Detection of cases of tuberculosis remains an important public health activity. Assumptions concerning the value of contact follow-up as a means of case finding were tested and the results are reported here. In the light of the current tuberculosis situation, the results are of considerable interest.

TUBERCULOSIS CONTACT FOLLOW-UP IN THE LOS ANGELES CITY HEALTH DEPARTMENT

James B. Swayne, M.A., and Leo Tepper, M.D., M.P.H.

Background

CASE detection activities to bring to light previously unsuspected tuberculosis disease in the apparently well members of the population have long been considered of major importance in a tuberculosis control program. Associates of known cases of tuberculosis have been believed to be a particularly fruitful group to concentrate upon. Discovery of disease in an early stage when most amenable to treatment and prior to its progression into a communicable form, it has been felt, merits a significant proportion of staff time and effort.

The validity of these assumptions about fruitfulness of contact investigation had not been tested in the light of the current tuberculosis situation, nor was information available about performance of staff in conducting contact investigations. Accordingly, a study was undertaken in the fall of 1961 with the following objectives:

1. Evaluate contact follow-up as a means of case finding.
2. Measure conformity of practice with departmental policy.
3. Strengthen supervision by giving public health nursing supervisors a guide for reviewing contact records.

The information desired, it was decided, could best be obtained through record review, and in the fall of 1961 a study was initiated using a sample of 226 new active and reactivated tuberculosis cases. This sample represented cases reported to the Los Angeles City Health Department between July 1, 1959, and June 30, 1960.

The reported new active and reactivated cases in the sample are known as the index cases. These were selected by taking every seventh name from alphabetic lists of new active cases and reactivated cases.

The sample index cases were found to be similar to total tuberculosis morbidity reported during 1959 and 1960 with respect to age, sex, and race (Table 1). All differences between the sample and the universe were within the range of expected sampling error. An apparent overrepresentation of male children and underrepresentation of female children should have no practical bearing on the study results since children constituted a small proportion of total morbidity.

Study data were obtained from nursing records, clinic charts, and contact register cards in district health cen-

ters. Information from these sources was supplemented by case and contact information obtained from the central tuberculosis register. The study schedules were completed by supervising and assistant supervising public health nurses.

If persons named as nonhousehold contacts lived outside the district of residence of the index case, a contact schedule was initiated and forwarded to the district where the patient lived. Similarly, if place of employment of the index case was outside the district of residence, an industrial schedule was initiated and forwarded to the health district where the plant was located.

If the contacts lived or worked outside the jurisdiction of the Los Angeles City Health Department, special schedules were initiated and forwarded to the other health jurisdictions, chiefly the Los Angeles County Health Department. Staff of that department and of other health departments in the Los Angeles metropolitan area cooperated by checking their records to provide information about the outcome of contact referrals.

The study data on contact ratios and costs of contact follow-up are limited to investigation and examination of contacts of new reported cases and reactivated cases within the city, excluding examination of contacts of skin test positive children found in screening programs and referrals of contacts living in other health jurisdictions.

Table 1—Comparison of Sample Index Cases with Total Reported Morbidity

Item	Sample of Index Cases		Cases Reported 1959		Cases Reported 1960	
	Number	Per cent	Number	Per cent	Number	Per cent
Total	226	100.0	1,589*	100.0	1,395*	100.0
Age and Sex						
Under 20 years	25	11.1	175	11.0	155	11.1
Male	17	7.5	77	4.8	66	4.7
Female	8	3.5	98	6.2	89	6.4
20–64 years	158	69.9	1,157	72.8	1,017	72.9
Male	119	52.7	878	55.2	754	54.1
Female	39	17.2	279	17.5	263	18.8
65 years and over	43	19.0	257	16.2	222	15.9
Male	30	13.3	184	11.6	149	10.7
Female	13	5.8	73	4.6	73	5.2
Race						
White	169	74.8	1,194	75.1	1,046	75.0
Negro	45	19.9	308	19.4	276	19.8
Other nonwhite	12	5.3	85	5.3	68	4.9

* Totals for age and race are slightly greater than sum of the items because age and race not stated cases do not appear in detail.

Table 2—Summary of Tuberculosis Contact Data

Characteristics of Index Case	Index Cases	All Contacts				Contacts Living with Index Case				Contacts Living Elsewhere			
				Discovered as Active Cases*				Discovered as Active Cases*				Discovered as Active Cases*	
		Named	Examined	Method I	Method II	Named	Examined	Method I	Method II	Named	Examined	Method I	Method II
All Index Cases	226	600	459	16	16	366	304	13	16	234	155	3	0
Sputum Status													
Positive	129	394	304	11	13	230	202	8	13	164	102	3	0
All other	97	206	155	5	3	136	102	5	3	70	53	0	0
Race or Cultural Group													
Latin American	39	166	145	7	6	100	91	5	6	66	54	2	0
Other white	130	249	183	6	3	156	128	5	3	93	55	1	0
Nonwhite	57	185	131	3	7	110	85	3	7	75	46	0	0
Sex and Age													
Male	166	357	259	6	9	223	179	5	9	134	80	1	0
Under 20	17	40	34	1	2	25	22	1	2	15	12	0	0
20–64	119	246	185	5	6	157	136	4	6	89	49	1	0
65 and over	30	71	40	0	1	41	21	0	1	30	19	0	0
Female	60	243	200	10	7	143	125	8	7	100	75	2	0
Under 20	8	22	22	3	0	18	18	2	0	4	4	1	0
20–64	39	165	132	7	7	78	69	6	7	87	63	1	0
65 and over	13	56†	46†	0	0	47†	38†	0	0	9	8	0	0

* See page 1273 for explanation of Method I and Method II. Cases discovered by investigation of contacts of skin test reactors are not included.
† Includes 32 contacts of three cases living in institutions, of whom 27 were examined.

Case discovery data were obtained by dual methods in this study. Under the first method, records of the index cases were reviewed to determine how the index cases were discovered.

Under the second method, contacts of index cases were identified and it was determined whether examination of these contacts resulted in discovery of new cases.

For the sake of brevity these separate sets of data are identified as "Method I" and "Method II," respectively (see Table 2). The contact discovery ratios presented in Table 3 and in the text, however, unless otherwise specified, are averages based on data from both methods combined.

The review of records of 226 sample index cases (Method I) gave a total for cases discovered by contact investigation which was identical with that obtained by identifying contacts of reported index cases (Method II). Data from the two methods reflect separate, although not independent studies.

Variation between the two sets of data in characteristics of cases discovered was within the limits of expected sampling variability. The fact that identical totals were obtained by the two methods is a coincidence. General agreement between results of the two methods supports their validity, but does not reduce sampling variation, since the two sets of data are not independent. However, a high degree of sampling error can be assumed without destroying reasonable confidence in the hypothesis that a relatively small proportion of total reported cases were discovered by examination of contacts.

Case Discovery

Data from records of 226 sample index cases, supplemented where necessary by data from other sources, resulted in the following distribution of index cases by method of discovery (Method I):

Case Discovery Method	No.	%
Total Index Cases	226	100.0
Contact investigation	17	7.5
Contacts of reported cases	16	7.1
Contact of child with positive skin test	1	0.4
Screening x-rays	19	8.4
Mobile unit (L. A. City)	7	3.1
Stationary units	5	2.2
Other health departments	3	1.3
Hospitals	4	1.8
Jail examinations (city and county)	32	14.2
Employment physicals	2	0.9
Reciprocal notifications	15	6.6
Illness, Symptoms or not stated	141	62.4

Case discovery programs aimed at finding cases before they become ill and seek medical care accounted for approximately one of each three reported cases. Of cases found by discovery programs, almost half were found by jail examinations. The remaining cases found by discovery programs were almost equally divided between screening x-rays and contact investigation.

Contact examinations yielded a high proportion of children in contrast with x-ray surveys and prisoner examinations as revealed by both Methods I and II. While two out of three cases discovered by contact examination were under 20 years of age, only one out of ten total reported cases was under the age of 20. Based on this sample study, it is estimated that more than 40 per cent of reported cases under the age of 20 were found by contact examinations. In the light of the age distribution of cases discovered, contact investigation is perhaps the most useful of the existing tuberculosis case finding technics.

Table 3—Discovery Ratios

Characteristics of Index Case	Cases Discovered per 100 Index Cases	Cases Discovered per 100 Contacts Examined		
		All Contacts	Contacts Living with Index Case	Contacts Living Elsewhere
All Index Cases	7.1	3.5	4.8	1.0
Sputum Status				
Positive	9.3	3.9	5.2	1.5
All other	4.1	2.6	3.9	0
Race or Cultural Group				
Latin American	16.7	4.5	6.0	1.9
Other white	3.5	2.5	3.1	0.9
Nonwhite	8.8	3.8	5.9	0
Sex and Age				
Male	4.5	2.9	3.9	0.6
Under 20	(A)	4.4	(A)	(A)
20–64	4.6	3.0	3.7	1.0
65 and over	1.7	1.3	(A)	(A)
Female	14.2	4.3	6.0	1.3
Under 20	(A)	(A)	(A)	(A)
20–64	17.9	5.3	9.4	0.8
65 and over	(A)	0	0	(A)

(A) Not computed if base less than 25. Composite ratio based on an average of Method I and II.

Contact Examinations

Nonhousehold Contacts

Nonhousehold contacts, exclusive of work contacts, comprised almost 35 per cent of all contacts examined. These contacts, however, were a relatively poor source for case finding. The discovery rate of one case per 100 nonhousehold contacts examined was approximately one-fifth that for contacts living with the index case (Table 3). Though low compared with household contacts, the rate for nonhousehold contacts is 17 times higher than the 1960 discovery rate for the mobile x-ray unit.

Sputum Status

Existence of one or more positive sputum reports at or soon after the time of the morbidity report was used as an index of infectiousness.

It is recognized that a positive or negative sputum report per se cannot be accepted as a sole indicator of degree of infectiousness or communicability. Extent and character of disease process, particularly with respect to the presence of cavitation, the amount of cough and sputum and hygienic practices of the patient along with the type and number of bacteriological studies are additional important factors to be weighed. These factors, however, were

not reflected in this study because they present special problems in classification and tabulation.

The discovery ratio per 100 index cases was 9.3 for positive sputum cases and 4.1 for other cases. The tabulation below shows that fewer contacts were named for nonpositive index cases and that fewer of the contacts named were examined.

	Positive Sputum Report	All Other
Contacts named per index case	3.1	2.1
Contacts examined per 100 contacts named	77	75
Cases discovered per 100 contacts examined	3.9	2.6

The substantial discovery rate among contacts of nonpositives may reflect in part a bias resulting from the fact that sputum studies may not have been performed, or a positive result may have been obtained, but not reported. It may also reflect the fact that the reported case is often not the source case, but is a contact of the true source case and may have disease of a noncommunicable form.

Cultural Group

Contacts in families of Latin American origin were the best source for case discovery. The cases named more contacts per case; a higher proportion of those named as contacts were examined, and of those examined a sub-

Table 4—Contact Ratios

Characteristics of Index Case	Contacts Named per Index Case: All Contacts	Contacts Living with Index Case	Contacts Living Elsewhere
All Index Cases	2.6	1.6	1.0
Sputum Status			
Positive	3.1	1.8	1.3
All other	2.1	1.4	0.7
Race or Cultural Group			
Latin American	4.3	2.6	1.7
Other white	1.9	1.2	0.7
Nonwhite	3.2	1.9	1.3
Sex and Age			
Male	2.2	1.3	0.8
Under 20	2.4	1.5	0.9
20–64	2.1	1.3	0.8
65 and over	2.4	1.4	1.0
Female	4.1	2.4	1.7
Under 20	(A)	(A)	(A)
20–64	4.2	2.0	2.2
65 and over	4.3	3.6	0.7

(A) Not computed if base less than 10.

Table 5—Examination Ratios

Characteristics of Index Case	Contacts Examined per 100 Contacts Named		
	All Contacts	Contacts Living with Index Case	Contacts Living Elsewhere
All Index Cases	77	83	66
Sputum Status			
Positive	77	88	62
All other	75	75	76
Race or Cultural Group			
Latin American	87	91	82
Other white	73	82	59
Nonwhite	71	77	61
Sex and Age			
Male	73	80	60
Under 20	85	88	(A)
20–64	75	87	55
65 and over	56	51	63
Female	82	87	75
Under 20	(A)	(A)	(A)
20–64	80	88	72
65 and over	82	81	(A)

(A) Not computed if base less than 25.

stantially higher proportion had active tuberculosis.

	Latin American	Other White	Nonwhite
Contacts named per index case	4.3	1.9	3.2
Contacts examined per 100 contacts named	87	73	71
Cases discovered per 100 contacts examined	4.5	2.5	3.8

The low contact ratio for other whites is accounted for by a relatively high proportion of single males highly transient in living arrangements.

Sex and Age

The discovery ratio per 100 female index cases (14.2) was three times that for male index cases (4.5). The female index cases had more contacts, a higher proportion of those named were examined, and of those examined, a higher proportion were diseased. The higher disease ratio for contacts of female cases probably reflects the close association of mothers with their children.

	Male Index Case	Female Index Case
Contacts named per index case	2.2	4.1
Contacts examined per 100 contacts named	73	82
Cases discovered per 100 contacts examined	2.9	4.3

The reason fewer named contacts of male index cases were examined (73 per cent) compared with female index cases (82 per cent) can be explained

by the fact that the males have a higher proportion of adult contacts. It is known that adult contacts were less apt to be examined than children. It follows that a lower proportion of contacts of male index cases would be examined.

Index cases age 65 and over, although constituting 19 per cent of total index cases, were a relatively unproductive source for discovery of new cases. The discovery ratio per 100 index cases under 65 (8.5) was seven times higher than that for index cases age 65 and over (1.2). This reflects in part a lower ratio of contacts examined and a substantially lower rate of disease among the contacts examined.

	Age of Index Case		
	Under 20	20-64	65+
Contacts named per index case	2.5	2.6	3.0
Contacts examined per 100 contacts named	90	77	68
Cases discovered per 100 contacts examined	5.4	3.9	0.6

The contact ratio was relatively high for age 65 and over because three of the sample cases lived in institutions with a total of 32 contacts named of whom 27 were examined and none were diagnosed as cases. Excluding institutional cases, the contact ratio was 2.4 for index cases age 65 and over.

The trend in the characteristics of reported new tuberculosis cases, even apart from the decline in total incidence, is working against the productivity of traditional programs of contact supervision. The trend is toward a higher proportion of older males who are relatively unproductive as a source of contact examinations.

Examination Series

Department policy called for re-examination of negative adult contacts three months after the initial examination with re-examinations at six month intervals until at least a year had elapsed after contact was broken. For young children re-examinations were more frequent.

Of 16 active cases discovered among contacts of index cases, 13 were positive on the first examination. Three were negative on the first examination, but positive on the second. These three were children ages 2, 4, and 12. These findings suggest that repeat examinations of adult contacts are not likely to be an important source for case finding. Consideration should be given, however, to the fact that re-examinations were frequently not performed in accord with the desired schedule.

It is possible that the findings with respect to discovery of cases by periodic re-examinations would not have been negative for adults if there had been greater success in bringing adults to re-examination. It appears that efforts directed toward bringing adults to at least one examination would be more productive than efforts directed toward re-examination of adults who are negative on the first examination.

Follow-up Failures

Contact supervision was not initiated for 10 per cent of the index cases because the patient gave no valid Los Angeles address. Perhaps these cases have few true contacts. It is likely, however, that the incidence rates are higher among associates of these cases than for the general population. Technics other than conventional contact follow-up by public health nurses are required to reach this group.

Almost one-fourth of all contacts named were never examined. Many of the contacts not examined were non-household contacts or were contacts to nonpositive sputum cases. The following tabulation shows contacts not exam-

ined by living arrangements and sputum status of index case.

Index Case	Total Not Examined	Contacts Living with Index Case	Contacts Living Elsewhere
Total	141	62	79
Positive sputum	90	28	62
All other	51	34	17

Of 366 named household contacts in the sample, 62 were not examined (Table 2). An analysis of the reported reasons these household contacts were not examined sheds some light on ways that follow-up failures can be reduced.

Reason Not Examined	Total	Children	Adults
Total not examined	62	21	41
Contact uncooperative	12	0	12
Index case nonpulmonary or finally diagnosed inactive	16	6	10
Contact moved	16	10	6
Staff failure (referrals, records, etc.)	18	5	13

Lack of cooperation was the least important reported reason for failure to obtain examinations. The more frequently given reasons such as "Contact moved" or "Staff failure" may have included an element of uncooperativeness.

The 12 contacts who were not examined because of uncooperativeness were all adults. Parents were apparently willing to cooperate in securing examinations for their children. No information was obtained on why the 12 adults refused examination. It can be conjectured that some knew or suspected that they had tuberculosis, but wished to avoid medical supervision.

In no instance in the sample was a citation reported for examination of household contacts. It is apparent that cooperation of the vast majority of household contacts can be secured without resort to citations.

The recorded explanation for lack of examination for 16 household contacts (five index cases) was that the case was "nonpulmonary" or "inactive." It seems likely that these reasons are rationalizations since contacts of nonpulmonary cases were usually examined, and since reported cases are assumed to be active at time of initial report. It is probable that the contacts were reluctant, and that only minimal efforts were made to obtain cooperation in view of noninfectiousness of the index case.

Moving of contacts without a new address was responsible for failure in five cases involving 16 named household contacts. These were instances where contact investigation was initiated, but the named contacts moved before the initial examination. The mobility of the tuberculous population increased the complexity of contact follow-up and reduced its effectiveness. This problem cannot be eliminated, but its effects can be reduced by promptness in initiating contact supervision.

There were five children and 13 adults who were not followed because of staff failure. A record may have been misplaced, no contact register card established, or a referral not initiated.

Staff failures may have resulted in part from cumbersomeness of the record system. The record procedures in effect during the period of this study provided a multiplicity of records about contacts including a nursing history, chest clinic record, a tuberculosis contact register card, and a central tuberculosis register card on which contact information was posted.

The record system has since been simplified. A unified family history has been established combining the nursing history with the chest clinic record. The tuberculosis contact registers in district health centers and the central city tuberculosis register have been eliminated.

After the nurse initiates contact supervision, reliance is placed on routine clinic appointment procedures for maintaining contact supervision. The public health nurse now reviews records periodically, using a Desk Card as a control, to determine whether the routine procedures are successful. If not, she takes appropriate steps to assure proper examination of contacts.

Subsequent to the period covered by this study, the policies regarding contact supervision were clarified and workshops conducted in the various health centers to enhance contact investigation skills.

A new contact follow-up study will be conducted after a suitable interval in an effort to evaluate whether the positive steps taken in contact policies and procedures result in greater productivity of contact examinations.

Work Contacts

Practices regarding identification and supervision of work contacts were not uniform during the period covered by this study. In some instances, arrangements were made to screen employees at the place of employment through the mobile x-ray unit. In other instances, contacts at work were specifically identified and followed for contact supervision in much the same way as a household contact. In view of this divergence of practice, data on work contacts were not included with other contact data in this study.

A total of 41 work premises were named in records of the sample index cases. Records of contact investigation were found for nine of the 41 work premises. In these nine records, 32 contacts were listed and 28 examined. No cases were discovered among these contacts. These numbers are too small to warrant a conclusion regarding examination of work contacts.

Review of the 226 sample index records revealed no instance where the index case was a contact of a tuberculosis case at the place of employment. Since inadequate epidemiological investigation or poor recording could have been responsible for negative results, it can only be said that this study produced no evidence that work contacts are a productive source for case discovery.

Conclusive evidence is available, however, that routine screening surveys in industrial plants are not productive. The case discovery rate for screening surveys in industrial plants during 1959 and 1960 of 2.7 per 10,000 minifilms was little more than half the case discovery rate for general public minifilms. On the basis of this and other evidence, routine screening surveys were discontinued in Los Angeles industrial plants in 1961.

Cost of Contact Follow-up

The total annual estimated cost of tuberculosis contact follow-up for the period covered by this study was approximately $71,000. This was 11 per cent of the total funds budgeted for tuberculosis control in 1960-1961.

The cost of contact investigation per case discovered was $636, approximately 10 per cent less than the estimated cost per case discovered by x-ray survey ($710). The estimated average cost per contact named was approximately $17 and the estimated average cost per contact examined was $22. These cost estimates include only the personnel and expenses directly involved in contact follow-up. Overhead factors such as supervision and central administration were not included.

How these costs compare with those of other health departments cannot be determined in the absence of accepted standards for cost determination.

The expenditure for contact investiga-

tion and follow-up were divided as follows:

	Per cent
Education and supervision of contacts (PHN telephone, home visits, and related office time)	73
Contact register (clerks)	14
Examinations (clinician time, mini-films, skin tests, large x-rays)	13
Total	100

Public health nursing services constitute almost three-fourths of the total cost. Costs of administering examinations are a relatively small part of the total cost. This is true even though the vast majority of examinations were performed by the health department.

Private physicians examined only 8 per cent of all the contacts. All the contacts examined by private physicians were adults. Families with children used health department facilities for skin tests and x-rays.

Principal Findings

1. Examination of contacts of reported tuberculosis cases accounted for 7 per cent of all reported new active cases.

2. Contact examinations are a major source for discovery of cases among children. Two-thirds of the cases discovered by contact examination were under 20 years of age. Forty per cent of reported cases in children were found by examination of contacts.

3. Case discovery programs aimed at finding cases before they seek medical care accounted for 30 per cent of all reported cases. Of cases found by discovery programs, approximately half were found by jail examinations, and the balance were evenly divided between contact examinations and x-ray screening.

4. The case discovery rate for nonhousehold contacts was one-fifth that for household contacts. Perhaps the technic of selecting nonhousehold contacts for follow-up should be improved.

5. The discovery rate among contacts of index cases without positive sputum reports was high (4.1 per 100 index cases). This probably reflects inadequacies in the sputum data as well as the possibility that the index case is not the source case but is a contact of the true source case.

6. Contacts in families of Latin American origin were the best source of case discovery.

7. The discovery rate for female index cases was three times that for male index cases. Index cases age 65 and over, although constituting 19 per cent of total index cases, were a relatively unproductive source for case discovery.

8. The trend in morbidity toward a higher proportion of older males will tend to reduce the productiveness of traditional contact investigation practices.

9. All adult cases discovered by contact examinations were found on the first examination. It appears that efforts directed toward bringing adults to at least one examination would be more productive than efforts directed toward re-examination of adults who are negative on the first examination.

10. Contact supervision was not initiated for almost 10 per cent of the index cases because the patient gave no valid Los Angeles address. It is likely that the incidence rates are higher among the associates of these cases than in the general population. Technics other than conventional contact follow-up are required to reach this group.

11. Almost one-fourth of all contacts named were never examined. The not-examined group would yield 26 cases annually if the discovery rates for those examined apply to those not examined.

12. Recalcitrance was a relatively

minor factor in explaining why named household contacts were not examined.

13. Mobility of the tuberculous population increases the complexity of contact follow-up and reduces its effectiveness. This problem cannot be eliminated, but its effects can be reduced by promptness in initiating contact supervision.

14. Staff failures in follow-up (record misplaced, referral not initiated, etc.) accounted for almost one-third of the named household contacts who were not examined.

15. None of the 226 index cases in the sample were identified as contacts of a tuberculosis case at place of employment.

16. The total annual estimated cost of tuberculosis contact follow-up for the period covered by this study was 11 per cent of total budgeted funds for tuberculosis control.

17. The estimated average cost per contact named was $17; the estimated average cost per contact examined was $22. The cost per case discovered was $636 which is 10 per cent less than the estimated cost per case discovered by x-ray survey. Public health nursing service constituted almost three-fourths of the total cost.

Mr. Swayne is director of statistics and analysis, and Dr. Tepper is medical director, City Department of Health, Los Angeles, Calif.

A Thesaurus on Tape

The Engineers Joint Council has announced the publication of a "Thesaurus of Engineering Terms." It is available as a 320-page book or on magnetic tape with punch print-out programs for computer manipulation in mechanized information storage and retrieval systems. Consisting of one reel, the magnetic tape edition measures one-half inch wide by 2,400 feet and can be used on an IBM 1401 computer. Both editions of the Thesaurus contain 10,515 main terms. In the printed edition they are arranged alphabetically and are displayed to show synonymous, heirarchical, and other relationships. The taped edition includes all the alphabetical terms along with each entry's processing codes.

The primary use for the Thesaurus is as a vocabulary control reference for indexing, storing, and retrieving technical literature and as a reference tool for authors and editors preparing technical papers. For further information write: Engineers Joint Council, Dept. FS, 345 East 47th Street, New York City 10017.