

**Model-based cost-effectiveness and impact  
assessment of needle-syringe programs  
in Ontario, Canada  
from 2006–2015**

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## Background

In 1989 the first needle-syringe program (NSP) was implemented in Ontario, Canada. By 2006, the Ontario Harm Reduction Distribution Program (OHRDP) (1) was established, with governance from the province of Ontario's Hepatitis C Secretariat, Ministry of Health and Long-term Care. The Secretariat also provides funding, harm reduction supplies, and other resources to needle and syringe programs across Ontario. Moreover, in 2006 provincial recommendations for best practices for NSP were published (2). The OHRDP provides funding for 36 public health units and 180 satellite locations across Ontario to distribute sterile needles and syringes to people who inject drugs (PWID).

The Optima HIV model is an epidemic and economic model used to estimate the most cost-effective mix of investment in HIV programs for minimizing new HIV infections, AIDS-related deaths, and/or disability-adjusted life years (DALYs). Results from country and regional level modeling analyses have been used to assist governments, funders, and their partners to assess epidemic trends, the potential impact of various investment scenarios, and to optimize resource allocation (3).

## Objectives

This study aims to assess the cost-effectiveness of the Ontario needle-syringe programs with respect to potential reductions in new HIV infections among PWID between 2006 and 2015.

## Methods

Best practice evaluations require an intervention arm and a control arm which are as comparative as possible. The comparative control arm (regions, sites, groups of people) reflects a counterfactual of what is assumed to have occurred in the intervention arm (region, site, population groups) if they did not have access to the intervention. These arms are established to assess the effectiveness of an intervention program. Pragmatic evaluations use other available systems, data and methods to estimate effectiveness as best as possible when best-practice evaluations are not possible. Data were not available for the number of new HIV infections among PWID for comparable regions in Ontario among populations with implemented needle-syringe programs, compared with populations or regions without needle-syringe programs. NSP were not implemented for various reasons. Data were also unavailable for incidence measurement prior to NSP implementation and routine measurements following implementation.

Instead, self-reported changes in needle-syringe sharing among PWID either exposed or not exposed to needle-syringe programs were available and used in conjunction with a mathematical model to conduct the evaluation. The needle-syringe sharing rate is defined as the proportion of PWID who report receptively sharing a needle and/or syringe at last injection, meaning that the same used, non-sterile needle or syringe are shared between injecting drug users. While, using self-reported needle-syringe sharing data to inform the model is much less robust than using epidemiological estimates, this was the only feasible approach given data availability.

### **Data collection**

Population size, HIV prevalence, HIV testing, antiretroviral therapy (ART) coverage, and injecting behavior data and estimates for PWID in Ontario from 2006 to 2015, were compiled from various sources. Ontario HIV prevalence rates were estimated from HIV/AIDS in Ontario surveillance reports dating to 2009 (4-7), reported the modelled estimates of HIV prevalence between 2006 and 2009. The latest estimated HIV prevalence for 2012 was obtained from 2016 Global AIDS Response Progress Report (8). Ontario population size among PWID were estimated from Ontario HIV/AIDS surveillance reports (4-7) and population census data by multiplying the adult population aged 15 years and older in Ontario (9-11) by the national reported estimate of overall Canadian population aged 15 years and older who inject drugs (12). HIV testing over the last 12 months in Ontario were obtained from 2009 OHRDP Final Evaluation report (13) and country progress reports (14-16). The

number of PWID who receiving antiretroviral therapy (ART) were estimated based on the reported data from Ontario HIV Treatment Network Cohort Study (17), by factoring in the proportion of HIV-positive people whose infection was attributable to injection drug use remain undiagnosed (18). Lifetime costs per HIV infection in Canada and ART unit cost in Ontario were obtained from the scientific literature (19, 20). Expenditures of NSP were obtained from actual costs submitted by eight NSP sites (refer to Table S1). All estimated costs are reported in 2016 Canadian dollars using the corresponding consumer price indices (CPI) (21).

### Needle-syringe sharing rates

Needle-syringe sharing rates among PWID in Ontario from 2006 to 2015, as well as information about relevant sharing indicators from 2009 OHRDP Final Evaluation report (13) and country reports are shown in Table 1; these data were plotted with an exponential curve fit and 95% confidence intervals as shown in figure 1. There has been a considerable decline in reported rates of needle and syringe sharing, from 31.7% (95% Confidence Interval (CI) 17.1–51.2%) to 2.1% (95% CI 0.2–7.1%) over the study time period. This decline could be attributed to increased coverage of effective needle-syringe programs; however, it could also be a result of increased HIV knowledge and changes to risk behavior independent of NSP. Self-reported needle-syringe sharing may also be underreported for reasons of social desirability bias or other sources of bias (sampling, etc.). Since it is possible that increased knowledge among the PWID community of how HIV is transmitted, as well as certain socio-cultural factors led to a natural decline in rates of needle-syringe sharing, it cannot be assumed that NSP implementation is solely responsible for the reported decline. We have made adjustments to account for the underlying trends.

**Table 1: Percentage of PWID who receptively shared a needle/syringe at last injection in Ontario, 2006-2015**

Year	Data value	Sample size	Reference
2006	32.3%	3,031	2008 UNGASS Country Progress Report <sup>1</sup> (22)
2007	19.0%	1,618	2009 OHRDP Final Outcome Evaluation <sup>2</sup> (13)
2008	15.9%	1,642	2009 OHRDP Final Outcome Evaluation <sup>3</sup> (13)
2008	25.6%	3,031	2010 UNGASS Country Progress Report <sup>4</sup> (14)
2010	3.2%	Not available	2012 UNGASS Country Progress Report <sup>5</sup> (15)
2012	5.7%	2,663	2014 Global AIDS Response Progress Report <sup>6</sup> (16)

<sup>1</sup>Indicator reported as 67.7% of PWIDs reporting injecting without used equipment in the previous 6 months from the I-Track Phase 1 (2003-2005) report.

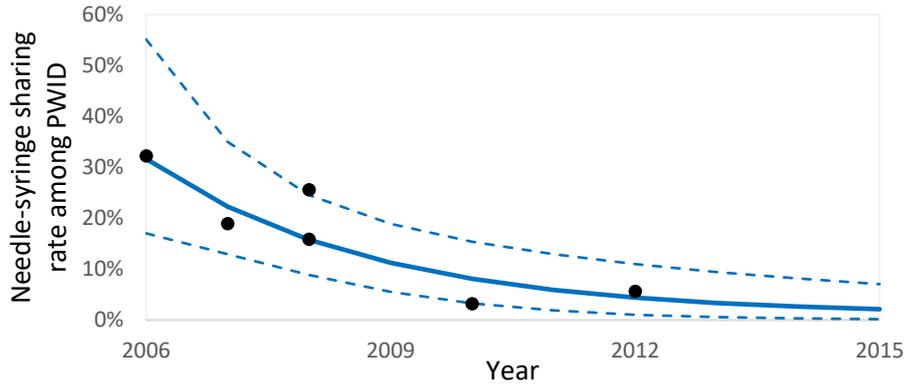
<sup>2</sup>Baseline interviews reported that 19% of PWID injecting with previously-used needles in the six months prior to interview, prior to implementation of needle-syringe programs, conducted in 26 sites representing 27 Public Health Units in Ontario between September 2006 and August 2007.

<sup>3</sup>Indicator reported as 74.4% of PWID reported not using needles that had already been used by someone else from the unpublished data in the I-Track Phase 2 (2006-2008) report.

<sup>4</sup>Final interviews reported that 15.9% of PWID injecting with previously-used needles in the six months, after implementation of needle-syringe programs, conducted in 26 sites representing 27 Public Health Units in Ontario between May 2007 and May 2008.

<sup>5</sup>Indicator reported as 96.8% of PWID reported using sterile injecting equipment the last time they injected from the unpublished data in the I-Track Phase 3 (2010-2011) report.

<sup>6</sup>Indicator reported as 94.3% of PWID reported using sterile injecting equipment the last time they injected from the I-Track Phase 3 (2010-2012) report.



**Figure 1: Needle-syringe sharing rate (solid line) with 95% confidence interval (dashed lines) among PWID in Ontario, 2006–2015**

The needle-syringe sharing rate is represented as the average sharing rate (derived from the best-fit sigmoidal curve of needle-syringe sharing data) weighted by proportion of PWID covered or not covered by NSP over time. This is expressed mathematically as:

$$S(t) = p_C(t)S_C(t) + p_{NC}(t)S_{NC}(t)$$

where

$S(t)$  = average sharing rate among PWID at time ( $t$ )

$S_C(t)$  = sharing rate among PWID covered by NSP at time ( $t$ )

$S_{NC}(t)$  = sharing rate among PWID not covered by NSP at time ( $t$ )

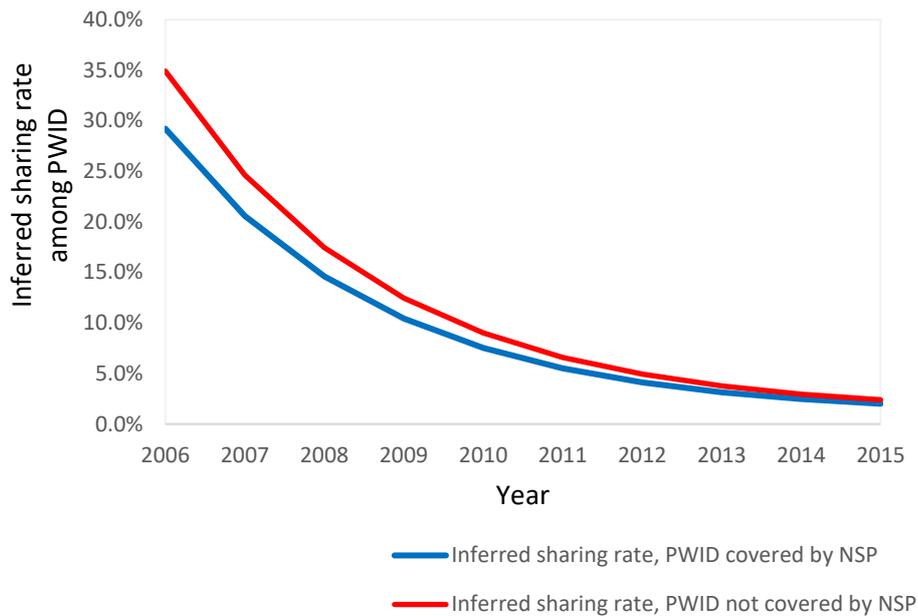
$p_C(t)$  = proportion of PWID covered by NSP at time ( $t$ )

$p_{NC}(t)$  = proportion of PWID not covered by NSP at time ( $t$ ).

As such, the average sharing rate,  $S(t)$ , was adjusted to account for any natural decreasing trend in sharing and for the impact of anticipated increases in NSP coverage over time. We assumed a natural decline in sharing to have been the same between PWID with access to NSP and those with no access, expressed mathematically,  $\frac{S_{NC}(t)}{S_C(t)} = k$ , as a constant with a value of 1.19.

Using the equation above, we incorporated measures of sharing rates among PWID covered or not covered by NSP, as well as the proportion of PWID covered by NSP to mathematically infer the trend of needle-syringe sharing over time using R software. For example, for 2006, there were 41,820 PWID with 57% PWID covered by NSP and 43% not covered, the calculated sharing rate was 32% (17%–55%).

The Ontario Harm Reduction Distribution Program report (13) provided the following sharing rate values: 19.0% of PWID not covered by NSP receptively shared a needle or syringe at their last injection compared with 15.9% for those covered by NSP. Using this data, and sharing rates noted in Table 1, as well as output from the weighted average sharing rate equation, we estimated how these rates would have changed over time as shown in figure 2.



**Figure 2: Inferred sharing rates among PWID covered or not covered by needle-syringe programs in Ontario, 2006–2015**

The curves for inferred sharing rate for PWID covered and not covered by NSP converge over the period from 2006 to 2015 given increased education programs and awareness, as 94.5% of people who inject drugs used sterile injecting equipment at last infection.

**NSP expenditure and program coverage data**

NSP spending and coverage data were collected from eight sites across Ontario, namely Hamilton, Kenora, London, Oshawa, Ottawa, Timmins, Toronto, and Woodstock. All spending and cost data are CPI-adjusted and reported in 2016 Canadian dollars.

*NSP spending, 2006–2015:* \$44,457,149 (\$47,680,619 CPI-adjusted) was spent on NSPs in Ontario.

*NSP unit cost, 2015:* for eight public health units (Hamilton, Kenora, London, Oshawa, Timmins, Toronto, and Woodstock) a total of \$6,647,921 (\$6,738,044 CPI-adjusted) was spent on needle-syringe exchange programs to cover 23,790 PWID, with a resulting unit cost of \$279, CPI-adjusted to \$283. This included service costs in accordance with the 2006 Ontario Needle Exchange Programs: Best Practice Recommendations report (2) (see table S1 for a description of included costs).

*NSP coverage:* a comprehensive provincial NSP services coverage value of 62% of PWID in Ontario was only available for 2011.

**Model calibration**

The Optima HIV model was calibrated to reflect the HIV epidemiology and injecting risk behavior among PWID in Ontario informed by data and estimates over the 2006 to 2015 study period, used to conduct a model-based estimation of the cost-effectiveness of NSP implementation in Ontario over this period (Figure S1). The model was first automatically calibrated using a Markov chain Monte Carlo (MCMC) algorithm. With this algorithm, the model is run 1,000–10,000 times to generate a range of epidemic projections; with differences representing uncertainty in the expected epidemiological trajectories. The resulting calibration was then manually adjusted using primarily the initial HIV prevalence, injection-related transmissibility, and force of infection parameters. It was

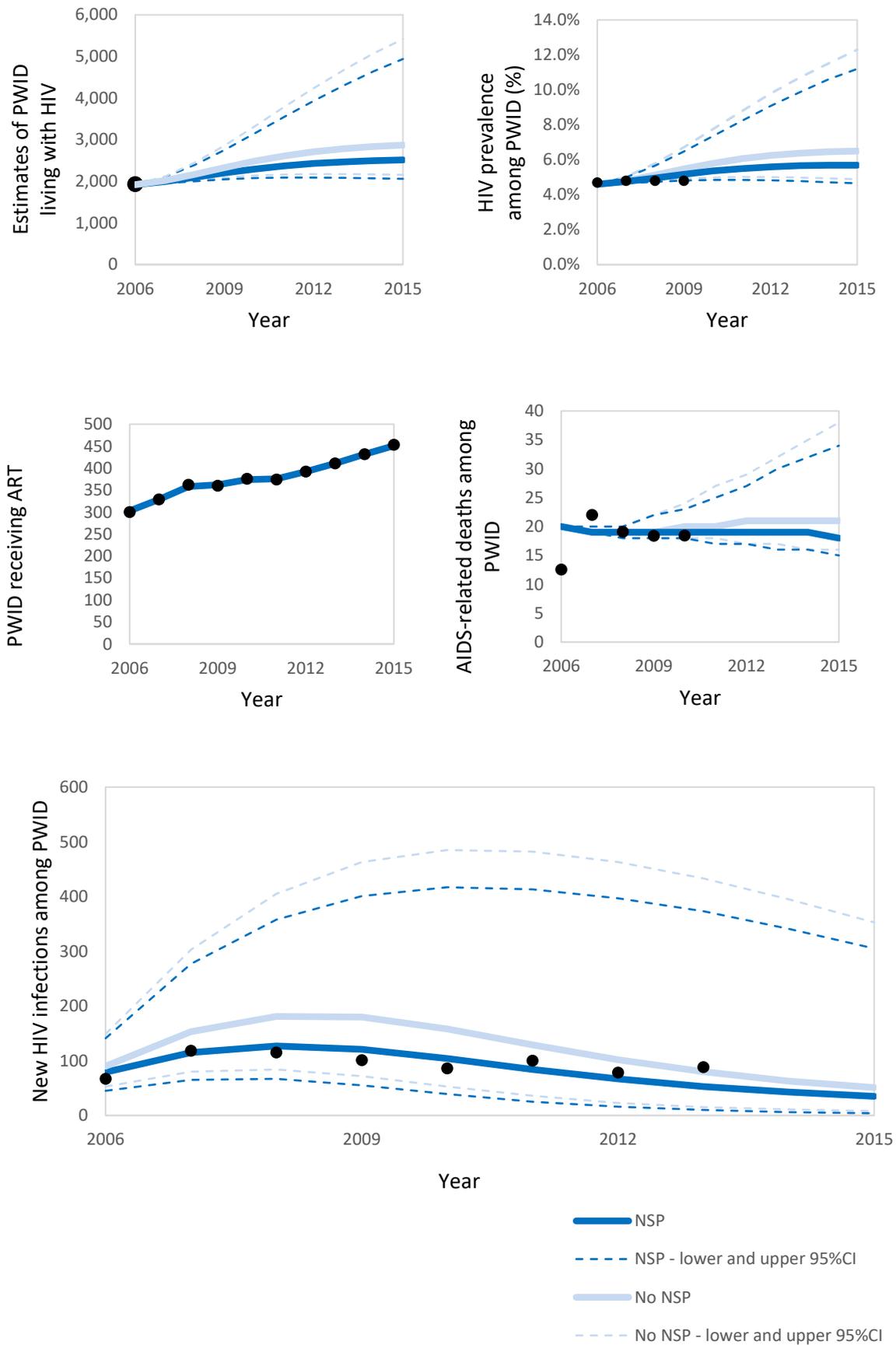
decided to put less weight on certain data values which did not follow a clear trend, e.g. AIDS-related deaths. Otherwise, the calibration curves are well matched to data values.

### **Scenario analysis**

We compared model output from:

- (A) A baseline scenario informed with needle-syringe sharing rates among PWID from Ontario from 2006 to 2015 calibrated to the observed HIV epidemic in this population reflective of the actual provincial NSP implementation; with
- (B) A counterfactual scenario modelled to reflect a setting with no harm reduction; i.e. assumed sharing rates among PWID are represented by inferred rates among PWIDs not covered by NSP (Figure 2), but still accounting for the likely natural decline in needle-syringe sharing risk due to factors independent of NSP implementation.

The Optima model was used to simulate the expected epidemiological impact among PWIDs as well as financial implications associated with a 'what if' scenario if needle-syringe programs had not been implemented in Ontario (3) between 2006 and 2015. This was compared to the calibrated model-simulated current 'baseline' scenario in the same population, location, and time period. We estimated the HIV epidemic trajectory and health outcomes among PWID in Ontario, including the number of new HIV infections and AIDS-related deaths for the two scenarios over this time-period (Figure 3).



**Figure 3: Modelled outcomes for scenarios with and without needle-syringe program implementation in Ontario, 2006–2015**

## Results and key messages

The key messages for this model simulation comparing (a) a baseline scenario, representing the outcome from the actual needle-syringe program implementation in Ontario between 2006 and 2015, and (b) a counterfactual scenario, simulating a setting with no harm reduction from NSP implementation over the same period, are as follows:

### **1. Over 350 new HIV infections and 350 DALYs were estimated to have been averted due to implementation of needle-syringe programs in Ontario from 2006 to 2015.**

#### *New HIV infections averted*

From the counterfactual scenario that simulated a scenario where NSP would not have been implemented in Ontario between 2006 and 2015, it was estimated that there would have been 1,187 (435–3,931) new HIV infections among PWID. Compared with the actual implementation of needle-syringe programs resulting in an estimated 828 (332–3,423) new HIV infections, we estimated that 359 (103–530, with upper limit values adjusted for 2006–2008) new HIV infections were averted among PWID due to implementation of needle-syringe programs in Ontario over this period.

#### *DALYs averted*

Over the 2006 and 2015 period, it was estimated that 358 (113–371) disability-adjusted life years (DALYs) were averted among PWID due to NSP implementation in Ontario.

### **2. Estimated CPI-adjusted cost per infection averted was \$132,815, with a cost of \$133,186 per DALY averted considering the benefits attained to the end of 2015.**

From available spending data, \$44,457,149 (\$47,680,619 CPI-adjusted) was invested in NSP in Ontario from 2006 to 2015 (Table S1). With an estimated 359 (103–530) new HIV infections averted among PWID due to implementation of needle-syringe programs in Ontario over this period, the estimated cost per infection averted was \$132,815 (\$89,963–\$462,919) using CPI-adjusted NSP spending divided by new infections averted.

With an estimated 358 (113–371) DALYs averted, this is equivalent to an estimated \$133,186 (\$128,519–\$421,952) per DALY averted using CPI-adjusted NSP spending divided by DALYs averted.

### **3. Estimated ART costs saved by averting the over 350 new infections through NSP over the 2006 to 2015 study period was \$6.2 million.**

Using a conservative approach, we estimated that approximately \$6,176,954 (\$1,772,218–\$9,119,180) would have been spent on ART if 359 (103–530) new HIV infections were not averted by NSP implementation from 2006 to 2015. That is, it was estimated that as a result of implementing needle-syringe programs, \$6.2 million was saved on healthcare treatment expenditure for HIV. This estimation is generated as informed by the following indicators and assumptions (Table S2):

- a. average time from infection to diagnosis was 5 years for 2006 through 2009 and 4 years for 2010 through 2015 (23),
- b. average CD4 counts at diagnosis (24) was 317 for 2006 and 2007 and 350 thereafter,
- c. assuming adoption of broader ART eligibility in Ontario with eligibility for CD4 counts equal to or less than 200 from 2006 through 2009, equal to or less than 350 from 2010 through 2012, equal to or less than 500 for 2013 and 2014, and treatment for all regardless of CD4 count for 2015 (25-27),
- d. average length of time to initiate ART once diagnosed with HIV of 2 additional years from 2006 through 2009, and no additional years to initiate ART once diagnosed from 2010 (28), and

- e. applying the 2014 annual ART unit cost of \$17,206 adjusted for 2016 CPI (\$16,800 with no CPI-adjustment) (20) for all years in study.

#### **4. Needle-syringe programs may not have been cost-effective in the short-term.**

Since \$44.5 million (\$47.7 with CPI-adjustment) was spent on NSP in Ontario from 2006 to 2015 (table S1), but only \$6.2 million was saved in ART costs (table S2), the difference in costs not recovered over this period is \$38.3 million. Therefore, the net cost per infection averted (with 359 (103–530) total new HIV infections averted) was estimated at \$106,630 (\$72,227–\$371,652) and the net cost per DALY averted (with 358 (113–371) total DALYs averted) was \$106,928 (\$103,181–\$338,763).

It is for the funders of the needle-syringe programs in Ontario, namely Ontario’s Hepatitis C Secretariat, Ministry of Health and Long-term Care, and their community partners, to assess whether this is considered good value for money. These costs are higher than thresholds for funding of other healthcare programs with short-term benefits.

#### **5. When considering the lifetime benefits of NSP operating during 2006 to 2015, the programs may become cost-saving.**

If PWID for which HIV infections were averted through implementation of NSPs remain infection-free, then the lifetime ART costs averted would be \$550 million (\$156 million–\$824 million. This far exceeds the \$44.5 million invested in NSP over this period. That is, the past investment will be considered to have reaped savings in healthcare expenditure in the future, which were not required to be spent due to HIV infections averted. It is estimated that the investment in NSP during the period from 2006 to 2015 would have returned the investment in HIV healthcare savings by year 2008. When considering lifetime benefits, the programs are estimated to yield a return on investment of \$11.54 (\$3.26–\$17.28 (undiscounted) or \$3.69 (\$1.11–\$6.19) (with 5% discounting) for every \$1 invested in addition to returning the invested \$1 (table S3).

#### **6. Needle-syringe programs in Ontario are cost-effective long-term compared to lifetime ART costs, over \$550 million will be saved in lifetime costs**

A study by Ouellet et al reported an undiscounted lifetime cost per HIV infection ranging from \$1,439,984–\$1,482,502, (\$1,532,376 median of range (\$1,510,082–\$1,554,670) CPI-adjusted) or \$448,901–\$485,806 (\$490,104 (\$470,753–\$509,455) CPI-adjusted) with 5% discounting (19). The estimated lifetime cost of the 359 (103–530) new HIV infections averted by NSP implementation from 2006 to 2015 was estimated at \$550,123,025 (\$115,538,470–\$823,975,100) or \$175,947,410 (\$48,487,604–\$270,011,134) with 5% discounting (Table S3).

Overall lifetime cost averted for 359 (103–530) new HIV infections prevented from needle-syringe program implementation from 2006 through 2015 was estimated at \$550.1 million minus the \$44.5 million spent on NSP over this period, with a projected lifetime savings of \$505.7 million.

Therefore, approximately \$500 million will be saved over the lifetime of these over 350 new HIV infections averted among PWIDs due to NSP implementation in Ontario between 2006 and 2015. Evidence to support these finding was previously stated in the 2006 Ontario needle exchange programs: Best practice recommendations report (2), “The lifetime costs of providing treatment for IDUs living with HIV greatly exceeds the costs of providing NEP services.”

Of note, while many studies have shown that ART is cost-effective for prolonging life, there is only weakly supportive, though growing evidence, of the additional cost-effectiveness of ART to prevent HIV transmission among PWID (29). Therefore, needle-syringe programs, which have shown to be effective in preventing HIV transmission among PWID, and have shown to be cost-effective in the

long-term, should be maintained as key programs for HIV prevention among PWID. A recent study from British Columbia published in the *Lancet* demonstrated that the combined effect of ART and needle-syringe programs contributed to a decline in HIV incidence (30). Importantly, the BC study showed that NSPs had the greatest contribution to reducing the incidence of HIV among PWID.

## Study assumptions and limitations

Assumptions for this study include using evidence from surveillance reports, clinical and research studies, and in some cases expert opinion. These assumptions were used to inform the model. HIV prevalence values among PWID used were reported surveillance estimates and may not be reflective of actual prevalence. The rate of injection per person over time was assumed to be constant. Data used to inform this study were based on non-random sampling or sampling of convenience and case notifications, as well as self-reported values (i.e. PWID who may visit the NSP clinic or mobile unit on more than one occasion, who may not be representative of the overall PWID population). Across needle-syringe programs from various public health units, definition may vary and change over time, for example for needle sharing equipment and their costs (e.g. tourniquets may or may not be included), as well, for current PWID versus former PWID (e.g. active drug injection over the last 12 months). We assumed all public health units used the same definitions. In some instances, the definition for HIV treatment initiation was based, on definitions from US guidelines (31). Reduction in the rate of needle-syringe sharing due to opiate substitution therapy was not evaluated. The study was conducted at the provincial level for NSP targeting PWID in Ontario and should not be directly compared with similar studies conducted at the national level (32).

Study limitations include limitations in data availability and reliability, which can lead to uncertainty surrounding projected results. Handling of uncertainty is described in the Methods section above. This may not account for systematic uncertainties, for example, small sample sizes for PWID (e.g. from the Ontario HIV Treatment Network Cohort Study), which may lead to uncertainty of evaluation results. There were instances whereby weighed averages across cities with larger populations in Ontario were used in lieu of sampling, for example for more rural areas. We did not measure the impact on hepatitis C virus (HCV) transmission, as this would require development and application of an HIV/HCV co-infection model and outside the scope of resources for this study. HCV is the major blood-borne viral burden to PWID. As such, even greater epidemiological impact is expected to have been achieved for HCV in Ontario than HIV. There could only be additional economic savings from NSPs through additional benefits, such as reducing HCV burden (and of course the primary social and judicial benefits). The extent of additional economic savings are less clear than those related to HIV.

## Conclusion

In Ontario, it was estimated that implementation of needle-syringe programs between 2006 and 2015 resulted in around 350 fewer new HIV infections among people who inject drugs. However, needle-syringe programs may not yet have produced their public health value from an economic perspective, but the lifetime cost to provide ART for PWIDs is far greater than the cost of NSP services and thus these programs are considered vitally important to reducing HIV incidence in this population and yield economic value if one considers longer time horizons.

The assent of Bill C-37: An Act to amend the Controlled Drugs and Substances Act and to make related amendments to other Acts is encouraging such that health and law enforcement officials are better equipped to reduce the harms associated with drug and substance use in Canada (33).

The authors wish to emphasize that caution be taken when interpreting results from this modelling analysis, as the model was informed with behavioral data on needle-syringe sharing with limitations in data completeness and availability, as well as assumptions made particularly around sharing rates in the hypothetical circumstance that the programs had not been implemented.

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## Supplementary materials

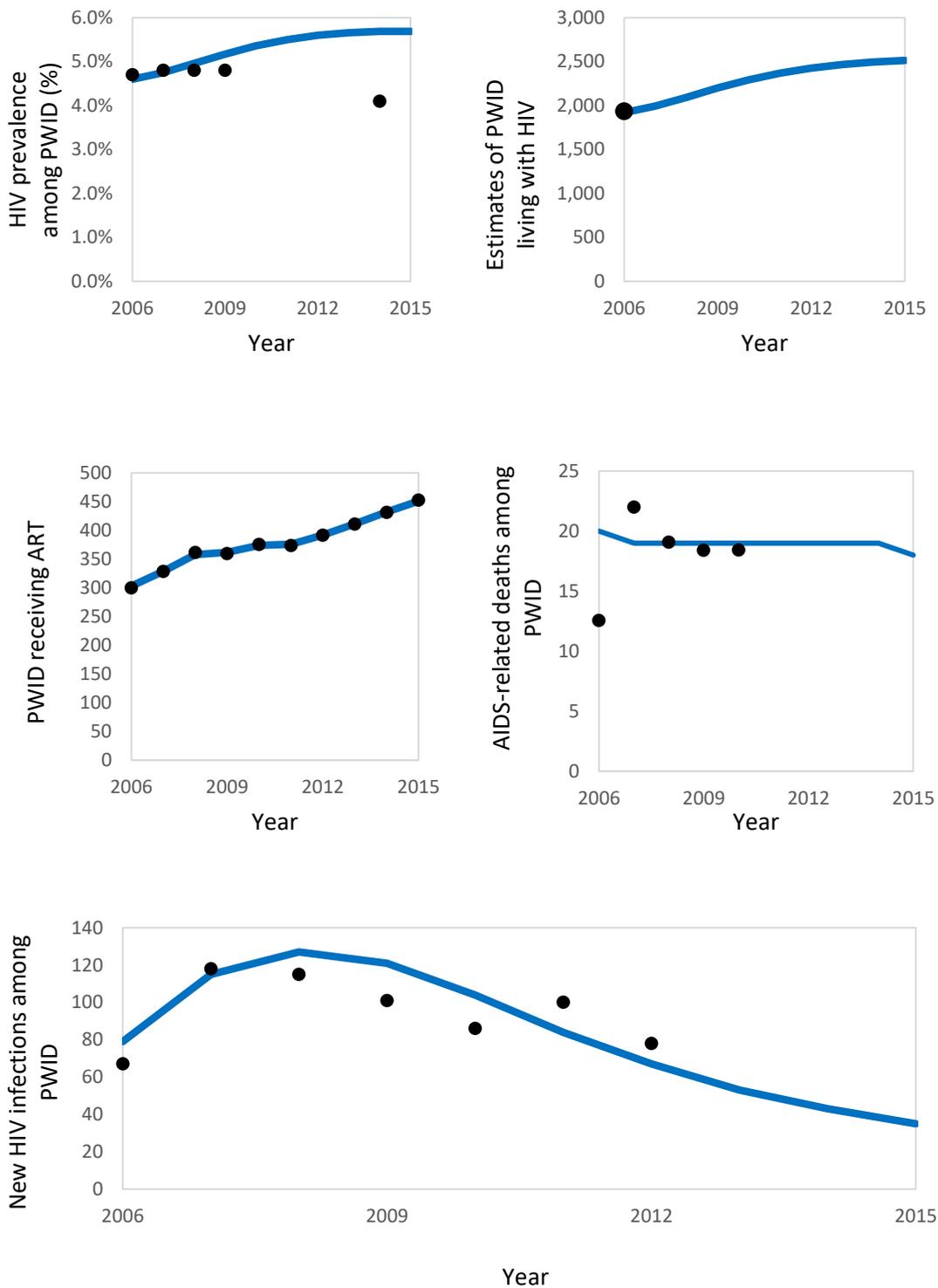


Figure S1: Model calibration for the Ontario needle-syringe program scenario analysis, 2006–2015

**Table S1: Spending on needle-syringe programs in Ontario\*, 2006–2015**

Year	Hamilton	Kenora	London	Oshawa	Ottawa	Timmins	Toronto	Woodstock	Total spending on NSP in Ontario, unadjusted for CPI	Total spending on NSP in Ontario, adjusted for 2016 CPI
2006	\$17,934	\$4,325	\$21,674	\$13,578	\$616,220	\$1,478	\$1,629,248	\$884	\$2,305,341	\$2,713,045
2007	\$19,012	\$7,772	\$246,329	\$34,747	\$842,828	\$2,262	\$1,747,660	\$3,938	\$2,904,548	\$3,349,982
2008	\$35,264	\$9,911	\$406,344	\$20,937	\$838,403	\$421	\$1,992,769	\$4,836	\$3,308,884	\$3,748,299
2009	\$388,855	\$18,116	\$512,609	\$60,070	\$906,148	\$1,821	\$2,106,540	\$28,777	\$4,022,936	\$4,493,103
2010	\$426,013	\$30,347	\$548,666	\$48,692	\$977,022	\$3,946	\$2,515,416	\$37,993	\$4,588,095	\$5,044,523
2011	\$499,448	\$19,595	\$580,395	\$42,770	\$1,230,465	\$3,010	\$2,134,499	\$43,188	\$4,553,370	\$4,900,367
2012	\$464,495	\$64,820	\$595,826	\$54,467	\$1,080,246	\$6,820	\$2,224,977	\$61,103	\$4,552,753	\$4,774,380
2013	\$616,959	\$279,564	\$783,199	\$110,453	\$1,164,078	\$22,585	\$2,537,546	\$116,518	\$5,630,903	\$5,832,826
2014	\$646,725	\$389,702	\$884,367	\$110,301	\$1,302,965	\$32,032	\$2,452,424	\$123,882	\$5,942,398	\$6,086,050
2015	\$796,113	\$312,115	\$893,890	\$417,371	\$1,380,512	\$35,933	\$2,631,433	\$180,555	\$6,647,921	\$6,738,044
<b>Total</b>									<b>\$44,457,149</b>	<b>\$47,680,619</b>

\*Spending includes costs associated with needle-syringe programs incorporating mobile and satellite unit costs .Specifically this includes: equipment costs (needles, syringes, sharps collection and disposal costs, etc.), human resources specifically for NSP (nurses, counsellors, outreach workers, management and clerical staff, excluding human resources for sexual health programs), administrative costs (office supplies, overhead, and other program costs (supplies for safer crack use, nursing supplies, maintenance of staff vehicles, costs associated with conference travel, and medications).

**Table S2: ART costs saved from new HIV infections averted among PWID through implementation of NSP in Ontario, 2006–2015**

Year	Average number of years from infection to diagnosis (23)	Average CD4 count at diagnosis (24)	ART eligibility by CD4 count (25-27)	Additional year(s) for CD4 counts to decrease to be eligible for ART (34)	Lag (years) between becoming eligible for ART and initiating ART (28)	Estimated number of new HIV infections averted from NSP implementation, estimate (lower-upper limit)	ART costs saved from averted infections due to NSP, estimate (lower-upper limit)
2006	5	317	≤200	2	2	11 (8–11**)	\$189,226 (\$137,648–\$189,266)
2007	5	317	≤200	2	2	38 (15–38**)	\$653,828 (\$258,090–\$653,828)
2008	5	350	≤200	2	2	54 (17–54**)	\$929,124 (\$292,502–\$929,124)
2009	5	350	≤200	2	2	59 (17–62)	\$1,015,154 (\$292,502–\$1,066,772)
2010	4	350	≤350	0	2	54 (11–68)	\$929,124 (\$189,266–\$1,170,008)
2011	4	350	≤350	0	2	45 (14–69)	\$774,270 (\$240,884–\$1,187,214)
2012	4	350	≤350	0	2	35 (7–66)	\$602,210 (\$120,442–\$1,135,596)
2013	4	350	≤500	0	2	27 (5–60)	\$464,562 (\$86,030–\$1,032,360)
2014	4	350	≤500	0	2	20 (5–54)	\$344,120 (\$86,030–\$929,124)
2015	4	350	Treatment for all	0	2	16 (4–48)*	\$275,296 (\$68,824–\$825,888)
Total						359 (103–530)	\$6,176,954 (\$1,772,218–\$9,119,180)

\*For example for 2015, the numbers of new HIV infections averted from NSP implementation derived from curves plotted in figure 3 with estimate value (value for without NSP implemented minus value for with NSP implemented), similarly for limit values using lower and upper 95%CI.

\*\*As upper limit was less than estimate value, upper limit value was revised to estimate value.

**Table S3: Lifetime costs and savings surrounding NSP in Ontario, 2006–2015 (2016 CPI-adjusted)**

	Undiscounted (upper-lower limit)	Discounted at 3% (upper-lower limit)	Discounted at 5% (upper-lower limit)
Lifetime cost per HIV new infection (35)	\$1,532,376* (\$1,510,082–\$1,554,670)	\$709,102 (\$694,535–\$723,668)	\$490,104 (\$470,753–\$509,455)
Lifetime cost for new HIV infections, 2006–2015	\$550,123,025 (\$155,538,470–\$823,975,100)	\$254,567,473 (\$71,537,149–\$383,543,913)	\$175,947,410 (\$48,487,604–\$270,011,134)
Lifetime savings from NSP	\$502,442,406 (\$107,857,851–\$776,294,481)	\$206,886,854 (\$23,856,530–\$335,863,294)	\$128,266,791 (\$4,888,733–\$226,412,263)
Lifetime savings from NSP implementation per new infection averted	\$1,399,561 (\$1,074,164–\$1,464,707)	\$576,287 (\$231,617–\$633,704)	\$357,289 (\$47,463–\$427,193)
Return on investment (ROI): lifetime cost of all infections averted/NSP spending, 2006-2015	\$11.54 (\$3.26–\$17.28)	\$5.34 (\$1.50–\$8.04)	\$3.69 (\$1.11–\$6.19)
Lifetime savings from NSP implementation per DALY averted	\$1,403,470 (\$954,494–\$2,092,438)	\$577,896 (\$211,120–\$905,292)	\$358,287 (\$43,263–\$610,276)

\*Estimate value is the median of the lower and upper limit values reported by Ouellet et al. (35) with CPI-adjustment