Needle exchange is not enough: lessons from the Vancouver injecting drug use study

Steffanie A. Strathdee*‡, David M. Patrick†§, Sue L. Currie*, Peter G.A. Cornelisse*, Michael L. Rekart†§, Julio S.G. Montaner*§¶, Martin T. Schechter*‡ and Michael V. O'Shaughnessy*¶#

Objective: To describe prevalence and incidence of HIV-1, hepatitis C virus (HCV) and risk behaviours in a prospective cohort of injecting drug users (IDU).

Setting: Vancouver, which introduced a needle exchange programme (NEP) in 1988, and currently exchanges over 2 million needles per year.

Design: IDU who had injected illicit drugs within the previous month were recruited through street outreach. At baseline and semi-annually, subjects underwent serology for HIV-1 and HCV, and questionnaires on demographics, behaviours and NEP attendance were completed. Logistic regression analysis was used to identify determinants of HIV prevalence.

Results: Of 1006 IDU, 65% were men, and either white (65%) or Native (27%). Prevalence rates of HIV-1 and HCV were 23 and 88%, respectively. The majority (92%) had attended Vancouver's NEP, which was the most important syringe source for 78%. Identical proportions of known HIV-positive and HIV-negative IDU reported lending used syringes (40%). Of HIV-negative IDU, 39% borrowed used needles within the previous 6 months. Relative to HIV-negative IDU, HIV-positive IDU were more likely to frequently inject cocaine (72 versus 62%; $P < 0.001$). Independent predictors of HIV-positive serostatus were low education, unstable housing, commercial sex, borrowing needles, being an established IDU, injecting with others, and frequent NEP attendance. Based on 24 seroconversions among 257 follow-up visits, estimated HIV incidence was 18.6 per 100 person-years (95% confidence interval, 11.1–26.0).

Conclusions: Despite having the largest NEP in North America, Vancouver has been experiencing an ongoing HIV epidemic. Whereas NEP are crucial for sterile syringe provision, they should be considered one component of a comprehensive programme including counselling, support and education.

AIDS 1997, **11**:F59–F65

Keywords: HIV-1, injecting drug users, incidence, prevalence, needle exchange, needle sharing, harm seduction

Introduction

Vancouver introduced a legal, free-standing needle exchange programme (NEP) and a street nurse programme in 1988 and 1989, respectively [1,2]. At that time, the estimated HIV prevalence was 1–2% among the city's population of 6000–10 000 injecting drug users (IDU) [3]. Vancouver's NEP appears to be the

From the *British Columbia Centre for Excellence in HIV/AIDS, St Paul's Hospital, †British Columbia Centre for Disease Control, B.C. Ministry of Health, ‡Department of Health Care and Epidemiology, the §Department of Medicine, University of British Columbia, ¶St Paul's Hospital, and the #Department of Pathology, University of British Columbia, Vancouver, British Columbia, Canada.

Requests for reprints to: Dr S.A. Strathdee, British Columbia Centre for Excellence in HIV/AIDS, 611-1081 Burrard Street, Vancouver, British Columbia, V6Z 1Y6 Canada.

Date of receipt: 28 February 1997; revised: 21 March 1997; accepted: 25 March 1997.

 ISSN 0269-9370

largest in North America, having exchanged over 1 million needles per year since 1993, and 2.3 million in 1996. Until recently, NEP was considered to be a major factor accounting for Vancouver's low HIV prevalence rate [4]. In 1993, among 16 NEP in North America that were independently evaluated by the US Centers for Disease Control and Prevention, the Vancouver NEP ranked in the top three in terms of the number of syringes exchanged and returned, the estimated proportion of IDU reached, and number of client referrals to drug treatment and support services [5].

However, following an initial period of stable, low HIV prevalence, a rapid increase in HIV infection among IDU has been documented in Vancouver since September 1994. Surveillance of HIV testing data in the province of British Columbia indicated that the proportion of self-identified IDU testing HIV-seropositive rose from 2 to 7% in an 18-month period [6]. As a result, in October 1994 the street nurse programme was bolstered. In addition, centralized bulk purchase of syringes for all 14 NEP in British Columbia was undertaken by the provincial government, allowing NEP to provide syringes in sufficient numbers to meet client needs. Although sterile syringes are exempt from paraphernalia laws in Canada, deregulation of syringe sales in British Columbia pharmacies was undertaken in December 1995 to further expand syringe access to IDU.

An outbreak investigation was conducted in 1995, which found needle sharing and social determinants such as unstable housing to be independently associated with recent HIV seroconversion among Vancouver's IDU [6]. Concern regarding the potential for continued HIV transmission in Vancouver's IDU population prompted the initiation of a new cohort study in 1996. Herein, this study reported upon baseline prevalence of HIV and hepatitis C virus (HCV) and associated risk behaviours among 1006 IDU, as well as first estimates of HIV incidence.

Methods

Study sample

Beginning in May 1996, persons who had injected illegal drugs at least once in the previous month and resided in the Greater Vancouver region were recruited into the Vancouver IDU Study through self-referral and street outreach. Evidence of recent injecting drug use was required by inspection of needle tracks. Eligible subjects provided written informed consent. At the baseline visit and semi-annually thereafter, subjects provided blood samples for HIV and HCV antibody testing, and underwent an interviewer-administered questionnaire. HIV tests reactive on enzyme-linked immunosorbent assay were confirmed by Western blot. Purified protein derivative (PPD) tuberculin skin testing was also performed at baseline. Subjects were reimbursed CDN$ 20 for each study visit, at which time referrals were provided for universal medical care, HIV/AIDS care, available drug and alcohol treatment, and counselling.

Study instrument

The study instrument was developed from a questionnaire used in our previous case–control investigation [6,7]. Questionnaires were administered by trained interviewers, all of whom were blind to the HIV serostatus of participants. Questionnaire information pertained to risk behaviours and living conditions in the previous 6 months. Detailed information was collected on demographics, injecting and non-injecting drug use, borrowing and lending of needles and other paraphernalia, re-use of one's own needle, syringe disinfection, source of needles, access and barriers to clean needle use, attendance at two local NEP, incarceration, housing, self-reported frequency of HIV testing, drug treatment, methadone maintenance and other drug/alcohol programmes.

Since our previous investigation revealed that attendance at shooting galleries *per se* was not a common practice [7], respondents were asked whether they had injected in places where they 'generally did not know the people and there was injecting in groups'. Persons who reported injecting for the first time in the previous 2 years were considered new IDU; the remainder were considered established IDU. Sexual behaviour and condom use were assessed for regular, casual and sex trade partners of the same and opposite sexes. Finally, subjects were asked about a variety of mental and social issues, including an abbreviated seven-item version of the Center for Epidemiological Study Depression Scale (CES-D) [8], suicidal ideation, sexual abuse, and self-reported diagnosis of mental illness.

Statistical analysis

IDU who tested HIV-seropositive at enrolment were compared with those who tested HIV-negative using contingency table analysis for categorical variables, and the Wilcoxon rank-sum test for continuous variables. NEP attendance was considered as follows: (i) ever attending any NEP, and (ii) frequent versus less frequent attendance (i.e., more than once per week versus less frequently). The latter categorization was chosen following inspection of the distribution of self-reported attendance. As in previous analyses [6,7], unstable housing was defined as living primarily in a hotel, boarding room, hostel, transition house, jail or on the street in the previous 6 months. CES-D scores were summed, and scores above the 75th percentile were considered to represent elevated depression scores.

Independent predictors of HIV prevalence at baseline were assessed using unconditional logistic regression. Variables that were significant at the 5% level in univariate models were entered into multivariate models in a stepwise, hierarchical fashion. In the final model, all relevant two-way interactions were evaluated. HIV incidence was calculated based on the incidence density approach, in terms of person-years of observation. All 95% confidence intervals (CI) were calculated based on the Poisson distribution.

Results

By February 1997, 1006 eligible IDU had completed baseline interviews and provided blood specimens for HIV and HCV antibody testing. Baseline HIV prevalence was 23.2% (95% CI, 20.6–25.8), of whom 58% were previously aware of their HIV-positive serostatus. HCV serology was conducted on the first 500 participants only, among whom HCV prevalence was 88% (95% CI, 85.2–90.8). PPD skin test reactivity was 25%.

Among 257 subjects who tested HIV-negative at baseline and attended their first semi-annual follow-up visit, 24 seroconversions were confirmed among 129.4 person-years of observation, yielding an estimated HIV incidence of 18.6 per 100 person-years (95% CI, 11.1–26.0). As of 28 February 1997, the overall follow-up rate among those who were eligible to return was 83%. Subjects eligible for follow-up who had not yet returned did not differ from those who had returned with respect to gender, ethnicity, frequency of injection, types of drugs used, or frequency of NEP attendance; however, they were significantly younger ($P = 0.01$).

Table 1. Comparison of HIV-positive and HIV-negative injecting drug users (IDU) at baseline in the Vancouver IDU Study (n = 1006).

	n (%)†			
Variable*	HIV-positive subjects (n = 233)	HIV-negative subjects (n = 773)	Total	P‡
Sex				
Male	135 (58)	518 (67)	653 (65)	0.02
Female	96 (42)	257 (33)	353 (35)	
Sociodemographics				
Median (range) age (years)	34 (16–55)	35 (14–58)	35 (16–58)	0.64
Ethnicity				
White	139 (60)	518 (67)	657 (65)	0.01
Native	80 (34)	192 (25)	272 (27)	
Other	14 (6)	63 (8)	77 (8)	
Unstable housing	165 (72)	454 (59)	619 (62)	0.001
Education (< high school)	201 (86)	617 (80)	818 (81)	0.03
Incarceration	78 (33)	241(31)	319 (32)	0.51
High depression score	70 (30)	208 (27)	278 (28)	0.35
Homo-/bisexual activity (men only)	36 (27)	109 (21)	145 (22)	0.20
Non-consensual sex ever	99 (44)	270 (36)	369 (37)	0.03
IDU sex partner	74 (32)	236 (30)	310 (31)	0.72
Been paid for sex	74 (32)	161 (21)	235 (23)	< 0.001
Drug-using behaviours				
Median (range) age at first injection	19 (7–51)	18 (9–51)	18 (7–51)	0.73
Main drug injected				
Cocaine	167 (72)	470 (62)	637 (64)	< 0.001
Heroin	34 (15)	213 (28)	247 (25)	
Speedball	32 (14)	81 (11)	113 (11)	
Injecting with others	178 (76)	512 (67)	690 (69)	0.005
Established IDU (>2 years)	213 (91)	628 (81)	841 (84)	< 0.001
Attend NEP (ever)	218 (96)	691 (91)	909 (92)	0.01
Frequent NEP attendance (more than once per week)	189 (81)	544 (71)	733 (73)	0.002
NEP most frequent source of syringes	186 (80)	591 (77)	777 (78)	0.33
Obtained syringes from pharmacy	112 (48)	364 (47)	476 (47)	0.79
Cited any difficulties obtaining sterile syringes	64 (28)	176 (23)	240 (24)	0.35
Cited difficulties purchasing syringes from pharmacies	55 (32)	169 (31)	224 (31)	0.70
Borrowed used needles (ever)	175 (76)	509 (67)	684 (69)	0.007
Borrowed used needles	95 (41)	304 (39)	399 (40)	0.69
Lent used needles	88 (39)	293 (40)	381 (40)	0.89
Consistent bleach use§	10 (11)	76 (25)	86 (22)	0.003
Methadone maintenance (ever)	45 (19)	138 (18)	183 (18)	0.61
Current methadone maintenance	34 (15)	84 (11)	118 (12)	0.12

*Unless otherwise stated, behaviours refer to previous 6 months. †Unless otherwise indicated. ‡Based on χ^2 tests. §Restricted to 381 IDU who reported borrowing used needles. NEP, Needle exchange programme.

Table 2. Final multivariate logistic regression model of predictors of HIV-positive serostatus at baseline among injecting drug users (IDU) in Vancouver.

Variable	Adjusted odds ratio (95% CI)	*P*
Unstable housing*	1.61 (1.15–2.98)	0.005
Education (< high school)	1.79 (1.14–2.82)	0.006
Commercial sex*	1.66 (1.18–2.35)	0.008
Ever used borrowed needles	1.49 (1.04–2.14)	0.03
Inject with others*	1.62 (1.13–2.32)	0.008
Established injector†	2.24 (1.34–3.74)	0.002
Frequent NEP* attendance (more than once per week)	1.68 (1.13–2.5)	0.011

*Based on previous 6 months. †First injection >2 years previously. NEP, Needle exchange programme.

Demographic and behavioural characteristics at baseline for the 1006 IDU are shown in Table 1. Of these, the majority were men (65%); however, subjects testing HIV-positive at baseline were more likely to be women ($P = 0.02$). Although most subjects were white (65%), HIV-positive subjects were disproportionately of Native origin. HIV-positive subjects were significantly more likely to have less than a high school education, unstable housing, and to reside in a downtown Vancouver neighbourhood, which is the poorest postal district in Canada.

With respect to drug use, the most frequently injected drug was cocaine, which was more common among HIV-positive IDU ($P < 0.001$; Table 1). Relative to HIV-negative IDU, HIV-positive IDU were significantly more likely to be established IDU, were more likely to report engaging in commercial sex work, and were more likely to inject with others. The proportions of HIV-positive and HIV-negative IDU who reported lending and borrowing used needles in the previous 6 months were nearly identical, regardless of self-reported HIV serostatus. Almost one-half (45%) reported sharing other injection paraphernalia.

HIV-positive IDU were more likely to have ever attended NEP, and to attend NEP on a more regular basis, compared with HIV-negative IDU. However, there were no differences between these groups with respect to self-reported barriers in accessing sterile injection equipment, or difficulties purchasing syringes from pharmacies. Almost one-half of HIV-positive and HIV-negative IDU reported purchasing syringes from pharmacies in the previous 6 months. Despite widespread needle availability, however, subjects reported re-using their own needle a median of three times [interquartile range (IQR), 2–4]. A conservative estimate of injection frequency based on regular drug use patterns was 2.5 injections per day (IQR, 1–6). There were no differences between HIV-positive and HIV-negative IDU in terms of current or previous enrolment in methadone maintenance or other drug/alcohol programmes, or difficulties accessing drug treatment.

Multiple logistic regression was conducted in a hierarchical stepwise fashion to identify independent predictors of HIV-positive serostatus (Table 2). In the final model, sociodemographic variables that remained significantly associated with HIV-positive serostatus were unstable housing and low education. In examining

Table 3. Profile of documented seroconverting injecting drug users (IDU) observed in the Vancouver Injection Drug User Study*.

	Sex	Age (years)	Race	New IDU†	Main source of syringes	Difficulty accessing syringes	Drug of choice	Shared injection equipment	Housing
1	Male	48	White	No	NEP	No	Methadone	Yes	Unstable
2	Female	46	Native	No	NEP	No	Heroin	Yes	Unstable
3	Male	36	Native	No	NEP	No	Cocaine	Yes	Unstable
4	Female	43	White	No	NEP	No	Cocaine/heroin	Yes	Unstable
5	Female	44	White	No	NEP	No	Cocaine/heroin	No	Unstable
6	Male	40	White	No	NEP	No	Cocaine/heroin	Yes	Unstable
7	Male	46	White	No	NEP	Yes	Cocaine/heroin	No	Unstable
8	Male	35	Native	No	NEP	No	Cocaine	Yes	Unstable
9	Male	21	White	Yes	NEP	No	Cocaine/heroin	Yes	Unstable
10	Female	42	White	Yes	NEP	Sometimes	Cocaine/heroin	Yes	Stable
11	Male	43	White	No	NEP	Yes	Heroin/speedball	Yes	Unstable
12	Female	35	Native	No	NEP	No	Cocaine	Yes	Unstable
13	Male	43	White	No	NEP	No	Cocaine	No	Unstable
14	Male	27	White	Yes	Pharmacy	No	Cocaine/speedball	Yes	Unstable
15	Male	29	White	No	NEP	No	Cocaine/heroin	Yes	Unstable
16	Female	40	White	No	NEP	No	Heroin	No	Unstable
17	Female	43	White	Yes	NEP	No	Cocaine	Yes	Unstable
18	Male	32	White	No	NEP	Sometimes	Cocaine	No	Unstable
19	Male	36	Native	No	NEP	No	Heroin/speedball	Yes	Unstable
20	Male	26	Asian	No	NEP	No	Cocaine/heroin	No	Stable
21	Male	32	White	No	NEP	Sometimes	Cocaine	No	Unstable
22	Female	48	White	No	NEP	No	Heroin/speedball	Yes	Unstable
23	Female	31	Native	No	NEP	No	Cocaine/heroin	Yes	Unstable
24	Male	22	Native	No	NEP	No	Cocaine/heroin	Yes	Unstable

*Characteristics refer to the seroconversion interval (i.e., period between baseline HIV-negative test and first HIV-positive test at follow-up). †Injected for the first time in previous 2 years. NEP, Needle exchange programme.

behavioural variables, commercial sex work, borrowing used needles, injecting with others, being an established IDU, and attending NEP more than once per week were all independently associated with HIV-positive serostatus. These associations were unchanged after adjusting for age, gender, frequency of injecting, main drug injected or other factors. No significant two-way interactions were observed. The likelihood ratio statistic, which tests the global null hypothesis that the coefficients are not significantly different from zero, was highly significant ($P < 0.001$), providing support for adequate goodness of fit.

Although the limited number of HIV seroconversions observed to date precluded a formal statistical analysis, a profile of sociodemographic and behavioural characteristics was generated, based on the period between the last negative HIV test at baseline, and first positive HIV test at follow-up (denoted seroconversion interval; Table 3). Of the 24 seroconverters identified to date, similarities were noted relative to the overall cohort in terms of the proportions who were women, those who were Native, those who were established IDU, and those who most commonly injected cocaine. All but two individuals reported unstable housing, residing primarily in single room occupancy hotels in Vancouver. Only three reported commercial sex work during the seroconversion interval. It is particularly striking that 23 of the 24 seroconverters reported NEP as their most frequent source of sterile syringes, and only five reported having any difficulty accessing sterile syringes.

Discussion

In our prospective study of more than 1000 IDU in Vancouver, baseline prevalence rates of HIV and HCV were very high, at 23 and 88%, respectively. After 8 months of follow-up, our preliminary estimate of HIV incidence was 18.6 per 100 person-years. Such an estimate could have been biased upward by selective return for follow-up of those at highest risk of HIV seroconversion; however, differences in baseline risk behaviour between subjects who did and did not return for follow-up when eligible were not found. The estimate could also have been inflated if individuals who suspected they had become HIV-infected selectively returned for follow-up.

To address these possible biases, the incidence calculation was repeated under a best case scenario, assuming all eligible persons who had not returned would have tested HIV-negative at their 6-month follow-up visit. Even under this optimal scenario, the HIV incidence was 16.5 per 100 person-years (95% CI, 9.9–23.2). Although these incidence estimates were based on small numbers, even the lower bound of the lowest possible 95% CI (9.9%) was much higher than that observed among prospective IDU studies in Baltimore, Montreal, Amsterdam and New York [9–12]. It was concluded that these preliminary results were entirely consistent with an ongoing and serious outbreak of HIV infection among IDU in Vancouver [6].

Also of great concern in our study was the high level of reported needle-sharing behaviours. The proportions of IDU who reported borrowing and lending used needles were similar to those observed in our 1995 case–control investigation, which was based on the same target population [6,7]. At baseline in the present study, the proportion of HIV-positive IDU who reported lending used needles was nearly identical to that of HIV-negative IDU, regardless of self-reported HIV serostatus. This suggests that little, if any, behaviour change occurred among individuals in our sample who had received an HIV-positive test result. As in our previous study [7], consistent use of bleach among IDU borrowing used needles was low, and sharing of other injection paraphernalia was common.

Our data are particularly disturbing in light of two facts: first, Vancouver has the highest volume NEP in North America; second, HIV prevalence among this city's IDU population was relatively low until recent years. The fact that sharing of injection equipment is normative, and HIV prevalence and incidence are high in a community where there is an established and remarkably active NEP is alarming. A vast body of literature has suggested that NEP are associated with reduced incidence of HIV and HCV and do not lead to increased drug use [5,12–15]. Several studies have also shown NEP to be associated with decreased needle borrowing [9,12,15]. In cities where NEP is part of a comprehensive programme that includes HIV testing, counselling, education and drug treatment options, HIV incidence and associated risk behaviours have declined significantly over time [9,16,17]. Provided that services are available and IDU are willing, NEP can act as a stepping stone to addictions treatment, which can serve as the ultimate prevention if IDU choose to cease injecting.

In Vancouver, NEP was introduced early, but access to drug and alcohol treatment, methadone maintenance and counselling services remains inadequate. As early as 1990, the lack of appropriate services for addictions treatment in British Columbia, especially for cocaine users, was identified as a major barrier encountered by Vancouver's NEP attenders, among whom there was already a marked demand for HIV-related counselling [1]. This situation continues at present [6]. Our results do not argue against the overall effectiveness of NEP as an HIV intervention, but rather, they lead us to propose that without adequate and appropriate community-wide

interventions such as addictions treatment, detoxification and counselling, stand-alone NEP may be insufficient to maintain low HIV prevalence and incidence for an indefinite period. Our study, and recent findings of higher HIV incidence among Montreal's NEP attenders compared with non- or infrequent attenders [10], strongly suggest that the concept of harm reduction requires a broader perspective beyond NEP alone [14,17,18]. Support for this was provided from Amsterdam, where a continuum of harm-reduction activities was associated with lower HIV incidence and needle-sharing behaviours, but there was no evidence of a protective effect for single interventions such as NEP or methadone maintenance [9].

Why is it that Vancouver is experiencing an ongoing HIV outbreak despite a high volume NEP and pharmacy access? Although it is too early to draw inferences from our seroconversion data, some clues arise from our analysis of determinants of HIV-positive serostatus at baseline. Like other studies, our study found that factors such as borrowing needles [6,9,10,19–21] and injecting with others [20] were associated with HIV prevalence. It was also found that established IDU were more likely to be HIV-infected relative to new IDU, although this may have been a reflection of duration of exposure. Although cocaine injection *per se* did not appear as an independent risk factor, it is noteworthy that cocaine was more likely to be the drug of choice among HIV-positive IDU. Other studies have reported an elevated risk of HIV seroconversion associated with cocaine injection [22,23]. Indeed, a shift from heroin use to increasing dependence on cocaine may be an important factor in Vancouver's escalating HIV prevalence and incidence, since cocaine is commonly associated with more frequent injections [22]. If the conservative estimate of 2.5 injections per day in our cohort may be generalized to the city's estimated IDU population of 6000–10 000, approximately 5–10 million needles per year would be needed to meet the ideal scenario of 'one-set one-shot'. Whether it is realistic to expect, even with expanded pharmacy access, that this goal can be achieved in cities where cocaine is the drug of choice, remains to be determined. Finally, since commercial sex work was also independently related to HIV prevalence, it may be that sexual transmission plays an important role.

In the midst of an ongoing HIV outbreak, it is important not to overlook social and contextual factors that may be directly or indirectly related to HIV transmission [24–26]. As previously found in this setting [6], unstable housing was independently associated with HIV-positive serostatus. The predominance of single-room occupancy hotel rooms, which have been reported to serve as shooting galleries in Vancouver's poorest neighbourhood, may contribute to needle sharing [6]. Risks associated with less secure injecting locations have also been noted by others [18,27]. The hypothesis that specific social networks of IDU may be risk factors for HIV seroconversion, possibly as a result of mixing between HIV-negative individuals and those who are newly infected and have high viral loads, is also currently being explored. Ethnographic research is needed in the study of social networks to complement existing quantitative data.

Our study was not intended to evaluate the effectiveness of NEP, since the majority of subjects attended NEP at least once, and there were no estimates of HIV incidence among IDU in Vancouver prior to the introduction of NEP in 1988. In fact, without the presence of an active NEP that was implemented early, HIV incidence among IDU in Vancouver may have been much higher, much earlier. The fact that frequent NEP attendance was independently associated with HIV prevalence should not be interpreted as causal, because risk behaviours and exposure to HIV interventions could have changed following an HIV-positive diagnosis. In addition, NEP attendance was self-reported; validation of self-reports through record linkage with NEP's administrative databases will improve attempts to correlate NEP attendance with HIV incidence. Finally, it has been suggested that NEP attract higher risk IDU [10,28–31]. NEP could thus be associated with HIV infection, even in multivariate models, if residual confounding persists.

If NEP attract higher risk IDU, then an appropriate public health response should be to capitalize on this window of opportunity by using NEP as a vehicle to change social norms surrounding needle sharing. From this perspective, it is crucial that NEP be maintained as a cornerstone in HIV prevention. Appropriate education, counselling and treatment options should be implemented simultaneously with the introduction of NEP. Allocation of adequate resources is required to allow NEP and other community agencies to enhance services other than the sole provision of needles. The present data have suggested that even in cities with sustained low HIV prevalence, outbreaks of HIV can occur. Long-term evaluation of NEP is therefore necessary to allow HIV prevention activities to adapt to changes in the local environment. If the effectiveness of NEP diminish over time, as others have found [29], other complementary strategies will be need to be bolstered to reduce HIV transmission among IDU populations.

Acknowledgements

The authors gratefully acknowledge the contributions of the Vancouver IDU Study staff for data collection and preparation (M. Pitchford, C. Johnson, R. Brooks, J. McLeod, J. Atwood, R. Brooks, S. Lipscombe,

G. Fernandez and T. Yip) and assistance from the Community Advisory Board, especially J. Turvey and J. McGuire from the Downtown Eastside Youth Activities Society. The authors also thank M. Fitzgerald, nurses from the TB control programme, K.J.P. Craib, E. van Ameijden and S. Jones for helpful discussions, and J. Egan for manuscript preparation. The authors gratefully acknowledge study funding from the BC Ministry of Health and Health Canada, and the National Research Development Program for a post-doctoral fellowship (S.A.S), Scholar Award (J.S.G.M.) and Scientist Award (M.T.S.).

References

1. Bardsley J, Turvey J, Blatherwick J: **Vancouver's needle exchange program.** *Can J Public Health* 1990, **81**:39–45.
2. Rekart ML, McCarthy M, Farrow C: **AIDS street nurses.** *V International Conference on AIDS.* Montreal, June 1989 [abstract MAP111].
3. Cook DA, Patrick DM, Rekart ML, *et al.*: **Enhanced surveillance for HIV infection in British Columbia, Canada.** *XI International Conference on AIDS.* Vancouver, July 1996 [abstract MoC333].
4. Strathdee SA, Schechter MT, Hogg RS, O'Shaughnessy MV: **Trends in the epidemiology of HIV/AIDS in British Columbia.** *Br Columbia Med J* 1994, **36**:98–114.
5. Lurie P, Reingold A, Bowser B, *et al.*: *The Public Health Impact of Needle Exchange Programs in the United States and Abroad: Summary, Conclusions and Recommendations.* Berkeley/San Francisco: School of Public Health, University of California, Berkeley/Institute for Health Policy Studies, University of California, San Francisco; October 1993.
6. Patrick DM, Strathdee SA, Archibald CP, *et al.*: **Determinants of HIV seroconversion in injection drug users during a period of rising prevalence in Vancouver.** *Int J STD AIDS* 1997 (in press).
7. Strathdee SA, Patrick DM, Archibald CP, *et al.*: **Social determinants predict needle sharing behaviour among injection drug users in Vancouver, Canada.** *Addiction* 1997 (in press)
8. Mirowsky J, Ross CE: **Age and depression.** *J Health Soc Behav* 1992, **33**:187–205.
9. van Ameijden EJC, van den Hoek AAR, Coutinho RA: **Injecting risk behaviors among drug users in Amsterdam, 1986 to 1992, and its relationship to AIDS prevention programs.** *Am J Public Health* 1994, **84**:275–281.
10. Bruneau J, Lamothe F, Franco E, *et al.*: **High rates of HIV infection among injection drug users participating in needle exchange programs in Montreal: results of a cohort study.** *Am J Epidemiol* 1997 (in press).
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, MD.** *Arch Intern Med* 1995, **155**:1305–1311.
12. Des Jarlais DC, Marmor M, *et al.*: **HIV incidence among injecting drug users in New York City syringe-exchange programmes.** *Lancet* 1996, **348**:987–991.
13. Hagan H, Des Jarlais DC, Friedman SR, Purchase D, Alter MJ: **Reduced risk of hepatitis B and hepatitis C among injection drug users in the Tacoma Syringe Exchange Program.** *Am J Public Health* 1995, **85**:1531–1537.
14. van Ameijden EJC, Watters JK, van den Hoek JAR, Coutinho RA: **Interventions among injecting drug users: do they work?** *AIDS* 1995, **9** (suppl A):S75–S84.
15. Kaplan E, Heimer R: **HIV incidence among New Haven needle exchange participants: updated estimates from syringe tracking and testing data.** *J Acquir Immune Defic Syndr* 1994, **7**:182–189.
16. van den Hoek JAR, van Haastrecht HJA, Coutinho RA: **Risk reduction among intravenous drug users in Amsterdam under the influence of AIDS.** *Am J Public Health* 1989, **79**:1355–1357.
17. Hunter GM, Donoghoe MC, Stimson GV, Rhodes T, Chalmers CP: **Changes in the injecting risk behaviour of injecting drug users in London, 1990–1993.** *AIDS* 1995, **9**:493–501.
18. Gostin LO, Lazzarini, Z, Jones TS, Flaherty K: **Prevention of HIV/AIDS and other blood-borne diseases among injection drug users.** *JAMA* 1997, **277**:53–62.
19. Friedman SR, Jose B, Deren S, Des Jarlais DC, Neaigus A: **Risk factors for human immunodeficiency virus seroconversion among out-of-treatment drug injectors in high and low seroprevalence cities.** *Am J Epidemiol* 1995, **142**:864–875.
20. Vlahov D, Munoz A, Anthony JC, Cohn S, Celentano DD, Nelson KE: **Association of drug injection patterns with antibody to human immunodeficiency virus type 1, among intravenous drug users in Baltimore, Maryland.** *Am J Epidemiol* 1990, **132**:847–856.
21. Lamothe F, Bruneau J, Coates R, *et al.*: **Seroprevalence of and risk factors for HIV-1 infection in injection drug users in Montreal and Toronto: a collaborative study.** *Can Med Assoc J* 1993, **149**:945–951.
22. Anthony JC, Vlahov D, Nelson KE, Cohn S, Astemborski J, Solomon L: **New evidence on intravenous cocaine use and the risk of infection with human immunodefiency virus type 1.** *Am J Epidemiol* 1991, **134**:1175–1189.
23. Chaisson RE, Bacchetti P, Osmond D, Brodie B, Sande MA, Moss AR: **Cocaine use and HIV infection in intravenous drug users in San Francisco.** *JAMA* 1989, **261**:561–565.
24. Koester SK: **Copping, running, and paraphenalia laws: contextual variables and needle risk behavior among injection drug users in Denver.** *Hum Organ* 1994, **53**:287–295.
25. Latkin C, Mandell W, Vlahov D, Oziemkowska M, Celentano D: **People and places: behavioral settings and personal network characteristics as correlates of needle sharing.** *J Acquir Immune Defic Syndr* 1996, **13**:273–280.
26. Neaigus A, Friedman SR, Jose B, *et al.*: **High-risk personal networks and syringe sharing as risk factors for HIV infection among new drug injectors.** *J Acquir Immune Defic Syndr* 1996, **11**:499–509.
27. Hartgers C, Van Ameijden EJ, van den Hoek JA, Coutinho RA: **Needle sharing and participating in the Amsterdam syringe exchange programme among HIV-seronegative injecting drug users.** *Public Health Rep* 1992, **107**:675–681.
28. Archibald CP, Ofner M, Patrick DM, *et al.*: **Needle exchange program attracts high-risk injection drug users.** *XI International Conference on AIDS.* Vancouver, July 1996 [abstract TuC320].
29. van Ameijden EJC, van den Hoek JAR, van Haastrecht HJA, Coutinho RA: **The harm reduction approach and risk factors for human immunodeficiency virus seroconversion in injecting drug users, Amsterdam.** *Am J Epidemiol* 1992, **139**:1153–1163.
30. Frischer M, Haw S, Bloor M, *et al.*: **Modeling the behavior and attributes of injecting drug users: a new approach to identifying HIV risk practices.** *Int J Addict* 1993, **28**:129–152.
31. Vlahov D, Junge B, Beilenson P, Brookmeyer RS, Cohn S, Armenian H: **Evaluation of the Baltimore Needle Exchange Program: preliminary results.** *XI International Conference on AIDS.* Vancouver, July 1996 [abstract MoD361].