NEEDLE-EXCHANGE ATTENDANCE AND HEALTH CARE UTILIZATION PROMOTE ENTRY INTO DETOXIFICATION

STEFFANIE A. STRATHDEE, PHD, DAVID D. CELENTANO, SCD, NINA SHAH, MSC, CYNTHIA LYLES, PHD, VERONICA A. STAMBOLIS, MA, GRACE MACALINO, MPH, KENRAD NELSON, MD, AND DAVID VLAHOV, PHD

ABSTRACT This study was undertaken to identify factors associated with entry into detoxification among injection drug users (IDUs), and to assess the role of needle-exchange programs (NEPs) as a bridge to treatment. IDUs undergoing semiannual human immunodeficiency virus (HIV) tests and interviews were studied prospectively between 1994 and 1998, during which time an NEP was introduced in Baltimore. Logistic regression was used to identify independent predictors of entry into detoxification, stratifying by HIV serostatus. Of 1,490 IDUs, similar proportions of HIV-infected and uninfected IDUs entered detoxification (25% vs. 23%, respectively). After accounting for recent drug use, hospital admission was associated with four-fold increased odds of entering detoxification for HIV-seronegative subjects. Among HIV-infected subjects, hospital admission, outpatient medical care, and having health insurance independently increased the odds of entering detoxification. After accounting for these and other variables, needle-exchange attendance also was associated independently with entering detoxification for both HIV-infected (adjusted odds ratio [AOR] = 3.2) and uninfected IDUs (AOR = 1.4). However, among HIV-infected subjects, the increased odds of detoxification associated with needle exchange diminished significantly over time, concomitant with statewide reductions in detoxification admissions. These findings indicate that health care providers and NEPs represent an important bridge to drug abuse treatment for HIV-infected and uninfected IDUs. Creating and sustaining these linkages may facilitate entry into drug abuse treatment and serve the important public health goal of increasing the number of drug users in treatment.

KEY WORDS Detoxification, HIV/AIDS, Injection Drug Use, Needle-exchange Programs, Substance Abuse Treatment

---

Drs. Strathdee, Celentano, Lyles, Nelson, and Vlahov and Ms. Shah and Ms. Stambolis are from the Johns Hopkins School of Public Health, Baltimore, MD, and Dr. Vlahov is also from the New York Academy of Medicine, New York City, NY.

Correspondence: Dr. Steffanie A. Strathdee, Associate Professor, Department of Epidemiology, Johns Hopkins School of Public Health, 615 North Wolfe Street, Baltimore, MD 21205. (E-mail: Sstrathd@jhsph.edu)

INTRODUCTION

Since 1984, needle-exchange programs (NEPs) have been implemented in both developed and developing countries as a prevention strategy for human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS). These programs have focused primarily on removing contaminated needles and syringes from circulation, and providing injection drug users (IDUs) with access to sterile injection equipment to reduce the potential for needle sharing. A large body of literature has demonstrated that NEPs can be effective in reducing HIV prevalence, incidence, and high-risk injection behaviors associated with transmission of blood-borne pathogens.[1-4]

Another important aspect of NEPs that has received attention more recently is their potential to act as a "bridge to treatment." A number of studies have demonstrated that NEPs provide referrals to drug abuse treatment programs.[1,5,6] Not only do IDUs readily accept drug treatment referrals offered by NEPs,[6,7] some IDUs appear to attend NEPs in search of scarce drug treatment slots.[6,8] A recent study in Baltimore, Maryland, reported that NEP attenders who were referred to a methadone maintenance program were less likely to have had a history of prior treatment and had comparable treatment outcomes over the short term compared to standard referrals.[9] These studies were important in documenting that NEPs can be a conduit to drug abuse treatment; however, data are lacking that quantify the association between NEP attendance and subsequent entry into drug abuse treatment in an out-of-treatment population.

The present study was conducted to identify predictors of entry into detoxification among a well-characterized cohort of IDUs in Baltimore who were primarily out of treatment at the time of recruitment. In particular, this study sought to determine the extent to which NEP attendance and contact with other health care services were associated with subsequent entry into detoxification. Entry into detoxification was chosen as the outcome of interest, since these programs often represent a drug user's first experience with drug abuse treatment. As such, detoxification programs play a critical role in generating individual perceptions toward drug treatment and can influence the course of any future drug abuse treatment. Following detoxification, drug users often are referred to longer-term treatment modalities that promote abstinence. The notion that drug abuse treatment is an effective primary prevention against infection with HIV and other blood-borne pathogens is gaining acceptance.[10] Since only 10% to 20% of IDUs are receiving drug treatment at any given time in the US,[11,12] the present study provides an opportunity to identify factors that facilitate or impede entry into detoxification programs to maximize their impact and to tailor them effectively.

METHODS

The AIDS Link to Intravenous Experiences (ALIVE) study is a prospective cohort study of IDUs that was initiated in 1988. The study design and methods of this study have been described previously.[13,14] Briefly, subjects were eligible to participate if they were aged 18 years or older at baseline, were AIDS free at enrollment, and had injected drugs since 1977, which roughly corresponded to the emergence of the HIV epidemic in Baltimore. Over 80% of subjects reported having been recruited by another study participant or friend rather than being referred by a drug treatment program, public health program, or trained street outreach worker.[13,14] A total of 2,960 IDUs meeting the study eligibility criteria were screened and enrolled in the study, of whom 24% were HIV infected at study entry.

At baseline, and semiannually thereafter, participants underwent venipuncture for HIV testing and an interviewer-administered questionnaire on demographics, risk behaviors for HIV infection, health status indicators, and health services utilization. Respondents were asked to provide information about visits to emergency departments and physicians and hospital admissions during the previous 6 months. At each semiannual visit beginning in 1993, respondents were asked if they had attended a detoxification program or methadone maintenance program and to report the duration of treatment. Finally, cohort data were linked to registration data from the Baltimore NEP, which was a legal program introduced in August 1994.[7] The availability of NEP registration data provided a validated measure of NEP attendance for cohort members independent of self-reported data.

The present analysis excluded individuals who reported not injecting drugs between study enrollment and February 1994. February 1994 was chosen as the start date for the analysis (hence referred to as the baseline visit) because it corresponded with the 6-month period of observation prior to the introduction of the NEP and coincided with the implementation of a questionnaire that included standardized questions about drug abuse treatment. Individuals who were lost to follow-up (i.e., 10% of the sample) were censored at their last visit. The remainder were censored in February 1998.

Descriptive analyses were used to compare baseline characteristics of IDUs who reported undergoing detoxification during the study period to those who did not. Chi-square tests were used to compare dichotomous and categorical data, whereas Wilcoxon rank sum tests were used to analyze continuous variables. Logistic regression was used to identify factors associated with entry into detoxification programs in the prior 6 months for the entire 54-month period. Since serial

measures on the same individuals were considered for this analysis, generalized estimating equations were used to adjust for correlation between these measures over time.[15] Variables significant at the 10% level according to Wald's statistic were offered into multivariate logistic regression models. Since we considered that drug use behaviors in a given 6-month period could have changed following drug abuse treatment, behavioral data (e.g., injection frequency, shooting gallery attendance, use of specific drugs, NEP attendance) were lagged one visit. Potential two-way interactions were assessed between variables that were predictive independently of entry into detoxification and calendar year.

All of the above analyses were conducted with stratification by HIV serostatus at baseline. Individuals who were HIV seronegative in January 1994 and who subsequently became infected during the follow-up period were included in the HIV-seronegative group until their date of seroconversion. A subanalysis also was conducted to examine predictors of entry into detoxification for seroconverting subjects, using the date of their first HIV-seropositive visit as the start date.

RESULTS

Of 1,483 IDUs who were eligible for analysis in February 1994, 430 (29%) were HIV seroprevalent and 1,053 (71%) were HIV seronegative. The overall sample was 74% male and 94% black. Median age was 40 years (interquartile range [IQR] 36–45 years). Identical proportions of HIV-infected and uninfected IDUs reported some form of drug abuse treatment prior to baseline (68%), and similar proportions reported undergoing detoxification during the 4.5-year follow-up period from 1994 to 1998 (26% vs. 23%, respectively). During this period, among those who reported at least one visit to a detoxification program, both HIV-infected and uninfected groups reported a median of one visit (IQR 1–2). The median number of days in a detoxification program was 14 (IQR 5–35). Of the individuals, 15% reported being enrolled in both a detoxification and a methadone maintenance program during the same 6-month period; this proportion did not differ by HIV serostatus and was consistent throughout the follow-up period.

Table I describes sociodemographic characteristics of IDUs according to whether or not they reported undergoing detoxification during follow-up, stratified by HIV serostatus. Overall, few demographic variables were associated with detoxification. Among HIV-seronegative IDUs, females were marginally more likely than males to report having undergone detoxification ($P = .05$). There was no corresponding gender difference for HIV-seropositive IDUs. Among HIV-seropositive IDUs, a higher proportion of non-blacks than blacks reported entering detoxification ($P = .04$), but these differences were based on small numbers

TABLE I Sociodemographic Characteristics of HIV-Seronegative and HIV-Seropositive Injection Drug Users Entering versus Not Entering Detoxification, 1994–1998

	Number (%) Entering Detoxification Program			
	Seronegative IDU (n = 1,053)		Seropositive IDU (n = 430)	
Variable	Yes	No	Yes	No
Gender				
Male	190 (70.6)	600 (76.5)*	71 (71.7)	251 (75.8)
Female	79 (29.4)	184 (23.5)	28 (28.3)	80 (24.2)
Ethnicity				
Black	256 (95.2)	732 (93.4)	93 (93.9)	324 (97.9)*
Non-Black	13 (4.8)	52 (6.6)	6 (6.1)	7 (2.1)
Age				
<40 years	143 (53.2)	379 (48.3)	56 (56.6)	186 (56.2)
≥40 years	126 (46.8)	405 (51.7)	43 (43.4)	145 (43.8)
Employment				
Employed	41 (15.2)	187 (23.9)*	8 (8.1)	57 (17.2)*
Unemployed	228 (84.8)	597 (76.1)	91 (91.9)	274 (82.8)
Housing				
Homeless	64 (23.8)	123 (15.7)*	23 (23.2)	51 (15.4)
Not Homeless	205 (76.2)	661 (84.3)	76 (76.8)	280 (84.6)

*$P < .05$ by chi-square or Fisher exact tests.

of whites (n = 13) and therefore should be interpreted with caution. There was no corresponding difference in the proportion by ethnicity of HIV-seronegative IDUs who reported entering detoxification. Among HIV-negative IDUs, a higher proportion of homeless than housed IDUs reported entering detoxification ($P = .003$). Higher proportions of unemployed than employed individuals reported detoxification in both HIV-seronegative and HIV-seropositive groups ($P = .003$ and $P = .07$, respectively).

Table II depicts univariate odds ratios obtained from logistic regression models in which entry into detoxification was treated as the outcome variable. A number of lagged behaviors were associated significantly with entry into detoxification programs. Injecting drugs daily or more often was associated with subsequent entry into detoxification for both HIV-seronegative and HIV-seropositive IDUs, as was involvement in the sex trade. In addition, having visited an emergency department or physician recently, being admitted recently to a hospital, and attending NEP were associated with increased odds of entering detoxification; in univariate analysis, this association only was significant statistically for HIV-seronegative IDUs.

TABLE II Predictors of Entry into Detoxification Programs Among HIV-Seronegative and HIV-Seropositive Injection Drug Users: Univariate Odds Ratio

Variable	Odds Ratio (95% CI)	
	Seronegative IDU (n = 1,056)	Seroprevalent IDU (n = 430)
Sociodemographics		
Ethnicity (black vs. non-black)	0.96 (0.53, 1.74)	0.36 (0.17, 0.77)
Female vs. male	1.22 (0.93, 1.61)	1.29 (0.82, 2.02)
Age (≥40 vs. <40 yrs)	0.73 (0.57, 0.94)	1.03 (0.70, 1.52)
Employed (yes vs. no)	0.57 (0.43, 0.76)	0.26 (0.12, 0.56)
Homeless (yes vs. no)	1.69 (1.25, 2.29)	1.63 (0.99, 2.65)
Behavioral characteristics*		
Injected drugs	1.84 (1.38, 2.46)	2.92 (1.78, 4.77)
Injected ≥ daily	2.05 (1.50, 2.80)	3.53 (2.10, 5.95)
Injected < daily	1.63 (1.17, 2.27)	2.25 (1.27, 4.00)
Shared needles	1.00 (0.71, 1.39)	1.09 (0.61, 1.97)
Engaged in sex trade	1.40 (1.03, 1.91)	2.08 (1.24, 3.50)
Attended shooting gallery	1.20 (0.74, 1.93)	2.10 (1.07, 4.09)
Injected cocaine	0.91 (0.69, 1.19)	0.75 (0.46, 1.25)
Injected heroin	1.19 (0.89, 1.61)	1.60 (0.92, 2.81)
Injected speedballs	0.98 (0.74, 1.31)	1.81 (1.05, 3.11)
Service utilization		
Visited emergency department	2.10 (1.67, 2.64)	1.42 (1.00, 2.01)
Visited physician	1.36 (1.09, 1.70)	1.70 (1.20, 2.40)
Any health insurance†	1.19 (0.94, 1.51)	1.53 (0.96, 2.46)
Admitted to hospital	3.91 (3.04, 5.04)	3.36 (2.25, 5.04)
Attended needle exchange*	1.58 (1.16, 2.14)	1.23 (0.70, 2.18)

*Lagged one visit (i.e., 6 months).
†Medicaid or private health insurance versus no insurance.

Table III shows the final multivariate models that identify predictors of entry into detoxification for both HIV-seronegative and HIV-seropositive IDUs. Among HIV-seronegative IDUs, injecting more than daily, attending an NEP, and recently being admitted to a hospital were associated independently with entering detoxification. In particular, hospital admission was associated with a four-fold increase in the odds of entering detoxification. Among the HIV-seropositive group, IDUs who injected daily and those who injected heroin or speedball (simultaneous injection of heroin and cocaine) were twice as likely to undergo detoxification. As in the HIV-seronegative group, recent hospital admission was highly predictive of detoxification (adjusted odds ratio [AOR] = 2.82, 95% confidence interval [CI] 1.82–4.38); however, having visited a physician recently was also an independent predictor.

TABLE III Independent Predictors of Entry Into Detoxification: Final Multivariate Logistic Regression Models Stratified by HIV Serostatus

Variable	Seronegative IDU	Seroprevalent IDU*
	Adjusted Odds Ratio (95% CI)	
Injected > once/day† (yes vs. no)	2.03 (1.48–2.78)	2.98 (1.66–5.35)
Injected speedballs or heroin† (yes vs. no)	—	2.22 (1.30–3.77)
Admitted to hospital‡ (yes vs. no)	4.00 (3.08–5.19)	2.82 (1.28–4.38)
Visited physician‡ (yes vs. no)	—	1.92 (1.28–2.89)
Health insurance (yes vs. no)‡	—	1.51 (1.01–2.28)
Attended needle exchange program† (yes vs. no)	1.38 (1.02–1.87)	3.2 (1.38–7.53)

*Adjusting for interaction between lagged NEP attendance and calendar year.
†Lagged one visit (i.e., 6 months).
‡During previous 6 months.

While NEP attendance also was associated independently with subsequent entry into detoxification among HIV-seropositive IDUs, a significant interaction was observed between NEP attendance and time (Fig. 1). During 1994 and 1995, HIV-positive IDUs attending NEP were 2.7 times more likely to enter a detoxification program subsequently (95% CI 1.18–6.06); however, these odds diminished to 0.72 in 1996 (95% CI 0.13–4.25) and 0.76 in 1997–1998 (95% CI 0.11–5.44). If the interaction was unaccounted for, the overall crude odds ratio associated with NEP would be 1.12 (0.61–2.05). Relative to the 1994–1995 period, this downward trend was significant statistically ($P < .05$). This interaction remained significant after adjusting for all other parameters in the model (Table III), as well as for race (results not shown). Adjusting for these covariates, the AOR associated with NEP attendance was 3.23 in 1994–1995 (95% CI 1.38–7.54), whereas in 1996 and 1997, it was 0.61 (0.10–3.67) and 0.64 (0.09–4.55), respectively.

Finally, a subanalysis was conducted to identify independent predictors of entry into detoxification among the 75 HIV-seronegative individuals in February 1994 who seroconverted during the study period. In this subset, IDUs who had been infected for less than 2 years were 4.3 times more likely to undergo detoxification (95% CI 1.66–11.20), and female IDUs were 4.8 times more likely to enter detoxification (95% CI 1.1–21.0). As in the other groups under study,

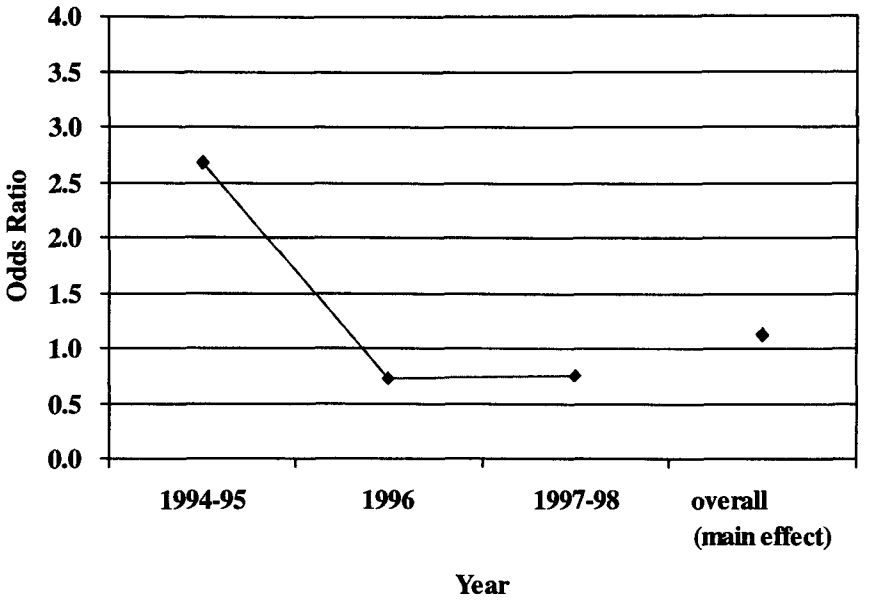

FIGURE 1 Odds of entering detoxification associated with NEP attendance over time among HIV + IDUs. Univariate OR derived from logistic regression models, adjusting for correlation between repeated measures using generalized estimating equations (see Methods section).

recent hospital admission was associated independently with detoxification (AOR = 5.49, 95% CI 1.42–21.16).

DISCUSSION

Approximately 50,000 persons in Baltimore were estimated to require drug abuse treatment in 1996, the most recent year for which data were available.[16] A substantial proportion of these individuals were believed to be IDUs. Increasing the number of IDUs receiving addiction treatment requires an understanding of the factors that facilitate entry into treatment, which often begins with detoxification as the point of entry. In Maryland, detoxification programs have consisted primarily of 24-hour ambulatory, residential (nonmedical), and hospital-based programs, as well as methadone detoxification. The last involves supervised administration of methadone to persons addicted to heroin or other opiates, whereas the other programs are appropriate for opiate addiction and/or polydrug use.

In our sample of active IDUs, we found that NEP attendance and health care utilization were associated independently with entry into detoxification for both HIV-seropositive and HIV-seronegative IDUs. HIV-positive NEP attenders were more than three times more likely to enter a detoxification program in the first year after NEP was introduced; however, this effect diminished significantly

over time. One possible interpretation is that the opening of the Baltimore NEP attracted HIV-infected IDUs who sought referrals to drug-abuse treatment. This is consistent with observations by Heimer et al.,[6,8] who found that one-quarter of NEP attenders in New Haven, Connecticut, requested drug treatment—primarily detoxification—in the first 7 months after the NEP was introduced. Of New Haven NEP attenders who received drug abuse treatment referrals from a dedicated NEP worker, 60% subsequently entered a detoxification program.

We explored the possibility that the decreasing association between NEP attendance and the odds of detoxification over time was explained by fewer requests for drug treatment. Of 255 cohort members who attended the NEP and underwent an interviewer-administered questionnaire as part of the NEP evaluation study,[7] the proportion who reported that they were pursuing drug treatment actively in 1995 (53%) did not decrease significantly over time ($P > .05$). An alternate explanation is that detoxification admissions became more difficult to obtain, and that barriers to access to drug treatment affected HIV-infected IDUs differentially. This hypothesis is supported by the fact that ambulatory detoxification admissions in Maryland decreased by more than half during the study period.[17] In 1995, known IDUs—who may be more likely to be HIV positive—became ineligible for social security benefits, which previously permitted third-party reimbursement for drug abuse treatment. We found that, among HIV-seroprevalent IDUs in our study, those who had health insurance were significantly more likely to undergo detoxification after controlling for injection behaviors, health care utilization, and NEP attendance.

Our findings support the conclusion that NEPs can be an important conduit to drug abuse treatment.[1,6,8,9,18] Since NEPs tend to reach IDUs at high risk of HIV infection, many of whom have had no history of drug abuse treatment,[7,9,2,19] promoting and sustaining strong linkages between NEPs and drug treatment programs should be a high public health priority. In the US, the majority of NEPs provide referrals for substance abuse treatment.[1,5] However, NEPs that operate illegally due to a continued congressional ban on federal funds to support these programs are significantly less likely to maintain a formal agreement with drug treatment providers. The lack of federal funds to support NEPs therefore limits the capacity of these programs to refer IDUs to the limited numbers of drug treatment slots available.[5]

In the absence of legal NEPs in many states, the role of health care providers in providing referrals to drug abuse treatment becomes critical. Our study revealed that health care utilization was associated strongly with detoxification. In particular, recent hospital admission was associated with a four-fold odds

increase of detoxification for IDUs who were HIV seronegative at baseline and those who seroconverted since entering the study and nearly a three-fold odds increase for HIV-seroprevalent IDUs. This finding is not surprising, given that hospital-based detoxification is offered in Baltimore. However, it is also possible that IDUs who experienced a serious health problem that required hospitalization were more likely to consider drug abuse treatment and to enter a residential detoxification program subsequently.

In univariate analyses, having attended an emergency department recently was associated with having undergone detoxification. According to the Drug Awareness Warning Network (DAWN), which conducts surveillance on drug-related morbidity and mortality across the US, "seeking detoxification" was the primary reason for 12% of all drug-related emergency department visits recorded in 1996.[20] Baltimore experienced a rate of 398 per 100,000 heroin-related emergency department visits in 1994, which was the highest among the 21 metropolitan areas sampled by DAWN.[21] Despite the fact that residential detoxification programs have been shown to incur one-fifth the cost of hospital-based programs,[22] the latter constitute a high proportion of admissions to detoxification programs in Maryland.[17] Our data suggest that hospital encounters may represent a unique opportunity to offer drug abuse treatment, which can be facilitated through detoxification. Increasing the number of residential detoxification admissions may reduce significantly the number of drug users seeking detoxification at hospitals, which would reduce health care costs substantially.

In our study, HIV-positive IDUs who had visited a physician recently were nearly twice as likely to undergo detoxification than IDUs who had not, even after adjusting for admission to a hospital. This association is likely to reflect a health problem that spurred a decision to enter drug abuse treatment and suggests that physicians can play an important role in referring patients to appropriate addiction treatment. Facilitating the reduction or cessation of injection drug use for HIV-infected persons is critical for promoting the health of individual drug users and reducing the transmission of blood-borne pathogens.

A previous analysis of baseline data in our cohort demonstrated that detoxification was associated with a recent episode of overdose.[23] The present analysis was limited by the fact that overdose data were not collected prospectively during the follow-up period. However, the results discussed here were independent of other factors related to drug use, such as injection frequency. Our study is limited by the fact that reports of drug treatment, health care utilization, and behaviors were self-reported and therefore were subject to recall bias and socially desirable responding. However, self-reports of drug use have been found previously to

be both valid and reliable.[24,25] Moreover, we were able to validate NEP attendance directly through the use of NEP registration data. Our findings may not be generalizable to all IDU populations, since our sample represented a subset of IDUs that had been followed prospectively since 1988. Although our participants over-represent older IDUs, this itself should not compromise external validity since it is well known that older drug users are more likely to enter substance abuse treatment.[26]

As in previous reports,[23,27] we observed that the proportion of IDUs who successfully experienced a transition from detoxification to a longer-term treatment program, such as methadone maintenance, was relatively low. The proportion of IDUs in our study that reported being enrolled in methadone maintenance was consistently 15% throughout the study period regardless of recent detoxification. While our data suggest that NEPs and health care utilization can promote entry into detoxification, provided that such admissions are available, the probability of sustained reductions or cessation of drug use is contingent on the availability of longer-term drug treatment programs. Given the acknowledged public health and social burden of substance abuse, injection drug use in particular, there is an urgent need to expand drug treatment programs and to create and maintain supportive linkages between existing health care and drug treatment services.

In particular, our data suggest that NEPs can provide wider access to drug abuse treatment by providing a bridge to treatment independent of health care services. NEPs have the potential to refer IDUs into drug abuse treatment before they experience major medical complications arising from years of drug dependence. Fostering this bridge to treatment by maintaining formal arrangements between NEPs and drug abuse treatment programs while expanding the numbers of drug treatment slots would help to achieve the important public health goal of increasing the number of drug users in treatment. More recently, the city of Baltimore has done just that, nearly doubling publicly funded treatment and linking drug abuse treatment more closely to NEPs. Other cities should replicate this effort.

ACKNOWLEDGEMENT

This study was supported by the National Institute on Drug Abuse through grants DA04334 and DA08009. We gratefully acknowledge technical assistance from Jacqueline Astemborski, Lisette Johnson, Victoria Kanecko, Paul Gentille, and Robert Schwartz for critical review of the manuscript; staff from the Baltimore

Needle Exchange Program and Evaluation study; and Tiffany Johnson for manuscript preparation.

REFERENCES

1. Lurie P, Reingold A, Bower B, et al. *The Public Health Impact of Needle Exchange Programs in the United States and Abroad.* Vol 1. Atlanta, GA: Centers for Disease Control and Prevention; 1993.
2. Strathdee SA, van Ameijden E, Mesquita F, et al. Can HIV epidemics among injection drug users be prevented? *AIDS.* 1998;12(suppl A):S71–S79.
3. Normand J, Vlahov D, Moses LE. *Preventing HIV Transmission: the Role of Sterile Needles and Bleach.* Washington, DC: National Academy Press; 1995.
4. Hurley S, Jolley D, Kaldor J. Effectiveness of needle-exchange programmes for prevention of HIV infection. *Lancet.* 1997;349:1797–1800.
5. Paone D, Clark J, Shi Qiuhu, et al. Syringe exchange in the United States, 1996: a national profile. *Am J Public Health.* 1999;89(1):43–46.
6. Heimer R. Can syringe exchange serve as a conduit to substance abuse treatment? *J Subst Abuse Treat.* 1998;15(3):183–191.
7. Vlahov D, Junge B, Brookmeyer R, et al. Reductions in high-risk drug use behaviours among participants in the Baltimore needle exchange program. *J Acquir Immune Defic Syndr Hum Retrovirol.* 1997;16:400–406.
8. Heimer R, Kaplan EH, O'Keefe E, et al. Three years of needle exchange in New Haven: what have we learned? *AIDS Public Policy J. 1994;9:59–74.*
9. *Brooner R, Kidorf M, King V, Beilenson P, Svikis D, Vlahov D. Drug abuse treatment success among needle exchange participants. Public Health Rep.* 1998;113(suppl 1):129–139.
10. Metzger DS, Navaline H, Woody GE. Drug abuse treatment as AIDS prevention. *Public Health Rep.* 1998;113(1):97–105.
11. Centers for Disease Control and Prevention (US). Risk behaviors for HIV transmission among intravenous drug users not in treatment—United States. *MMWR Morb Mortal Wkly Rep.* 1990;39:273–276.
12. Schuster CR. Intravenous drug use and HIV prevention. *Public Health Rep.* 1988;103: 261–263.
13. 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. *J Drug Issues.* 1991; 21(4):759–776.
14. Anthony JC. Vlahov D, Nelson KE. New evidence on intravenous cocaine use and the risk of infection with human immunodeficiency virus type 1. *Am J Epidemiol.* 1991;134: 1175–1189.
15. Zeger S, Liang KY. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics.* 1986;42:121–130.
16. Department of Health and Human Service, Substance Abuse and Mental Health Services Administration (SAMHSA), Office of Applied Studies. *National Admissions to Substance Abuse Treatment Services, the Treatment Episode Data Set (TEDS) 1992–1996.* Rockville, MD: Office of Applied Science; 1997.
17. Alcohol and Drug Abuse Administration. *Trends and Patterns in Maryland Alcohol and Drug Abuse Treatment 1997.* Baltimore, MD: Maryland Department of Health and Mental Hygiene; 1998.
18. Heimer R, Khoshnood K, Bigg D, Guydish J, Junge B. Syringe use and re-use: effects of syringe exchange programs in four cities. *J Acquir Immune Defic Syndr Hum Retrovirol.* 1998;18(suppl 1):S37–S44.
19. Schechter MT, Strathdee SA, Cornelisse PGA, et al. Do needle exchange programs increase the spread of HIV among injection drug users: an investigation of the Vancouver outbreak. *AIDS.* 1999;13:F45–F51.

20. Substance Abuse and Mental Health Services Administration (SAMHSA), Office of Applied Science, Drug Abuse Network (DAWN) Series. *D-3, Year-End Preliminary Estimates from the 1996 Drug Abuse Warning Network.* Rockville, MD: Office of Applied Science; 1997.
21. CESAR. *Heroin Related Emergency Report Visits in Baltimore Metro Area Highest Among Cities in DAWN System.* Baltimore, MD: Drug Awareness Warning Network; 1995. Advance Report Number 11.
22. Lewin VHI, Inc. *An Analysis of Pilot Data on the Cost of Substance Abuse Treatment: Unit Costs From 77 Service Delivery Units.* Technical Report to the Center for Substance Abuse Treatment. Fairfax, VA: National Evaluation Data and Technical Assistance Center (NEDTAC); 1996.
23. Shutz CG, Rapiti E, Vlahov D, et al. Suspected determinants of enrollment into detoxification and methadone maintenance treatment among injecting drug users. *Drug Alcohol Depend.* 1994;36:129–138.
24. Latkin C, Vlahov D, Anthony JC. Socially desirable responding and self-reported HIV infection risk behaviors among intravenous drug users. *Addiction.* 1993;88:517–526.
25. De Irala J, Bigelow C, McCusker J, et al. Reliability of self-reported human immunodeficiency virus risk behaviors in a residential drug treatment population. *Am J Epidemiol.* 1996;143:725–731.
26. Graeven DB, Graeven KA. Treated and untreated addicts: factors associated with participation in treatment and cessation of heroin use. *J Drug Issues.* 1983;83(2):207–218.
27. McCusker J, Bigelow C, Luippold R, et al. Outcomes of a 21-day drug detoxification program: retention, transfer to further treatment, and HIV risk reduction. *Am J Drug Alcohol Abuse.* 1995;21(1):1–16.