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Characteristics of Injection Drug Users Who Utilize Tuberculosis Services at Sites of the Baltimore City Needle Exchange Program

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ABSTRACT

Objective. *To describe characteristics of needle-exchange program (NEP) participants who utilized tuberculosis services from an NEP site.*

Methods. *Between June 1998 and May 1999, tuberculosis services were advertised and offered to Baltimore, Maryland, NEP participants. Demographic and tuberculosis-specific data were collected on participants who self-selected into services. Analyses were based on being tuberculin skin tested, returning for a skin test reading, and testing tuberculin positive.*

Results. *Among 691 contacts with NEP participants, this service performed 296 tuberculin tests, with an 84% return rate for skin test reading. Participants were 32% female, 87% African American, and 11% employed. Higher frequency of NEP visits was positively associated with requesting tuberculosis services and returning for skin test reading. Among those who returned for skin test reading, longer smoking duration and problems getting food in the past year due to a lack of money were associated with a positive test.*

Conclusions. *Utilization of a tuberculosis service and high return rates can be achieved among NEP participants without formal recruitment strategies. Frequent exchange appears to facilitate return visits for NEP-based tuberculosis screening, which may imply accessibility for frequent exchangers. More extensive health services at sites of the Baltimore NEP appear to be warranted, with particular attention paid to effectiveness for frequent exchangers.*

KEYWORDS *Injection Drug Use, Needle-Exchange Program, Tuberculosis Prevention.*

INTRODUCTION

In contrast to the national trend of increasing tuberculosis cases reported during the 1980s, Baltimore City, Maryland, experienced a substantial decline.[1] This decline of active tuberculosis cases was attributed to 30 years of aggressive outreach and

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community-based, directly observed therapy, which was credited with facilitating high treatment completion rates and bacteriologic evidence of cure.[1] Even though rates of reported tuberculosis cases were decreasing for the general population of Baltimore City during the 1980s, Galai et al.[2] used data from a Baltimore-based cohort study (the ALIVE study) of injection drug users (IDUs) to show that yearly incidence rates among Baltimore injectors increased from 73 per 100,000 person-years in 1988 to 232 per 100,000 person years in the first quarter of 1992. In addition, the tuberculosis incidence rate among IDUs of the same cohort was more than 30 times higher than the rate for Baltimore City at its 1991 peak (i.e., 600 vs. 19.9 per 100,000 person-years).[3] Bishai et al.[4] reinforced this point in reporting that 40% of Baltimore's tuberculosis continued to be transmitted in microepidemics of recent transmission among individuals who tended to be black males with high rates of homelessness and drug use. Thus, while Baltimore City has maintained low rates of tuberculosis through aggressive, directly observed therapy services, IDUs maintained a disproportionately high rate of recently diagnosed active disease. Although innovative approaches to tuberculosis service delivery that reach drug users could benefit cities like Baltimore, such services and studies assessing them are scarce.

One of the few tuberculosis services run specifically for IDUs operates from a needle-exchange program (NEP) site in New York City's Lower East Side. In 1997, this program offered $15 worth of incentives for tuberculin skin test follow-up visits and reported a 91% return rate.[5] High return rates and high rates of chest X rays among tuberculin-positive participants (78%) led Perlman et al.[5] to conclude that the program was feasible. In addition, the same group reported that tuberculosis-related knowledge was associated with returning for tuberculin skin test reading.[6] While these early data suggest that NEP sites may be appropriate and effective venues for tuberculosis services, more information is needed to characterize individuals who utilize services, are retained for tuberculin skin test reading, and test tuberculin positive. Such information would aid in assessing the needs of those being served, thus helping to identify means by which to improve such services.

Previous studies of IDUs have indicated that health-related service utilization was associated with older age,[7] female sex,[8] human immunodeficiency virus (HIV) symptoms,[9,10] and long duration of drug use.[7] These predictors have never been examined with specific regard to a tuberculosis program run from sites of NEP, but were hypothesized to be significant predictors of tuberculosis screening utilization in this study. Since tuberculin testing requires a second visit to assess test results, service utilization by itself is not sufficient to prevent the spread of tuberculosis. Those tested must return for tuberculin skin test reading. Retention of IDU research study participants has been associated with non-white ethnicity, age over 35 years, recent injection,[11] stable residence,[12] and HIV-positive serostatus.[13] In a tuberculosis-specific study conducted in an HIV clinic, but not necessarily among drug users, characteristics independently associated with returning for tuberculin skin test reading included the use of incentives, city residence, and sex.[14] Even though drug use is a commonly named risk factor for tuberculosis, most tuberculosis-specific studies regarding utilization of and retention in services have not been conducted solely among IDUs. Malotte et al.[15,16] conducted two IDU-specific tuberculosis studies and reported that incentives, particularly monetary incentives, dramatically increased return rates for tuberculin skin test reading. Other than incentives, few characteristics have been associated with returning for tuberculin skin test reading among IDUs. Moreover, few reports have included participants of a NEP.

The Baltimore NEP is a community-based program designed to slow the spread of HIV infection among IDUs through the distribution of clean syringes, the distribution of clean injecting equipment, HIV counseling/testing, drug treatment referrals, and informal referrals to health care facilities in Baltimore City. Baltimore NEP participants are injectors of illicit drugs, 38 years of age on average, 73% male, 87% African American, and 8% employed.[13] Compared to Baltimore IDUs who do not use a NEP, NEP participation has been associated with higher rates of injection frequency (positive trend), unemployment, jail time, homelessness, and alcohol use.[17] The Baltimore NEP is predominantly comprised of active IDUs who choose to make repeated visits to NEP sites, making this a unique opportunity for health service provision and follow-up. Since a large proportion of Baltimore's tuberculosis cases occur among IDUs, offering tuberculosis-related health services and examining predictors of utilization, retention, and infection among NEP participants is warranted. These data could be instrumental in the development of strategies for addressing tuberculosis in this population and perhaps preventing a substantial portion of tuberculosis transmission.

METHODS

Service Provision

Between June 1998 and May 1999, tuberculosis services were advertised and available to Baltimore NEP participants. One sign that explained the services was posted in an area where participants waited to exchange needles, and one sign was posted in the exchange area itself. In addition, NEP staff made participants aware of the tuberculosis services during registration and exchange visits. No active recruitment took place, and no efforts were made to increase participant adherence.

Tuberculosis services were offered to participants who exchanged needles at two of eight sites located in different parts of the city. These sites were selected because they were the only two sites operating twice weekly on the inception of the tuberculosis program (two working shifts were required for tuberculin testing and reading, as well as for the distribution of medication). Tuberculosis services at sites of a NEP (TB/NEP) consisted of education, tuberculin test placement, and interview at the first visit; tuberculin test reading at the second visit; and preventive therapy when appropriate. Tuberculin skin test placement, reading, and therapy were administered by a trained licensed practical nurse, while interviews were conducted by trained study interview staff. All tuberculin-positive participants were referred for a free chest X ray at Baltimore's Eastern District Tuberculosis Clinic, a fixed site of the Baltimore City Health Department. When appropriate, participants were given the opportunity to receive directly observed therapy from the NEP site where they were originally tested. Individuals who refused medication at an NEP site also had the option of receiving therapy from the Eastern District Tuberculosis Clinic.

In addition to tuberculin testing, an HIV test was made available to all participants. Participants opting for HIV testing received pretest counseling at the time of tuberculin testing and posttest counseling at the time results were given. In accordance with Centers for Disease Control and Prevention (CDC) recommendations,[18] anergy testing was not conducted during this study. After placement of a skin test, participants were asked to return in 72 hours. In accordance with the American Thoracic Society recommendations,[19] tests of participants returning within 1 week were read, while participants returning later than 1 week were retested. Individuals

who tested HIV seronegative were considered tuberculin positive if they had 10 or more millimeters of induration, while individuals who tested HIV seropositive and individuals who declined HIV testing were considered tuberculin positive if they had 5 or more millimeters of induration. Participants testing tuberculin positive were referred to Baltimore's Eastern Tuberculosis Clinic for chest X rays.

Data Collection

Individuals who utilized tuberculosis services and who had no history of completed prophylactic therapy or tuberculin testing in the prior 6 months were eligible for tuberculosis testing. Restricting testing services to individuals who had not been tested during the prior 6 months was an attempt to minimize excessive testing by persons wishing to repeatedly receive the monetary incentive. Study participants were consenting individuals who completed an interview and received a tuberculin skin test. All interviews were conducted in a private area of the project site. The monetary incentive, in the form of a $5 check, was explained at the time of tuberculin placement and was paid at the time of the return visit. All participants received bus tokens to facilitate return visit transportation. This research protocol was approved by the Committee on Human Research at the Johns Hopkins Bloomberg School of Public Health.

Analysis

Three dichotomous outcome variables were assessed: utilized tuberculosis services, returned for tuberculin skin test reading, and tested tuberculin positive. With regard to utilizing tuberculosis services, the sample population of interest consisted of all NEP participants who made an exchange at a TB/NEP site during the period of the study. With regard to returning for test results, the sample population of interest consisted of all NEP participants who had a tuberculin skin test and interview. With regard to tuberculin test results, the sample population of interest consisted of all TB/NEP participants who returned for skin test reading.

Independent variables tested for each of the three outcome measures were sex, age greater than the median for the population, race, employment status, total number of NEP visits greater than the population median during the 11-month study period, and median number of syringes exchanged per NEP visit greater than the population median during the study period. Independent variables assessing return for tuberculin skin test reading and tuberculin test result also included detailed information gathered during TB/NEP interviews regarding risk factors for tuberculosis and HIV.

Odds ratios (ORs) and 95% confidence intervals (CIs) were examined to determine the magnitude of effect, as well as the amount of variability in each estimate. Inferences were based on simultaneous adjustment for independent variables using multiple logistic regression. Independent variables were deleted from the logistic regression models if they did not contribute to the fit of the model. Goodness of fit was determined by log likelihood ratio tests. While inclusion criteria for logistic regression models were guided mainly by model fit, Bonferroni corrections have also been reported by which *P* values were multiplied by three to account for three outcome variables. Interaction terms were also tested for variables that comprised final models.

RESULTS

A total of 2,372 individuals exchanged 393,071 syringes (mean = 165.7, median = 46 syringes per person) in 21,596 visits (mean = 9.1, median = 3 visits per person)

to two study sites during the 11-month study period. Exchangers were 32% female, 87% African American, and 11% employed. The median age was 40 years; the median duration of injection drug use was 18.8 years; and the median number of syringes exchanged per visit was 11 (Table 1).

TB/NEP services were available on 98 days during this study period. A total of 691 NEP participants approached TB/NEP staff for education, informal health service referral, or inquiry for TB/NEP participation, resulting in 296 tuberculin tests being placed. Of the 296 tests, 10 were repeated tests given to TB/NEP participants during the second 6 months of the project and thus were excluded from analysis to preserve independence of the data (n = 286).

As shown in Table 1, utilizing tuberculosis screening among NEP participants who exchanged during the study period (n = 2,372) was associated with female sex (OR = 1.56), African American race (OR = 1.91), more than 3 NEP visits during the study period (OR = 7.17), and median number of syringes exchanged per visit less than 11 during the study period (OR = 0.65). Multiple logistic regression made only trivial differences in odds ratios, with the exception of "African American race/ethnicity." For this variable, the level of magnitude decreased such that the

TABLE 1. Associations between tuberculin skin testing and demographic/drug characteristics among Baltimore Needle Exchange Program (NEP) participants between June 1998 and May 1999 (n = 2,372)

Characteristic	Tuberculin skin tested (n = 286) no. (%)	Not tuberculin skin tested (n = 2,086) no. (%)	Unadjusted odds ratio (95% CI)
Sex			
Female	118 (41.3)	649 (31.1)	1.56*,†
Male	168 (58.7)	1,437 (68.9)	(1.21–2.00)
Age, years			
>40	130 (45.5)	904 (43.4)	1.09
≤40	156 (54.5)	1,180 (56.6)	(0.85–1.39)
Race			
African American	262 (92.2)	1,785 (86.2)	1.91
Non–African American	22 (7.8)	287 (13.8)	(1.22–3.00)
Employed at time of registration			
Yes	23 (8.0)	236 (11.4)	0.68
No	263 (92.0)	1,836 (88.6)	(0.44–1.06)
Duration of injection, years			
>18.8	148 (51.8)	1,031 (49.7)	1.09
≤18.8	138 (48.2)	1,044 (50.3)	(0.84–1.39)
Total number of NEP visits			
>3 during the study period	236 (82.5)	828 (39.7)	7.17*,†
≤3 during the study period	50 (17.5)	1,258 (60.3)	(1.04–1.06)
Median number of syringes exchanged			
>11 per NEP visit	113 (39.5)	1,045 (50.1)	0.65*,†
≤11 per NEP visit	173 (60.5)	1,041 (49.9)	(0.51–0.84)

CI, confidence interval.
*Adjusted variable contributed to the overall fit of the final model.
†Bonferroni adjusted *P* value <.05.

confidence interval included 1. In addition, African American race/ethnicity did not contribute to the fit of the model. No significant interaction terms were observed in this model.

Of the 286 participants tested and interviewed, 241 (84%) returned for their tuberculin skin test reading. Returning for a skin test reading was positively associated with making more than 15 NEP visits during the study period (OR = 2.42) (Table 2). No other demographic, drug use, or NEP variable was significantly associated with returning for a skin test reading.

Of the 241 individuals who returned for skin test reading, 40 (17%) tested positive. A positive tuberculin skin test was associated with age older than 42 years (OR = 2.51), smoking duration longer than 27 years (OR = 3.37), problems getting food during the past year due to a lack of money (OR = 3.58), and self-reported HIV infection (OR = 0.20) (Table 3). Multiple logistic regression had a negligible effect on the odds ratios of smoking duration, problems getting food due to a lack of money, and HIV status; however, the magnitude of association decreased for age older than 40 years such that the confidence interval included 1. In addition, age older than 40 years did not contribute to the fit of the model. No significant interaction terms were observed in this model.

DISCUSSION

The main findings of this study were that 691 contacts occurred between TB/NEP staff and NEP participants, 296 tuberculin tests were placed, over 80% of those tested returned for tuberculin skin test reading, and these activities occurred among individuals who self-selected into tuberculosis services. Furthermore, NEP-specific variables were significant predictors of utilizing and returning for a tuberculin skin test. NEP participants who made more than 3 NEP visits during the study period were more likely to utilize the TB/NEP service, and TB/NEP participants who made more than 15 NEP visits during the study period were more likely to return for tuberculin skin test reading. These results reinforce those of earlier studies in suggesting that sites of NEP may be propitious venues for tuberculosis services.[5] However, this study also suggests that effective methods to engage infrequent exchangers need to be identified. In addition, participants whose median exchange was greater than 11 syringes per NEP visit were 35% less likely to utilize the service. Thus, frequent participants were more likely to utilize tuberculosis services, but high-volume exchangers were less likely to utilize services. There was no association between number of visits and syringes exchanged per visit.

Similar to a previous study of drug treatment utilization among Baltimore NEP participants,[8] female sex was associated with utilizing this health service, but did not predict a return for follow-up. To explore this effect, we considered the possibility that women were in worse physical health and thus requested more services. However, no associations were found between sex and skin test result, tuberculosis screening history, insurance status, overall health, having a regular place to access health care, or tuberculosis knowledge. Why male participants were less likely to utilize tuberculosis services is still unclear. Studies that explore sex-related health utilization issues among NEP participants could be helpful in elucidating this issue.

The 84% return rate observed in this study was lower than the 91% return rate observed from New York City's Lower East Side. Whether this was due to a differential in the monetary incentive ($15 in New York vs. $5 in Baltimore) or other factors is unknown. In New York, respondent knowledge of tuberculosis was

TABLE 2. Associations between returning for a tuberculin skin test reading and demographic/drug characteristics among Baltimore Needle Exchange Program (NEP) participants who were tuberculin tested between June 1998 and May 1999 (n = 286)

Characteristic	Returned for tuberculin skin test reading (n = 241) no. (%)	Did not return for tuberculin skin test reading (n = 45) no. (%)	Unadjusted odds ratio (95% CI)
Sex			
Female	98 (41.0)	17 (37.8)	1.14
Male	141 (59.0)	28 (62.2)	(0.59–2.18)
Age, years			
>42	104 (45.4)	19 (42.2)	1.14
≤42	125 (54.6)	26 (57.8)	(0.60–2.15)
Race			
African American	218 (92.0)	41 (91.1)	1.12
Non–African American	19 (8.0)	4 (8.9)	(0.38–3.32)
Employed at time of registration			
Yes	21 (8.9)	1 (2.2)	4.32
No	214 (91.1)	44 (97.8)	(0.72–*)
Stayed in a homeless shelter during the past year			
Yes	50 (20.8)	9 (20.0)	1.05
No	190 (79.2)	36 (80.0)	(0.48–2.29)
Currently "lived on the streets or in an abandoned house"			
Yes	41 (28.9)	12 (44.4)	0.51
No	101 (71.1)	15 (55.6)	(0.22–1.16)
Ever incarcerated			
Yes	203 (84.2)	37 (82.2)	1.16
No	38 (15.8)	8 (17.8)	(0.51–2.63)
Answered both tuberculosis knowledge questions correctly			
Yes	207 (85.9)	36 (80.0)	1.52
No	34 (14.1)	9 (20.0)	(0.68–3.39)
Tuberculosis tested during past three years			
Yes	173 (76.9)	35 (77.8)	0.95
No	52 (23.1)	10 (22.2)	(0.45–2.03)
Frequency of smoking episodes			
>1 per day	229 (95.0)	42 (93.3)	1.36
≤1 per day	12 (5.0)	3 (6.7)	(0.40–4.72)
Smoking duration, years			
>27	102 (47.2)	21 (51.2)	0.85
≤27	114 (52.8)	20 (48.8)	(0.44–1.65)
Ever shared smoking equipment			
Yes	212 (93.0)	37 (92.5)	1.07
No	16 (7.0)	3 (7.5)	(0.32–3.64)

TABLE 2. *Continued*

Characteristic	Returned for tuberculin skin test reading (n = 241) no. (%)	Did not return for tuberculin skin test reading (n = 45) no. (%)	Unadjusted odds ratio (95% CI)
Injection frequency			
>1 per day	198 (93.0)	34 (75.6)	1.49
≤1 per day	43 (7.0)	11 (24.4)	(0.71–3.14)
Visited a shooting gallery during the past year			
Yes	127 (52.7)	20 (44.4)	1.39
No	114 (47.3)	25 (55.6)	(0.74–2.62)
Visited a crack house during the past year			
Yes	61 (25.3)	12 (26.7)	0.93
No	180 (74.7)	33 (73.3)	(0.46–1.90)
Duration of injection drug use, years			
>21	107 (48.2)	22 (50.0)	0.93
≤21	115 (51.8)	22 (50.0)	(0.49–1.77)
Problems getting food in past year due to a lack of money			
Yes	168 (69.7)	34 (75.6)	0.74
No	73 (30.3)	11 (24.4)	(0.36–1.53)
HIV seropositive			
Yes	41 (18.2)	6 (14.6)	1.30
No	184 (81.8)	35 (85.4)	(0.52–3.2)
Total number of NEP visits			
>15 during the study period	117 (52.2)	14 (31.1)	2.42†
≤15 during the study period	107 (47.8)	31 (68.9)	(1.23–4.75)
Median number of syringes exchanged			
>10 per NEP visit	96 (42.9)	23 (51.1)	0.72
≤10 per NEP visit	128 (47.1)	22 (48.9)	(0.38–1.35)

CI, confidence interval.
*Unable to estimate an upper limit due to small cell size.
†Adjusted variable contributed to the overall fit of the final model.

significantly associated with returning for tuberculin skin test reading[6]; however, this was not the case in Baltimore. The fact that the knowledge questions were different between studies may explain this discrepancy. In Baltimore, frequent NEP visits was the only characteristic associated with returning for tuberculin skin test reading. This may suggest that the NEP site was a location to which the respondent would have returned regardless of whether the respondent had been tuberculosis tested. This might imply accessibility for NEP participants, which could mean that follow-up for health care interventions targeted toward IDUs is improved by offering them at NEP sites.

In past studies, poverty and homelessness have been associated with active tuberculosis in the general US population. In the current study, utilizing a homeless

TABLE 3. Associations between testing tuberculin positive and demographic/drug characteristics among Baltimore Needle Exchange Program (NEP) participants who returned for skin test reading between June 1998 and May 1999 (n = 241)

Characteristic	Tested positive (n = 40) no. (%)	Did not test positive (n = 201) no. (%)	Unadjusted odds ratio (95% CI)
Sex			
Female	15 (37.5)	83 (41.7)	0.83
Male	25 (62.5)	116 (58.3)	(0.42–1.67)
Age, years			
>42	25 (64.1)	79 (41.6)	2.51
≤42	14 (35.9)	111 (58.4)	(1.24–5.08)
Race			
African American	36 (90.0)	182 (92.4)	0.74
Non–African American	4 (10.0)	15 (7.6)	(0.25–2.24)
Employed at time of registration			
Yes	3 (7.7)	18 (9.2)	0.82
No	36 (72.3)	178 (90.8)	(0.25–2.77)
Stayed in a homeless shelter during the past year			
Yes	8 (20.0)	42 (21.0)	0.94
No	32 (80.0)	158 (79.0)	(0.41–2.16)
Currently "lived on the streets or in an abandoned house"			
Yes	4 (18.2)	37 (30.8)	0.51
No	18 (82.8)	83 (69.2)	(0.17–1.51)
Ever incarcerated			
Yes	35 (87.5)	168 (83.6)	1.38
No	5 (12.5)	33 (16.4)	(0.52–3.64)
Answered both tuberculosis knowledge questions correctly			
Yes	34 (85.0)	173 (86.1)	0.92
No	6 (15.0)	28 (13.9)	(0.36–2.32)
Tuberculosis tested during past three years			
Yes	31 (81.6)	142 (76.0)	1.40
No	7 (18.4)	45 (24.0)	(0.59–3.33)
Frequency of smoking episodes			
>1 per day	39 (97.5)	190 (94.5)	2.26
≤1 per day	1 (2.5)	11 (4.5)	(0.36–*)
Smoking duration, years			
>27	27 (71.1)	75 (42.1)	3.37†,‡
≤27	11 (28.9)	103 (57.9)	(1.59–7.13)
Ever shared smoking equipment			
Yes	32 (88.9)	180 (93.8)	0.53
No	4 (11.1)	12 (6.2)	(0.17–1.66)
Injection frequency			
>1 per day	33 (82.5)	165 (82.1)	1.03
≤1 per day	7 (17.5)	36 (17.1)	(0.42–2.45)

TABLE 3. *Continued*

Characteristic	Tested positive (n = 40) no. (%)	Did not test positive (n = 201) no. (%)	Unadjusted odds ratio (95% CI)
Visited a shooting gallery during the past year			
Yes	23 (57.5)	104 (51.7)	1.26
No	17 (42.5)	97 (48.3)	(0.64–2.48)
Visited a crack house during the past year			
Yes	8 (20.0)	53 (26.4)	0.70
No	32 (80.0)	148 (73.6)	(0.31–1.59)
Duration of injection drug use, years			
>21	23 (60.5)	84 (45.7)	1.83
≤21	15 (39.5)	100 (54.3)	(0.90–3.69)
Problems getting food in past year due to a lack of money			
Yes	35 (87.5)	133 (66.2)	3.58†,‡
No	5 (12.5)	68 (33.8)	(1.38–9.24)
HIV seropositive			
Yes	2 (5.1)	39 (21.0)	0.20†
No	37 (94.9)	147 (79.0)	(0–0.8)
Total number of NEP visits			
>15 during the study period	19 (50.0)	98 (52.7)	0.90
≤15 during the study period	19 (50.0)	88 (47.3)	(0.45–1.79)
Median number of syringes exchanged			
>10 per NEP visit	16 (42.1)	80 (43.0)	0.96
≤10 per NEP visit	22 (57.9)	106 (57.0)	(0.48–1.94)

CI, confidence interval.
*Unable to estimate an upper limit due to small cell size.
†Adjusted variable contributed to the overall fit of the final model.
‡Bonferroni adjusted *P* value <.05.

shelter during the past year, currently "living on the streets or in an abandoned building," or a combination of the two did not have a strong association with a positive tuberculin test. This may be due to homogeneity within the population. Conversely, "problems getting food during the past year due to a lack of money" was strongly associated (OR = 3.56) with a positive tuberculin skin test in this population. This finding suggests that traditional risk factors for tuberculosis infection among the general population may need to be redefined for IDUs in order to be relevant in this population. The question of whether problems getting food due to a lack of money would be associated with a positive tuberculin test in IDU or homeless communities, outside the NEP environment, should be explored.

Although tuberculosis is transmitted through airborne droplet nuclei and not through injection, injection drug use has been implicated as a risk factor for tuberculosis infection.[20–28] We tested the hypothesis that those who injected at a higher

frequency would have been exposed to such situations more often and that IDUs who had injected for a longer period of time would likewise have had more opportunity to be in these higher risk environments. Neither increasing frequency nor longer duration of drug use was associated with a positive tuberculin skin test in this study. However, the probability of having a positive tuberculin skin test did increase over 300% for individuals who smoked cigarettes, marijuana, and/or crack longer than 27 years.

One possible explanation for the association between injection drug use and tuberculosis found in previous studies may be a failure to control for smoking characteristics. In addition, smoking cocaine has been associated with increased cough,[29–31] thus potentially increasing exposure of bacilli to groups of cocaine users. If this was the case, smoking cocaine may have been the actual cause of tuberculosis infection in some previously studied populations and not injecting cocaine. Of the TB/NEP population, 70% reported smoking crack or noncrack cocaine, and a previous NEP study showed that cocaine was injected by 92% of the population.[13] Another possible explanation for the association between injection drug use and tuberculosis may involve the illegality of drug use, which forces IDUs to congregate in confined clandestine areas to minimize detection. This, in combination with increased coughing due to smoking cocaine, may contribute to the disproportionately large number of reported cases that have been associated with injection drug use. Finally, the possibility exists that injection drug use has acted as a surrogate for an unmeasured portion of poverty. Further studies that employ more extensive drug use questions may be beneficial to elucidate this issue.

HIV-positive serostatus was negatively associated with a positive tuberculin test. The adjusted odds of testing tuberculin skin test positive were 80% lower for HIV-seropositive individuals than for seronegative individuals. However, decreased prevalence of tuberculin skin test reactivity has been reported in HIV-infected drug users,[22,32] as well as non-drug users[32,33] and probably reflects HIV-associated anergy.

Overall, 12% of the NEP participants who made at least one NEP visit during the study period were tested through this service. This seemingly low rate of utilization was partly due to the facts that (1) not all participants were eligible for screening (i.e., they had already undergone prophylactic therapy, or they had been tested within 6 months of requesting tuberculosis services); (2) the TB/NEP service was only able to operate for 98 days in the 11-month study period; and (3) the service had a limited capacity and could screen and interview no more than 4 participants in a given 2-hour shift, 2 days per week, thus limiting the number of individuals who could be accommodated. In addition, utilization may be partly explained by previous aggressive tuberculosis outreach to IDUs by other research studies and by the tuberculosis clinic of the Baltimore City Health Department. Even though the current program had a limited service capacity and even though tuberculosis services were widely available to IDUs, the TB/NEP service still had almost 700 contacts and tested almost 300 IDUs who had not been tested 6 months prior to utilizing services and who were at higher risk for tuberculosis than the general population. Furthermore, the indirect benefits of education and educational materials were not considered in the current analyses. Recent studies have shown that peer networks have substantial influence on the risk behavior of Baltimore IDUs.[34,35] Those who were tested may have raised tuberculosis awareness or influenced their social networks to be tested.

The main limitations in the current study were restricted opportunities for testing and a short duration of program observation, both resulting in a small sample

size. Significant associations with relatively small numbers could speak to the strength of the associations found, but this sample may be just a fraction of the participants who would have utilized services given a longer study period. It is unknown whether the profile of TB/NEP participants would change if the program were allowed to run for an extended period of time. It is possible that those most likely to test tuberculin positive would utilize the service first or vice versa. Although there were no time trends found in the current study to indicate this, the study was limited to an 11-month period of observation. Selection bias should not be an important factor in this study because self-selection (i.e., utilized service) was one of the outcome variables in these analyses, and all NEP participants were made aware of the service through advertisement signs and through NEP staff. If tuberculosis program awareness was not universal among NEP participants exchanging during the study period, there would be no reason to suspect systematic differences in program knowledge.

The strengths of the program included the facts that two NEP sites were represented (no differences by site were observed). Every individual interviewed was included in the study. Participants were not actively recruited, but self-selected to facilitate a more representative sample of those who would utilize services outside a research environment.

Baltimore is not the only city to have reported associations between drug use and tuberculosis. Similar relationships have been reported from multiple US cities since the 1960s, and the 1990s saw a continuation of these relationships.[6] However, the clandestine nature of injection drug use makes the implementation and assessment of IDU-targeted services difficult.[36,37] Moreover, reports indicate that IDUs avoid tuberculosis-specific care for fear of incarceration[38] and are often uninformed, which can ultimately lead to interference with tuberculosis control efforts.[39] Needle-exchange services bring IDUs to specific sites and have been shown to engage IDUs in tuberculosis-specific services; thus, continuing to incorporate health care into current program operations appears to be an option that could facilitate utilization of health care by IDUs. This is particularly important for health concerns, like tuberculosis, that disproportionately effect IDUs.

This study suggests that an NEP, originally designed as an HIV prevention program, can facilitate use of additional health services. Moreover, the highest frequency exchangers may benefit most through higher rates of follow-up with utilized services. This study corroborates findings of earlier studies that NEPs appear to be reasonable venues from which to offer other public health services in addition to syringe exchange. The extent to which an NEP can attract into health services IDUs who otherwise would not have received services should be explored further. Future studies should address follow-up for therapy, as well as redundancy of community services. Such studies may help to coordinate between NEP and community services, perhaps partitioning specific types of care to make services cost-effective.

The facts that 691 contacts occurred between NEP participants and TB/NEP staff during 98 days of operations and that high rates of follow-up found here and in New York City's Lower East Side are consistent with reports of programs offering general health care to New Haven, Connecticut, and San Francisco, California, NEP participants. High rates of service utilization have led Altice et al.[40,41] and Lum et al.[42] to deem these programs an effective means by which to engage drug users into health care. Combined, these studies suggest that sites of NEP are appropriate venues to offer health care and may increase health care access to IDUs using an NEP.

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REFERENCES

1. Chaulk CP, Moore-Rice K, Rizzo R, Chaisson RE. Eleven years of community-based directly observed therapy for tuberculosis. *JAMA*. 1995;274:945–951.
2. Galai N, Graham N, Chaisson R, Nelson KE, Vlahov D, Lewis J. Multidrug-resistant tuberculosis. *N Engl J Med*. 1992;327:1172–1173.
3. Graham NM, Galai N, Nelson KE, et al. Effect of isoniazid chemoprophylaxis on HIV-related mycobacterial disease. *Arch Intern Med*. 1996;156:889–894.
4. Bishai WR, Graham NM, Harrington S, et al. Molecular and geographic patterns of tuberculosis transmission after 15 years of directly observed therapy. *JAMA*. 1998;280: 1679–1684.
5. Perlman DC, Perkins MP, Solomon N, Kochems L, Des Jarlais DC, Paone D. Tuberculosis screening at a syringe exchange program. *Am J Public Health*. 1997;87:862–863.
6. Salomon N, Perlman DC, Perkins MP, et al. Knowledge of tuberculosis among drug users: relationship to screening return rates. *J Subst Abuse Treat*. 1999;16:229–235.
7. Platt J. *Heroin Addiction Theory, Research and Treatment*. 2nd ed. Malabar, FL: Robert E Krieger Publishing Co.; 1986:221.
8. Riley E, Vlahov D, Safrahein M, Junge B, Beilenson P, Strathdee S. Gender differences in drug use patterns and successful referrals to drug treatment among Baltimore needle exchange participants. Paper presented at: Annual Meeting of the College on Problems of Drug Dependence; June 13–17, 1999; Acapulco, Mexico.
9. Solomon L, Frank R, Vlahov D, Astemborski J. Utilization of health services in a cohort of intravenous drug users with known HIV-1 serostatus. *Am J Public Health*. 1991;81: 1285–1290.
10. Hunter RVM, Rios E, Gomez MA. Persistent intravenous drug abuse and health encounters. *Natl Conf Hum Retroviruses Relat Infect*. 1995;2:165.
11. Nelson KE, Vlahov D, Solomon L, Cohn S, Munoz A. Temporal trends of incident human immunodeficiency virus infection in a cohort of injecting drug users in Baltimore, Maryland. *Arch Intern Med*. 1995;155:1305–1311.
12. Jimenez AD, Johnson WA, Hershow RC, Wiebel WW, Rahimian A. Behavioral and sociocultural factors related to variations in TB treatment compliance among IDUs: an ethnographic study. Paper presented at: Annual Meeting of the American Public Health Association; November 17–21, 1996; New York, New York.
13. Vlahov D, Junge B, Brookmeyer R, et al. Reductions in high-risk drug use behaviors among participants in the Baltimore needle exchange program. *J Acquir Immune Defic Syndr Hum Retrovirol*. 1997;16:400–406.
14. Chaisson RE, Keruly JC, McAvinue S, Gallant JE, Moore RD. Effects of an incentive and education program on return rates for PPD test reading in patients with HIV infection. *J Acquir Immune Defic Syndr Hum Retrovirol*. 1996;11:455–459.

15. Malotte CK, Rhodes F, Mais KE. Tuberculosis screening and compliance with return for skin test reading among active drug users. *Am J Public Health*. 1998;88:792–796.
16. Malotte CK, Hollingshead JR, Rhodes F. Monetary versus nonmonetary incentives for TB skin test reading among drug users. *Am J Prev Med*. 1999;16:182–188.
17. Flynn C, Junge MB, Riley E, Cohn S, Beilenson P, Vlahov D. Selection bias in needle exchange participation as observed in two cohorts of injection drug users. Paper presented at: Twelfth World AIDS Conference; June 28–July 3, 1998; Geneva, Switzerland.
18. Centers for Disease Control and Prevention. Anergy skin testing and tuberculosis preventive therapy for HIV-infected persons: revised recommendations. *MMWR Morb Mortal Wkly Rep*. 1997;46:1–10.
19. American Thoracic Society/Centers for Disease Control and Prevention. Targeted tuberculin testing and treatment of latent tuberculosis infection. *Am J Respir Crit Care Med*. 2000;161:S221–S247.
20. Vlahov D, Anthony JC, Munoz A, et al. The ALIVE study, a longitudinal study of HIV-1 infection in intravenous drug users: description of methods and characteristics of participants. *NIDA Res Monogr*. 1991;109:75–100.
21. O'Connor PG, Selwyn PA, Schottenfeld RS. Medical care for injection-drug users with human immunodeficiency virus infection [see comments]. *N Engl J Med*. 1994;331: 450–459.
22. Graham NM, Nelson KE, Solomon L, et al. Prevalence of tuberculin positivity and skin test anergy in HIV-1-seropositive and -seronegative intravenous drug users. *JAMA*. 1992;267:369–373.
23. Robert CF, Hirschel B, Rochat T, Deglon JJ. Tuberculin skin reactivity in HIV-seropositive intravenous drug addicts. *N Engl J Med*. 1989;321:1268.
24. Stoneburner RL, Des Jarlais DC, Benezra D, et al. A larger spectrum of severe HIV-1--related disease in intravenous drug users in New York City. *Science*. 1988;242:916–919.
25. Selik RM, Starcher ET, Curran JW. Opportunistic diseases reported in AIDS patients: frequencies, associations, and trends. *AIDS*. 1987;1:175–182.
26. Rieder HL, Cauthen GM, Comstock GW, Snider DE, Jr. Epidemiology of tuberculosis in the United States. *Epidemiol Rev*. 1989;11:79–98.
27. Centers for Disease Control and Prevention. Prevention and control of tuberculosis in US communities with at-risk minority populations, and prevention and control of tuberculosis among homeless persons: recommendations of the Advisory Council for the Elimination of Tuberculosis. *MMWR Morb Mortal Wkly Rep*. 1992;41:1–21.
28. Burwen DR, Bloch AB, Griffin LD, Ciesielski CA, Stern HA, Onorato IM. National trends in the concurrence of tuberculosis and acquired immunodeficiency syndrome. *Arch Intern Med*. 1995;155:1281–1286.
29. Tashkin DP, Khalsa ME, Gorelick D, Chang P, Simmons MS, Coulson AH, Gong H Jr. Pulmonary status of habitual cocaine smokers. *Am Rev Respir Dis*. 1992;145:92–100.
30. Perper JA, Van Thiel DH. Respiratory complications of cocaine abuse. *Recent Dev Alcohol*. 1992;10:363–377.
31. Warner EA. Is your patient using cocaine? Clinical signs that should raise suspicion. *Postgrad Med*. 1995;98:173–176, 180.
32. Markowitz N, Hansen NI, Wilcosky TC, et al. Tuberculin and anergy testing in HIV-seropositive and HIV-seronegative persons. *Ann Intern Med*. 1993;119:185–193.
33. Janis EM, Allen DW, Glesby MJ, et al. Tuberculin skin test reactivity, anergy, and HIV infection in hospitalized patients. *Am J Med*. 1996;100:186–192.
34. Hawkins WE, Latkin C, Mandel W, Oziemkowska M. Do actions speak louder than words? Perceived peer influences on needle sharing and cleaning in a sample of injection drug users. *AIDS Educ Prev*. 1999;11:122–131.
35. Latkin CA, Knowlton AR, Hoover D, Mandell W. Drug network characteristics as a predictor of cessation of drug use among adult injection drug users: a prospective study. *Am J Drug Alcohol Abuse*. 1999;25:463–473.

36. Wiebel WW. Identifying and gaining access to hidden populations. *NIDA Res Monogr*. 1990;98:4–11.
37. Adler P. Ethnographic research on hidden populations: penetrating the drug world. *NIDA Res Monogr*. 1990;98:96–112.
38. Curtis R, Friedman SR, Neaigus A, Jose B, Goldstein M, Des Jarlais DC. Implications of directly observed therapy in tuberculosis control measures among IDUs. *Public Health Rep*. 1994;109:319–327.
39. Wolfe H, Marmor M, Maslansky R, et al. Tuberculosis knowledge among New York City injection drug users. *Am J Public Health*. 1995;85:985–988.
40. Altice FL, Fleck EM, Selwyn PA, Kaplan EH, Barry M, Gomez J. Provision of health care and HIV counseling and testing for clients of the New Haven Needle Exchange Program (NEP). Paper presented at: Ninth International Conference on AIDS; June 7–11, 1993; Berlin, Germany.
41. Altice F, Khooshnood K, Blankenship KM, Lamberti MP, Selwyn PA. Needle exchange based health services as a comprehensive community prevention program. Paper presented at: Twelfth World AIDS Conference; June 28–July 3, 1998; Geneva, Switzerland.
42. Lum PJ, Guydish JR, Brown C, Allen R. An innovative needle exchange program exclusively for women is well accepted by women injection drug users in San Francisco. Paper presented at: Twelfth World AIDS Conference; 1998; Geneva, Switzerland.