

# Injecting Risk Behavior among Drug Users in Amsterdam, 1986 to 1992, and Its Relationship to AIDS Prevention Programs

## ABSTRACT

**Objectives.** Serial, cross-sectional trends in injecting risk behavior were studied among drug users from 1986 to 1992.

**Methods.** From a cohort study in Amsterdam, 616 intake visits of drug users who had injected in the 6 months preceding intake were selected.

**Results.** The proportion of drug users who reported borrowing and lending used injection equipment and reusing needles/syringes (in the previous 6 months), continuously declined from 51% to 20%, from 46% to 10% and from 63% to 39%, respectively. In multivariate analysis, it appeared unlikely that a selective recruitment of participants over time was responsible for these trends. Participants, recruited later in time, had been previously tested for human immunodeficiency virus (HIV) more often, had received daily methadone less often, and had obtained a higher proportion of new needles via exchange programs. Indications were found that (1) voluntary HIV testing and counseling leads to less borrowing, lending, and reusing equipment; and (2) obtaining needles via exchange programs leads to less reusing needles/syringes. It appeared that nonattenders of methadone and exchange programs have reduced borrowing and lending to the same extent as attenders.

**Conclusions.** Methodologically, evaluating specific measures is difficult. However, the combination of various preventive measures in Amsterdam is likely to be responsible for the observed decrease in injecting risk behavior. (*Am J Public Health.* 1994;84:275-281)

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### Introduction

In several studies among injecting drug users in Amsterdam, prevalence of the human immunodeficiency virus (HIV) was estimated to be 30% and appeared to be stable from 1986 to 1992.<sup>1-4</sup> In a cohort study in Amsterdam, HIV incidence initially declined from 10 per 100 person-years in 1986 to 4 in 1987 and remained stable up to 1991.<sup>5</sup>

However, trends in HIV prevalence and incidence are difficult to interpret. First, HIV prevalence is the result of many complex mechanisms—for example, the geographical migration of injecting drug users; the high rates of initiation and cessation of injecting drug use; the high acquired immunodeficiency syndrome (AIDS) and non-AIDS mortality, both of which are largest among HIV positives<sup>6</sup>; and the HIV incidence. Second, HIV incidence in itself is also influenced by various factors—for example, HIV prevalence, mixing patterns,<sup>7</sup> and risk behavior; thus, to estimate HIV incidence, large cohorts of drug users are necessary, and because of specific methods of recruitment and relatively high dropout rates, generalization of incidence is difficult.

Therefore, to monitor the HIV epidemic among injecting drug users, it is important to study trends in risk behavior. And among this population, the sharing of injecting equipment is the predominant route by which HIV is transmitted. Moreover, if the effect of a prevention program aimed at reducing injecting risk behavior is to be evaluated, the extent to which the sexual transmission of HIV influences the prevalence and incidence of the virus among injecting drug users must also be considered.

In Amsterdam, easily accessible methadone programs and a large-scale needle/syringe exchange program have been implemented within the concept called harm reduction<sup>8</sup> (see Methods). In the cohort study in Amsterdam, early results (follow-up was conducted from 1986 to 1988) indicated that the borrowing of used injection equipment decreased only as a function of the number of follow-up visits but not at intake visits over time.<sup>9</sup> Therefore, this risk reduction was attributed mainly to participation in the study. Several other studies have shown that injecting drug users are capable of reducing risk behavior,<sup>10,11</sup> but only a few have presented data on long-term trends.<sup>12,13</sup>

The present study is an update of the Amsterdam cohort study mentioned above. In that same study, only data measured at intake visits were used to determine serial, cross-sectional trends in injecting risk behavior from 1986 to 1992 among participants who, at entry, reported current injecting. The high-risk behaviors studied were borrowing and lending used injection equipment, and reusing needles/syringes. We also extended the present study to evaluate the potential protective effects on risk behavior of HIV antibody-test counseling, methadone treatments, and the obtaining of new needles via exchange programs.

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## Methods

### *AIDS Prevention among Drug Users in Amsterdam*

The specific purpose of the Amsterdam harm reduction approach is to create a situation that greatly reduces the risk of addicts harming themselves or their environment.<sup>8</sup> Within this context, three main measures were established to slow down the spread of HIV: (1) a needle and syringe exchange program (in 1984), (2) an information campaign targeted at drug users (in 1987), and (3) a program to distribute condoms (free of charge) among addicted prostitutes (in 1987).

The goal of the exchange program, begun through an initiative of the "junkiebond" (drug users organization) to prevent the spread of hepatitis B, is to prevent HIV infections by promoting the single use of needles and syringes and ensuring the availability of new needles. Equipment can be exchanged at methadone posts and other drug-help organizations (14 locations in 1991), and leaflets concerning safe drug use are available. To ensure a low threshold of the exchange program, no registration is necessary and high numbers of used needles and syringes can be exchanged.<sup>14</sup> This low threshold has most likely led to the sharp increase in distributed needles/syringes: from 100 000 per year in 1985 to approximately 1 000 000 per year in 1990, 1991, and 1992 (S. van Lieshout, personal communication).

The low-threshold methadone programs, operated by the Drug Department of the Municipal Health Service, are focused on stabilizing drug use and contacting drug users so they can receive appropriate social and medical care.<sup>15</sup> The illicit injection and other use of opiates or other drugs is tolerated. Although they are not primarily aimed at preventing HIV infection, these programs may contribute to AIDS prevention by lowering the frequency of injecting (methadone being a substitute for heroin) and increasing the proportion of drug users receiving educational information on AIDS.

### *Study Design*

In December 1985, an open and ongoing cohort study among drug users was started in Amsterdam.<sup>1,2,5,6,9</sup> The participants for this study are recruited from methadone posts, from a sexually transmitted disease clinic for addicted prostitutes, and, to a lesser extent, by word of mouth. Participation in the study is volun-

tary, and informed consent is obtained. In the first 3 years, participants were seen at eight different locations. Since 1989, they have been seen at one central location, except for the addicted prostitutes, who are still interviewed at the sexually transmitted disease clinic. At intake, participants are given standardized questionnaires, which are administered by specially trained nurses; questions regarding current behavior refer to the previous 6 months.

Between December 1, 1985, and November 30, 1992, a total of 973 drug users entered this cohort study. For the present study, 616 of these users who had reported injecting during the 6 months preceding intake were selected. The only data used to determine trends in risk behavior were collected at intake visits. A large individual risk reduction has already been reported.<sup>9</sup> However, the validity of self-reported behavioral changes during follow-up is questionable when one considers the high and stable incidence of injecting related viral infections during follow-up.<sup>16</sup> In addition, injecting drug users who visited more than once appear to differ from single visitors, which might have led to a selection bias.

Trends in high-risk behaviors were determined over five periods of intake visits (1986 [n = 182], 1987 [n = 137], 1988 [n = 106], 1989/90 [n = 125], and 1991/92 [n = 66]). The smaller number of injecting drug users in the last periods is owing to a temporary cessation of recruitment of new participants between September 1990 and August 1991. The variables were divided into four sets. The first set consists of the three outcome variables that reflect current behavior (i.e., behavior measured over the 6 months preceding intake): borrowing needles or syringes already used by somebody else (yes, no), lending used needles/syringes to others (yes, no), and reusing one's own needles/syringes (mainly, not mainly). These variables do not include "frontloading" (i.e., injecting some drug solution into the front of another syringe of which the needle has been taken off in order to honestly divide drugs).<sup>17</sup> This behavior seems to be not very prevalent in Amsterdam.

Trends in risk behavior over time might be fully explained by a selection bias of participants over time; injecting drug users with certain characteristics that might be related to injecting risk behavior could have selectively entered the study over time. Therefore, trends in risk behavior were multivariately adjusted for differences in general characteristics (set 2) and current behavior variables (set 3),

shown in Table 1. Sets 2 and 3 are distinguished because adjustment for current behavior might lead more easily to overmatching than adjustment for general characteristics; variables like age and gender cannot be influenced by interventions whereas variables for current behavior can. For example, if it is assumed that both borrowing and cocaine injecting decline in time (owing to intervention) and that cocaine injectors borrow more often than heroin injectors, adjusting the effect of year of intake visit on borrowing for frequency of cocaine injecting would lead to overmatching.

In 1989, the coding categories of the general characteristics of time living in Amsterdam, duration of injecting, and frequency of borrowing since 1980 were changed from broad categories to exact number of years or times. Only for frequency of borrowing did this result in more missing values (before 1989, 1% were missing; from 1989 on, 16% were missing.) Subjects with missing values on this variable were included in the multivariate analyses within a separate category, "missing." On all other variables, less than 1% of subjects had missing values. The current behavior variables were not subject to important changes.

The intervention variables, which may have a protective effect on high-risk behavior, form the fourth set. These variables include being previously tested for HIV (never, tested HIV positive, tested HIV negative), currently receiving methadone daily via methadone programs (yes, no), and currently obtaining new needles/syringes via exchange programs (0%, 1% to 99%, 100%).

In general, all testing was done two-tailed, and a *P* value of .05 was the criterion of significance. Statistical significance of trends was univariately analyzed using chi-square trend tests for categorical variables and Spearman's rank correlation tests for continuous variables. Multivariately, logistic regression was used to adjust for differences between participants over time, to determine significant and independent predictors for the outcome variables, and to investigate interactions between important variables.<sup>18</sup> Significance was based on the likelihood ratio statistic. The fit of the models was evaluated by calculating variable specific delta betas; no observations showed a disproportionately large influence on the odds ratios. The fit was also assessed using the Pearson goodness-of-fit test; this test was never significant. For all analyses, SPSS 4.0 was used.<sup>19</sup>

## Results

Of the 616 injecting drug users who had injected during the 6 months preceding intake and who entered our study between 1986 and 1992, 57% were men and 43% women, with mean ages of 31.2 (SD = 5.8) and 27.5 (SD = 5.7) years, respectively. Of these current injectors at intake, 57% had their last injection 1 day ago or less, 18% had injected 2 to 7 days ago, 13% had injected 1 to 4 weeks ago, and 13% had injected 1 to 6 months ago. Sixty percent had currently injected mainly speedballs (a mixture of heroin and cocaine), and 24% had injected mainly heroin.

### Unadjusted and Adjusted Trends in High-Risk Behavior

The three outcome variables showed a strong and highly significant decline per intake period (Table 1). From 1986 through 1991/92, borrowing needles/syringes decreased from 51% to 20%; lending, from 46% to 10%; and reusing, from 63% to 39% (all  $P < .0001$ ). The concept of role separation is of epidemiological importance here since the incidence pattern of HIV depends on the proportion of injecting drug users who only borrow or lend and on the proportion of those who do both.<sup>20</sup> In 1986, 36% reported neither borrowing nor lending, 14% reported only lending, 18% reported only borrowing, and 32% reported both risk behaviors. In 1991/92, these figures were 77%, 3%, 13%, and 7%, respectively.

Table 1 also shows trends in general characteristics and current behavior variables per intake period. Per intake period, both the mean age and the proportion of men significantly increased, whereas the frequency of borrowing since 1980; the proportion of injecting drug users currently prostituting; and the proportions of users using amphetamines, barbiturates, and tranquilizers orally all show decreases.

Unadjusted and adjusted trends in the outcome variables were calculated by entering the period of intake visit continuously into logistic regression models in three ways: (a) unadjusted (bivariately), (b) adjusted for general characteristics (set 2), and (c) additionally adjusted for current behavior variables (sets 2 and 3). It appears that the odds ratios reflecting the decrease in borrowing, lending, and reusing needles per period of intake visit hardly changed after adjustment (model a compared with models b and c, Table 2). Therefore, the decrease in high-risk be-

TABLE 1—Trends in Outcome Variables, General Characteristics, and Current Behavior Variables, among 616 Intake Visitors Who Had Injected Drugs during the Previous 6 Months

	Period of Intake Visit					P
	1986 (n = 182)	1987 (n = 137)	1988 (n = 106)	1989/90 (n = 125)	1991/92 (n = 66)	
<b>Outcome variables<sup>b</sup> (set 1)</b>						
Borrowing needles/syringes	51 <sup>a</sup>	51	45	38	20	***
Lending needles/syringes	46	30	34	14	10	***
Reusing needles/syringes	63	54	51	42	39	***
<b>General characteristics (set 2)</b>						
Mean age, y	28.7	29.2	28.2	31.2	32.2	*** <sup>c</sup>
Male	45	58	64	62	67	***
Nationality						
Dutch	66	58	63	54	67	
German	23	23	19	25	9	
Living >5 years in Amsterdam	53	61	58	45	61	
Duration of injecting						
<1 year	7	7	9	6	6	
>5 years	75	75	65	71	63	
Frequency of borrowing since 1980 <sup>d</sup>						
<10 times	55	64	55	71	77	*
100 or more times	12	13	12	15	9	
Last moment of injection						
<2 days ago	59	58	55	51	62	
1-6 months ago	12	11	13	14	14	
Prostitution <sup>e</sup>	43	31	34	37	24	*
<b>Current behavior variables<sup>b</sup> (set 3)</b>						
Injecting >1 time/day	53	45	40	55	49	
Type of drug mainly injected						
Heroin alone	23	22	20	28	22	
Cocaine alone	9	10	11	7	8	
Heroin and cocaine	57	61	61	58	66	
Amphetamine	8	7	5	3	2	
Heroin use, nonparenteral	34	45	51	38	48	
Cocaine use, nonparenteral	25	34	40	23	36	
Amphetamines use, orally	14	9	8	2	3	***
Barbiturates use, orally	22	10	19	12	6	**
Tranquilizers use, orally	66	61	50	36	33	***
Alcohol use, >4 glasses/day	20	23	18	21	12	
Having a currently injecting steady sex partner	25	22	19	24	17	

<sup>a</sup>In percentages, except for age.

<sup>b</sup>Reported over the 6 months preceding intake.

<sup>c</sup>By Spearman's rank test.

<sup>d</sup>36 had missing values (see Methods).

\* $P < .05$ , \*\* $P < .01$ , \*\*\* $P < .001$  (by chi-square trend test).

havior was probably not caused by selective participation over time.

### Evaluation of Specific Interventions

The variables concerned with potentially protective interventions also showed trends. Participants recruited later in time had been previously tested for HIV more often, received daily methadone less often, and obtained a higher proportion of new needles via exchange programs (all  $P < .0001$ , Table 3). The decrease in those receiving methadone is owing to a selective recruitment of participants at the methadone posts early in time. It may be that the decrease in risk behavior is related

to these trends in intervention variables; indeed, in bivariate logistic regression analyses (unadjusted), injecting drug users who obtained all needles via exchange programs and those who had previously been tested for HIV (especially those whose test results were HIV positive) reported less high-risk behavior: they borrowed, lent, and reused needles significantly less often (Table 4). Receiving daily methadone was not strongly associated with either outcome.

For each outcome, a multivariate logistic regression model was constructed to determine independent predictors among the intervention variables and year of in-

**TABLE 2—Logistic Regression Analysis: Unadjusted and Adjusted Trends in Outcome Variables, among 616 Intake Visitors Who Had Injected Drugs during the Previous 6 Months**

	Effect of Intake Period <sup>a</sup> on		
	Borrowing	Lending	Reusing Needles
Unadjusted OR <sup>b</sup>	0.77**	0.61**	0.78**
Adjusted OR for set 2, general characteristics	0.79**	0.58**	0.82*
Adjusted OR for sets 2 and 3, general characteristics and current behavior variables	0.80*	0.57**	0.81*

<sup>a</sup>Continuous into model (the odds ratios correspond with every increase of 1 unit in intake period; e.g., using 1987 as a reference, the odds of borrowing [unadjusted] in 1988 are 0.77 and in 1989/90 are 0.77<sup>c</sup>.  
<sup>b</sup>OR = odds ratio.  
<sup>c</sup>\*P < .01, \*\*P < .001 (likelihood ratio test).

**TABLE 3—Trends in Intervention Variables among 616 Intake Visitors Who Had Injected Drugs during the Previous 6 Months**

Intervention Variables (set 4)	Period of Intake Visit					P
	1986 (n = 182), %	1987 (n = 137), %	1988 (n = 106), %	1989/90 (n = 125), %	1991/92 (n = 66), %	
Being previously tested for HIV						
Never tested	100	100	95	74	64	*
HIV positive	0	0	2	10	9	
HIV negative	0	0	3	16	27	
Receiving daily methadone <sup>a</sup>	85	86	70	67	62	*
Obtaining new injecting equipment via needle exchange programs <sup>a</sup>						
0%	51	41	25	15	20	*
1–99%	18	15	26	24	27	
100%	31	44	50	60	53	

Note. P < .001 (chi-square trend test).  
<sup>a</sup>Reported over the 6 months preceding intake.

take visit, adjusted for general characteristics. (Additionally adjusting for current behavior variables yielded very similar results.) With regard to the outcomes of borrowing and lending, comparable results were found (Table 4). The likelihood of borrowing and lending decreased with a later period of intake visit and with having been previously tested for HIV, both variables bearing a stronger relation to lending than to borrowing. Multivariately adjusted, the relations between pbx-exchanging and the outcomes of borrowing and lending were weaker than they were unadjusted and were no longer significant. Further analyses revealed that these relations weakened because of adjustment for the variable period of intake visit only.

Different results were obtained with regard to the outcome of reusing needles/syringes. Independent and significant predictors were having received an HIV-positive test result and exchanging

needles/syringes frequently. However, the effect of period of intake visit was much weaker and no longer significant; this is probably explained by the increasing proportion of injecting drug users who frequently exchange over time.

Both the outcome variables and the intervention variables show statistically significant trends per intake period. It appears that these variables are also significantly interrelated except for the associations between receiving daily methadone and the three outcome variables or exchanging (Table 5). Therefore, severe problems of multicollinearity arise. For instance, adjusting the relationship between exchanging and borrowing or lending for period of intake visit might produce overmatching; however, one should adjust for calendar time to control for the potential presence of other (secular) trends (e.g., other preventive measures taken or a general spread of knowledge of safe injection methods).

To gain more insight into the mechanisms of the observed risk reduction, trends were compared in risk behavior among injecting drug users who did and did not receive daily methadone and who obtained syringes 100% and less than 100% via exchange. It appears that the proportion of users who reported current borrowing and lending decreased over time in all subgroups. Whether the magnitude of trends differed between the subgroups was then formally tested by evaluating if first-order interaction terms (i.e., between exchanging or receiving methadone and period of intake visit) could significantly improve a logistic regression model also containing the main effects. None of these interaction terms could do so (likelihood ratio test: P > .11).

Injecting drug users who obtained 100% of new needles/syringes via exchanging reported as early as 1986 that they were reusing their needles less often than those users who were exchanging them less. The relationship between reusing and exchanging became even stronger in time. This difference in the magnitude of trends (i.e., in subgroups based on strata of exchanging) was statistically significant (likelihood ratio test: P = .04). In 1986, injecting drug users who received daily methadone treatments also reported reusing needles less often than those who received methadone irregularly or not at all. However, the relation between reusing and receiving methadone disappeared in 1991/92. This difference in magnitude of trends was of marginal statistical significance (likelihood ratio test: P = .08).

### Discussion

Among intake visitors in our cohort study of injecting drug users in Amsterdam, a substantial and continuous risk reduction occurred between 1986 and 1992. The proportion reporting current borrowing declined from 51% to 20%; lending from 46% to 10%; and reusing, from 63% to 39% (all P < .0001). However, there were some potential sources of bias in these trends.

First, participants showing a high level of risk behavior may have been selectively recruited earlier in time in our study. Therefore, we adjusted these trends multivariately for differences in eight general characteristics; the same decline in risk behavior was found. A possible drawback to this method may have been that injecting drug users differed in characteristics for which no information was available. However, even after addi-

tionally adjusting for nine current behavior variables, which theoretically could lead to overmatching, we found the same magnitude of decline in borrowing, lending, and reusing needles.

Second, we selected only drug users who had injected in the preceding 6 months. Assuming that, under the influence of the HIV epidemic, drug users initiate injection less often or are more likely to cease injecting, the decline in risk behavior among all drug users in Amsterdam would be underestimated.

Third, the prevalence of borrowing and lending may be underestimated owing to memory loss and the deliberate giving of socially desirable answers. However, underreporting would have had to increase systematically in time to explain the decrease in risk behavior. When we adjusted for having been tested for HIV and for participation in methadone and needle exchange programs—assuming that these interventions are markers for social desirability because they reflect more knowledge of risky behavior—the decline in borrowing and lending was still statistically significant. However, one can never rule out this type of bias since the norms against sharing in the entire injecting drug culture may have been strengthened.

Finally, the outcomes of borrowing and lending are only roughly measured. For example, it is likely that injecting drug users who borrowed injecting equipment that had already been used borrowed less often in the previous 6 months, borrowed less often from those testing HIV positive (e.g., they borrowed only from their HIV-negative steady partner), or adequately cleaned the needles and syringes more often. Given such changes, the decline in risk behavior would be underestimated.

The overall direction of these potential sources of bias is unknown. However, the observed risk reduction is in accordance with the stable HIV prevalence in Amsterdam and the decline in HIV incidence in our cohort.<sup>5</sup> We want to stress that, in 1992, 20% of injecting drug users still reported current borrowing and that the HIV incidence within our cohort was estimated to be 3 per 100 person-years. This indicates the need to improve the AIDS prevention campaign among injecting drug users in Amsterdam.

In the present study, we tried to evaluate the effects of three interventions on injecting risk behavior. Because of two general methodological problems, however, our results should be interpreted with caution. First, secular trends may be

**TABLE 4—Logistic Regression Analyses: Associations between the Borrowing, Lending, and Reusing of Needles and Syringes and the Intervention Variables, among 616 Intake Visitors Who Had Injected Drugs during the Previous 6 Months**

	Outcome Variable					
	Borrowing		Lending		Reusing Needles	
	Unadjusted OR	Adjusted <sup>a</sup> OR	Unadjusted OR	Adjusted <sup>a</sup> OR	Unadjusted OR	Adjusted <sup>a</sup> OR
<b>Intervention variables</b>						
Being previously tested for HIV						
Never tested	1	1	1	1	1	1
HIV positive	0.14**	0.18*	0.002	0.003	0.23**	0.29*
HIV negative	0.47*	0.78	0.053**	0.124*	0.67	1.17
Receiving daily methadone <sup>b</sup>						
	1.00	0.87	1.35	1.11	0.75	0.65
Exchanging <sup>b</sup>						
0%	1	1	1	1	1	1
1–99%	0.96	0.99	1.03	1.21	0.60*	0.60*
100%	0.68*	0.86	0.61*	0.78	0.28***	0.29***
Period of intake visit <sup>c</sup>						
	0.77***	0.83*	0.61***	0.64***	0.78***	0.89

<sup>a</sup>Odds ratio (OR) derived from a logistic regression model including the intervention variables, period of intake visit, and general characteristics (associations with general characteristics not shown).  
<sup>b</sup>Reported over the 6 months preceding intake.  
<sup>c</sup>Continuously into the model.  
\*P < .05, \*\*P < .01, \*\*\*P < .001 (likelihood ratio test).

**TABLE 5—Spearman's Rank Correlations between Period of Intake Visit, Outcome Variables, and Intervention Variables, among 616 Intake Visitors Who Had Injected Drugs during the Previous 6 Months**

	Intake Period	Borrowing	Lending	Reusing Needles	Previously Tested	Received Methadone Daily
<b>Outcome variables</b>						
Borrowing needles/syringes	-.17***					
Lending needles/syringes	-.28***	.45***				
Reusing needles/syringes	-.17***	.19***	.18***			
<b>Intervention variables</b>						
Previously tested for HIV <sup>a</sup>	.42***	-.14***	-.20***	-.10**		
Received methadone daily	-.21***	.00	.06	-.07	-.16***	
Exchanging <sup>b</sup>	.27***	-.09*	-.10**	-.27***	.12**	.03

<sup>a</sup>Ranked 0 = HIV status unknown, 1 = HIV status known.  
<sup>b</sup>Ranked 1 = 0%, 2 = 1–99%, 3 = 100%.  
\*P < .05, \*\*P < .01, \*\*\*P < .001 (Spearman's rank test).

present. For instance, before AIDS prevention measures had been established in Amsterdam, it was already public knowledge that HIV could be transmitted parenterally. In addition, shortly after the start of specific programs for drug users, a national large-scale media campaign was executed in the Netherlands. Therefore, causality is difficult to prove. However, by multivariately adjusting the relationships between high-risk behavior and the intervention variables for year of intake period, we have (in part) adjusted for such

secular trends. Second, in the present cross-sectional study, cause and effect cannot be distinguished. In Amsterdam, both HIV testing/counseling and attending exchange programs are voluntary. Thus, injecting drug users who were strongly motivated to reduce risk behavior or had already reduced it might have been attracted to these two interventions. On the other hand, the prevention programs can provide the means by which persons who are trying to avoid risk are in fact able to do so.

Despite these potential drawbacks, we found indications that voluntary HIV antibody testing/counseling reduces high-risk behavior. This intervention was related to all three outcomes (borrowing, lending, and reusing), independent of year of intake visit (secular trends) and other potential confounders. HIV testing is very strongly related to lending; almost none of the previously tested injecting drug users lent equipment to others. Injecting drug users who knew themselves to be HIV positive reported the lowest levels of risk behavior. However, being tested and found HIV negative does not seem to give false feelings of safety; these users were less likely to borrow than those who were never tested. In a review (1991), it was concluded that, "to date, the studies among injecting drug users do not provide compelling evidence for an effect of counseling and testing on either drug or sexual risk reduction."<sup>11</sup> In a clinical trial no protective effect was found.<sup>21</sup> Other recent studies, however, indicate beneficial effects.<sup>22-26</sup>

One important goal of the exchange programs is to promote the single use of needles and syringes, which is beneficial for hygienic reasons in general (e.g., to prevent bacterial and fungal infections). Beyond that, such behavior is expected to prevent HIV infection because habitual single-needle users will better organize injecting drug use, will less easily interchange injection equipment by accident, and will be more reluctant to borrow needles used by somebody else. Indeed, single-needle users reported less borrowing. The results of the present study suggest that the decrease in reusing equipment was caused by the increase in exchanging equipment. There was not only a strong but also a dose-effect relationship between exchanging and reusing needles, which was independent of year of intake visit (secular trends) and other potential confounders. Furthermore, a decline in reusing needles was only found among injecting drug users who exclusively exchanged needles. As for how attending exchange programs affected borrowing and lending, the results are difficult to interpret owing to multicollinearity (see Results).

No relation was found between receiving daily methadone and either outcome. However, because of methadone programs, drug users may have stopped drug injection. This might have led to a selection bias since participants eligible for the present study were required to have been currently injecting. Another complicating factor is that, owing to the

low threshold of the programs, it is relatively easy to leave and reenter the programs. As a result, almost all injecting drug users in the present study received methadone after information on HIV became available at these programs. In any case, because in 1991 70% of the estimated 6500 drug users in Amsterdam received methadone,<sup>27</sup> low threshold programs are able to reach the majority of drug users, to whom information on HIV could be provided and syringe exchange and HIV testing/counseling services<sup>28</sup> could be offered.

Surprisingly, in the multivariate analyses, the decline in borrowing and lending was independent of intervention and other variables, and we found that injecting drug users attending needle exchanges or methadone programs reduced their risk to the same extent as nonattenders. Even among injecting drug users who neither obtained new needles via the exchange nor received methadone regularly, a significant risk reduction was found (data not shown). Not only secular trends (as described above) but also "contamination of the control group" may be responsible for these findings: nonattenders had probably received information about safe injection practices from attenders, and because of the exchange programs, the availability of needles/syringes may have been increased overall. For instance, exchangers may have given new injection equipment away to others more easily. At present, exchanging may be seen as a convenient way to obtain injection equipment, which is not strongly related to a desire to reduce risk.<sup>5,29</sup>

These findings have important implications for studies previously performed within our cohort. The lack of convincing evidence that attending exchange programs or receiving methadone treatments has a beneficial effect on the HIV prevalence, HIV incidence, or current borrowing<sup>5,24,30</sup> might be owing to the two factors mentioned above. Methodologically, evaluating specific prevention activities is very difficult. Even randomized intervention trials may be subject to secular trends and contamination of the control group. In the introduction to this paper, we mentioned limitations in the monitoring of HIV prevalence and incidence. Using the incidence of hepatitis B infection as a surrogate marker may give misleading results.<sup>16</sup>

However, a communitywide reduction in injecting risk behavior can be demonstrated by performing serial, cross-sectional studies using standardized ques-

tionnaires. In some serial, cross-sectional studies, a decline in injecting risk behavior was observed<sup>31-34</sup>; in others, no risk reduction was found.<sup>13,23,35,36</sup> Such differences between cities or regions may give clues to the relative effectiveness of prevention programs. However, apart from preventive measures, other differences between cities (e.g., drug use culture) complicate these comparisons.

In conclusion, a substantial risk reduction in injecting risk behavior has occurred since 1986 among injecting drug users in Amsterdam. Indications have been found that (1) voluntary HIV testing and counseling leads to less borrowing, lending, and reusing of injecting equipment; and (2) obtaining needles via exchange programs leads to less reusing of equipment. It appears that nonattenders of methadone and exchange programs have reduced borrowing and lending to the same extent as attenders. Therefore, evaluating specific measures methodologically is difficult. However, the combination of various measures in Amsterdam is probably responsible for the observed decrease in injecting risk behavior. □

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