

Outcomes of contact investigation among homeless persons with infectious tuberculosis

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SUMMARY

SETTING: Homelessness is an important risk factor for tuberculosis (TB). Health departments often fail to identify contacts for homeless TB cases, but little else is known about the outcome of contact investigations for these cases.

OBJECTIVE: To describe the outcomes of identification, tuberculin skin testing (TST), clinical evaluation and treatment for contacts of infectious homeless TB cases.

DESIGN: Retrospective multicenter review of data of contact investigations conducted in 1996 by five health departments in the United States.

RESULTS: Twenty-seven (8%) of 349 TB cases were homeless. Failure to identify contacts occurred in six (50%) of 12 cases residing in shelters vs. one (7%) of 15 non-shelter cases. Of 479 contacts identified, 297 (62%)

were fully evaluated, 97 (20%) had only initial testing, and 85 (18%) were not evaluated. Of the 394 evaluated contacts, 13 (3%) had a prior positive TST. Of the remaining 381 contacts, six (1.6%) had active TB and 67 (17.6%) were TST-positive. Only 27 (44%) of 61 contacts completed treatment for latent TB infection.

CONCLUSION: Despite the failure to identify contacts for some cases, contact investigations for homeless TB cases identified large numbers of contacts for whom evaluation and treatment were often not completed. Prospective studies with more complete documentation are needed to improve contact investigations for homeless TB cases.

KEY WORDS: contact investigation; tuberculosis; homelessness; transmission

ALTHOUGH TUBERCULOSIS (TB) has declined in the United States and elsewhere in recent years, the homeless remain a high-risk population, contributing to a large number of TB cases.¹ The rate of TB among homeless persons in the US may be as high as twenty times that of the general population, and the majority of cases are most likely due to ongoing transmission of *Mycobacterium tuberculosis*.²

Contact investigations require prompt and thorough interviews of the person with active disease to identify those who may have had sufficient exposure to be at risk of airborne transmission of *M. tuberculosis*.^{1,3,4} The potential for a large number of contacts for those homeless persons residing or gathering in congregate settings makes identification and follow-up of their contacts difficult.⁵⁻⁷ A number of studies have been published describing outbreaks of TB in homeless shelter populations and evaluating transmission with the use of DNA fingerprinting techniques.⁸⁻¹⁰

A Centers for Disease Control and Prevention (CDC) sponsored multicenter, retrospective study described the outcome of contact investigations for

active TB cases conducted during 1996 by five health departments.¹¹ This five-site study, and a previous 11-site retrospective study conducted by the CDC,¹² found that homelessness was associated with a lack of contact identification. The current report provides a more detailed analysis of contact investigations within the multicenter study for all TB cases reported among persons who were homeless within the year prior to diagnosis, as defined in the CDC National Surveillance System. We compared the characteristics of contact investigations performed for homeless persons residing and not residing at homeless shelters at the time of TB diagnosis.

METHODS

Participating sites

Methods for the multicenter contact investigation study have been described previously.¹¹ Five health departments in the US were selected through a competitive process to participate in the study. Three study sites were large metropolitan areas, one comprised a

large metropolitan area and five surrounding counties, and one comprised 10 counties containing small- or medium-size cities and surrounding rural areas.*

Study design

As described previously for the multicenter study,¹¹ data were abstracted from existing health department records for persons aged ≥ 15 years with culture-positive pulmonary TB reported to the CDC National Surveillance System during 1996 (all patients at four sites and a random sample at one site). Data on homelessness on individual cases were obtained using the CDC Report of Verified Cases of Tuberculosis (RVCT) number to link with data on homelessness within the past year for the same cases reported through the CDC TB National Surveillance System. In addition, cases who were not listed as being homeless within the past year by the CDC-RVCT report, but were found to live in homeless shelters by the retrospective review, were also classified as 'homeless' TB cases. A list of contacts identified for each patient was compiled by reviewing health department medical records. The project was determined to be exempt by the CDC Human Subjects Office. It was submitted to the local Institutional Review Board at each institution; one conducted a full review and was granted approval, and an exemption for review was granted by the Institutional Review Board chair at the remaining four institutions.

Study definitions

Homeless case

A homeless case was defined as a person with culture-confirmed pulmonary TB identified in the multicenter study who was homeless at the time of TB diagnosis as recorded on the medical charts and/or was listed as having been homeless the year prior to TB diagnosis in the CDC-RVCT report. Based on chart review, 'shelter cases' were those persons residing in a homeless shelter at diagnosis, and 'non-shelter cases' were those persons not residing in a shelter at diagnosis.

Contacts

Contacts were defined as those persons listed in the health department records as being identified during the contact investigation for active cases of TB. Contacts noted to be members, visitors, or workers in the case's place of residence, or were friends or relatives of the case, were defined as 'close contacts'.

Method of contact investigation, evaluation and treatment

Tuberculin skin testing (TST) was performed using the Mantoux method, as previously described.¹¹ The

transverse diameter of induration was measured 48–72 h after the intradermal injection of 0.1 ml (5 tuberculin units) of either of two commercially available antigens (Aplisol or Tubersol). For contacts with symptoms of active TB, those with a positive TST (defined as ≥ 5 mm of induration for contacts),¹¹ and those at high risk for active TB (children aged < 5 years, human immunodeficiency virus [HIV] positive, or immunocompromised), the evaluation included chest radiography plus additional clinical and bacteriologic testing as clinically indicated. Contacts with latent TB infection (LTBI), ≥ 5 mm induration on TST and no evidence of active TB, and selected TST-negative, high-risk contacts as noted above, were offered treatment with isoniazid as previously described,¹³ usually as a self-administered 6-month course, as recommended by the CDC in 1996.

Initial evaluation

For the purpose of this analysis, all identified contacts were considered eligible for the initial evaluation. The initial evaluation was considered complete for those contacts with a recorded TST or diagnosis of active TB within 10 weeks of the case's diagnosis of TB and for those contacts with a documented prior positive TST.

Final evaluation

A final evaluation 10–12 weeks after the start of treatment of the active case was not indicated for those contacts already known to be TST-positive, those who initially tested positive, or those who were diagnosed with active TB during the initial evaluation. Thus, eligible contacts included those with a negative TST at the initial evaluation and those who did not receive an initial evaluation. The final evaluation was considered complete for contacts with a documented TST reading and a chest X-ray when indicated, or a diagnosis of active TB.

Skin test converter

As in the main study,¹¹ contacts with a previously known negative TST within the 2-year period prior to screening (if documented in health department records), who had a positive TST at the initial testing, or contacts with an initial negative TST who subsequently had a positive TST at 3 months of the initial screening, were considered converters.

Contacts completely evaluated

Contacts were considered completely evaluated if they had 1) a documented record of positive TST prior to the contact investigation, 2) a positive initial TST, 3) a final TST (as a follow-up or only test), or 4) a diagnosis of active TB during, or within 2 years following, the contact investigation.

Data analysis

Analysis was performed using SAS¹⁴ and Epi Info software.¹⁵ Two-tailed statistically significant differ-

* Large cities and metropolitan areas were those with a population range of 2–5 million, medium cities a range of 180 000–1 900 000, and small cities a range of 8000–170 000.

ences ($P < 0.05$) in risk variable responses were assessed with two-by-two tables using Mantel-Haenzel χ^2 test or Fisher's exact test when appropriate.

RESULTS

Characteristics of homeless TB cases

There were 27 TB cases among homeless persons, accounting for 8% (27/349) of all cases identified in the multicenter study. Among the homeless cases, 12 were shelter residents at the time of TB diagnosis, and 15 had a history of homelessness within the year before diagnosis (data from CDC-RVCT report) but were not residing at a homeless shelter at the time of TB diagnosis. Three of the cases were identified as shelter residents by health department records, but were not identified as homeless by the CDC-RVCT report. All 27 homeless cases were hospitalized within 6 months of diagnosis compared to 222 (69%) of 322 non-homeless cases. The reason for hospitalization was generally not recorded. Three cases were diagnosed at death. Five (19%) homeless cases were noted to have cavitory disease, four of whom were known to have positive sputum acid-fast bacilli (AFB) smears. Of the 22 (81%) homeless cases without a record of cavitory disease, five had positive sputum AFB smears.

Contact identification

Twenty-six per cent (7/27) of the homeless cases had no contacts identified in the health department records compared to 12% (38/322) of the non-homeless cases ($P = 0.09$). The seven homeless cases with no identified contacts included six of the 12 shelter cases and one of the 15 non-shelter cases. All five homeless cases with cavitory TB were interviewed and had contacts identified. Of the 22 homeless cases without a record of cavitory disease, four (18%) were not interviewed, three (14%) were interviewed and had no contacts identified, and 15 (68%) were interviewed and had contacts identified. Of the seven cases with no contacts identified, none had cavitory disease, five

had positive sputum AFB smears, and four had no record of an interview by the health department (data not shown).

There were a total of 479 contacts for the 20 homeless cases with identified contacts (Table 1), representing 13% (479/3824) of all contacts for the 349 TB cases identified in the multicenter study. Of the contacts identified for the homeless cases, 355 were contacts of six shelter cases and 124 were contacts of the 14 non-shelter cases. The median number of contacts per homeless case was nine (range 1–147). The median number of close and other contacts was higher for shelter homeless cases than for non-shelter homeless cases. Two large contact investigations occurred in shelters, each identifying more than 100 contacts; these contacts were both shelter and non-shelter residents. Even after excluding these two cases from the analysis, the median number of contacts identified for shelter resident cases remained higher than for non-shelter resident cases (data not shown).

There was no significant association between the number of contacts identified and sputum AFB smear status or cavitation on chest radiograph. The median number of contacts for AFB smear-positive and smear-negative cases was 11 and 9, respectively ($P = 0.5$). The median number of contacts for cases with cavitory disease, non-cavitory disease and unknown cavitation status was 8, 9 and 17, respectively ($P > 0.4$ for all pairwise comparisons).

Lack of documentation of the location of contact with the case was more common for the contacts of shelter (74%) than non-shelter cases (41%; $P < 0.01$). Location of exposure to the case, when specified, occurred mainly at shelters for shelter cases, whereas contact with non-shelter cases occurred at various locations, such as workplace and schools (Table 1). The lack of documentation on location of exposure was more often missing for contacts with negative TST than for those with positive TST (63% [193/308] vs. 6% [4/73], respectively, $P < 0.001$). Lack of documentation was also noted more often for race (75%), ethnicity

Table 1 Characteristics of contact investigation for homeless TB cases with contacts identified, by residence (shelter vs. non-shelter) at time of diagnosis, 1996

Characteristics	Shelter residents (<i>n</i> = 6)	Non-shelter residents (<i>n</i> = 14)	Total (<i>n</i> = 20)
Median no. (range) of contacts/case	24 (2–147)	7 (1–32)	9 (1–147)
Median no. (range) of close contacts/case	19 (2–25)	2 (1–13)	3 (1–25)
Location of contact, <i>n</i> (%)			
Case or contact home	8 (2)	16 (12)	24 (5)
Workplace	3 (1)	32 (26)	35 (7)
Shelter	79 (22)	0 (0)	79 (16)
School	0 (0)	15 (12)	15 (3)
Other places	6 (2)	10 (8)	16 (4)
Undocumented location	259 (73)	51 (41)	310 (65)
Total	355 (100)	124 (99)*	479 (100)

* Total does not add up to 100% due to rounding.
TB = tuberculosis.

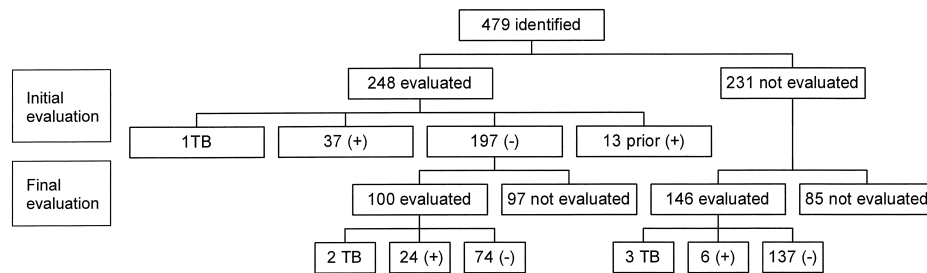


Figure Evaluation of contact investigation for homeless TB cases in 1996: the number of contacts identified, the number of contacts evaluated and not evaluated, and among the contacts evaluated, the number and the results of the screening (including those found to have active disease) for those evaluated at the initial and follow-up screening process. TB = case of active tuberculosis; (+) = TST-positive; (-) = TST-negative; TST = tuberculin skin test.

(95%), and country of birth (97%) among TST-negative contacts compared to those with positive TST or active TB (4%, 15%, and 18%, respectively).

Completion of contact evaluation

The contact investigation process is illustrated in the Figure. Of the 479 contacts identified, only 248 (52%) underwent an initial evaluation, and only 100 (51%) of those eligible for follow-up evaluation were retested. Among the 231 who did not receive an initial evaluation, 146 (63%) were evaluated during the follow-up screening period. Overall, 297 (62%) of the 479 identified contacts had a complete evaluation (a final negative TST or a positive TST or active TB at any time), 85 (18%) were never evaluated, and 394 (82%) had at least one evaluation.

HIV testing results were available for 64 (13%) contacts, of whom eight (13%) were positive. There were no statistically significant differences in the completeness of evaluation for contacts of shelter vs. non-shelter homeless cases, nor for contacts of smear-positive cases and cavitory lesion on chest radiograph vs. those without either characteristic (data not shown). The public health records lacked documentation of specific plans, rationale or reasons for the low rate of completion of the different steps in the contact evaluation process.

Clinical outcome of contact investigation

The clinical outcome of the contact investigation and each step in the process, as seen in the Figure, is summarized in Table 2. From the Figure, 13 (5.2%) of the

Table 2 Clinical outcome for evaluated contacts of homeless TB cases, 1996

Evaluation*	Outcome†	Shelter n (%)	Non-shelter n (%)	Total n (%)
Initial	Active TB	0	1 (1.5)	1 (0.4)
	Positive TST‡	27 (16)	10 (14.5)	37 (15.6)
	Negative TST	140 (84)	57 (84.0)	197 (84.0)
	Total	167 (100)	68 (100)	235 (100)
Final follow-up	Active TB	2 (3.0)§	0	2 (2.0)
	TST converters	18 (28.5)	6 (16.2)	24 (24.0)
	Negative	43 (68.5)	31 (83.8)	74 (74.0)
	Total	63 (100)	37 (100.0)	100 (100.0)
Final only	Active TB	0	3 (10.0)	3 (2.0)
	Positive	1 (1.0)	5 (15.0)	6 (4.0)
	Negative	112 (99.0)	25 (75.0)	137 (94.0)
	Total	113 (100.0)	33 (100.0)	146 (100.0)
All phases	Active TB	2 (0.7)	4 (4.0)	6 (1.6)
	Positive TST¶	46 (16.4)	21 (20.8)	67 (17.5)
	Negative first TST only	77 (27.5)	20 (19.8)	97 (25.5)
	Negative first and second TST	43 (15.4)	31 (30.6)	74 (19.4)
	Negative final TST	112 (40.0)	25 (24.8)	137 (36.0)
	Total: any evaluation	280 (100.0)	101 (100.0)	381 (100.0)

* The evaluation phases are not mutually exclusive since patients who were initially screened could be screened in the final follow-up phase, if eligible.

† Excluding 13 with documented previous positive TST (9 for shelter and 4 non-shelter).

‡ Prior records indicated TST conversion in 21/27 homeless case contacts but in none of the non-homeless case contacts.

§ One of the contacts who developed TB was TST-negative up to the final follow-up evaluation.

¶ Forty-five of the 67 were TST converters (39 shelter and 6 non-shelter).

TB = tuberculosis; TST = tuberculin skin test.

248 contacts who underwent an initial evaluation had documentation of a previously positive TST with no evidence of active TB during the investigation. From Table 2, of the 381 contacts who underwent some type of evaluation (initial and/or final), six (1.6%) had active TB and 67 (17.6%) were TST-positive. TST conversion was documented in 45 of the 67 TST-positive contacts. The rate of TB infection among all evaluated contacts, after excluding the 13 with prior positive TST, was 19.1% (73/381); this rate increased to 24.6% (73/297) for contacts who were fully evaluated.

The contacts who underwent an initial evaluation and the subset of those who were successfully evaluated at the 10-week follow-up period yielded three of the six active TB cases and 61 of the 67 contacts with a positive TST. The evaluation of those contacts who were only evaluated once, at 10–12 weeks after the presumed source case diagnosis, yielded the other three active TB cases and the remaining six contacts with positive TST. The 6.2% rate of positive TST for contacts tested only at follow-up was much lower than the rates of infection during the initial evaluation (16%) and the TST conversion rate during the repeat evaluation (24%).

The six cases of active TB were associated with only two of the 27 homeless TB cases (one with four and the other with two cases). Of the six cases of active TB, 1) one was found with a positive TST at the initial evaluation; 2) one was a converter (initially testing negative with a positive follow-up TST); 3) one had negative TST at both the initial and follow-up evaluation; and 4) three were not tested initially but were found with positive TST and active TB at the final evaluation (Figure, Table 2). The contact who TST converted and subsequently developed active disease started isoniazid but completed only 4 months of directly observed preventive treatment (DOPT). One contact with active TB was diagnosed at an unknown point following a second negative TST. Limited data were collected for the six cases detected among the contacts, but all had pulmonary TB, and two were diagnosed at death.

Completion of treatment for latent TB infection

For shelter cases, of the 46 contacts who began LTBI treatment, 25 (54%) completed treatment. Among contacts of non-shelter resident cases, 15 were started on treatment for LTBI but only two (13%) completed treatment. Overall, 27 (44%) of 61 contacts completed treatment for LTBI. DOPT was used in 45 (74%) of the 61 contacts, a higher frequency than the 20% of the 398 contacts started on treatment in the entire five-site study.¹² The completion rate in those receiving DOPT was similar to those without documentation of this mode of treatment (20/45 [44%] vs. 7/16 [43%], respectively).

DISCUSSION

A history of homelessness in the previous year was recorded in the case reports for 6.5% of newly diagnosed cases of active TB in the US in 1996,¹⁶ a similar proportion to the 8% recorded in the multicenter study from which the data for this study were derived.¹¹ We included three cases found to be homeless by medical chart review but not identified as homeless in the RVCT report to the CDC; this shows a need for more accurate recording of homelessness status by the health department staff. Previous studies have described contact investigation for homeless cases with no clear distinction between those who are shelter residents and other homeless cases.^{1–2,12,17,18} In this study, we found that only 12 of the 27 homeless cases were shelter residents at the time of diagnosis. There were important differences in the results of contact investigation for shelter and non-shelter TB cases, with more contact exposures of non-shelter cases reported at worksites, schools and other locations.

Two previously published retrospective studies found that health departments are more likely to report identifying no contacts for TB cases among homeless persons.^{11,12} This finding was confirmed in the present study. We also found that lack of contact identification among homeless persons is more common in shelter cases than non-shelter cases (6/12 vs. 1/15, respectively). Although all the seven cases with no identified contacts had non-cavitary pulmonary TB, five had positive sputum AFB smears and contact investigation was certainly warranted. The reasons for non-identification of contacts for some homeless cases, and shelter cases in particular, could not be addressed in this retrospective study, and further investigation with a prospective approach is needed.

The health departments found similar difficulties in completing the complex process of contact investigation for shelter and non-shelter cases. A large proportion of identified contacts of both shelter (50%) and non-shelter cases (40%) were not initially evaluated, and many of those eligible for a final evaluation did not receive one. The reasons why many contacts did not receive an initial evaluation are not clear and could potentially include the following: 1) the use of the concentric circle approach with a decision to perform a single, final evaluation of those contacts perceived to be at lower risk; 2) the identification of additional contacts too late (beyond 3 months after initial contact with an infectious case) for an initial TST; or 3) failure to perform the initial evaluation due to error or lack of resources. The medical records lacked documentation of specific plans and rationale for how the process was done. However, those contacts who had only a single TST at the follow-up period had a markedly lower prevalence of positive TST than other contacts (6% vs. 20% and 24% for initial and repeat tests). This difference suggests that

some of these contacts may have been perceived to be at lower risk and scheduled for later testing. However, not all were at low risk, as three active cases were found in those with only a final TST. Eight (13%) of the 64 contacts with documented HIV testing were HIV-positive, but only 13% of the contacts were known to have been tested. The high prevalence of HIV among those tested may reflect selective testing of high-risk contacts, but further analysis was limited by lack of documentation.

We also found no statistically significant differences in the number of contacts identified by the cases' sputum smear result and presence of cavitory disease. The extent of the contact investigation performed for contacts of cases with non-cavitory TB and negative sputum AFB smears may not have been appropriate, but transmission from such cases does occur and may account for 17% of cases in the community.¹⁹

The six cases of active TB identified represent 1.3% of the 479 identified contacts, 1.5% of the 394 contacts with at least an initial evaluation, and 2% of the 297 who were completely evaluated. This is similar to the finding that 1.1% of close contacts in the entire five-site study,¹¹ as well as 2% of close contacts in the 11-site study,¹² were found to have active TB. Of the six contacts diagnosed with active disease, three were not initially evaluated and were found to be TST-positive at the follow-up evaluation. It is possible that these cases resulted from exposure to the initial case, and that some were potentially preventable. However, due to incomplete data and lack of DNA fingerprinting of the isolates, it is also possible that some of these presumed secondary cases were epidemiologically unrelated or may have been the source of infection for the presumed index case. These active cases illustrate the need for more prompt investigation, reassessment of those considered at 'high risk', or to extend the investigation beyond the individuals named by the case into a 'location-based' investigation,²⁰ particularly among homeless persons who may be reluctant to name contacts. Another approach is to perform ongoing screening for active TB among the homeless, which has been shown to reduce transmission by earlier case detection, reducing the need for contact investigation in these difficult to reach populations.^{21,22}

Completion of treatment for LTBI among contacts is crucial for preventing additional cases of active disease. The rate of treatment completion among contacts of homeless cases was 44% (27/61) compared to the 51% completion rate among all contacts in the five-site multicenter study.¹³ It is not clear why documentation of DOPT of LTBI was not associated with better completion of treatment. Additional studies should be done to define and overcome the specific barriers to starting and completing treatment for LTBI in this important population of contacts.

Overall, our study was limited by incomplete documentation due to the retrospective nature of the study,

and the use of data from only five health departments in a single year. Prospective studies of contact investigations with more complete documentation are needed. One such study has been initiated by the CDC in collaboration with four of the health departments that participated in this retrospective study. In addition, the development and implementation of such electronic databases, available at none of the five health departments in this study in 1996, in conjunction with the development and validation of a model for predicting the likelihood of transmission to contacts of active TB cases,²³ would certainly improve both the process and the outcome of contact investigations.

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