Estimation of the Number of Injecting Drug Users Attending an Outreach Syringe-Exchange Program and Infection With Human Immunodeficiency Virus (HIV) and Hepatitis C Virus: the AJUDE-Brasil Project

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ABSTRACT *This study estimated the number of street injecting drug user (IDU) clients of a syringe-exchange program (SEP) who were infected with human immunodeficiency virus (HIV) and hepatitis C virus (HCV). A two-sample capture-recapture method was carried out. The first capture listed all interviewed IDUs outreached for syringe exchange from April 1 to May 1, 1998; the second capture involved those outreached from May 2 to June 6, 1998. Blood spots were collected for HIV and HCV serologies. Analysis used captured probability model varying with time. We interviewed 55 IDUs in the first capture and 99 in the second; 17 participated in both samples. An estimate of 317 IDUs attending the SEP was obtained (95% confidence interval [CI] 235–467). Based on the overall seroprevalence rates for HIV (47.7%) and HCV (53.1%), it was estimated that 151 IDUs were HIV infected (95% CI 112–223) and 168 (95% CI 125–248) were HCV infected. Enumeration of IDUs associated with estimates of the total number of HIV and HCV seropositives provide a powerful tool for SEPs to help monitor the number of IDUs, to plan for provisions, and to organize the new demands on existing health facilities for HIV and HCV care.*

KEYWORDS *Capture-recapture, HIV, HCV, Injecting drug users, Syringe-exchange program.*

INTRODUCTION

Injecting drug users (IDUs) constitute a group with frequent exposure to several viral infections due to their high-risk sexual and injecting behavior. Moreover, IDUs play a role as possible reservoirs and source of those infections in the inter- and extraexposure categories.^{1–4}

In Brazil, cases of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) related to the IDU have increased over the last 10 years,

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leading to greater visibility of this hidden population, seldom targeted by public health interventions. About 21% of all AIDS cases were related to drug use.⁵⁻⁸

Harm-reduction approaches, including ready access to sterile injection equipment through syringe-exchange programs (SEPs) and encouraging drug users only to use such equipment, are well supported by evidence as a very important strategy despite some controversies.⁹⁻¹³

SEPs in Brazil, created since 1995, have provided several different forms of care to the IDUs despite the threatening conditions outreachers encountered due to the national drug legislation and local police activities. Despite the increasing number of SEPs and their positive initiatives, they still are rather small with limited operational capacity, including their ability to provide a precise estimate of the number of IDUs they are accessing.^{5,12,13}

A better understanding of the profile and the total number of injectors reached by one program in the era of syringe exchange is mandatory to foster information for implementation, monitoring, and financing the SEP. An accurate estimate of the total number of IDUs in one SEP unit would be helpful in (1) monitoring the amount of HIV and hepatitis C virus (HCV) transmission; (2) planning services for infected and uninfected users, including drug and HIV/AIDS treatments and other health care facilities; (3) allowing a reasonable prediction of the number of AIDS and hepatitis C cases among this population in the coming decades; and (4) estimating the coverage of provisions.

Various approaches have been employed to estimate undetected populations. The capture-recapture technique, originally designed to estimate the size of wildlife populations in a context of a non-pre-existing lists, has been recently used in epidemiology. Many studies on vulnerable populations, including those of drug users and sex workers, have used the technique by matching pre-existing lists as a modification of the original method.¹⁴⁻²²

In this study, considering the absence of any database on IDUs attending an SEP, capture-recapture methodology was used in conditions very close to those originally reported, sampling the field (region) on two different occasions to estimate the total number of current IDUs being outreached by a SEP unit.²¹ The number of IDUs who were HIV and HCV infected and co-infected were also estimated.

METHODS

This study is part of a multicenter, cross-sectional study of out-of-treatment IDUs carried out in 1998 in five SEPs located in the southeast and south of Brazil for the AJUDE-Brasil Project.²³ The results in this article are related to one SEP site, located in Porto Alegre, Rio Grande do Sul State.

Capture-Recapture Methodology

Face-to-face interviews were used during a two-sample capture-recapture design and included IDUs outreached by the SEP's team during the fieldwork. Participants signed a consent form after receiving assurance of the anonymous and confidential nature of the study, which was previously approved by the institutional review board (ETIC 056/98 March 11, 1998).

The first capture took place from April 1 to April 30, 1998, and the second (recapture) from May 2 to June 6, 1998. Labor Day, May 1, was the date assigned to separate the capture and recapture occasions.

The criteria used to determine matching persons for the two capture occasions were based on the IDUs initials, date of birth, and their parents' initials. This information was included in the demographic section of the two specific questionnaires designed for the study.

For both capture occasions, the IDUs who were interviewed for the first time were enrolled in the serological survey, for which they had to answer a very detailed questionnaire about demography, drug use, needle/syringe sharing, sexual behavior, health services access, and prison experience. In addition, a fingerprint blood sample using paper filter was collected.

For those IDUs who were interviewed for the second time during the recapture occasion, a simplified questionnaire that included demographic and drug use questions was used. It also included questions such that we could detect in the matching procedure if the interviewee was really a recapture. Besides this, to ensure even more reliability, other questions addressed exclusively to the interviewer were added at the end of the questionnaire to cross validate with the interviewee answers.

Information collected for both samples was entered twice into a computer database. After keypunch error corrections, the matching process was performed using capture-recapture software specially designed in Turbo Pascal,²⁴ combined with sorting of the database and visual inspection.

A descriptive analysis comparing the two samples was performed. The estimation of the size of the IDU population attending the Porto Alegre SEP was done by using the probabilistic model M_i proposed by Darroch.²⁵ This estimator was built using the maximum likelihood statistical procedure, which is a method that produces optimal estimators for larger samples. Also, the information that the capture probabilities vary with time was incorporated in the estimated variance of the estimator for the total sample. This model assumes that all members of the population were equally at risk to capture on any particular trapping occasion, but probability can change from one occasion to the next. This model was selected because of two main reasons. First, by design, we had only two capture occasions; consequently, we were unable to use more sophisticated models for which different probabilities between individuals could be assigned. Second, the model assuming constant probability between captures was not suitable considering possible modifications due to the study and other environment changes.

The software Capture²⁶ was used to perform the estimation.

HIV and Hepatitis C Testing

As described elsewhere, antibodies to HIV and HCV were tested by enzyme-linked immunoassay (ELISA) using paper filter after a serological reliability study for standardization of the paper filter blood collection technique.^{23,27,28}

RESULTS

Fifty-five IDUs were interviewed in the first capture and 99 in the second. Using the matching process, 17 IDUs were identified as having participated in both samples. All eligible attendees agreed to participate.

The criteria used to determine matching entries are shown in Table 1. Names were considered similar if they contained only minor spelling differences, possibly due to mistakes of the interviewer when filling the letters or numbers in the ques-

TABLE 1. Criteria used to determine matching injecting drug users (IDUs) in the two captures and the number of matches identified for each match type

Date of birth	IDUs' initials	Mothers' initials	Fathers' initials	Number of matches
Same	Same	Same	Same	4
Same	Same	Similar*	Similar	3
Same	Same	Same	Missing	3
Same	Same	Missing	Same	1
Same	Similar	Similar	Same	1
Same	Similar	Same	Similar	1
Same	Similar	Same	Same	1
Similar	Same	Similar	Similar	1
Similar	Similar	Similar	Same	1
Similar	Similar	Similar	Similar	1
Total				17

*Names were considered similar if they contained only minor spelling differences, possibly due to the phonetics of the Portuguese language or small mistakes when filling the letters or numbers related to either the interviewer (misinformation or lack of memory) or the interviewee (misinterpretation or miscommunication) and to punch error during the process of data entry.

tionnaire, to the lack of memory, to misinterpretation or miscommunication of the interviewee, or to keypunch errors during the data entry process.

Using the 17 matches found when comparing the two samples, an estimate of 317 IDUs attending the SEP (95% confidence interval [CI] 235–467) was obtained. The estimated capture probabilities for each occasion were 0.17 for the first and 0.31 for the second. No significant difference was found between the first and the second samples in terms of the number of capture-recapture IDUs ($P = .955$).

To understand the profile of the IDUs who participated in the two capture occasions, some characteristics among them were compared in Table 2. The IDUs in the second sample (recapture occasion) were significantly younger than those on the first occasion (24 compared to 29 years old median age, $P = .008$). They also presented with HIV prevalence almost two times lower (39.7% compared to 61.1%, $P = .016$) and HCV prevalence about 1.5 times lower (44.4% compared to 64.2%, $P = .026$) than the IDUs of the first sample. Higher rates of inadequately discarding the injecting tools were reported by the IDUs of the second sample (94.9% compared to 83.3%, $P = .042$). The frequency of searching for health treatment in the last 12 months reported by the IDUs of the second sample was 1.5 times lower than the frequency reported by those in the first sample; however, this difference was not statistically significant at the 5% level ($P = .067$). The IDUs of both samples were similar in regard to time and frequency of SEP use (for both comparisons, $P > .05$).

Based on the seroprevalence rates for HIV (47.7%) and HCV (53.1%) obtained in the survey study, we estimated that about 151 IDUs were HIV infected (95% CI 112–223); 168 (95% CI 125–248) were HCV infected; 132 (95% CI 97–195) were HIV-HCV co-infected; and 129 (95% CI 96–191) were not infected by HIV or HCV (Table 3).

TABLE 2. Baseline information on injection drug users during the two-phase capture-recapture

Characteristics, %	Capture 1 (n = 55)	Capture 2 (n = 82)	Recaptured (n = 17)	P*
Age, mean ($\pm$ SD) years	30.4 $\pm$ 7.7	27.3 $\pm$ 8.6	31.2 $\pm$ 8.0	.032
Age, median years	29.0	24.0	29.0	.008
Male gender	83.6	85.4	94.1	.783
Non-Caucasian	63.6	76.8	47.0	.094
Illiteracy	16.4	9.8	17.7	.250
HIV seroprevalence ^{†‡}	61.1	39.7	58.8	.016
HCV seroprevalence ^{†‡}	64.2	44.4	58.8	.026
Injected cocaine last 6 months	69.1	78.1	76.5	.239
SEP use	62.2	51.9	52.9	.321
Injection tools obtained from SEP last 6 months [†]	68.6	51.6	66.7	.102
Shared syringes/needles last 6 months [†]	50.0	55.0	55.6	.746
Inadequate discarding of injecting tools last 6 months [†]	83.3	94.9	82.4	.042
Health treatment in the last 12 months [†]	41.8	26.8	47.1	.067
Intention to test for HIV [†]	25.5	33.8	23.5	.303
HIV testing in the last 12 months [†]	41.8	32.5	52.9	.269
Condom use in all or the majority of sexual intercourse [†]	61.2	60.3	78.6	.913

HCV, hepatitis C virus; HIV, human immunodeficiency virus; SEP, syringe-exchange program.

*Comparison between capture 1 and capture 2.

[†]The number may vary because of missing number.

[‡]HIV and HCV were determined by enzyme-linked immunoassay (ELISA).

DISCUSSION

In 1998, we estimated that the SEP located in Porto Alegre was outreaching about 317 IDUs, and that about half of them were either HIV or HCV infected and co-infected. However, the more relevant information found in this study was that about half of them (about 158) were neither HIV nor HCV infected, justifying a very consistent public health intervention from the SEPs, with the implementation of comprehensive primary and secondary prevention programs, including information and education on health, empowerment strategies, and distribution or exchange of clean injecting equipment and condoms.

TABLE 3. Estimation of injection drug user number according to HIV and HCV infection

Infection	%	Estimated number (95% CI)
HIV+/HCV+	41.5	132 (97–194)
HIV+/HCV–	6.2	20 (15– 29)
HIV–/HCV+	11.5	36 (27– 54)
HIV–/HCV–	40.8	129 (96–191)

CI, confidence interval; HCV, hepatitis C virus; HIV, human immunodeficiency virus.

In general, estimation of population size from the overlaps between lists may be very uncertain. This uncertainty can be related either to the major assumptions required by the estimation method or to a very important discussion about the validity and reliability of the information of the samples.²¹

The first question is related to the assumption that the IDU population is closed. In fact, no city, region, or unit is really closed. Although many authors have issued the dynamics of the drug users, two arguments in our study may support that the “closed population” assumption has been satisfied to a reasonable degree. First, it was observed that the IDUs interviewed in both samples consistently reported to be living in their respective town an average of 2 years.²³ Second, to allow for the assumption of a stable population, the duration of the study was limited to only 3 months. Therefore, it is unlikely that a substantial proportion of IDUs have entered or left the Porto Alegre City during this brief time.

The next question is related to accuracy of the markers used to identify the IDUs. The risk behaviors were based on self-reported data and could raise concerns regarding biased information either due to poor recall or due to a socially desirable responses. Questions could also be raised regarding the demographic information related to the initials collected in an anonymous survey and therefore not verified by identification card. However, this study was conducted with very good supervision in the field, and the data set was analyzed very carefully several times to minimize the chance of errors in finding the matches. Also, the cross-validation analysis of the interviewer information and interviewee answers showed a very high agreement in those questions used to identify whether a person was eligible for being a recapture.

Although recent reports using audio computer-assisted self-interviewing (ACASI) have shown an enhancement of the quality of behavioral assessment among IDUs, there is substantial evidence in the literature that supports the validity and reliability of IDU self-reported drug use, criminality, and HIV risk taking collected in a traditional face-to-face interview.^{29–32}

The last question is related to the capture probability for each occasion. According to Otis et al.,²¹ capture probabilities may vary between occasions due to several factors, such as time, trapping, and personal behavior. However, with two capture occasions, the only factor that can be considered in the statistical model is the difference due to time. Considering that the size of the second sample was almost twice the size of the first and that the time used to collect the data was practically the same in both occasions, it is clear that the capture probability changed from one occasion to the other. This fact makes the choice of the Darroch M_t model reasonable.²⁵

Considering IDUs as a “partially hidden population,” the two samples presented in this study may not represent truly random samples.³³ Questions could be raised about how representative these samples are of the SEP clients. This concern is based especially on the fact that some peculiar differences were found in the profiles of both samples. The IDUs of the first sample were significantly different from the IDUs of the second in age, HIV and HCV seroprevalence, and discarding habits, suggesting that the two capture occasions might be subsamples of different groups.

Furthermore, it is not very clear which population is being estimated because it is likely that subgroups of IDUs did not have an equal chance of appearing during the two capture occasions. Young people who had recently start injecting and ill

users are likely to be under-represented in both captures. On the other hand, users who had ever injected may have been overestimated.

Regardless of the above limitations, in this study the IDUs who were captured might represent the part of the population at higher risk and may be the target population for SEPs intervention and for a more time-sensitive HIV and HCV surveillance.³³

IDUs constitute an important source of viral infections, especially considering the high transmission and natural history of the HCV infection.¹⁻⁵ Based on the seroprevalence of HCV-RNA in Brazil,³ it is known that about 70% of all IDUs with anti-HCV are able to transmit HCV to other IDUs. Therefore, it seems that current provision of new sterile equipment is mandatory to further reduce the spread of HCV among this population. The use of other paraphernalia, such as filters, spoons, and water, may also be influencing the spread of HCV. These equipment should be routinely provided by exchangers/distributors.

Concomitantly, it is important to give to the drug users clear messages about the possible danger of sharing all injecting paraphernalia. A recent study has shown a significant gap in knowledge of hepatitis C transmission, perceived risk, and willingness to receive treatment plus unreliable HCV self-reported status among IDUs.³⁵ Moreover, a substantial encouragement for HIV and HCV testing and health care utilization for those infected in the context of IDUs has been advocated for development of alternative treatments and improvement of the provisions of medical care for HCV infection.⁴

To have a better feeling about the applicability of the capture-recapture methodology in a SEP context, we may use the personal information about the average number of syringes distributed in the Porto Alegre City SEP in 1998. At that time, around 4,000 syringes were distributed monthly (48,000 syringes a year). Considering that in this population there was an estimated 0.5 injection per day,²³ then about 180 injections per year would be expected per IDU. Therefore, in 1 year, the estimated number of IDUs covered by the SEP would be around 266 (48,000 divided by 180). This result supports that estimation by the capture-recapture analysis may be a very sensible methodology.

Therefore, despite several limitations, capture-recapture can be used to estimate the size of difficult-to-count subpopulations in the SEP context. Certainly, the statistical model for estimation could be improved by using multiple capture occasions. However, the cost of the survey would increase substantially.

Finally, the findings presented support the fact that the enumeration of IDUs associated with estimates of the total number who are HIV and HCV seropositive can provide a powerful, simple, and intuitive tool for SEPs that can be helpful for monitoring the size and trend of the local IDU population outreached. Also, it may be useful for planning provisions and organizing the new demands on existing health facilities for HIV and HCV care and for providing information for a time-sensitive surveillance of this population.³³

ACKNOWLEDGEMENT

The AjUDE-Brasil Project is sponsored by the National STD/AIDS Program, Ministry of Health, Brazil.

We are grateful to the SEP coordinators, the outreachers, and the IDUs who agreed to contribute to this study. W. T. C. and F. A. P. are recipients of a National

Research Council grant. AjUDE-Brasil has been approved by a Federal University of Minas Gerais Institutional Review Board (ETIC 056/98, March 11, 1998).

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