INT J TUBERC LUNG DIS 7(12):S397–S404

Finding contacts of homeless tuberculosis patients in New York City

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SUMMARY

OBJECTIVE: To determine factors associated with no contacts identified for homeless patients in New York City.

DESIGN: Culture-confirmed pulmonary tuberculosis cases in persons >18 years old diagnosed in 1997–1999 were included. Demographic and clinical characteristics of tuberculosis patients associated with the number of contacts identified according to homeless status were analyzed using unconditional logistic regression.

RESULTS: Homeless patients ($n = 152$) had a significantly lower median number of contacts than non-homeless patients ($n = 2836$) (1 vs. 4, $P < 0.001$). Among homeless patients, having AFB smear-positive sputum with cavitary lesions reduced the likelihood of having no contacts identified. Homeless patients who lived on the street at the time of diagnosis were more likely to have no contacts identified compared to those with contacts identified (61.4% vs. 56.1%); however, the difference was not statistically significant ($P = 0.506$). Unlike non-homeless patients, being hospitalized at the time of tuberculosis diagnosis was not associated with having contacts identified in homeless patients.

CONCLUSIONS: Homelessness independently predicted the likelihood of having no contacts identified. Strategies such as interviews that focus on location rather than persons may be more effective for identifying contacts. Furthermore, being homeless at the time of diagnosis should be used as an indicator for prioritizing prompt contact evaluation.

KEY WORDS: contact investigation; homelessness; tuberculosis

IDENTIFYING AND EVALUATING contacts of patients with active tuberculosis (TB) is an essential component of tuberculosis prevention and control programs.[1] For a contact investigation to be of value, it is ultimately necessary to find the means to complete the evaluation of those contacts for active TB and latent tuberculosis and to ensure treatment. The first step of this process, identification of contacts, is key. While the number of contacts elicited per case is often used by programs as an indicator of program effectiveness, the 'correct' number of contacts who should be identified is not known. The number of contacts elicited or identified addresses only the initial step in contact investigation, but it is a critical step to the identification of contacts in need of evaluation and treatment for active or latent TB. Since infection and disease are more likely in contacts of infectious TB cases,[2,3] characteristics of infectiousness, such as presence of acid-fast bacilli (AFB) in sputum and/or the presence of cavitary lesions on chest radiographs, are commonly used to prioritize contact investigations.

Traditional contact investigation approaches are poorly suited to some groups. For example, homeless patients who live either on the streets or in unstable housing such as shelters or single-room-occupancy (SRO) hotels may not have regular contact with others, and may have a more transient lifestyle that precludes them from identifying contacts. This is compounded by the relatively high risk of homeless persons for both tuberculosis infection and disease.[4–6]

It is estimated that each year 100 000 New Yorkers experience homelessness, and there are 30 000 homeless people in New York City on a daily basis. In 1992, the peak year of the recent TB epidemic, approximately 15–25% of persons with active TB were homeless.[7] By 1999, the proportion decreased to 5–6%.[8] This decline was largely achieved through strengthened tuberculosis control efforts implemented since 1992, which included enhanced case management of all cases. In addition, all Division of AIDS Services (DAS) referrals were reviewed for housing placement, history of tuberculosis by cross-matching to the TB registry and a brief questionnaire, provision of directly

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observed treatment for tuberculosis patients on site in certain DAS hotels, and the offering of incentives and provision of peer counseling to ensure treatment completion.[9–11] The Tuberculosis Program also provided a shelter specifically for homeless men with tuberculosis until treatment completion. Despite these recent achievements, in 1999 the incidence rate of TB in the homeless was 77/100 000, which is 3.9 times higher than the citywide rate of 19.9/100 000.[8]

Based on observed TB case clusters in persons with residence in a number of SRO hotels and unstable housing settings (unpublished data, New York City Department of Health), this study sought to explore the first step of contact investigations, i.e., the elicitation of contacts among homeless patients and the evaluation of existing control efforts associated with contact identification. The results of contact elicitation over a 3-year period among homeless and non-homeless patients were reviewed to determine factors associated with having no contacts identified. Subsequent steps in a contact investigation such as evaluation of contacts for active tuberculosis and treatment of those with latent tuberculosis infection were not assessed in this study.

METHODS

Study cases were identified utilizing the New York City Department of Health (NYC DOH) tuberculosis surveillance data, and included all culture-positive, pulmonary tuberculosis cases verified in New York City from 1 January 1997 through 31 December 1999. Pulmonary tuberculosis was defined as having *Mycobacterium tuberculosis* isolated from a respiratory source. Patients with sputum that was AFB smear-positive were referred to as smear-positive. AFB smear status of respiratory specimens other than sputum was not assessed in this study.

In New York City, contact investigations were performed by the Tuberculosis Control Program, NYC DOH, following the Centers for Disease Control and Prevention (CDC) guidelines.[1,12–14] A contact of an active TB patient was defined as anyone who spent any time with the patient during the 3 months before diagnosis, including household members, and additional work, school and leisure contacts. In order to ensure that analysis in this study reflects the routine practice of contact elicitation, contacts identified as part of an expanded contact investigation by the screening unit in a congregate setting were excluded.

Homeless tuberculosis patients were defined as those who reported having been homeless or unstably housed (i.e., living in a shelter, a SRO, or a DAS hotel) at the time of diagnosis or in the 12 months prior to diagnosis.[13] Non-US-born patients were individuals born outside the US or territory of the US. Unemployment was defined by patient report of being unemployed within the 24 months before tuberculosis diagnosis. A history of drug and alcohol abuse referred to substance abuse in the 12 months before the diagnosis of tuberculosis.

In data analysis, homeless patients were compared to non-homeless patients according to demographic and clinical characteristics. The Wilcoxon Rank-Sum test was used to compare medians; Student's *t*-test was used to compare means. Pearson's χ^2 test was used for comparison of categorical variables. Bivariate and multivariate analyses were performed using unconditional logistic regression[15] to identify risk factors for having no contacts identified among homeless patients and non-homeless patients, respectively. Variables identified in bivariate analysis that were significantly associated with the number of contacts were further evaluated in multivariate analysis. Odds ratios (OR) and 95% confidence intervals (CI) were used as estimates of relative risk. Data analyses were performed using SPSS (SPSS Inc., Chicago, IL, version 10.0). Statistical significance was set at a two-sided 5% level.

Age group-specific comparisons between homeless and non-homeless TB cases were conducted. Because there were no homeless patients with TB aged under 19 years, we excluded the 87 non-homeless, culture-confirmed TB cases identified in persons aged under 19 years during the study period.

RESULTS

Between 1 January 1997 and 31 December 1999, 4748 tuberculosis cases were confirmed by the NYC DOH, 3075 (64.8%) of which were bacteriologically confirmed cases of pulmonary tuberculosis. Of 3075 patients, 2988 (97.2%) were aged over 18 years and met the study criteria. Of these, 1459 (48.8%) had four or more contacts identified, 1155 (38.7%) had one to three contacts, and 374 (12.5%) had no contacts. The median number of contacts per patient was three, ranging from 0 to 64. One patient was a church member who participated in prayer services in multiple households during the infectious period, resulting in 64 contacts identified for that patient. Sputum AFB smear-positive cases (n = 1651) had a higher median number of contacts identified per case than patients with smear-negative disease (four vs. three contacts, $P < 0.01$). Over the study period, the median number of contacts per patient was highest in 1998 (median = 4; mean = 5.2), followed by 1999 (median = 3; mean = 4.7), and was lowest in 1997 (median = 3; mean = 4.4) ($P < 0.05$).

Homeless vs. non-homeless

One hundred and fifty-two (5%) of the 2988 patients were homeless or unstably housed. A comparison of homeless and non-homeless patients according to selected demographic and clinical characteristics is presented in Table 1. Homeless and non-homeless patients did not differ significantly by age. However,

Table 1 Characteristics of pulmonary culture-positive TB patients by homeless status, New York City, 1997–1999 (n = 2988)

Characteristics	Homeless (n = 152) n (%)	Non-homeless (n = 2836) n (%)	P value
Sex			
Male	119 (78.3)	1850 (65.2)	0.0009
Female	33 (21.7)	986 (34.8)	
Race/ethnicity			
Asian	5 (3.3)	623 (22.0)	<0.0001
Hispanic	36 (23.7)	760 (26.8)	0.3975
Non-Hispanic Black	88 (57.9)	1141 (40.2)	<0.0001
Non-Hispanic White	23 (15.1)	312 (11.0)	0.1159
Country of birth			
US	119 (78.3)	1284 (45.3)	<0.0001
Non-US	31 (20.4)	1541 (54.3)	<0.0001
Unknown	2 (1.3)	11 (0.4)	0.1390*
Unemployment			
Yes	140 (92.1)	1800 (63.5)	<0.0001
No	7 (4.6)	934 (32.9)	<0.0001
Unknown	5 (3.3)	102 (3.6)	0.8426
Alcohol abuse			
Yes	96 (63.2)	572 (20.2)	<0.0001
No	53 (34.9)	2195 (77.4)	<0.0001
Unknown	3 (2.0)	69 (2.4)	1.0000*
Drug abuse			
Yes	66 (43.4)	353 (12.4)	<0.0001
No	78 (51.3)	2414 (85.1)	<0.0001
Unknown	8 (5.3)	69 (2.4)	0.0319
Mental illness			
Yes	32 (21.1)	147 (5.2)	<0.0001
No	111 (73.0)	2602 (91.7)	<0.0001
Unknown	9 (5.9)	87 (3.1)	0.0519
Manhattan address			
Yes	84 (55.3)	687 (24.2)	<0.0001
No	68 (44.7)	2149 (75.8)	
HIV status			
Positive	67 (44.1)	738 (26.0)	<0.0001
Negative	66 (43.4)	1427 (50.3)	0.0975
Unknown	19 (12.5)	671 (23.7)	0.0015
Hospitalized at the time of TB diagnosis			
Yes	145 (95.4)	2278 (80.3)	<0.0001
No	7 (4.6)	558 (19.7)	
Sputum AFB smear			
Positive	87 (57.2)	1564 (55.1)	0.6139
Negative	65 (42.8)	1272 (44.9)	
Cavitary lesion on radiograph			
Yes	23 (15.1)	581 (20.5)	0.1092
No, abnormal	116 (76.3)	2077 (73.2)	0.4027
No, normal	13 (8.6)	166 (5.9)	0.1719
Unknown	0 (0.0)	12 (0.4)	1.0000*
Sputum AFB smear/cavitary lesion			
SM+ and cavitary	15 (9.9)	479 (16.9)	0.0232
SM+ and non-cavitary	69 (45.4)	1046 (36.9)	0.0510
SM− and cavitary	8 (5.3)	102 (3.6)	0.2878
SM− and non-cavitary	47 (30.9)	1031 (36.4)	0.1742
Other	13 (8.6)	178 (6.3)	0.2637
Lost to follow up before completing treatment			
Yes	10 (6.6)	44 (1.6)	<0.0001
No	142 (93.4)	2792 (98.4)	
Number of contacts identified			
None	70 (46.1)	304 (10.7)	<0.0001
1–3	42 (27.6)	1113 (39.2)	0.0042
⩾4	40 (26.3)	1419 (50.0)	<0.0001

* Fisher's exact test was used if indicated.
Note: For variables with 3 or more categories, comparisons were made of one category versus the remaining categories.
TB = tuberculosis; HIV = human immunodeficiency virus; AFB = acid-fast bacilli; SM+ = smear-positive; SM− = smear-negative.

compared with non-homeless patients, homeless patients were significantly more likely to be male, non-Hispanic Black, US-born, unemployed, alcohol or drug abusers, report an address in Manhattan (one of five boroughs in NYC), be infected with the human immunodeficiency virus (HIV), and have mental illness. Moreover, homeless patients were more likely to have been lost to follow-up prior to treatment completion.

Nearly all of the homeless patients were diagnosed with tuberculosis in a hospital, significantly more so than non-homeless patients. Homeless patients were less likely to have AFB present in sputum in combination with cavitary lesions on chest radiograph and more likely to have AFB present in sputum without cavitary lesion(s) on chest radiograph (45.4% vs. 36.9%, $P = 0.051$). However, these associations were no longer significant after adjusting for HIV status. Homeless patients did not differ from non-homeless patients with respect to drug resistance patterns of the *M. tuberculosis* isolates, history of prior tuberculosis disease or tuberculosis exposure, and proportion who died prior to treatment completion (not shown in Table 1).

The number of contacts identified per homeless patient was significantly lower than for non-homeless patients (median 1 vs. 4, $P < 0.001$; mean 2.7 vs. 4.8, $P < 0.001$). Homeless patients were four times more likely to have no contacts identified. After controlling for the presence of AFB in sputum, both median and mean contact index remained significantly different between homeless and non-homeless patients ($P < 0.001$).

Predictors of no contacts identified among homeless

Of 152 homeless patients, 40 (26.3%) had four or more contacts identified, 42 (27.6%) had one to three contacts, and 70 (46.1%) had no contacts identified. The mean number of contacts identified was 2.7; the median was 1.0 and ranged from 0 to 43 contacts. The distribution of type of address reported by patients at the time of diagnosis by the number of contacts identified is shown in Table 2. Over 61% of homeless patients who did not have contacts identified lived on the street at the time of diagnosis. However, having no contacts identified was not associated with type of address.

Table 2 Distribution of homeless TB patients by type of address at the time of diagnosis and the number of contacts identified ($n = 152$)

	Having contacts identified	
Type of address	No ($n = 70$) n (%)	Yes ($n = 82$) n (%)
Shelter	14 (20.0)	17 (20.7)
Division of AIDS Services hotel	5 (7.1)	8 (9.8)
Single room occupancy hotel	7 (10.0)	9 (11.0)
Prison	1 (1.4)	2 (2.4)
Street*	43 (61.4)	46 (56.1)

* Street was presumed if addresses provided by patients were non-existent, a hospital, or a drop-in center.
TB = tuberculosis; AIDS = acquired immune-deficiency syndrome.

Compared to homeless patients with any contacts identified, having no contacts identified was only associated with male sex, presence of AFB in sputum and having cavitary lesions on chest radiograph (Table 3). After adjusting for age, sex, and countries of birth, homeless patients with AFB in sputum and cavitary lesions on chest radiograph were 3.3 times more likely to have contacts identified.

Predictors of no contacts identified among non-homeless

Among the 2836 (95%) patients who were not homeless, the mean number of contacts identified was 4.8, and the median was 4.0, ranging from 0 to 64 contacts. During the study period, the mean number of contacts identified remained stable.

The proportion of non-homeless patients with contacts identified and the relative risk for having no contacts identified are presented in Table 4 by selected demographic and clinical characteristics. Non-homeless patients with no contacts identified were more likely to be male, US-born, non-Hispanic Black or White, HIV-infected, unemployed or have unknown employment history, reside in Manhattan, be lost to follow-up before completing treatment, and have a history of prior tuberculosis disease or tuberculosis exposure. In multivariate analysis, country of birth, residence in Manhattan, and HIV infection were no longer significantly associated with having no contacts identified among non-homeless patients, while being male, non-Hispanic Black or White, unemployed, AFB smear-positive and having cavitary lesions, being lost to follow-up, and having a history of prior tuberculosis disease or tuberculosis exposure remained significant.

Infectiousness indicated by the presence of AFB in sputum and/or the presence of cavitary lesions on chest radiograph was strongly associated with having contacts identified (Table 4). This association remained statistically significant in multivariate analyses. Hospitalization at the time of diagnosis was associated with a significantly reduced risk of having no contacts identified. Non-homeless patients with no contacts were less likely to be hospitalized (crude OR = 0.5, 95%CI = 0.3–0.6; adjusted OR = 0.4, 95% CI = 0.3–0.6).

Only 1.6% of non-homeless patients were lost to follow-up during the course of treatment. Patients lost to follow-up were 6.7 times more likely to have no contacts identified than those remaining in treatment; this remained significant after adjusting for age, sex, race/ethnicity, country of birth, employment status, borough of residence, HIV status, presence of AFB sputum smear or cavitary lesions, hospitalization and prior history of tuberculosis or tuberculosis exposure.

Table 3 OR and 95%CI for having no contacts identified in relation to demographic and clinical factors among homeless TB patients, New York City, 1997–1999 (n = 152)

Characteristics	Having contacts identified: No (n = 70) n (%)	Having contacts identified: Yes (n = 82) n (%)	Crude OR (95%CI)	Adjusted OR* (95%CI)
Median age, years	42	43	0.99 (0.97–1.03)	0.99 (0.96–1.03)
Sex				
Male	60 (85.7)	59 (72.0)	2.3 (1.03–5.3)	1.9 (0.8–4.7)
Female	10 (14.3)	23 (28.1)	Referent	Referent
Race/ethnicity				
Non-Hispanic Black,	34 (48.6)	54 (65.9)	0.6 (0.3–1.2)	—
Non-Hispanic White	14 (20.0)	9 (11.0)	1.4 (0.5–4.0)	
Asian	3 (4.3)	2 (2.4)	1.3 (0.2–9.0)	
Hispanic	19 (27.1)	17 (20.7)	Referent	
US-born				
Yes	49 (70.0)	70 (85.4)	0.4 (0.2–1.0)	0.4 (0.2–1.1)
No	19 (27.1)	12 (14.6)	Referent	Referent
Unknown	2 (2.9)	0 (0.0)	NA	
Alcohol abuse history				
Yes	46 (65.7)	50 (61.0)	1.3 (0.7–2.6)	—
No	22 (31.4)	31 (37.8)	Referent	
Unknown	2 (2.9)	1 (1.2)	2.8 (0.2–33.0)	
Drug abuse history				
Yes	26 (37.1)	40 (48.8)	0.7 (0.4–1.4)	—
No	37 (52.9)	41 (50.0)	Referent	
Unknown	7 (10.0)	1 (1.2)	7.8 (0.9–66.1)	
HIV status				
Positive	30 (42.9)	37 (45.1)	1.0 (0.5–1.9)	—
Negative	30 (42.9)	36 (43.9)	Referent	
Unknown	10 (14.3)	9 (11.0)	1.3 (0.5–3.7)	
Hospitalized at the time of TB diagnosis				
Yes	64 (91.4)	81 (98.8)	0.1 (0.02–1.1)	—
No	6 (8.6)	1 (1.2)	Referent	
Sputum AFB smear/cavitary lesion on chest radiograph				
SM+ and cavitary	4 (5.7)	11 (13.4)	0.3 (0.1–0.9)	0.2 (0.1–0.9)
SM+ and non-cavitary	30 (42.9)	39 (47.6)	0.6 (0.3–1.2)	0.5 (0.3–1.2)
SM− and cavitary	5 (7.1)	3 (3.7)	1.2 (0.3–5.8)	1.4 (0.3–6.9)
SM− and non-cavitary	27 (38.6)	20 (24.4)	Referent	Referent
Other	4 (5.7)	9 (11.0)	0.3 (0.1–1.2)	0.3 (0.1–1.2)
Lost to follow-up before completing treatment				
Yes	5 (7.1)	5 (6.1)	1.2 (0.3–4.3)	—
No	65 (92.9)	77 (93.9)	Referent	
Prior history of TB or TB exposure				
Yes	7 (10.0)	12 (14.6)	0.6 (0.2–1.7)	—
No	63 (90.0)	70 (85.4)	Referent;	

* Variables included in multivariate analysis were age, sex, US-born and sputum AFB smear and cavitary lesion on chest radiograph. Two patients with unknown country of birth were excluded.
OR = odds ratio; CI = confidence interval; TB = tuberculosis; NA = not available; HIV = human immunodeficiency virus; AFB = acid-fast bacilli; SM+ = smear-positive; SM− = smear-negative.

DISCUSSION

The objective of this study was to identify factors associated with having no contacts identified among active tuberculosis patients, especially among homeless patients. Our results suggest that homelessness alone, defined as having been homeless or unstably housed at the time of diagnosis or in the 12 months prior to the diagnosis of tuberculosis, was sufficient to predict the likelihood of having no contacts identified. The very low median number of contacts identified among homeless patients is consistent with the findings from studies which evaluated contact investigations in tuberculosis programs nationwide,[16–17] and substantiates the difficulty of current contact elicitation in this group.

In our study, 95% of homeless patients were hospitalized at diagnosis, which would have provided an optimal opportunity for interviewing these patients for contacts. Nevertheless, any advantage afforded by such an opportunity for homeless patients was not evident in our data. In contrast, non-homeless patients who were hospitalized tended to have more contacts identified. In addition, the impact of infectiousness, defined by the presence of AFB in sputum and/or the presence of cavitary lesions on the number of contacts identified, differed for homeless and non-homeless patients. According to current contact investigation

Table 4 OR and 95%CI for having no contacts identified in relation to demographic and clinical factors among non-homeless TB patients, New York City, 1997–1999 (n = 2836)

Characteristics	Having contacts identified: No (n = 304) n (%)	Having contacts identified: Yes (n = 2532) n (%)	Crude OR (95%CI)	Adjusted OR* (95%CI)
Median age, years	44	43	1.0 (0.99–1.01)	NS
Sex				
Male	217 (71.4)	1633 (64.5)	1.4 (1.1–1.8)	1.5 (1.1–2.0)
Female	87 (28.6)	899 (35.5)	Referent	Referent
Race/ethnicity				
Asian	58 (19.1)	565 (22.3)	1.2 (0.8–1.7)	NS
Non-Hispanic Black	148 (48.7)	993 (39.2)	1.7 (1.3–2.4)	1.9 (1.3–2.7)
Non-Hispanic White	38 (12.5)	274 (10.8)	1.6 (1.1–2.5)	1.8 (1.1–2.9)
Hispanic	60 (19.7)	700 (27.7)	Referent	Referent
US-born				
Yes	160 (52.6)	1124 (44.4)	1.4 (1.1–1.8)	NS
No	138 (45.4)	1403 (55.4)	Referent	Referent
Unknown	6 (2.0)	5 (0.2)	12.2 (3.7–40.5)	4.4 (1.1–18.2)
Unemployed				
Yes	185 (60.9)	1615 (63.8)	1.3 (1.0–1.8)	1.4 (1.0–1.9)
No	74 (24.3)	860 (34.0)	Referent	Referent
Unknown	45 (14.8)	57 (2.3)	9.2 (5.8–14.5)	6.3 (3.8–10.4)
Residing in Manhattan				
Yes	85 (28.0)	602 (23.8)	1.2 (1.0–1.6)	NS
No	219 (72.0)	1930 (76.2)	Referent	Referent
HIV status				
Positive	94 (30.9)	644 (25.4)	1.4 (1.1–1.8)	NS
Negative	136 (44.7)	1291 (51.0)	Referent	Referent
Unknown	74 (24.3)	597 (23.6)	1.2 (0.9–1.6)	NS
Hospitalized at the time of TB diagnosis				
Yes	204 (67.1)	2074 (81.9)	0.5 (0.3–0.6)	0.4 (0.3–0.6)
No	100 (32.9)	458 (18.1)	Referent	Referent
Sputum AFB smear/cavitary lesion on chest radiograph				
SM+ and cavitary	24 (7.9)	455 (18.0)	0.3 (0.2–0.5)	0.4 (0.3–0.6)
SM+ and non-cavitary	85 (27.9)	961 (38.0)	0.5 (0.4–0.7)	0.6 (0.4–0.8)
SM− and cavitary	12 (4.0)	90 (3.6)	0.8 (0.4–1.5)	0.8 (0.4–1.5)
SM− and non-cavitary	151 (49.7)	880 (34.8)	Referent	Referent
Other	32 (10.5)	146 (5.8)	1.3 (0.8–1.9)	1.2 (0.8–1.9)
Lost to follow-up before completing treatment				
Yes	19 (6.3)	25 (1.0)	6.7 (3.6–12.3)	6.2 (3.0–12.7)
No	285 (93.8)	2507 (99.0)	Referent	Referent
Prior history of TB or TB exposure				
Yes	50 (16.5)	240 (9.5)	1.9 (1.4–2.6)	1.6 (1.1–2.3)
No	254 (83.6)	2292 (90.5)	Referent	Referent

* Adjusted for variables listed in the table.
OR = odds ratio; CI = confidence interval; TB = tuberculosis; NS = non-significant; HIV = human immunodeficiency virus; AFB = acid-fast bacilli; SM+ = smear-positive; SM− = smear-negative.

practice in our program, infectiousness of the patient is a trigger for initiating a contact investigation. In homeless patients, having AFB smear-positive sputum and cavitary lesions was significantly associated with identifying contacts, but not with finding a large number of contacts (data not shown). In contrast, among non-homeless patients, characteristics of infectiousness were significantly associated with greater number of contacts identified. These findings suggest that the priority given to infectiousness for contact investigation led to an earlier patient interview, which in turn resulted in having contacts identified among both homeless and non-homeless patients. Infectiousness was not sufficient, however, for identifying a greater number of contacts in homeless patients. Homelessness at the time of diagnosis or during the infectious period could be used as an indicator in the same way that infectiousness is used in prioritizing contact investigation by initiating a patient interview for contacts as soon as homelessness in a suspected tuberculosis patient is revealed.

This study also showed that factors associated with having no contacts identified varied significantly for homeless versus non-homeless patients. The difference between homeless and non-homeless patients implies that strategies for contact elicitation among homeless patients should be different from those applied to non-homeless patients. Mass tuberculin screening and screening with chest radiograph have been used in shelters and SROs in NYC[9,11,18,19] as case finding

measures. These approaches have met with varying success. Our program experience has suggested that these measures are not cost-effective in terms of case finding and treatment for latent tuberculosis infection because of the very low case yield and non-adherence to treatment.[9–11] In addition, screening with chest radiograph is possibly harmful owing to the transience of this group. In 1999, our program began searching the tuberculosis registry to identify patient clusters by address of residence as an additional measure to identify potential transmission sites. This surveillance by address of residence identified four previously undetected clusters which involved 29 homeless patients living in SROs or cubicle hotels in NYC between 1995 and 1999. It is likely that transmission was taking place, but without being identified by a traditional contact approach. Nine clusters involving 57 patients residing in SROs or cubicle hotels in NYC had previously been detected by traditional contact investigation methods during the same period (unpublished data, NYC DOH, 2000). The four additional clusters identified by address of residence searches illustrate the usefulness of such a method in supplementing current conventional methods for homeless patients.

An approach suggested by Barnes et al. may also be useful in improving contact investigation in homeless patients.[20] This study, conducted in central Los Angeles, used a score to define the degree of homelessness, and found that patients who slept in a shelter or on the street (score = 4) were less likely to become infected with tuberculosis than those who slept in an SRO hotel or a rehabilitation program during the 2 years before tuberculosis diagnosis (score = 2.1–3.9).[20] The homelessness score used in Barnes's study is a quantitative measure of the degree of homelessness described by coordinates of sleeping locations and time. Focusing on locations frequented by homeless patients and the average amount of time spent at these locations during the infectious period may be more productive than asking who they spent time with. Homeless patients may be less likely to know their contacts by name, or may not be able or willing to name contacts. Yet, they may more easily identify the places they go to for food and shelter. The homelessness score can be adapted by a program to supplement current approaches. Nevertheless, maintaining contacts with latent tuberculosis infection in treatment will be difficult. Our program experience has shown that treatment completion in this group is low despite extensive efforts (unpublished data, NYC DOH).

Factors significantly associated with having no contacts identified among non-homeless patients, such as being male, non-Hispanic Black, unemployed, and HIV-infected, were common characteristics in homeless patients. Therefore, approaches to improve contact investigation suggested for homeless patients, such as shortening the time from suspected diagnosis to initial interview and focusing on places they frequent, may also be useful for non-homeless patients who have no contacts identified. While location-based strategies provide an appealing alternative to traditional contact elicitation, it is possible that there is a group of non-homeless individuals who live in relative isolation. Under such circumstances, having no contacts identified may be a realistic occurrence.

Contact elicitation is the initial important step in successful contact investigations. Having no contacts identified by tuberculosis patients prevents identification of persons who may be infected. The social network approach recently explored and applied in tuberculosis control settings may be useful in such situations. Social network analysis has recently been used in tuberculosis control settings to examine the temporal evolution of an outbreak, visualize the interrelationship of subsets of people within a network, and calculate the probability of direct contact with a case as a function of selected characteristics.[21] This approach is useful for highly interactive groups, and can offer great potential for making links among cases or identifying the contacts, based on characteristics, of those patients without contacts identified. However, a social network approach may not be as useful in homeless as in non-homeless patients, because of their relative lack of social interactions.

While our program was successful in meeting the national objectives of identifying contacts for at least 90% of smear-positive tuberculosis cases, greater knowledge of the barriers to contact identification and better approaches to contact investigation among homeless patients are needed. Application of strategies focused on identifying the location of exposure rather than on eliciting names of contacts is one such approach that may be useful among homeless patients. However, such alternative strategies should be operationalized and tested in tuberculosis control program settings in order to determine their effectiveness.

Acknowledgements

We are indebted to Sukhminder Osahan, PhD, for assistance with data abstraction, to Pamela Kellner, Christina C Larkin and Gouri Mukherjee for providing invaluable insight on shelters and contact investigation activities, to Dr Lisa Adams for critical review of the manuscript, to Midelyn Montilla for providing secretarial assistance, and to program staff for their dedication and commitment on contact investigation, without which this study would not have been possible.

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