of induration to initial 5 TU test (mm)	Estimated age (years)	Total contacts		Contacts in whom the induration to any later 5 TU test exceeded the initial induration by:							
				10 mm or more				8 mm or more			
				home		sanatorium		home		sanatorium	
		home	sanatorium	No.	%	No.	%	No.	%	No.	%
0-4	0-4	43	41	4	*9*	9	*22*	6	*14*	11	*27*
	5-14	27	36	8	*30*	6	*17*	9	*33*	7	*19*
	15-24	5	4	2	*(40)**	3	*(75)*	2	*(40)*	3	*(75)*
	25 or more	11	6	6	*(55)*	1	*(17)*	7	*(64)*	2	*(33)*
	Total	86	87	20	*23.3*	19	*21.8*	24	*27.9*	23	*26.4*
5-7	0-4	4	2	2	*(50)*	0	*(0)*	2	*(50)*	1	*(50)*
	5-14	12	6	2	*(17)*	3	*(50)*	5	*(42)*	4	*(67)*
	15-24	11	10	3	*(27)*	3	*(30)*	5	*(45)*	5	*(50)*
	25 or more	19	21	8	*(42)*	7	*(33)*	9	*(47)*	8	*(38)*
	Total	46	39	15	*32.6*	13	*33.3*	21	*45.7*	18	*46.2*

* Percentages based on fewer than 25 observations are enclosed in parentheses, as an indication of the small totals.

TABLE 22

CUMULATIVE TOTALS OF HOME AND SANATORIUM CONTACTS WHO SHOWED TUBERCULIN CONVERSION BY THREE, SIX AND NINE MONTHS AND ONE YEAR

Diameter of induration to initial 5 TU test (mm)	Period	Total contacts with 5 TU tests at one or more set examinations *		Contacts in whom the induration to any 5 TU test at a set examination exceeded the initial induration by:							
				10 mm or more				8 mm or more			
				home		sanatorium		home		sanatorium	
		home	sanatorium	No.	%	No.	%	No.	%	No.	%
0-4	0-3 months	47	46	7	*15*	5	*11*	8	*17*	6	*13*
	0-6 months	64	60	11	*17*	7	*12*	17	*27*	8	*13*
	0-9 months	74	76	17	*23*	11	*14*	22	*30*	12	*16*
	0-1 year	78	84	20	*26*	19	*23*	24	*31*	23	*27*
5-7	0-3 months	8	4	3	*(38)***	1	*(25)*	3	*(38)*	2	*(50)*
	0-6 months	27	13	9	*33*	4	*(31)*	13	*48*	5	*(38)*
	0-9 months	35	25	14	*40*	10	*40*	17	*49*	11	*44*
	0-1 year	44	36	15	*34*	13	*36*	21	*48*	18	*50*

* That is, the examinations at three, six and nine months and one year.
** Percentages based on fewer than 25 observations are enclosed in parentheses, as an indication of the small totals.

the last previous test. The rules were modified progressively and this had the effect that some contacts were only given an opportunity to show tuberculin conversion towards the end of the year, and a few not even then. It is therefore of value also to study the frequency with which conversions occurred in relation to the total number of contacts who had been tested by the 3-, 6- and 9-month and 1-year examinations. These figures are shown in Table 22. At the end of three months 47 of the 86 home contacts who had an initial induration of 0-4 mm were tested and seven (15% of those tested) showed conversion on the criterion of an increase of 10 mm or more. The corresponding figure for 46 of the 87 sanatorium contacts was five (11%). By the end of six months 64 home contacts had been tested, either then or at three months (or both), and a total of 11 (including the seven who were known to have converted by three months) had converted, representing 17% of those tested. The corresponding figure for the sanatorium contacts was seven (12%) of the 60 contacts who were tested. By the end of nine months 23% of 74 home contacts had converted compared with 14% of 76 sanatorium contacts. The corresponding percentages at the end of the year were 26% and 23%.

The right-hand section of the table gives corresponding figures for conversions defined by the criterion of an increase in induration of 8 mm or more. At the end of each period there was a rather larger proportion of converters in the home than in the sanatorium series, the differences being greater at six and at nine months than at the end of the year.

It is not permissible to draw conclusions from these figures as to whether the conversions occurred earlier in the one group of contacts than in the other. It so happened that a large proportion of the sanatorium contacts who showed tuberculin conversion at the end of the year had either not been tested at all at the intervening set examinations or had been tested only at three or six months. Some of the conversions first detected at one year in sanatorium contacts may thus have occurred earlier than in the last three months.

Conversion rates for each separate 3-month period have been calculated, the comparison being restricted to those contacts who were tested at the beginning and end of each period. Table 23 shows that according to the 10 mm criterion there was a slightly higher proportion of conversions in the home than in the sanatorium contacts in each 3-month period, though the numbers are very small.

TABLE 23

NUMBERS OF HOME AND SANATORIUM CONTACTS WHO SHOWED TUBERCULIN CONVERSION IN EACH 3-MONTH PERIOD DURING THE YEAR

Diameter of induration to initial 5 TU test (mm)	Period	Total contacts with 5 TU tests at the beginning and the end of the period		Contacts in whom the induration to the 5 TU test at the end of the period exceeded the initial induration by 10 mm or more				Total contacts with 5 TU tests at the beginning and the end of the period		Contacts in whom the induration to the 5 TU test at the end of the period exceeded the initial induration by 8 mm or more			
		home	san.	home		sanatorium		home	san.	home		sanatorium	
				No.	%	No.	%			No.	%	No.	%
0-4	0-3 months	47	46	7	*15*	5	*11*	47	46	8	*17*	6	*13*
	3-6 months	28	33	1	*4*	0	*0*	28	33	4	*14*	0	*0*
	6-9 months	30	37	3	*10*	0	*0*	26	37	1	*4*	0	*0*
	9 months-1 year	34	49	3	*9*	3	*6*	30	49	1	*3*	4	8
5-7	0-3 months	8	4	3	*(38)**	1	*(25)*	8	4	3	*(38)*	2	*(50)*
	3-6 months	3	2	1	*(33)*	0	*(0)*	3	1	1	*(33)*	0	*(0)*
	6-9 months	12	6	3	*(25)*	1	*(17)*	9	5	2	*(22)*	0	*(0)*
	9 months-1 year	14	10	1	*(7)*	0	*(0)*	12	10	3	*(25)*	3	*(30)*

* Percentages based on fewer than 25 observations are enclosed in parentheses, as an indication of the small totals.

According to the 8 mm criterion, the proportions converting were larger in the home than in the sanatorium contacts in the first three periods but the reverse was true in the last period. This suggests that there may possibly have been a higher rate of conversion among the home contacts in the early months of the follow-up, but reference to Table 22 shows that any differences had disappeared by the end of the year.

The lower section of Table 22 gives the frequencies of conversion among those with initial indurations of 5-7 mm to the 5 TU test. By the end of the year 34% of the home contacts and 36% of the sanatorium contacts who had been tested had shown an increase in induration of 10 mm or more. The figures according to the 8 mm criterion were 48% and 50% respectively. The two groups had thus fared similarly. In the lower section of Table 23 the numbers are very small indeed and so provide little indication of the relative risks of conversion in the home and sanatorium contacts during any 3-month period in the year.

The four definitions of conversion which have been used in the present report differ from the definition which is commonly used—namely, the appearance of a reaction which is regarded as positive, i.e., is of a certain minimum size (in this study, an induration of 5 mm or more to 5 TU), in a subject whose previous reactions have all been smaller than this (in this study, an induration of 0-4 mm to 5 TU). The numbers of conversions according to this criterion in the present study by the end of the year were 40 of 86 home contacts (47%) and 41 of 87 sanatorium contacts (also 47%). Two other definitions of conversion were investigated—namely, an increase in induration from 0-4 mm to 8 mm or more and to 10 mm or more. There was very little difference between the two groups of contacts according to either definition. The results have not been tabulated here. Appendix 2, Tables F and G, gives further information on the 5 TU tests.

In summary, tuberculin conversions, according to the definitions used, occurred frequently in both home and sanatorium contacts during the year. As far as could be judged, the incidence was similar in the two groups of contacts, though there may have been a slightly higher rate of conversion among the home contacts during the early months of the year. The occurrence of conversions in the latter part of the year in contacts of the patients treated in sanatorium suggests that sources *outside* the family were giving rise to tuberculous infections. It may be presumed that such sources were also giving rise to infections in the home contacts.

RELATIONSHIP BETWEEN TUBERCULIN CONVERSION AND DEVELOPMENT OF TUBERCULOUS LESIONS

A total of 12 cases of active tuberculosis developed among the 173 contacts (home and sanatorium combined) who had had an initial induration of 0-4 mm to the 5 TU test (Table 20). Of these, seven showed conversion as indicated by an increase of 10 mm induration or more, and one other showed an increase of 8 mm induration. Of the remaining four cases of active tuberculosis, one had no 5 TU test after the appearance of the lesion; one converted according to the 10 mm criterion in the second year; one showed a 6 mm increase at the time when the radiographic lesions were first manifest, but had no subsequent 5 TU test; and one, although tested on several occasions before and after the appearance of the lesion, showed no induration to 5 TU at any test.

There were three cases of active tuberculosis among the 85 home and sanatorium contacts with an induration of 5-7 mm to 5 TU initially: two showed an increase of 10 mm induration or more; one showed a 7 mm increase.

Of the three doubtfully tuberculous abnormalities which developed among those with an induration of 0-4 mm to the initial 5 TU test, one showed an increase of 10 mm induration or more subsequently, and two gave no evidence of tuberculin conversion. The one contact in the 5-7 mm category initially who developed a doubtfully tuberculous abnormality showed tuberculin conversion according to the 10 mm criterion.

DEATHS OF CONTACTS DURING THE YEAR

During the course of the year there were 10 deaths, seven in home and three in sanatorium contacts. Each death was reviewed by the independent assessor in the light of all the available data and the full clinical history.

Two of the 10 deaths, both in sanatorium contacts, were considered to be due to tuberculosis which developed during the year. One of these, a male aged 75 (see Appendix 1, Table D), developed a pulmonary lesion and, in the eighth month, a massive pleural effusion; he was admitted to hospital for aspiration, but died suddenly. The other was a girl aged 11 months (see Appendix 1, Table D) who was admitted to hospital with tuberculous meningitis but was removed from treatment by her mother.

The remaining eight deaths were classified as non-tuberculous. All the seven non-tuberculous deaths among the home contacts occurred in children under the age of three years; six of these were due to acute gastro-enteritis and, in the seventh, the cause of death was malnutrition. Two died in the first month, one in the second, one in the third, one in the fourth, one in the sixth and one in the twelfth month. In contrast, there was only one non-tuberculous death amongst the sanatorium contacts, due to enteric fever in a male aged 16 years. These figures, although small, thus raise the possibility that the presence of the index case in the home may have increased the risk of gastro-intestinal infection in these very young contacts. It is of interest that in five of the seven deaths the index case was the mother; in four of these the child was under six months of age and was changed from breast to artificial feeding on the advice of the Centre's staff.

Apart from the clinical course (all were under close observation or treatment) there was considerable supporting evidence that the deaths of the seven home contacts were, in all likelihood, non-tuberculous. All had indurations of 0-4 mm initially to 5 TU and all, except one, to 50 or 100 TU. Five had these small indurations to 50 or 100 TU within six days, 12 days, 23 days, 33 days and seven weeks of death. The sixth had a 5 mm induration to 50 TU eight months before death and the seventh had a 5 mm induration to 5 TU five weeks before death. None had had an abnormal radiograph at any time, the interval between the last normal film and death being 13 days, 22 days, 29 days, six weeks, eight weeks, nine weeks and 10 weeks, respectively.

Special care was taken to verify that all the other 522 contacts included in this comparison were alive at the end of the year.

BIRTHS DURING THE YEAR

In the course of the year there were 12 births into the group of home contacts and six into the group of sanatorium contacts, representing additions to the total of 532 close family contacts in the comparison. All survived except one home contact who died at the age of five months from gastro-enteritis, having a normal radiograph and no induration to either a 5 TU or a 100 TU test within six weeks of death.

Of the 12 births into the home families, four occurred in the first six months, compared with five of the six births into the sanatorium families; thus, the births in the home families were spread over the year, whereas those in the sanatorium

families occurred mainly in the first six months. In the home group, of the 11 newborn infants alive at the end of the year, nine were radiographed, nine had a 5 TU test and eight had a 100 TU test. In the sanatorium group the six newborn infants were all radiographed at the end of the year, five had a 5 TU test and four a 100 TU test. All radiographs of these infants (including eight in the home and 10 in the sanatorium infants taken earlier in the year) were classified as normal by the assessor. Except for one 6-month reading in a home contact (2 mm) and one 9-month reading in a sanatorium contact (3 mm), there was no induration to any 5 TU test in either group. Of the total of twelve 100 TU tests in home contacts and nine in sanatorium contacts, only one (7 mm), in a sanatorium contact at nine months, gave an induration of more than 4 mm.

There was thus no evidence that any of the newborn infants in either group had a tuberculous infection in the course of the year of treatment for the index case.

ATTACK RATE OF TUBERCULOSIS IN FAMILIES WITH MORE THAN ONE INFECTIOUS MEMBER INITIALLY

As already explained (see page 482) 23 families, containing a total of 77 contacts (40 home, 37 sanatorium) with no initial evidence of tuberculosis (apart from calcification), were excluded from the above comparison of the attack rates of tuberculosis and the incidence of tuberculin conversion because each had one or more members, in addition to the index case, excreting tubercle bacilli at the prevalence survey. This section presents briefly the findings in these contacts.

Among the 40 home contacts, six (four of whom were tuberculin-positive initially) developed active tuberculosis during the year (Appendix 1, Table E), whereas there was no case among the 37 sanatorium contacts. The two cases in initially tuberculin-negative contacts became apparent at three and six months, respectively, and the four cases in initially tuberculin-positive contacts became apparent at one, three, three and six months, respectively. In all, four of the six cases developed within the first three months, and four were under seven years of age.

One doubtfully tuberculous abnormality appeared at eight months in a home contact, compared with none in the sanatorium contacts.

Considering the tuberculin-test results, seven of the home and nine of the sanatorium contacts had an induration of 0-4 mm to the initial 5 TU test. By the end of the year one of the former and three of the latter had an increase in induration of 10 mm or more; the same numbers had an increase of 8 mm or more. Considering those with initial induration of 5-7 mm to the 5 TU test, one of 10 home contacts had an increase in induration of 8 mm and one of four sanatorium contacts had an increase of 10 mm.

If the contacts considered in this section are amalgamated with those for the main comparison, a total of 15 cases (5.1%—nine in initially tuberculin-negative and six in initially positive contacts) of active tuberculosis developed during the year among 297 home contacts compared with 17 cases (5.4%—five in initially negative and 12 in initially positive contacts) among 312 sanatorium contacts. Even if the cases of doubtfully tuberculous abnormalities are included with the above figures, the total becomes 20 lesions among the home contacts (6.7%) compared with 18 among the sanatorium contacts (5.8%). Thus, considering *all* the close family contacts in the two groups, whether exposed to one or to more than one case of infectious tuberculosis at the prevalence survey, there was no general disadvantage to the contacts of the patients treated at home.

In this subgroup of 23 families there was one birth during the year, three months after the start of treatment of the index case (in sanatorium). The baby showed no evidence of tuberculous infection during the remainder of the year.

There were no deaths among the 77 contacts.

DEATHS OF CONTACTS EXCLUDED FROM THE STUDY OF THE ATTACK RATE OF TUBERCULOSIS

There was one death among the 21 contacts with no initial radiographic examination and five among the 63 contacts with tuberculous lesions initially; these contacts have been excluded throughout this section (see page 482).

The sanatorium contact who had no initial radiograph died from heart failure secondary to mitral stenosis. The other five contacts all had active tuberculosis initially. A boy aged 10 months (sanatorium) also suffered from malnutrition and possibly congenital syphilis and died with acute gastro-enteritis. A girl aged 1½ years (home) also suffered from severe malnutrition. A woman aged 50 years (home) died suddenly in a way which suggested mycocardial infarction. The assessor regarded the cause of one death as unascertainable, since it occurred in a girl aged four years (home) who was taken away from Madras shortly after her

initial radiographic examination (which showed a small lesion) and died, within a month, of " fever ". The fifth was a sudden death, suggestive of myocardial infarction, in a woman aged 47 years (sanatorium) who was under treatment for her pulmonary tuberculosis and who had had 27 consecutive negative cultures in a period of nine months.

IV. DISCUSSION

The present study has given information on the prevalence and the subsequent attack rate of tuberculosis among the close family contacts of patients with newly diagnosed, infectious pulmonary tuberculosis, drawn from a poor and overcrowded section of a large urban community in South India. The interpretation of the findings has, fortunately, not been complicated by previous BCG vaccination, since this has scarcely been practised in Madras City.

The 191 patients had a total of 693 close family contacts, all of whom had been living, cooking and feeding with the patients for at least the three months immediately prior to diagnosis, and the great majority for very much longer. The findings on prevalence are based upon the 97% of these contacts who had a chest radiograph at the time of diagnosis of the index case. The prevalence of active tuberculosis was 6.8%, 6.2% for the males and 7.5% for the females. It was high in children under five years of age (9.2%) and in contacts aged 20 years or more (9.9%); it was particularly low (less than 1%) at ages 10-19 years. Ten of the 11 cases of inactive tuberculosis were found in contacts aged 25 years or more, with a prevalence of 4.3% at these ages. The total prevalence of active, doubtfully active and inactive tuberculosis was 7.3%, 1.4% and 13.8% among those under 10 years, 10-19 years and 20 years or more, respectively. Many of the contacts with active tuberculosis excreted tubercle bacilli, the prevalence of infectious tuberculosis at all ages being 4.2%.

This prevalence of active tuberculosis is considerably higher than that in the *general* Indian population in large cities, discovered in the national sample survey of tuberculosis in India between 1955 and 1958 (Indian Council of Medical Research, 1959). In that survey the prevalence of " active and probably active tuberculosis " in those aged five years or more ranged from 1.5% to 2.1% in six cities; the prevalence of active tuberculosis at these ages in the present study was 6.3%. Madras was not included in the sample, but in Bangalore, the nearest of the six cities to Madras, the prevalence was 2.0%. The prevalence of infectious tuberculosis ranged from 0.2% (in Bangalore) to 0.6%, but the intensity of bacteriological investigation was naturally less than in the present contact study.

The high prevalence of active disease in this contact group is nevertheless in keeping with that in other contact studies, both in India and elsewhere. Warawdekar & Shah (1958) found a prevalence of active tuberculosis of 5.7% in family contacts of tuberculous patients in Bombay. Tyrrell & Smith (1956) reported a prevalence of active tuberculosis also of 5.7% in household contacts in Glasgow; and Loudon, Williamson & Johnson (1958) found a prevalence of 4.5% of " significant respiratory tuberculosis " in household contacts in Edinburgh. It may be concluded that the examination of urban contact groups in India, as elsewhere, is a valuable method of case-finding.

Half the index cases, chosen at random, were treated with a standard chemotherapy for a year in sanatorium, the others receiving the same chemotherapy for a year, but at home (Tuberculosis Chemotherapy Centre, 1959), so that the contacts were divided, as a result of this random process, into " home contacts " and " sanatorium contacts ". Both groups of contacts have so far been followed for a year to determine the attack rate of tuberculosis among them. This being the aim, they were given neither BCG vaccination nor chemoprophylaxis. Instead, they were followed by an intensive routine of supervision. To make a pure comparison between contacts from whom the source of infection in the family had been removed by segregation in sanatorium, and those remaining exposed to infection because the index case was treated at home, all the families with one or more cases of infectious tuberculosis initially, in addition to the index case, were excluded. Moreover, all the contacts found initially to have a closed tuberculous lesion (apart from calcification) were also excluded, since they could not contribute to the attack rate. There remained 532 close family contacts in the comparison, 257 being contacts of patients treated at home and 275 of patients treated in sanatorium. These groups of home and sanatorium contacts were

similar at the time of diagnosis of the index case, and were studied with similar intensity radiographically, by tuberculin testing and bacteriologically throughout the year; the high coverage at the set 3-monthly radiographic examinations and at the end of the year (when 94% of the surviving contacts had radiographs taken) indicates the completeness of the resulting information on the attack rate of tuberculosis.

The sanatorium contacts in this comparison were exposed to the risk of contracting tuberculosis from two sources—from the index case *before* the diagnosis of tuberculosis had been made (and before the case had been segregated in sanatorium) and from some other source in the urban community in which the family lived. The home contacts were exposed to both these risks and, *in addition*, to continued contact with the index case. The 1-year follow-up gives some information on the relative importance of these three sources of infection, although a longer period of observation may be expected to clarify the position further. In no less than 17 of the total of 26 home and sanatorium contacts who developed tuberculosis, the lesions became apparent during the first three months of observation; these 17 included all five of the cases among the sanatorium contacts found to be tuberculin-negative initially, the index case having been segregated within a few days of this finding. This strongly suggests that these 17 early cases had already been infected and were incubating the disease when the index case started treatment, although the disease (and in some instances even sensitivity to tuberculin) only became manifest afterwards. Thus, the main risk of tuberculosis among the contacts in this study was from exposure to the index case *before* treatment had begun.

There were four cases in home contacts who were initially tuberculin-negative, and who developed tuberculosis between three months and one year, all in the second six months; no such cases were found in the initially tuberculin-negative sanatorium contacts, whose index cases were segregated. These four cases may, thus, have been infected by the unsegregated index cases after the start of treatment (although the index cases had converted to bacteriological negativity by the end of two, three, three and four months of treatment, respectively, and remained negative thereafter); on the other hand, one or more may have arisen from a source outside the family. On the present figures, it cannot be concluded that there was necessarily an added risk to contacts if the index case was treated at home, but the continuation of the follow-up which is in progress may shed further light on this important possibility. Whatever the eventual interpretation of the source of infection for these contact cases proves to be, it is clear that the risk of contacts contracting tuberculosis after the start of effective treatment of the index case was notably less than the risk before the diagnosis had been made. It will be appreciated that an intense risk of tuberculous infection is likely to persist if the diagnosis is delayed, if treatment of the index case is inadequate, or if chemotherapy is withheld until the patient can be admitted to a sanatorium, as is still sometimes the case. Earlier diagnosis of the disease might play an important role in preventing cases among contacts.

Of the 26 cases, 20 (including 15 of the 17 developing within three months) were children under the age of seven years. All the 20 lesions in the contacts under the age of seven years were primary or post-primary in type, and a number were serious. They included one case of tuberculous meningitis, two of miliary pulmonary tuberculosis, and one of spinal tuberculosis with a pulmonary lesion, all in sanatorium contacts, three of these arising in the first three months. The annual attack rate was 14.9% in the contacts under five years of age and 6.4% at ages 5-9 years. These findings, in common with those for the prevalence survey, are all based upon assessments of the radiographic series and other relevant data, made by an observer who was unaware whether the contact under review was related to a home or a sanatorium patient.

The above findings, if representative of known contacts in urban India, suggest that it may be advisable to give antituberculosis chemoprophylaxis to all young household contacts of newly diagnosed sputum-positive patients living in overcrowded urban conditions, even if the contacts have normal radiographic appearances, whether they are tuberculin-negative or tuberculin-positive, and whether the index case is segregated in sanatorium or treated at home. Such treatment might also effectively prevent the development of overt disease later in the first year as well as in the early months. If undertaken, the treatment for the young contacts would begin immediately. Its duration would obviously depend upon the facilities available, but it is suggested that a minimum period of six months would be desirable, and that isoniazid might be used alone if a suitable companion drug were not available (World Health Organization Study Group on Chemotherapy and Chemoprophylaxis in Tuberculosis Control, 1957;

United States, Public Health Service, 1957). This view takes into consideration the substantial number of cases of tuberculosis which developed in the young contacts in this study, the speed with which they appeared, and the severity of many of the lesions.

The precise role of BCG vaccination for these contacts is not clear. It has been shown (Great Britain, Medical Research Council, 1959) that BCG vaccine confers substantial protection on tuberculin-negative subjects for a number of years and that this protection is evident very soon after vaccination (Great Britain, Medical Research Council, 1956). The long-term protection of tuberculin-negative contacts by BCG vaccine would thus be a desirable addition to the immediate protection, of limited duration, which might be afforded by a course of chemoprophylaxis. However, protection might still develop too late to benefit tuberculin-negative contacts who have either already been infected or are on the verge of infection at the time of vaccination. Moreover, the development of protection might be hindered if prophylactic isoniazid is administered to those just vaccinated with isoniazid-sensitive BCG. This possible disadvantage might be overcome if an isoniazid-resistant BCG vaccine could be used (Canetti, 1955), but such vaccines are still at the experimental stage (Canetti, 1956; Gernez-Rieux et al., 1956; Ogata (quoted by Toda, 1956); Bretey & Canetti, 1957; Gernez-Rieux et al., 1957a, 1957b; Schaefer et al.. 1957; Canetti et al., 1958; Kikuth & Pothmann, 1959). Thus it is uncertain whether BCG might be effectively given at the beginning of a course of chemoprophylaxis or should await its end.

The annual attack rate of tuberculosis in this group of *urban contacts* is considerably greater than that found by Frimodt-Møller (1960) in the *general* population of a *rural area* in South India in the years 1950 to 1955, also based upon periodic radiographs. Considering all tuberculous lesions, the annual attack rate found by Frimodt-Møller was 0.4% among those aged five years or more, compared with 2.7% for active tuberculosis in the same age-group in the present study; the annual attack rate for bacillary cases in the rural survey was 0.03% compared with 0.4% in the present study. Sikand, Raj Narain & Mathur (1959) reported an annual attack rate of tuberculosis of 1.1% in Delhi policemen in the period 1952 to 1958; the annual attack rate of bacillary cases was 0.3%. In the present study two (2.1%) of 96 males aged between 20 and 54 years (the corresponding age and sex group) developed active tuberculosis, but neither yielded a positive culture.

The distribution of indurations to 5 TU of PPD in the index cases at the time of diagnosis suggests that an induration of 5 mm or more was indicative of tuberculous infection (RT 22, the PPD used, was a particularly weak batch—Guld et al., 1958). Corresponding distributions for the contacts tested at the same time indicate that this criterion provided a satisfactory division of the contacts in the present study into those uninfected with tuberculosis and those with a present or a past tuberculous infection. In particular, small diameters of induration to the 5 TU test in these contacts, associated with large indurations to the 100 TU test, which might indicate a non-tuberculous source of tuberculin sensitivity, were relatively uncommon, unlike the findings reported from elsewhere in South India (World Health Organization Tuberculosis Research Office, 1955b, 1957; Frimodt-Møller, 1960). According to the 5 mm criterion, about 90% of the contact population in the 15-24 age-group in the present study had already had a first tuberculous infection. Benjamin et al. (1939) surveyed a suburb of Madras from which some families in the present study were drawn and found that in 1938-39, 69.8% of the general population of the area aged 16 years or more had indurations of 5 mm or more to 20 TU of Old Tuberculin.

Tuberculin retesting during the year was at first restricted to those contacts with negative tuberculin reactions (0-4 mm induration to 5 TU), but was later extended to those with indurations of less than 20 mm to 5 TU. Because of this policy, conversions from tuberculin insensitivity to tuberculin sensitivity (defined for the purposes of this study in several ways, the principal definition being an increase in diameter of induration of 10 mm or more from an initial induration of 0-4 mm) may not have been completely enumerated. Nevertheless, the observed incidence of such 10 mm conversions during the year was similar in the home and sanatorium contacts (23% and 22%, respectively) and did not appear to be confined to the early months of the year, suggesting that sources outside the family were also giving rise to tuberculous infections.

There were seven deaths, all under three years of age, among home contacts. The independent assessor reviewed all these deaths in detail and found no evidence that any of them was due to tuberculosis. There were three deaths among sanatorium contacts,

two (one in a child under three years of age) being due to tuberculosis.

Finally, the study has demonstrated that, given careful planning and suitable facilities, it is possible in India to obtain and retain the co-operation of a group of families of patients with tuberculosis for a considerable period of time. This is a very important observation which opens up prospects for long-term field research into other chronic diseases in India, and may well have application in other sociological fields also.

The follow-up is continuing, with a high rate of response, and the further findings will be reported later. It is already evident, however, that young contacts, especially those under seven years of age, are very vulnerable; studies of the epidemiology and prevention of tuberculosis in this group are therefore of particular importance.

V. SUMMARY

1. A total of 191 South Indian patients with pulmonary tuberculosis in a comparison of a year of home and sanatorium treatment had 693 close family contacts, that is, relatives living, cooking and feeding with them for at least the three months immediately prior to diagnosis.

2. The living conditions and dietary standards were poor, the families being drawn from the lower income groups in Madras City.

3. The contacts were studied to determine (*a*) the prevalence of tuberculosis among them at the time of diagnosis of the index case, and (*b*) the attack rate of tuberculosis during the first year of a 5-year follow-up.

4. Of the 693 contacts, 347 were male and 346 female; 48.5% were children under the age of 15 years.

5. In the prevalence survey 97% of the 693 contacts had a radiographic examination. At an independent assessment, active tuberculosis was found in 6.2% of the males and 7.5% of the females, inactive and doubtfully active tuberculosis in 1.8% of the males and 2.1% of the females, and tuberculous calcification in 3.3% of the males and 3.9% of the females. Also, 3.8% of the males and 4.5% of the females were excreting tubercle bacilli.

6. Of the 46 cases of active tuberculosis, 27 were adult-type disease and the remaining 19 primary or post-primary in type. Most of the lesions were progressive.

7. An initial tuberculin test with 5 TU of PPD was performed on 647 of the contacts. The frequency distribution of diameters of induration suggested that 5 mm or more indicated tuberculous infection. (The distribution of indurations to 5 TU for 186 of the index cases suggested the same criterion.)

8. Using this criterion, 90% of the contacts in the 15-24 age-group had already had a tuberculous infection. With an 8 mm criterion the proportion was 66%; with a 10 mm criterion it was 60%.

9. Small positive reactions which might indicate a non-tuberculous infection did not occur commonly in this contact group.

10. In the study of the attack rate the main comparison was between 257 contacts of 75 patients treated at home and 275 contacts of 73 patients treated in sanatorium, in the families whose only infectious member was the index case. (The index cases had been allocated, at random, to treatment at home or in sanatorium for one year.)

11. These two contact groups were similar at the start of treatment for the index case and were followed with equal intensity by radiography, tuberculin testing and bacteriology. The coverage by radiographic examinations at three, six and nine months and one year in the two groups combined was 91%, 87%, 88% and 94%, respectively.

12. During the year active tuberculosis developed in 26 contacts—namely, nine (3.5%) home contacts (seven initially tuberculin-negative and two tuberculin-positive) and 17 (6.2%) sanatorium contacts (five initially tuberculin-negative and 12 tuberculin-positive).

13. Of these 26 cases, 15 were under the age of five years and 21 under the age of 10 years. The annual attack rate was 14.9% under the age of five years, and 6.4% at ages 5-9 years. Some of the lesions were serious; there was one case of tuberculous meningitis and two of miliary pulmonary tuberculosis (all in sanatorium contacts).

14. Seventeen (four home, 13 sanatorium) of the 26 cases arose in the first three months. These have all been attributed to infection by the index case

before the start of treatment, since they included all the five cases in initially tuberculin-negative sanatorium contacts, who had been immediately segregated from the index case.

15. Four tuberculin-negative home contacts and no tuberculin-negative sanatorium contacts developed lesions in the second six months. It is uncertain whether these cases were due to infection from a source outside the family or resulted from exposure to the index case earlier in the year of treatment. It is hoped that the continuing follow-up will clarify this important point.

16. There were five doubtfully tuberculous lesions during the year, four in home contacts and one in a sanatorium contact, all in the second six months.

17. There were seven deaths in home contacts (all non-tuberculous and all in contacts under the age of three years), six being due to acute gastro-enteritis. Three sanatorium contacts died, two of tuberculosis.

18. Serial tuberculin tests were made during the year, but did not yield evidence of more tuberculous infections in the home than in the sanatorium contacts.

19. It is concluded that the examination of contacts at the time of diagnosis of the index case was a valuable method of case-finding. Further, in this study, the major risk to contacts during the year resulted from exposure to the index case *before* diagnosis. The contacts of the patients treated at home were not exposed to special risk of infection when compared with the contacts of the sanatorium patients. Since these new cases arose particularly in contacts under the age of seven years, it is suggested that young contacts of newly diagnosed sputum-positive patients living in poor urban conditions in India, whether the contacts are tuberculin-positive or tuberculin-negative, might be protected by an immediate course of chemoprophylaxis for a minimum period of six months. The role of BCG vaccination in reducing the attack rate is also discussed.

RÉSUMÉ

Une étude comparative faite dans l'Inde méridionale sur les avantages respectifs de l'hospitalisation et du traitement à domicile, a permis de suivre pendant une année 191 malades atteints de tuberculose pulmonaire et 693 contacts familiaux qui vivaient en étroits rapports avec eux depuis trois mois au moins lorsque la maladie a été diagnostiquée. Le niveau de vie de cette population est bas et l'alimentation défectueuse.

On a cherché à déterminer parmi les contacts: *a)* la fréquence globale de la tuberculose au moment du diagnostic du cas repère; *b)* la fréquence des cas nouveaux de tuberculose au cours de la première de cinq années de surveillance. 347 d'entre eux étaient du sexe masculin et 346 du sexe féminin; 48,6% étaient des enfants de moins de 15 ans.

Pour déterminer la fréquence globale au départ, on a soumis à la radiographie 97% des 693 sujets. Au cours d'un contrôle indépendant, on a trouvé une tuberculose évolutive chez 6,2% des hommes et 7,5% des femmes, une tuberculose non évolutive — avérée ou douteuse — chez 1,8% des hommes et 2,1% des femmes, et des lésions calcifiées chez 3,2% des hommes et 3,9% des femmes. Enfin, 3,8% des hommes et 4,4% des femmes excrétaient des bacilles. Sur les 46 cas de tuberculose évolutive, 27 étaient du type adulte et les 19 autres primaires ou post-primaires.

La distribution de fréquence des diamètres d'induration chez 647 sujets ayant reçu 5 UT de PPD a conduit à penser qu'un diamètre de 5 mm ou plus indiquait l'existence d'une infection tuberculeuse. (La distribution de fréquence des diamètres d'induration obtenus avec 5 UT sur 186 cas repères a confirmé ce critère.) On a constaté ainsi que 90% des contacts ont été infectés avant l'âge de 20 ans. La proportion tombait à 66%, pour un diamètre de réaction de 8 mm et à 60% pour 10 mm. Les petites réactions positives, pouvant indiquer une infection non tuberculeuse, ont été rares dans ce groupe.

Pour l'étude de la fréquence des cas nouveaux, la comparaison principale a porté, d'une part, sur 257 contacts rattachés à 75 cas repères traités à domicile, et, d'autre part, sur 275 contacts rattachés à 73 malades traités en sanatorium. Ces sujets ont été pris parmi les familles dont le seul membre contagieux était le cas repère. (Les cas repères ont été répartis au hasard entre le groupe traité à domicile et le groupe en sanatorium).

Analogues au début du traitement du cas repère, ces deux groupes de contacts ont été suivis avec une égale attention au moyen d'examens radiographiques, tuberculiniques et bactériologiques. Dans l'ensemble des deux groupes, la proportion des sujets radiographiés après trois mois, six mois, neuf mois et une année a été respectivement de 91%, 87%, 88% et 93%.

Au cours de l'année, une tuberculose évolutive est apparue chez 26 sujets, à savoir chez 9 (3,5%) contacts de malades traités à domicile (7 contacts initialement tuberculino-négatifs et 2 tuberculino-positifs), et chez 17 (6,2%) contacts de malades traités en sanatorium (5 contacts initialement tuberculino-négatifs et 12 tuberculino-positifs).

De ces 26 cas, 15 étaient âgés de moins de 5 ans et 21 de moins de 10 ans. Le taux d'atteinte annuel a été de

14,9% chez les enfants de moins de 5 ans, de 6,4% chez les enfants de 5 à 9 ans. Quelques-unes des lésions étaient graves; il y a eu un cas de méningite tuberculeuse et 2 de tuberculose pulmonaire miliaire (tous chez des contacts de malades traités en sanatorium).

Des 26 cas en question, 17 (4 chez des contacts de malades traités à domicile, 13 chez des contacts de malades traités en sanatorium) se sont produits au cours des trois premiers mois. Ils étaient tous attribuables à une infection transmise par le cas repère *avant* le début de son traitement.

Au cours du deuxième semestre d'observation, des lésions sont apparues chez 4 des contacts tuberculino-négatifs de malades traités à domicile; il n'y a eu aucun cas de ce genre chez des contacts de malades traités en sanatorium. On ne peut dire avec certitude si ces cas sont dus à une infection provenant d'une source extérieure à la famille ou à une contamination par le cas repère durant le premier semestre de traitement. On espère que la suite des observations permettra d'élucider ce point important.

Sept contacts de malades traités à domicile sont décédés (tous non tuberculeux et tous âgés de moins de 3 ans), dont 6 par gastro-entérite aiguë. Trois contacts de malades traités en sanatorium sont morts, dont deux par tuberculose.

Des tuberculino-réactions successives ont été pratiquées durant l'année mais n'ont pas apporté la preuve que les cas de tuberculose étaient plus nombreux chez les contacts de malades traités à domicile que chez les autres.

Les auteurs concluent à l'utilité du dépistage des cas parmi les contacts au moment du diagnostic du cas repère. Le risque principal pour les contacts est l'exposition au cas repère *avant* le diagnostic; à cet égard, il n'y a eu aucune différence entre le traitement à domicile et l'isolement du cas repère. Comme les cas nouveaux ont été particulièrement nombreux chez les enfants de moins de 7 ans, il est indiqué, dans les milieux urbains pauvres de l'Inde, de soumettre immédiatement à un traitement chimioprophylactique de 6 mois au minimum tous les enfants tuberculino-positifs, ou les tuberculino-négatifs qui sont en contact avec des malades récemment dépistés dont les crachats sont positifs. L'article examine enfin l'effet du BCG sur la fréquence des cas nouveaux.

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APPENDIX 1

Appendix 1 (Tables A to E) summarizes the results of the examinations of the contacts who developed definite tuberculosis during the course of the year. Tables A to D give the findings for the families in which the only source of infection initially was the index case, and Table E refers to the families (all of patients treated at home) who had at least one other source of infection initially in addition to the index case. The dating of the radiographic abnormalities and their descriptions were made by the independent assessor, as were the summaries in the last column.

APPENDIX 2

Appendix 2 (Tables F and G) presents, for the home and sanatorium contacts separately, the relationship between the initial 5 TU test and the last available 5 TU test in the year, i.e., if a 12-month test was not performed, the 9-month or, failing this, the 6-month or, failing this, the 3-month test. Of the 201 available tests in the home contacts (Table F), 152 (76%) were performed at 12 months, 28 (14%) at nine months, 13 (6%) at six months, and eight (4%) at three months. Of the 204 available tests in sanatorium contacts (Table G), 163 (80%) were performed at 12 months, 25 (12%) at nine months, 12 (6%) at six months and four (2%) at three months.

In considering these tables it is important to recall (see page 466) that at no time in the study was 5 TU testing continued once the contact had shown a diameter of induration of 20 mm or more to 5 TU, and that at an early stage this limit was 10 mm, and at the start only 5 mm. Hence, contacts with large indurations were not always given an opportunity to demonstrate " reversion " to smaller indurations. This partially accounts for the paucity of results towards the bottom left-hand corners of the two tables.

TABLE A

HOME CONTACTS WITH 0-4 MM INDURATION TO 5 TU INITIALLY WHO DEVELOPED AN ACTIVE TUBERCULOUS LESION DURING THE YEAR (THERE BEING NO OTHER SOURCE OF INFECTION IN THE FAMILY)

Registration numbers of contact (T No.) and of index case (P No.)	Sex and age (years)	Radiographic findings (all early normal and important abnormal radiographs)				Tuberculin-test results			Culture results (sputum and laryngeal swab)				Independent assessor's summary
		interval from date of start of treatment of the index case (mths)	independent assessment of radiographs			interval from date of start of treatment of the index case (mths)	diameter of induration (mm)		before any chemotherapy for contact†		after start of chemotherapy for contact		
			normal or abnormal*	type of abnormality	extent (rib interspaces) **		5 TU	50 or 100 TU	No. positive	No. negative	No. positive	No. negative	
T 0755 (P 39)	Male 1	0	N			0	0	—	0	4	No chemotherapy		Simple primary disease; regressive without chemotherapy
		3	A	Glandular enlargement		2	0	—					
		4	M	Glandular enlargement		3	8	—					
						15	0	—					
T 1045 (P 59)	Male 8	0	N			0	0	5	0	0	No chemotherapy		Simple primary disease; regressive without chemotherapy
		1	N			6	0	—					
		4	N			10	35	—					
		6	N										
		9	A	Glandular enlargement									
T 1046 (P 59)	Male 2	0	N			0	2	2	0	2	No chemotherapy		Progressive primary disease
		3	N			3	2	0					
		6	N			6	0	—					
		9	A	Segmental lesion	Less than 1	10	3	—					
		12	M	Segmental lesion	More than 2	10††	—	10					
						12	4	18					
						14	7	—					
T 1590 (P 104)	Female 5	0	N			0	0	0	1	6	No chemotherapy		Tuberculin conversion with positive sputum; the radiographic abnormality was doubtfully tuberculous; regressive without chemotherapy
		3	A	Glandular enlargement plus doubtful parenchymal lesion	Less than 1	3	20	—					
T 1629 (P 107)	Male 1	0	N			0	0	0	0	0	No chemotherapy		Transient segmental lesion; complete resolution without chemotherapy
		3	N			6	0	0					
		6	N			10	2	—					
		9	N			12	0	5					
		10	A	Segmental lesion	1-2								
T 2239 (P 157)	Male 2½	0	N			0	0	—	0	0	0	9	Progressive primary disease; regressed under chemotherapy
		3	A	Segmental lesion	1-2	1	—	0					
		9	M	Lobar lesion	More than 2	4	25	—					
T 2884 (P 190)	Female ¾	0	N			0	0	0	0	4	No chemotherapy		Progressive primary disease; complete resolution without chemotherapy
		3	N			3	1	25					
		6	N			6	8	—					
		7	A	Segmental lesion	1-2	9	23	—					
		12	N										

* N = normal; A = first abnormality; I = increased abnormality; M = maximal abnormality.
** For definition, see footnote on page 475.
† By chemotherapy is meant *antituberculosis* chemotherapy.
†† 21 days after the previous 5 TU test.

TABLE B

HOME CONTACTS WITH 5 MM INDURATION OR MORE TO 5 TU INITIALLY WHO DEVELOPED AN ACTIVE TUBERCULOUS LESION DURING THE YEAR (THERE BEING NO OTHER SOURCE OF INFECTION IN THE FAMILY)

Registration numbers of contact (T No.) and of index case (P No.)	Sex and age (years)	Radiographic findings (all early normal and important abnormal radiographs)				Tuberculin-test results			Culture results (sputum and laryngeal swab)				Independent assessor's summary
		interval from date of start of treatment of the index case (mths)	independent assessment of radiographs			interval from date of start of treatment of the index case (mths)	diameter of induration (mm)		before any chemotherapy for contact†		after start of chemotherapy for contact		
			normal or abnormal*	type of abnormality	extent (rib interspaces)**		5 TU	50 or 100 TU	No. positive	No. negative	No. positive	No. negative	
T 1989 (P 134)	Male 6	0	N			0	6	—	0	3	2	10	Progressive primary disease; regressed under chemotherapy
		3	A	Glandular enlargement plus segmental lesion		4	25	—					
		4	M	Glandular enlargement plus lobar lesion		10	16	—					
T 2883 (P 190)	Female 17	0	N			0	25	—	0	5 also 1 from pleural fluid	No chemotherapy		Pleural effusion; regressive without chemotherapy
		3	N										
		6	A	Pleural effusion									

* N = normal; A = first abnormality; I = increased abnormality; M = maximal abnormality.

** For definition, see footnote on page 475.

† By chemotherapy is meant *antituberculosis* chemotherapy.

TABLE C

SANATORIUM CONTACTS WITH 0-4 MM INDURATION TO 5 TU INITIALLY WHO DEVELOPED AN ACTIVE TUBERCULOUS LESION DURING THE YEAR (THERE BEING NO OTHER SOURCE OF INFECTION IN THE FAMILY)

Registration numbers of contact (T No.) and of index case (P No.)	Sex and age (years)	Radiographic findings (all early normal and important abnormal radiographs)				Tuberculin-test results			Culture results (sputum and laryngeal swab)				Independent assessor's summary
		interval from date of start of treatment of the index case (mths)	independent assessment of radiographs			interval from date of start of treatment of the index case (mths)	diameter of induration (mm)		before any chemotherapy for contact†		after start of chemotherapy for contact		
			normal or abnormal*	type of abnormality	extent (rib interspaces) **		5 TU	50 or 100 TU	No. positive	No. negative	No. positive	No. negative	
T 0487 (P 22)	Female 1½	0	N			0	0	—	0	0	0	11	Progressive primary disease; complete resolution under chemotherapy
		1	N			1	5	—					
		2	A	Lobar lesion	More than 2	12	10	—					
T 0556 (P 24)	Female 1	0	N			0	0	0	0	4	0	3	
		2	A	Segmental lesion	More than 2	2	3	—					Progressive primary disease; regressing under chemotherapy
		8	M	Lobar lesion	More than 2	10	18	—					
T 0605 (P 28)	Male 2	0	N			0	0	0	0	3	0	1	
		2	N			3	10	—					
		3	A	Parenchymal lesion	Less than 1								Progressive primary tuberculosis, with spinal lesion
		6	I	Vertebral lesion (T.10-T.11)									
		11	M	Parenchymal lesion	More than 2								
T 0606 (P 28)	Female 1/6	0	N			0	0	0	0	0	2	11	
		3	A	Glandular enlargement plus lobar lesion	More than 2	3	6	—					Primary disease progressing to miliary tuberculosis; complete resolution under chemotherapy
		3††	M	Miliary mottling									
T 1718 (P 114)	Female 1	0	N			0	0	0	0	3	No chemotherapy		Progressive primary disease; regressive without chemotherapy. The child was last radiographed at nine months, then disappeared from observation, but was known to be alive and well at one year
		1	A	Parenchymal lesion	1-2	1	—	4					
		1†††	M	Lobar lesion	More than 2								

* N = normal; A = first abnormality; I = increased abnormality; M = maximal abnormality.

** For definition, see footnote on page 475.

† By chemotherapy is meant *antituberculosis* chemotherapy.

†† 11 days after the first abnormal radiograph.

††† 15 days after the first abnormal radiograph.

TABLE D

SANATORIUM CONTACTS WITH 5 MM INDURATION OR MORE TO 5 TU INITIALLY WHO DEVELOPED AN ACTIVE TUBERCULOUS LESION DURING THE YEAR (THERE BEING NO OTHER SOURCE OF INFECTION IN THE FAMILY)

Registration numbers of contact (T No.) and of index case (P No.)	Sex and age (years)	Radiographic findings (all early normal and important abnormal radiographs)				Tuberculin-test results			Culture results (sputum and laryngeal swab)				Independent assessor's summary
		interval from date of start of treatment of the index case (mths)	independent assessment of radiographs			interval from date of start of treatment of the index case (mths)	diameter of induration (mm)		before any chemotherapy for contact†		after start of chemotherapy for contact		
			normal or abnormal*	type of abnormality	extent (rib interspaces) **		5 TU	50 or 100 TU	No. positive	No. negative	No. positive	No. negative	
T 0478 (P 22)	Male 36	0 2 3	N A M	Infiltration plus cavity Infiltration	Less than 1 1-2	0	10	—	0	10	No chemotherapy		Progressive adult-type disease; regressive without chemotherapy
T 0612 (P 29)	Female 11/12	0 3 5	N N A	Segmental lesion	1-2	0	8	—	0	2	No chemotherapy		Progressive primary tuberculosis with tuberculous meningitis; taken to village against medical advice and died three weeks after the abnormal radiograph
T 0668 (P 31)	Male 19	0 6 9 11	N N N A	Infiltration	1-2	0 12	8 18 (9-day reading)	— —	0	3	No chemotherapy		Progressive adult-type disease
T 1125 (P 68)	Male 6	0 2	N A	Lobar-lesion	More than 2	0 9 11	10 22 10	— — —	0	7	No chemotherapy		Progressive primary disease; regressive without chemotherapy
T 1127 (P 68)	Female 2	0 2 4	N A M	Glandular enlargement Glandular enlargement plus segmental lesion	1-2	0 9 11	6 13 5	— — —	0	3	No chemotherapy		Progressive primary disease; regressive without chemotherapy
T 1132 (P 65)	Female 6	0 1 2 4 6 9 12	N N N N N N A	Glandular enlargement		0 9	6 25	— —	0	2	No chemotherapy		Simple primary disease; apparent at the end of the year

TABLE D (concluded)

Registration numbers of contact (T No.) and of index case (P No.)	Sex and age (years)	Radiographic findings (all early normal and important abnormal radiographs)				Tuberculin-test results			Culture results (sputum and laryngeal swab)				Independent assessor's summary
		interval from date of start of treatment of the index case (mths)	independent assessment of radiographs			interval from date of start of treatment of the index case (mths)	diameter of induration (mm)		before any chemotherapy for contact†		after start of chemotherapy for contact		
			normal or abnormal*	type of abnormality	extent (rib interspaces) **		5 TU	50 or 100 TU	No. positive	No. negative	No. positive	No. negative	
T 1133 (P 65)	Female 3	0	N			0	8	—	0	0	0	14	Progressive primary disease; complete resolution under chemotherapy
		1	A	Parenchymal lesion plus effusion									
		4	M	Lobar lesion	More than 2								
T 1205 (P 71)	Male 75	0	N			0	12	—	0	1	No chemotherapy		Adult-type lesion with effusion; died in hospital four days after the last abnormal radiograph
		3	A	Parenchymal lesion	More than 2					also 1 from pleural fluid			
		6	I	Slight progression of lesion	More than 2								
		7	M	Massive effusion									
T 1428 (P 91)	Female 2	0	N			0	15	—	0	0	1	12	Miliary tuberculosis; complete resolution under chemotherapy
		1	N										
		1††	A	Miliary tuberculosis									
		2	M	Maximal maturation of lesions									
T 1956 (P 129)	Male 6	0	N			0	12	—	0	12	No chemotherapy		Progressive primary disease; regressive without chemotherapy
		0†††	N			6	11	—					
		1	A	Gland		9	8	—					
		6	M	Segmental lesion	Less than 1	12	13	—					
T 2094 (P 146)	Female 18	0	N			0	10	—	0	0	No chemotherapy		Simple primary disease; regressive without chemotherapy
		6	A	Glandular enlargement		9	6	—					
		7	M	Glandular enlargement									
T 2430 (P 167)	Male 2	0	N			0	12	—	0	12	No chemotherapy		Progressive primary disease; regressive without chemotherapy
		2	A	Gland		5	12	—					
		5	I	Gland plus upper lobe	More than 2	9	14	—					
		7	M	Gland plus lower lobe	More than 2	13	23	—					

* N = normal; A = first abnormality; I = increased abnormality; M = maximal abnormality.

** For definition, see footnote on page 475.

† By chemotherapy is meant *antituberculosis* chemotherapy.

†† 7 days after the last normal radiograph.

††† 11 days after the previous radiograph.

TABLE E

HOME CONTACTS WHO DEVELOPED AN ACTIVE TUBERCULOUS LESION DURING THE YEAR, BUT WHO WERE IN CONTACT WITH ANOTHER SOURCE OF INFECTION IN THE FAMILY

Registration numbers of contact (T No.) and of index case (P No.)	Sex and age (years)	Radiographic findings (all early normal and important abnormal radiographs)				Tuberculin-test results			Culture results (sputum and laryngeal swab)				Independent assessor's summary
		interval from date of start of treatment of the index case (mths)	independent assessment of radiographs			interval from date of start of treatment of the index case (mths)	diameter of induration (mm)		before any chemotherapy for contact†		after start of chemotherapy for contact		
			normal or abnormal*	type of abnormality	extent (rib interspaces) **		5 TU	50 or 100 TU	No. positive	No. negative	No. positive	No. negative	
T 0368 (P 5)	Male 12	0	A	Hilar calcification		0	10	—	0	0	No chemotherapy		Simple primary disease; regressive without chemotherapy
		3	M	Glandular enlargement									
T 0423 (P 13)	Male 2 ½	0	N			0	0	—	0	2	No chemotherapy		Simple primary disease; regressive without chemotherapy
		3	N			1	0	0					
		6	A	Parenchymal lesion	Less than 1	3	0	3					
						6	7	—					
						9	0	—					
						12	10	—					
T 0675 (P 33)	Male ¾	0	N			0	2	0	1	0	0	8	Progressive primary disease; regressed under chemotherapy
		3	A	Lobar lesion	More than 2	4	8	—					
T 0810 (P 40)	Male 4	0	N			0	12	—	0	0	No chemotherapy		Simple primary disease; regressive without chemotherapy
		3	N			0††	30	—					
		6	A	Glandular enlargement									
T 2359 (P 163)	Male 32	0	N			0	15	—	0	2	No chemotherapy		Progressive adult-type disease; regressive without chemotherapy
		3	A	Parenchymal lesion	Less than 1	7	12	—					
		4	M	Parenchymal lesion	Less than 1	9	9	—					
						14	9	—					
T 2471 (P 173)	Male 3	0	N			0	18	—	0	2	No chemotherapy		Intrathoracic primary disease with tuberculous cervical adenitis and tuberculous ulceration of skin (biopsy confirmation)
		1	A	Glandular enlargement		5	12	—					
		2	M	Glandular enlargement		7	25	—					

* N = normal; A = first abnormality; I = increased abnormality; M = maximal abnormality.

** For definition, see footnote on page 475.

† By chemotherapy is meant *antituberculosis* chemotherapy.

†† 7 days after the previous 5 TU test.

TABLE F

INDURATION TO THE INITIAL 5 TU TEST RELATED TO INDURATION TO THE LATEST 5 TU TEST DURING THE YEAR IN THE HOME CONTACTS

Diameter of induration to the initial 5 TU test (mm)	Diameter of induration to the latest 5 TU test during the year (mm)																																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	32 or more	Total
0	30	—	6	2	2	5	3	1	—	1	1	1	—	1	—	—	—	—	—	—	2	—	1	1	—	3	1	—	—	—	—	—	61
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	6	—	—	1	1	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10
3	1	—	—	—	1	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	5
4	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
5	—	—	—	1	—	1	1	2	—	2	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	12
6	—	—	1	—	—	2	1	1	2	2	2	—	—	2	2	2	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	19
7	1	—	—	—	—	—	1	1	2	1	1	1	2	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	13
8	—	—	—	1	—	—	1	—	1	1	1	—	—	—	1	6	—	—	—	—	2	—	1	1	—	—	—	—	1	—	1	1	19
9	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
10	1	—	—	1	—	—	2	1	—	—	—	—	1	2	—	1	—	—	—	—	—	—	—	1	—	2	—	1	—	—	—	—	13
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
12	2	—	—	—	—	1	—	—	1	2	—	1	2	3	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	14
13	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	4	—	1	1	—	1	—	—	—	—	—	—	—	1	—	1	—	—	—	—	2	2	13
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	3
18	—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	3	7
24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
Total	41	—	7	6	4	11	9	7	8	11	11	3	13	11	5	11	2	—	—	—	6	—	4	4	—	9	2	1	1	—	5	9	201

TABLE G

INDURATION TO THE INITIAL 5 TU TEST RELATED TO INDURATION TO THE LATEST 5 TU TEST DURING THE YEAR IN THE SANATORIUM CONTACTS

Diameter of induration to the initial 5 TU test (mm)	Diameter of induration to the latest 5 TU test during the year (mm)																																
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	32 or more	Total
0	30	2	1	6	1	2	6	—	3	—	4	—	3	—	—	1	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	1	63
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	6	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	10
3	4	—	—	1	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
4	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	3
5	—	—	—	—	—	1	2	2	1	—	—	—	—	2	—	—	—	—	—	—	2	—	—	—	2	—	—	—	—	—	—	—	12
6	—	—	—	—	—	2	—	—	—	—	—	2	—	—	—	1	—	—	—	—	1	—	—	—	—	2	—	—	—	—	—	—	8
7	—	—	—	1	—	1	1	1	—	2	1	1	1	1	—	2	—	—	—	—	—	1	2	—	—	1	—	—	—	—	—	—	16
8	—	—	—	1	—	—	1	1	1	—	3	3	1	1	—	1	—	1	1	—	—	—	1	—	—	—	1	—	—	1	—	—	18
9	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
10	2	—	—	—	—	—	4	2	3	1	3	1	2	—	2	—	—	—	1	—	3	1	1	—	—	—	—	—	—	—	2	1	29
11	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	2
12	—	—	—	—	—	—	—	—	—	—	—	2	1	1	1	3	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	10
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	1	—	—	—	—	1	—	1	2	1	3	—	—	—	—	—	—	—	—	—	—	1	3	—	—	—	—	—	—	—	—	2	15
16	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	1	3
19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	3
25	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2
40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
Total	43	2	3	9	1	8	16	7	11	6	16	9	9	5	3	8	—	2	3	1	10	4	8	1	3	4	1	1	—	—	3	7	204