



## The Cost of Inaction on HIV Transmission among Injection Drug Users and the Potential for Effective Interventions

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**ABSTRACT** *Estimated and potential medical costs of treating patients infected with human immunodeficiency virus (HIV) in urban areas of high HIV prevalence have not been well defined. We estimated the total medical cost of HIV disease among injection drug users in Vancouver, British Columbia, Canada, assuming stable and increasing HIV prevalence. Total medical costs were estimated by multiplying the average lifetime medical cost per person by the number of HIV-infected individuals. We assumed the cost of each HIV infection to be \$150,000 (Canadian), based on empirical data, and HIV prevalence estimates were derived from the Vancouver Injection Drug Users Study (VIDUS) and external data sources. By use of Monte Carlo simulation methodology, we performed sensitivity analyses to estimate total medical cost, assuming the HIV prevalence remained stable at 31% and under a scenario in which the prevalence rose to 50%. Expected medical expenditures based on current HIV prevalence levels were estimated as \$215,852,613. If prevalence rises to 50% as reported in other urban centers, the median estimated medical cost would be approximately \$348,935,865. This represents a difference in the total costs between the two scenarios of \$133,083,253. Health planners should consider that predicted medical expenditures related to the HIV epidemic among injection drug users in our setting may cost an estimated \$215,852,613. If funding cannot be found for appropriate prevention interventions and the prevalence rises to 50%, a further \$133,083,253 may be required.*

**KEYWORDS** AIDS, Cost, Health care, HIV, Injection drug use.

### INTRODUCTION

High utilization of certain medical services among injection drug users compared to non-injection drug users<sup>1-3</sup> contributes to higher overall health costs in this population.<sup>1,4</sup> Among injection drug users infected with human immunodeficiency virus (HIV), health costs may be further inflated because of longer hospital stays and frequent inpatient and emergency department visits compared to their HIV-negative counterparts.<sup>5-8</sup> These findings are of particular concern in urban areas, such as Vancouver, British Columbia, Canada, where HIV prevalence is high among injection drug users.<sup>9-11</sup>

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In Vancouver, the HIV epidemic emerged in the mid-1990s among injection drug users,<sup>12</sup> and currently, there is an estimated approximately 31% HIV prevalence.<sup>9,13</sup> In other urban centers with more mature epidemics, such as New York and Milan, Italy, HIV prevalence levels as high as 50% were reported among injection drug users.<sup>14,15</sup> Because estimates of health care costs because of HIV infection among injection drug users in urban areas of high HIV prevalence are not widely available, we examined anticipated costs of HIV infection in Vancouver's Downtown Eastside using recent cost estimates of HIV in Canada<sup>16,17</sup> and current HIV prevalence estimates in this neighborhood.<sup>9,13</sup> In addition, because HIV incidence in many urban areas, including Vancouver, remains unacceptably high<sup>9,18</sup> and because funding for prevention initiatives is commonly extremely limited, we also estimated hypothetical costs under a scenario in which HIV prevalence rises to 50% in our setting.<sup>14,15</sup>

## METHODS

We estimated the total medical cost of treating Downtown Eastside HIV-infected injection drug users using methods described previously.<sup>19–21</sup> Briefly, we established two scenarios from which to estimate total health care costs. In the first scenario, we estimated anticipated costs using the most recent data from the Vancouver Injection Drug Users Study (VIDUS), which has a 31% cumulative HIV prevalence.<sup>9</sup> In the second scenario, we estimated the medical cost if the HIV prevalence rises to 50% among injection drug users in the neighborhood.<sup>14,15</sup> In each scenario, total costs were determined by multiplying the average cost of treatment per person by the number of HIV-infected individuals.

We estimated the cost of HIV per patient based on previous studies that estimated an approximate \$150,000 median lifetime medical cost of each case of HIV infection.<sup>16,17</sup> The perspective of these studies was to examine societal costs,<sup>16</sup> and the reported estimates were based on medical billings, hospitalizations, and antiretroviral costs, including highly active antiretroviral therapy (HAART). Furthermore, the estimated costs accounted for varying transit times within each major CD4 cell count range, with costs increasing particularly during the last 2 years of life.<sup>17</sup> The study by Albert and Williams<sup>16</sup> further defined "pre-HAART" and "HAART" episodes to account for transit times specific to the HAART episode.

To incorporate the uncertainty surrounding costs per person and overall costs, we used Monte Carlo simulation methodology by varying the key model parameters as follows. Because in scenario 1 the actual number and HIV prevalence among injection drug users in the community was uncertain<sup>9</sup> and the HIV prevalence was hypothetical in scenario 2 and because the cost of HIV varies widely from patient to patient,<sup>16,17</sup> we allowed uncertainty around these estimates. For each Monte Carlo trial, 10,000 iterations were run, and for each iteration in a trial, a random number was generated for the cost per individual and the total number of individuals infected with HIV in the Downtown Eastside. Each random number conformed to this preset probability based on assigning a normal distribution around each point estimate (Table 1), which was used to describe the potential uncertainty in each model parameter. Therefore, although an unlikely value could be selected, the probability of this was markedly reduced based directly on the probability of a value falling outside the normal distribution.

Each model parameter in Table 1 was allowed to vary. A normal distribution was assumed in each case because we only had point estimates for the various

**TABLE 1. Model parameters, data sources, and values used in models**

Parameter	Source	Values used
Number of injection drug users	Refs. 17 and 22	4,700
HIV prevalence	VIDUS (Refs. 9 and 13), Ref. 15	31%,* 50%†
Cost	Refs. 16 and 17	\$150,000 Canadian

VIDUS, Vancouver Injection Drug Users Study.

\*Scenario 1.

†Scenario 2.

model parameters, and we had no evidence to suggest that earlier calculations were an over- or underestimate. We should note that we wished to consider overall lifetime costs, so the impact of community CD4 cell count levels was not directly considered in our models, although as noted above the total cost estimates we used to construct our models did account for disease stage in deriving the total cost estimates.

From these random values produced by the simulation, we arrived at estimates of total cost based under the scenarios of 31% and 50% HIV prevalence. We also derived 95% confidence limits for model estimates from the model simulations. All values are in Canadian dollars.

**RESULTS**

As shown in Table 2, under the scenario of 31% prevalence, which reflects the current prevalence of HIV among injection drug users in Vancouver’s Downtown Eastside,<sup>9,13</sup> we found that the median estimated cost for the 31% prevalence scenario was \$215,852,613 (95% confidence limits \$159,023,917 to \$285,448,992). This is the medical cost that health planners should anticipate under the scenario in which no further HIV infections occur among Downtown Eastside injection drug users.

We found a striking difference in the total cost predicted under the 50% HIV prevalence scenario. Specifically, if HIV prevalence was to rise to 50%, the median estimated cost estimated in scenario 2 would be \$348,935,865 (95% confidence limits \$264,876,928 to \$453,104,212). This represents a difference in the total costs between the two scenarios of \$133,083,253 and is the medical cost that health planners could anticipate if ongoing HIV incidence levels result in HIV prevalence observed in urban centers with more mature epidemics.<sup>14,15</sup>

**TABLE 2. Point estimates for cost (Canadian dollars) and 95% confidence intervals**

Scenario	Estimated cost	95% Confidence limits*
Scenario 1		
31% prevalence	\$215,852,613	\$159,023,917 to \$285,448,992
Scenario 2		
50% prevalence	\$348,935,865	\$264,876,928 to \$453,104,212

\*Confidence limits were derived from simulation results.

## INTERPRETATION

Our results indicated enormous medical expenditures will be required to treat the HIV epidemic among injection drug users in one Canadian urban setting. Furthermore, if ongoing HIV transmission leads to HIV prevalence levels observed in other settings,<sup>14,15</sup> an increase in prevalence to 50% would see a dramatic overall cost increase.

The present study demonstrated the substantial medical costs that can be expected in these areas given the number of HIV infections that have already occurred.<sup>9,18</sup> Furthermore, because HIV prevalence in many settings remains well below that of Vancouver,<sup>10,23,24</sup> our findings should indicate the substantial cost savings that could potentially accrue from effective prevention programs in these areas. Finally, even in settings with high HIV prevalence such as our own, our data suggested that reducing further HIV spread will substantially reduce medical expenditures.

A limitation of our study was that we examined total costs based on HIV-related illness alone, not accounting for other illnesses related to injection drug use. Previous studies have shown that hospitalizations among injection drug users in early-stage HIV disease are more likely caused by injection-related illnesses rather than HIV-related complications,<sup>25</sup> and that many injection drug users experience various injection-related illnesses, such as endocarditis and hepatitis, long before complications from AIDS (acquired immunodeficiency syndrome) arise.<sup>26</sup> Obviously, preventing these health-related complications would also be cost saving. Nevertheless, study results consistently pointed to the reality that HIV/AIDS-related complications contribute a significant portion of health care costs among injection drug users.<sup>5</sup> Alternatively, although the costs of HIV may be higher among injection drug users,<sup>27</sup> overall costs could be reduced in this population because of competing causes of death, such as overdoses. Although we entered uncertainty into our costing models, it is important to note that the costs are only estimates that could be affected by an increase in competing causes of death or other factors.

Although the costs suggested in scenario 1 will likely be a reality, it is also important to stress that the costs estimated under scenario 2 are hypothetical, and a cost savings of \$133,083,253 could accrue if effective prevention programs are put in place.<sup>28</sup> Although the increase in HIV prevalence to 50% may seem to be an extreme example in the present era, with the advent of life-extending antiretroviral therapy<sup>29</sup> and recent public policies that may be exacerbating the HIV situation in Vancouver,<sup>30,31</sup> our findings should be a caution to health policymakers.

Our data indicates that the total health care costs related to HIV will be extremely high given the current prevalence among injection drug users in Vancouver's Downtown Eastside, and that these costs would substantially increase if the prevalence was to rise to rates reported in other settings, such as New York.<sup>15</sup> Given these costs, it is likely that expanding effective interventions, such as addiction treatment, supervised injection facilities<sup>32</sup> and syringe exchange programs,<sup>33,34</sup> to reduce further spread of HIV would likely be highly cost effective.<sup>33,35</sup> This could in turn reduce the burden on health systems and prevent unnecessary human suffering.

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