Needle exchange programs: an economic evaluation of a local experience

Evidence

Études

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Abstract

Objective: To determine whether providing a needle exchange program to prevent HIV transmission among injection drug users would cost less than the health care consequences of not having such a program.

Design: Incidence outcome model to estimate the number of cases of HIV infection that this program would prevent over 5 years, assuming that the HIV incidence rate would be 2% with the program and 4% without it, and that an estimated 275 injection drug users would use the service over this time.

Setting: Hamilton, Ont.

Outcome measures: Estimated number of cases of HIV infection expected to be prevented with and without the program over 5 years; estimated lifetime health care costs of treating an AIDS patient. The indirect costs of AIDS to society (e.g., lost productivity and informal caregiving) were not included. Projected costs were adjusted (discounted) to reflect their present value. In a sensitivity analysis, 3 parameters were varied: the estimate of the HIV transmission rate if no needle exchange program were provided, the number of injection drug users participating in the program, and the discount rate.

Results: With very conservative estimates, it was predicted that the Hamilton needle exchange program will prevent 24 cases of HIV infection over 5 years, thereby providing cost savings of $1.3 million after the program costs are taken into account. This translates into a ratio of cost savings to costs of 4:1. The sensitivity analysis confirmed that these findings are robust.

Conclusion: Needle exchange programs are an efficient use of financial resources.

Résumé

Objectif : Déterminer si l'établissement d'un programme d'échange d'aiguilles afin de prévenir la transmission du VIH chez les consommateurs de drogues injectées coûterait moins cher que les répercussions qu'aurait sur les soins de santé le fait qu'il n'y ait pas de programme.

Conception : Modèle d'incidence des résultats afin de diminuer le nombre de cas d'infection par le VIH que ce programme pourrait prévenir en 5 ans, si l'on suppose que le taux d'incidence du VIH serait de 2 % avec le programme et de 4 % sans le programme et qu'un total estimatif de 275 consommateurs de drogues injectées utiliseraient le service pendant cette période.

Contexte : Hamilton (Ont.).

Mesures des résultats : Nombre estimatif de cas d'infection par le VIH que l'on s'attend à prévenir avec et sans le programme en 5 ans; coûts estimatifs en soins de santé pendant toute une vie du traitement de patients atteints du sida. Le calcul ne comprend pas les coûts indirects du sida pour la société (par exemple, perte de productivité et soins dispensés en dehors du réseau de santé). On a rajusté (réduit) les coûts projetés pour refléter la valeur actuelle. Dans le cadre d'une analyse de sensibilité, on a varié 3 paramètres : l'estimation du taux de transmission du VIH sans programme d'échange d'aiguilles, le nombre de consommateurs de drogues injectées participant au programme et le taux de réduction.

Résultats : À partir d'estimations très conservatrices, on a prédit que le programme d'échange d'aiguilles de Hamilton préviendra 24 cas d'infection par le VIH en 5 ans, et permettra ainsi de réaliser des économies de 1,3 million de dollars, compte tenu des coûts du programme. Ces chiffres se traduisent en un ratio d'économies sur les coûts de 4:1. L'analyse de sensibilité a confirmé que ces résultats sont solides.

Conclusion : Les programmes d'échange d'aiguilles constituent une utilisation efficiente de ressources financières.

AIDS is a global epidemic. In Canada, there have been 14 677 cases and 10 735 deaths as of March 1997, of which 624 cases have been attributed to injection drug use.[1] It has been estimated that cases of HIV/AIDS are underreported by one-third to one-half, and therefore these figures are likely an underrepresentation.[2]

AIDS can be acquired from injection drug use through the sharing of infected needles.[3,4] The impact of this risk behaviour extends beyond those participating in it: in the US, studies indicate that at least 40% of drug users have been in intimate relationships with nonusers[5] and that, as of 1995, 80% of HIV-positive heterosexual men and women who never used injection drugs had become infected through sexual contact with someone who did.[6]

Interviews with injection drug users indicate that a common reason for sharing needles is difficulty in obtaining clean equipment.[5,7,8] The long-term objective of a needle exchange program (NEP) is to prevent HIV infection from needle-sharing. The immediate objective is to minimize harm by reducing needle-sharing through the provision of clean needles. An explanation of how NEPs reduce HIV incidence is the "circulation theory"[9] — they decrease the amount of time that contaminated needles are in circulation. There is no evidence that the programs increase either initiation into injection drug use,[10,11] the frequency of injecting, or prevailing levels of drug use in the community.[12]

Rigorous evaluations of how effective NEPs are at reducing the incidence of HIV infection have not been possible because of ethical issues associated with experimental methods and because of difficulty with follow-up in observational studies. However, prevalence studies have indicated that AIDS epidemics have been avoided in areas that do have such a program. In Sweden, for example, the HIV seroprevalence rate in 1988 in Stockholm, which did not have an NEP, was 13%;[13] while in the nearby city of Lund, which did have one, the rate was maintained at 1% over a period of more than 3 years.[14] In other studies, relatively stable HIV prevalence rates of less than 5% among injection drug users have been found in cities where NEPs were initiated while the prevalence rates were still low.[15] It is plausible that if shared needles are a source of HIV transmission, then measures to reduce this sharing will reduce transmission.

We conducted an economic appraisal of an NEP in Hamilton, Ont., in order to investigate, in a Canadian context, whether the provision of such a program produces overall cost savings to society. We first reviewed the literature in order to estimate HIV incidence among injection drug users with and without such a program, and then developed an incidence outcome model to estimate the number of cases of HIV infection that would be prevented because of the program. The dollar cost of illness avoided was valued, and an investigation of possible cost savings conducted.

Methods

Background information

Hamilton is an industrial metropolitan area with a population of 450 000. The Van Needle Exchange Program, begun in 1992, is a part-time service that operates out of 3 sites — 1 mobile and 2 fixed. The mobile unit is an unmarked van that visits areas known to be frequented by substance abusers, and the other sites are a community pharmacy and the Street Health Centre. The only paid staff are a public health nurse and a community outreach worker. In addition, there are 7 community volunteers who help provide nonmedical services, and a volunteer pharmacist who exchanges needles at the community pharmacy. The services of the community outreach worker are contracted through the Hamilton AIDS Network, which also arranges for the services of the community volunteers.

Besides needle exchange, this program provides a variety of related harm-reduction services to drug users, including substance abuse counselling and referral, anonymous HIV testing, hepatitis B vaccination, safer-sex counselling, and the provision of condoms and dental dams. (This is typical of the role of NEPs in Canada and elsewhere.[12]) It has also evolved to provide primary health care to a marginalized, urban core population through the Street Health Centre.

It was not possible to determine the exact number of injection drug users participating in the Van Needle Exchange Program. According to the staff, drug users in Hamilton face a "small-town culture" and feel a need to

maintain their anonymity; hence, it is difficult for staff to accurately log the number of injection drug users exchanging needles. Their estimate of this number for 1995 was 275. In that year, 14 207 needles were handed out and 7780 were taken in, resulting in an exchange rate of 55%.

Incidence outcome model

We developed an incidence outcome model in order to estimate the number of new cases of HIV infection expected over 5 years among the injection drug users currently using the program, and the incidence of HIV infection expected if there were no program for these users. We arbitrarily chose 5 years because it is difficult to predict the status of HIV prevention or treatment beyond this point. For purposes of the model, we assumed that the population of injection drug users is fixed and that none enters or leaves it, except through death from AIDS. This is of course a simplistic representation stemming from data limitations; a real-life drug-using population would be transient and thus the prevalence would vary. Because new HIV cases are drawn from the remaining universe of drug users, the model is not adequate for perpetuity, but it is adequate as a conservative estimate of the number of HIV cases prevented. In this theoretical model, one would expect the population to eventually diminish to 0 as all its members would eventually die of AIDS.

Baseline HIV prevalence rates

The expected number of new HIV cases each year is a function of the incidence rate multiplied by the population still at risk. This involves subtracting the number of HIV-positive drug users from the population pool. Developing a baseline estimate of HIV prevalence is difficult, because different communities have had their first HIV-positive people arrive and initiate the transmission of the virus at different times. Several Canadian studies have investigated seroprevalence rates among injection drug users in the early days of NEPs (between 1988 and 1992) and found the rates in Calgary, Toronto, Vancouver, Ottawa and Montreal to be 3%, 4.3%, 4.7%, 8.1% and 11.1%, respectively.[7,8,16–18] These studies appear to provide the most plausible estimates of what may have been the seroprevalence rate in Hamilton at baseline. We chose the most conservative estimate of 3%.

HIV incidence without the needle exchange program

To ascertain the likely rate of HIV transmission among injection drug users in the absence of an NEP, we consulted with AIDS experts, conducted a literature review and read published and unpublished studies and abstracts. In deciding on our inclusion criteria, we considered which subjects would be representative of a "natural" cohort. There have been some attempts to develop statistical models to predict the transmission rate;[2,19] however, use of these models requires certain knowledge about the population under study, such as frequency of drug injection, frequency of needle sharing, ratio of users to injection equipment and the number of users who were HIV positive at baseline, and these variables are unknown for Hamilton.

Many of the studies we looked at suffered from inadequate rates of follow-up, but we identified 2 that appeared to provide feasible estimates. Nelson and associates,[20] in a study that achieved a follow-up rate of 68% over 4 years, recorded an HIV incidence rate of 3.8 per 100 person-years in a large American cohort of injection drug users who were offered only needle bleach kits during semiannual interviews. Metzger and collaborators,[21] in a study that achieved a follow-up rate of 85% over 18 months, recorded a rate of 10.7 per 100 person-years among 103 injection drug users in Philadelphia who were offered only counselling about prevention strategies. For our study, we chose a value close to the lower rate (4%) in order to apply a conservative estimate of the preventive effects of an NEP.

HIV incidence with the needle exchange program

To complete our model, we required information regarding the expected HIV incidence rate if an NEP were provided. Kaplan and Heimer[22] used the number of syringes being turned in to an NEP in New Haven, Conn., to develop a well-known statistical model. Employing a detailed tracking system, they calculated the HIV incidence rate among program users to be 1.63 per 100 person-years.[23] These figures appear plausible, given the relatively stable HIV prevalence rates noted previously in other cities with programs. For our model, we assumed an HIV incidence rate of 2% among program participants.

Costs of providing the program

Direct costs are those incurred in providing a program, including capital costs at start-up. The Hamilton program has had few capital costs because it is administered by the regional Public Health Department. The only potentially variable cost is for medical supplies, depending on the demand for needles. Shared costs are mutually borne by departments or programs from a larger global budget. From a review of the program's activity log, NEP staff estimated that 70% of its services are allocated for harm-reduction

strategies provided to drug users, and the remainder for primary health care services to non-drug users. We therefore decreased the cost of the needle-exchange component to 70% of the total program costs, with the exception of the pharmacist volunteer and the outreach volunteers, who are involved exclusively in needle exchange, and the van, which serves as the outreach vehicle for contacting drug users on the streets.

"Non-market costs" (also called "shadow pricing") refers to the values placed on resources that might otherwise be considered free because they do not impose a direct cost to the program budget. From a societal perspective, when a program uses a resource, the opportunity to use that resource is then not available elsewhere. Accordingly, we included non-market costs for the time contributed by the community volunteers and the pharmacist.

Costs of treating HIV infection

The direct health care costs that result when a person becomes HIV positive are not incurred at a constant rate; rather, they increase as the natural history of HIV-related illness progresses.[24] A trend to shifting from inpatient to outpatient services is occurring:[25] people with HIV infection are receiving earlier intervention through outpatient services and as a result are living longer.[26] Improvements in drug treatments are prolonging life, but at an increased monetary price. The time to progress from infection with HIV to AIDS among injection drug users now exceeds 10 years;[27] one study concluded that the new drugs are doubling health care costs.[28]

We based our estimates of health care costs on a Canadian study by Grover and colleagues,[29] who conducted a prospective study involving 122 people with HIV/AIDS at 4-month intervals over 2 years. They estimated the average lifetime direct health care costs to be $100 167 (1991 Canadian dollars), based on an expected survival time of 10.6 years. (Because the inflation rate in Canada has been very low in recent years, we did not feel it necessary to adjust the 1991 dollar costs in order to compare them with those in 1995.) This estimate included inpatient and outpatient hospital costs, physician services and medication costs, but did not include community-based services or the increased costs of medications only recently available. Thus, it is highly conservative. Grover and colleagues apportioned annual treatment costs for each stage of illness, as follows:

> For asymptomatic (n = 14), symptomatic (n = 31) and AIDS (n = 51) subjects, respectively, annual total costs were estimated to be $5160, $7735 and $25 447. . . . Average lifetime costs were estimated to be $100 167, assuming 3.26 asymptomatic years (half of which incurred no costs prior to an HIV diagnosis), 5.39 symptomatic years and 1.97 years of survival with AIDS.

We used these values to calculate the rate of discounting that should be applied to the costs of each stage of illness.

Discounting

Discounting expresses all future costs in terms of their present value because of the existence of a time preference. That is, people value money in the present more than they do money that will be spent — or not spent — in the future. Costs that are deferred must therefore be discounted to reflect their lesser perceived value. Currently, there is no government-recommended discount rate for Canada, so as a baseline we used the traditional rate of 5%.[30] We assumed that the costs for delivering the NEP are incurred at the beginning of each year, so we did not discount its costs for Year 1. We discounted the program costs of the remaining 4 years, as well as the lifetime health care costs of HIV-related illnesses.

Sensitivity analysis

Our baseline estimates of HIV incidence without an NEP (4%) and of the number of injection drug users using the program (275) were in fact very conservative. We conducted a sensitivity analysis in order to investigate what the impact on cost savings would be if these parameters were increased.

We used Metzger's incidence rate of 10.7 as an alternative estimate of HIV incidence if no NEP were provided.[21] This number is plausible because very rapid spread of HIV (20% or more in 1 year) has been well documented[10] and this has been primarily attributed to lack of awareness concerning the risks of injecting, as well as to drug cultures that promote needle-sharing through mechanisms such as "shooting galleries."[10]

The second alternative was to increase the estimate of the number of injection drug users using the NEP to 550. Our rationale was that the program staff were not certain as to numbers and may be reaching more people than they estimated. According to data from the Substance Abuse Monitor, a client database coordinated by the Hamilton office of the Addiction Research Foundation that has collected information from 9 out of 12 local substance abuse treatment agencies, in 1994 there were 77 people who identified themselves as injection drug users who shared needles. It has been estimated that 7% of substance abusers use local treatment programs each year; so, extrapolating from 77 suggests that 1100 people in the Hamilton area may be at risk because of needle sharing.[31] We based our estimate of 550 on just half this number.

Results

Fig. 1 displays the incidence outcome model, showing the predicted number of new cases of HIV infection among injection drug users in Hamilton over 5 years with and without an NEP. The model estimates that there would be 49 new cases of HIV infection if no program existed, and 25 if one did. Therefore, 24 cases would be prevented as a result of having the program: 6 cases in Year 1, and 5, 5, 4 and 4 cases prevented in each of the remaining 4 years, respectively.

Table 1 identifies the costs of running the Van Needle Exchange Program. We calculated the total cost, including costs for both needle exchange services and other services, to be $76 775 per year (1995 figures). Over 5 years, the discounted cost of providing the program will total $349 012.

At a discounted rate of 5%, we calculated the lifetime cost of illness for a person with HIV/AIDS to be $68 394 (Table 2).

Table 3 presents the cost savings resulting from the prevention of HIV cases with the NEP. In the first year of operation the program would be expected to provide total cost savings of $333 589. Over 5 years this amount would be $1 292 444. This translates into a ratio of cost savings to costs of 4:1; that is, for each dollar of resources spent in providing the program over 5 years, 4 dollars would be saved in costs.

For these calculations we used very conservative estimates for both the likely HIV transmission rate in the absence of an NEP and the number of participants in the program. To illustrate what the economic benefits would be if these numbers were higher, we performed a sensitivity analysis using higher values (Table 4). If the expected HIV incidence in the absence of an NEP were 10.7% rather than 4.0%, an estimated 92 cases of HIV infection

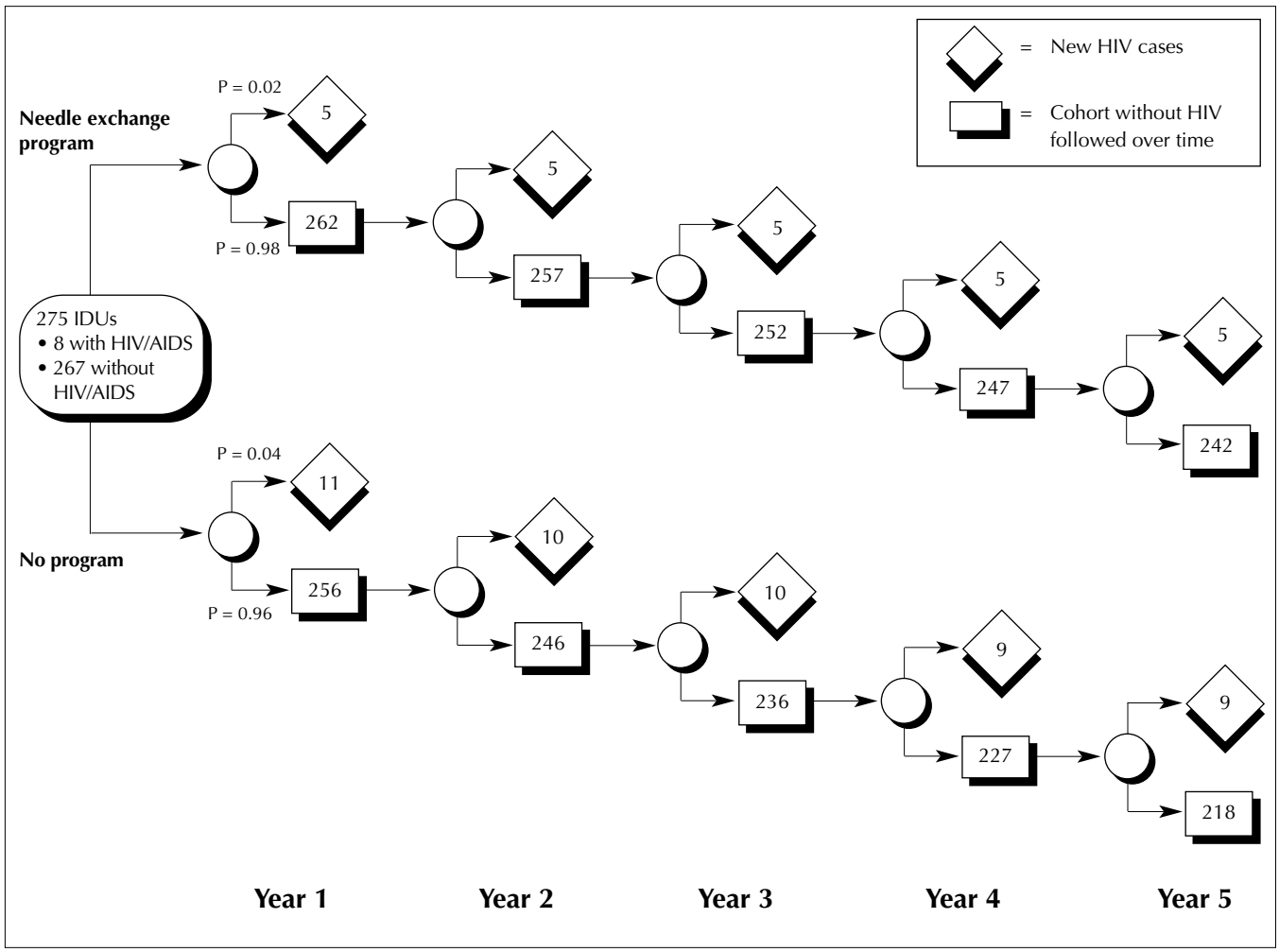

Fig. 1: Incidence outcome model, showing predicted number of new cases of HIV infection among injection drug users (IDUs) in Hamilton, Ont., over 5 years with and without a needle exchange program. Assumptions: annual incidence of HIV is 2% with program and 4% without program; number of IDUs in Year 1 is 275; and baseline HIV prevalence rate is 3%.

would be prevented with the program over 5 years. With this figure the cost savings would be $5 943 236 and the ratio of cost savings to costs would be 17:1. If the number of injection drug users using the service over 5 years were 550 rather than 275, with all other baseline factors held constant, an estimated 47 cases of HIV infection would be prevented. Here, the cost savings would be $2 865 605 and the ratio of cost savings to costs would be 8:1.

In addition, we varied the discount rate from 1% to 10%, based on current convention.[32] At all values the cost savings were substantial, ranging from $800 000 at a 10% rate of discount to $1.8 million at a 1% rate. This corresponds to ratios of cost savings to costs of 3:1 and 5:1, respectively.

Discussion

In our analysis we reviewed the literature on the effectiveness of NEPs and applied our findings to the situation in Hamilton in order to determine whether the program represents an efficient use of resources. We estimate that a small, inexpensive program such as the Van Needle Exchange Program can result in direct cost savings to a publicly funded health care system of $1.3 million over 5 years, based on 24 cases of HIV infection prevented. In our baseline calculation, for which we used highly conservative estimates of program coverage and effectiveness, the ratio of cost savings to costs was 4:1. In the other calculations, this ratio was even higher.

The costs of HIV-related illness are likely even higher than the valuation we applied, because of the recent addition to treatment therapies of 3TC and protease inhibitors. This will likely increase drug costs, although it may possibly reduce the number of hospital admissions, at least in the short term. The financial costs and benefits of new treatment advances should be included in future valuations.

Not included in our estimates were the indirect costs of illness such as the loss of human capital: that is, the future economic burden to society of lost productivity because of premature death. Hanvelt and associates[33] estimated the present value of projected future earnings, based on potential years of life lost, for Canadian men who died of AIDS between 1987 and 1991 to be $40 billion (1990 US dollars).

The role of informal caregivers in providing care and support to people with HIV/AIDS has also been recognized.[34] Informal care reduces direct health care costs, but it incurs out-of-pocket costs for the caregivers themselves, as well as physical and emotional burdens. Additional studies should be conducted in the valuation of intangible costs for informal care, and these costs should be included in future economic analyses.

Table 1: Annual cost of providing the Van Needle Exchange Program, Hamilton, Ont.

Source	Cost, $*	
	Entire program	Harm-reduction activities for injection drug users
Direct costs		
Office supplies	2 000	1 400
Operating supplies	7 050	4 935
Vehicle lease and maintenance	12 020	12 020
Medical supplies	10 100	7 070
Advertising and publicity	1 000	700
Staff salaries	51 200	35 840
Indirect costs		
Outreach volunteers†	8 960	8 960
Pharmacist volunteer‡	5 850	5 850
Total	98 180	76 775

*In 1995 Canadian dollars.
†Based on 7 volunteers providing 56 hours per month. Valued at entry-level social service worker salary of $26 000 per annum.
‡Based on pharmacist providing 16.25 hours per month, valued at $30 per hour.

Table 2: Lifetime health care costs (in Canadian dollars) of HIV-related illnesses*

Year	Allocation by phase of illness	Annual cost of illness, $	Annual cost of illness discounted at rate of 5%†, $
1	–	–	–
2	$0 \times 0.63 + 5\,160 \times 0.37$	1 909	1 731
3	$5\,160 \times 1$	5 160	4 457
4	$5\,160 \times 0.26 + 7\,735 \times 0.74$	7 066	5 813
5	$7\,735 \times 1$	7 735	6 060
6	$7\,735 \times 1$	7 735	5 772
7	$7\,735 \times 1$	7 735	5 497
8	$7\,735 \times 1$	7 735	5 235
9	$7\,735 \times 0.65 + 25\,447 \times 0.35$	13 934	8 982
10	$25\,447 \times 1$	25 447	15 622
11	$25\,447 \times 0.62$	15 777	9 225
Total		100 233‡	68 394

*Based on lifetime cost of $100 167 and 10.6 years of survival.[29]
†Discounted to reflect present value (see Methods).
‡Difference due to rounding error.

Table 3: Cost savings of needle exchange program over 5 years (in 1995 Canadian dollars)*

Year	No. of cases prevented	Cost of illness avoided, $	Cost of program, $	Cost savings†
1	6	410 364	76 775	333 589
2	5	341 970	73 121	268 849
3	5	341 970	69 635	272 335
4	4	273 576	66 318	207 258
5	4	273 576	63 163	210 413
Total	24	1 641 456	349 012	1 292 444

*Costs in years 2–5 are discounted to present value.
†Cost of needle exchange program subtracted from cost of illness avoided.

Our sensitivity analysis supports the conclusion that the cost savings from an NEP are robust. A simple look at the treatment costs for HIV-related illness indicates that even if the program were to prevent slightly more than 1 "statistical" case of HIV infection every year, it would still result in cost savings to the system. The results of the sensitivity analysis were to be expected, because even our very conservative baseline calculation yielded significant cost savings. It is clear that if more drug users than we first estimated used this service, then the program would prevent an even greater number of HIV cases. Estimates of the proportion of injection drug users using NEPs range from 15% to 60%.[12] Drug users are not a homogeneous group, and it is important for the administrators of NEPs to conduct evaluations in order to know their client population and to tailor their outreach.

The rate of HIV transmission in the drug-using population was the most challenging variable we dealt with, and, accordingly, our incidence outcome model is based on varying parameters of incidence. We came up with a conservative estimate of what this incidence rate would be if no program were available, based on studies that offered drug users only risk-reduction counselling or bleach kits. (Studies with "uncontaminated" control groups are not possible, due to the ethical issues involved.) It is worth noting that although estimates of HIV incidence rates among drug users who participate in NEPs are derived from following a cohort over time, those who are lost to follow-up because of success with counselling or referral to treatment are not included in the estimates. This may paradoxically appear to diminish the effectiveness of the programs — that is, the number of HIV cases prevented by such programs may be even higher than we estimated.

The economic evaluations we used with the Hamilton program may be applicable to similar programs elsewhere in Canada. Kaplan[35] has developed models to deal with questions such as What is the optimal size for an NEP, given baseline incidence and program costs, in order to optimize resource allocation between potential uses? We did not, however, have enough information about independent variables to use Kaplan's models.

The overwhelming weight of evidence supports the role of NEPs in reducing the incidence of HIV infection among injection drug users.[36] However, a program in Montreal found that the incidence rate was higher among program participants than among nonparticipants.[37] Research is under way to determine whether the program could be playing a causative role; for example, by creating new social networks among people who would not otherwise have contact with one another. This case illustrates the complexity of HIV prevention programs for injection drug users and the need to evaluate the factors involved in their success. The outcomes of individual programs need to be evaluated, at the very least through the monitoring of HIV infection rates in the populations they serve to determine incidence trends.

A final consideration is that NEPs may offer benefits from a societal viewpoint in addition to financial ones. It has been suggested that the purpose a of health care system is to maximize health subject to available resources rather than to save costs.[32] The benefits attributed to a program may include personal valuations such as value of life-years saved, avoidance of pain and suffering, and altruistic motives. Indeed, it has been our assumption that preventing HIV transmission is a positive outcome that is valued by our society in its own right. We believe that NEPs offer a win–win situation for all members of society and that they produce an efficient use of resources that we cannot afford to ignore.

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Table 4: Impact of needle exchange program over 5 years on cost savings if HIV incidence rate is higher without a needle exchange program (alternative 1) or number of injection drug users (IDUs) using the program increased (alternative 2)

	Assumptions				Impact	
Case	No. of IDUs using program	Baseline HIV prevalence, %	HIV incidence with program, %	HIV incidence without program, %	No. of HIV cases prevented	Cost savings to cost ratio
Baseline	275*	3‡	2§	4‖	24	4:1
Alternative 1	275	3	2	11¶	92	17:1
Alternative 2	550†	3	2	4	47	8:1

*Estimated by program staff.
†Derived from DeVillaer et al.[31]
‡Derived from Elnitsky et al.[16]
§Derived from Kaplan et al.[23]
‖Derived from Nelson et al.[20]
¶Derived from Metzger et al.[21]

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