Return on investment of needle-syringe programs in the Philippines

David P. Wilson, Josephine Reyes, Cliff C. Kerr, Richard T. Gray

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The Kirby Institute, University of New South Wales, Sydney Australia

Introduction

The HIV epidemic in the Philippines

The Philippines is one of nine countries in the world documented by UNAIDS with increasing HIV cases. The UNAIDS Report on the Global AIDS epidemic 2010 reported a 25% increase of HIV cases between 2001 and 2009. While the national HIV prevalence remains below 0.1% of the adult population, HIV prevalence among the most-at-risk populations (MARPs) has substantially increased from 0.08% in 2007 to 0.47% in 2009. The primary drivers for the increase in HIV cases are unprotected sexual intercourse between men having sex with men (MSM), needle sharing among injecting drug users (IDUs), followed by unprotected sex with female sex workers (FSWs).

HIV among IDUs in the Philippines

The most alarming trend of HIV infections has been among IDUs – from seven reported cases during 1984-2006 to 147 reported cases for 2010 alone. In Cebu, HIV prevalence among IDUs has increased from 0.59% (n=341) in 2009 [1] to 53.16% (n=301) in 2011 [2]. This trend could continue to grow, as seen in other parts of the world [3], if not checked in time with effective interventions. The HIV epidemics in the Philippines are predominantly urban in distribution, severely affecting such major urban hubs as Metro Manila and Metro Cebu. This is likely due to the fact that risk behaviors are more prevalent in urban areas (due to larger networks of sexual partners), and drugs more widely available. In Metro Manila, there are an estimated 1,252 IDUs (about 7.5% of the national total for IDUs). In Metro Cebu, there is an estimated 6,000 IDUs.

Needle-syringe programs

Needle-syringe programs (NSPs) are a public health measure designed to reduce the spread of HIV infections among IDUs. NSPs operate in many different modes in different contexts and they may provide a range of services that include the provision of injecting equipment, education and information on reduction of drug-related harms, referral to drug treatment, medical care and legal and social services [4]. Equipment provided by NSPs usually includes needle-syringes, swabs, sterile water, and sharps bins for the safe disposal of injecting equipment.NSPsmay also act as a pivotal entry point for drug treatment and rehabilitation[5].

The primary aim of NSPs is to prevent the shared use of injecting equipment in order to reduce the risk of acquiring blood-borne infections among IDUs. Sharing of syringes by IDUs is an important mode of global transmission of blood-borne viruses, such as HIV and hepatitis C virus [6,7]. IDUs are unlikely to use another person's syringes if they have convenient access to sterile needle-syringes [8,9].

Evidence from 20 years of research shows that NSPs are a safe and effective means to reduce prevalence of HIV and other blood-borne infections among injecting drug users in some developed and developing country settings [10,11,12,13,14,15,16]. In a systematic review, 6 out of 11 studies found that NSPs were protective against HIV transmission [16,17,18,19,20,21]. There are large differences in HIV epidemics among IDUs between different international settings [3,6,7]. However, ecological studies suggest that where NSPs are not easily accessible, HIV prevalence tends to be substantially greater than in locations where NSPs are available [5,14,20,22,23,24,25,26,27]. Successful NSP interventions in some developing countries have been set up in some areas of Nepal[28], Thailand[29], Vietnam[30] and Bangladesh[12]. Implementation of NSPs were shown to be cost-effective in developed countries [31,32,33,34] and in at least one resource-poor setting [35].

Table 1. Effectiveness of NSPs.

Region	NSP implementation	Outcome indicator(s)
Asia-Pacific region		
Kathmandu, Nepal [28]	4 years, 127 IDUs (first NSP in Asia)	Prevalence decreased from 1.6% to 0%; Average injections decreased from 24 to 18 Shared needles per month decreased from ~13 to 6
Northern Thailand [29]	1 year, 25 IDUs	Prevalence decreased from 33% (5/15) to 32% (8/25) Only 1 new HIV case
Vietnam [30]	7 months, ~11,000 IDU contacts made	~21,000 syringes distributed, ~17,000 syringes collected (~81% syringe return rate)
Bangladesh [12]	1 year, ~600 male IDUs	Average proportion of shared injections in <u>NSP sites</u>: 28%; in <u>Non-NSP sites</u>: 56%; IDUs who share in <u>NSP sites</u>: 70%; in <u>Non-NSP sites</u>: 87%
Australia [36]	Late 1980s to 2000	25,000 HIV infections averted; 500 deaths averted
Other regions		
Amsterdam [37]	3 years, 263 IDUs (first NSP in the world)	Prevalence decreased from 50% to 24%; Borrowing used syringe decreased from 56% to 16% Lending used syringe decreased from 44% to 8%
South Sweden[17]	3 years, ~180 IDUs	Prevalence maintained at ~1% No new HIV cases Frequent sharing decreased from 40% to 18% Occasional sharing decreased from 8% to 1%
Connecticut, USA [18]	1 year, ~300 IDUs	Prevalence decreased from ~64% to ~49%; ~57% syringe return rate
New York, USA [19]	2 years, ~300 IDUs	**Prevalence:** <u>Users of NSP</u>: 1.6%; <u>Non-users of NSP</u>: 5.3%; **Incidence**: <u>Users of NSP</u>: ~1.5 person-yrs; <u>Non-users</u>: ~5.5person-yrs
Chicago, USA [21]	2 years; ~2,300-3,700 IDUs	**Prevalence** maintained at ~13% **RR ratio of HIV seroconversion**: • NSP users: 0.57; • reduction of injection frequency: 0.33; • not using previously used needles: 0.29; • cleaning of used needles: 3.7
Odessa, Ukraine [11]	1 year	HIV prevalence decreased from 54% to 53%; HIV incidence among IDUs decreased by 22%; 792 HIV infections averted
Multiple countries literature review (Global); Regression analysis [20]		Average prevalence <u>among cities with NSPs</u>: maintained at 15.7% Average prevalence <u>among cities without NSPs</u>: from 18.4% to 24.9%

NSPs in multi-component programs (combined with services such as outreach and education in risk reduction, distribution of condoms, and referrals to substance abuse treatment with reduction in drug-related risk behaviour) have been recommended for implementation where feasible because of consistent evidence associating these programs with reductions in risk behaviour consequently leading to reductions in HIV prevalence [38,39]. For example, reports from implementation of peer education coupled with NSPs in Vietnam and China on 2002-2003 show significant declines in drug-related risk behaviours and reductions in HIV prevalences among IDUs in Vietnam and China[40].

HIV prevention strategies specific to IDUs also include drug dependence treatment. Maintenance opiod substitution therapy (OST) is effective in controlling drug dependence that can help reduce the frequency of injection, therefore reducing the risk for HIV infection [38]. Further benefits include improved access and adherence to antiretroviral therapy (ART). To achieve at least low-level target of OST programmes (20%) in Cebu would need to reach at least 1,200 in Cebu or 4,000 in whole of the Philippines.

Harm reduction in the Philippines

To date, harm reduction programs for IDUs (namely, NSPs and opioid substitution therapy) have not been endorsed within the Philippines due to R.A. No. 8504 (the Philippines AIDS Prevention and Control Act of 1998)[41] and R.A. No. 9165 (the Comprehensive Dangerous Drugs Act of 2002)[42]. A 2004 report by the Philippines National AIDS Council estimated that only 48% of IDUs reported using sterile injecting equipment the last time they injected, and most IDUs reported that they regularly share injecting equipment. A 2008 report published by the Joint United Nations Programme on HIV/AIDS (UNAIDS) indicated that the prevalence of sharing injecting equipment is still very high, with 29% of IDUs self-reporting use of an unsterile needle/syringe the last time they injected. Sharing HIV-contaminated injecting equipment is an efficient mode of HIV transmission, with a 0.5% to 5% chance of transmission (see Table S1).

Reports on the success of implementation of NSPs in Thailand and Vietnam cite the importance of cooperation between government and nongovernment agencies as well as gaining local acceptance by key community people and law enforcement groups[29,30]. Despite protection under RA 8504, stigma and discrimination in various sectors (work, community, health services, etc.) against people living with HIV, including those who inject drugs, may be among the barriers that hinder effective implementation of HIV/AIDS interventions such as NSPs[43]. There is no evidence that NSPs can lead to more drug users, more frequent injection among established users, expanded networks of high-risk users or more discarded needles in community [38].

This study aims to assess the potential cost-effectiveness and return on investment of implementing NSPs in the Philippines. Specifically, assessments are conducted for Cebu city and nationally in the Philippines.

Methods

This study uses mathematical modeling informed by behavioral and epidemiological data from the Philippines and international observations in comparable settings of relative costs and influence of NSPs to evaluate the potential impact of NSPs in the Philippines. The evaluation includes two main analytical components. A *cost-effectiveness analysis* assesses the potential impact of scenarios of increased coverage of needle-syringe distribution for HIV prevention among IDUs. Cost-effectiveness analysis involves estimation of the cost and the expected effect. The effect is estimated through a modeling approach coupled with assumptions on the relative reduction in average levels of receptive syringe sharing that are caused by increased coverage and intensity of NSPs among IDUs. A population-level feedback model is used to examine the medium-term impacts, including prevention of secondary transmissions, which may occur as a result of short-term interventions. An incremental cost-effectiveness ratio (cost per quality adjusted life year gained) of NSP coverage levels compared to the status quo of no NSPs is calculated. Economic benefits considered are the amount of disability years averted as well as health care costs (based on Table 2) saved. The second model component is a *return-on-investment analysis*. This component builds upon the results of the cost-effectiveness analysis to assess the economic rationale to finance this strategy in allocating sufficient resources to address the epidemic at the most appropriate scale and ascertain the long-term economic benefits of investment in prevention.

<u>Key assumptions</u>

What is the potential impact of distributing needle-syringes to IDUs on their risk behaviors?

In most settings there is little-to-no evidence that the existence or degree of implementation of NSPs affect the number of people who inject drugs or the frequency at which they inject (see Table 1). It is assumed that needle-syringe distribution by NSPs would affect the frequency at which IDUs share injecting equipment. A review of available data from countries in the region where NSPs have been implemented resulted in the following data relationship; there is clearly a decreasing association of extent of sharing of injecting equipment as the number of needle-syringes distributed increases.

The effect of number of needle-syringes (ns) distributed on the sharing rates are analysed based on available data from Malaysia, Thailand, Cambodia, Vietnam, Myanmar and Indonesia (Figure S1). A best fitting rate of relative decline in sharing with NSP coverage was obtained (Figure 1).

***How much will it cost to implement NSPs in the Philippines?***

A review was conducted of the estimated unit costs to reach IDUs and the cost per needle-syringe distributed per IDU in other Asian countries, scaled by per capita GDP (Figure 3). Based on the GDP in the Philippines, it was estimated that the cost per IDU reached with NSPs would be approximately US$122 ($76-198, 95%CI) but the overall unit cost per needle-syringe distributed would be approximately US$0.50 ($0.44-0.94). A recent costing study of HIV programs in the Philippines [44] reported a unit cost per needle syringe as $US0.15 (PhP

6.00), which was then used to produce the assumptions for the expected relationship between NSP coverage and risk behavior in the Philippines over time (Figure S2).

Figure 1. Number of needle-syringes (ns) distributed and the decrease in the sharing among IDUs in the Philippines
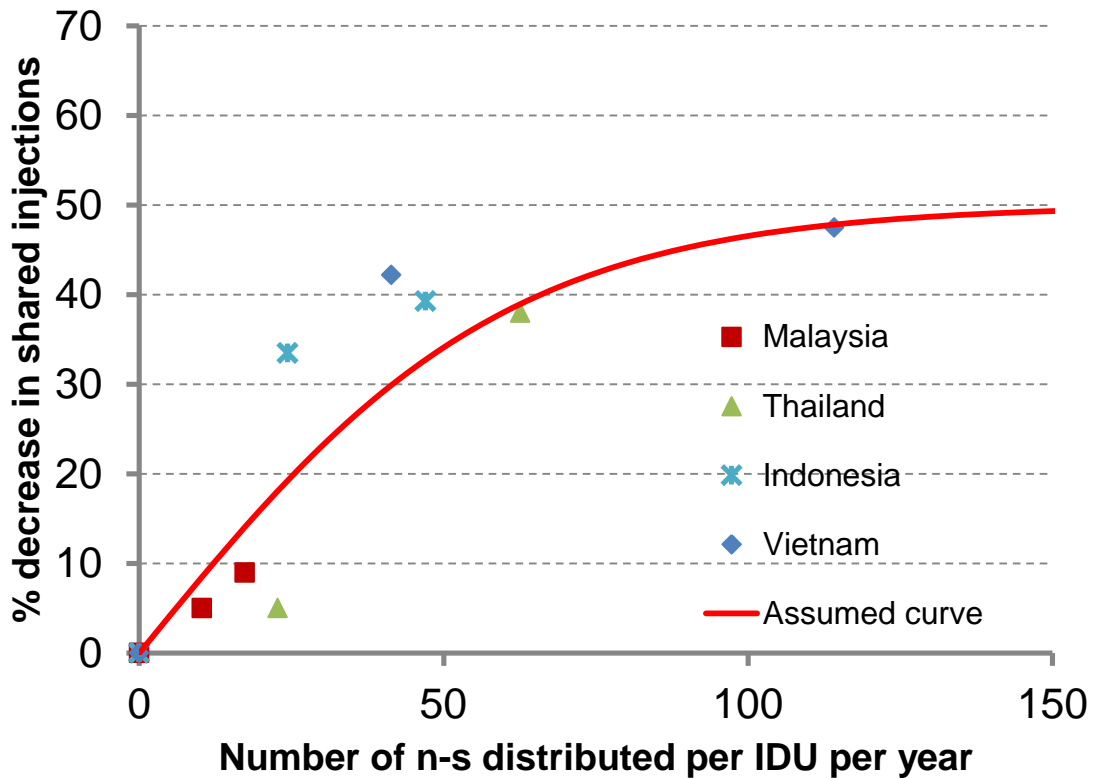
Figure 2. Cost per IDU reached per capita
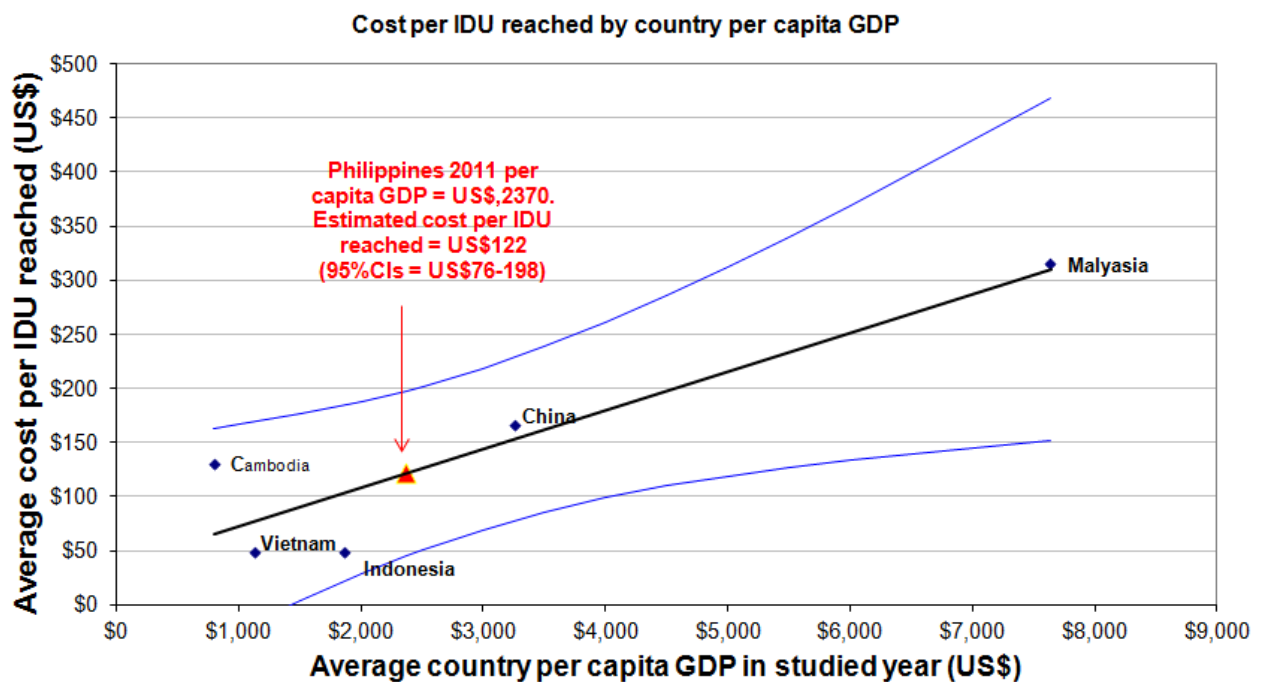
<u>Mathematical model</u>

A mathematical model was developed to describe HIV transmission, the distribution of the IDU population across health states over time, and the associated healthcare costs under actual conditions and according to the hypothetical scenarios of NSPs operating to coverage levels of N= 12.5, 25, 50, or 100 needle-syringes per IDU per year. Very few countries currently achieve levels of syringe distribution that could be considered as high coverage (>= 200 needle-syringes distributed per IDU per year) [45].

The model consists of a number of linked subpopulations ("compartments"), categorized by infection, diagnosis, disease progression (in terms of CD4 categories), and treatment states. A schematic of the model is shown in Figure S1.

The rates of transition between compartments are defined by parameters based on available data. These can be divided into biological parameters (including transmission probabilities, HIV-related death rates, transition probabilities, and treatment effectiveness) and behavioral parameters (including the frequency of injections, the fraction of IDUs who engage in receptive syringe sharing, and the fraction of syringes that are cleaned prior to sharing). The model estimates the change in the number of IDUs in each compartment due to disease progression, initiation of treatment, death or aging, and incidence of infection. The model also calculates the expected numbers of HIV transmissions through probabilities associated with risk behaviors (see Table S1)

Economic analysis was carried out to estimate the cost-effectiveness of NSPs from a health sector perspective. Average annual costs for different HIV health states were estimated based on a recent costing study on HIV programs in the Philippines[44]. The cost per year of first-line ART is estimated as ~$US410 per year per individual; second-line ART at ~$US840 (see Table 2).

Table 2. Healthcare costs

	Cost, US$ per year
HIV testing	6.3 (3.1-12.7)
CD4>500	168.5 (126.4-210.6)
500>CD4>350	168.5 (126.4-210.6)
350>CD4>200	168.5 (126.4-210.6)
CD4<200	168.5 (126.4-210.6)
1st-line ART	407.9 (305.9-509.9)
Subsequent ART	836.6 (627.4-1045.7)

All costs were estimated in 2012 US dollars and inflated to 2012 US dollars using the health consumer price index. Health state utilities were used to adjust the absolute life expectancy to derive disability-adjusted life years (DALYs)[46] (see Table 3).

Table 3. Health utilities

	Disability-adjusted life years (DALYs)
Uninfected IDUs	0 (0-0)
Untreated HIV, CD4>200	0.221 (0.146-0.31)
Untreated HIV, CD4<200	0.547 (0.382-0.715)
Treated HIV, (any CD4 level)	0.053 (0.034-0.079)

The incremental cost-effectiveness ratio (ICER), expressed as cost per DALY averted, is the difference in costs between the hypothetical NSP scenario and the status quo (no NSP) divided by the difference in DALYs between the same two scenarios. Analyses were performed for two time frames: 2013-2018 to study the impact of a five-year program and 2013-2113 to examine the lifetime costs and consequences for the population related to an investment over the period 2013-2023. Costs and QALYs were discounted at an annual rate of 3%. Latest cost-effectiveness thresholds from WHO-CHOICE (2005) for the Philippines, belonging to subregion SEARO B are $4,959 (GDP per capita) and $14,876 (3 x GDP per capita)

The model was calibrated using a Bayesian melding procedure [47] to reflect the HIV epidemics among IDUs in Cebu city and all of the Philippines over the period 2000-2012. Credible intervals and upper and lower bounds for each parameter were derived and used to define cumulative distribution functions (CDFs) for each model parameter (i.e., the priors). CDFs for each prevalence data point were defined similarly. A total of 1,000 simulations were conducted, with parameter values chosen randomly based on the parameters' inverse CDFs. The likelihood, as a measure of goodness-of-fit, of each simulation was defined as the product of the likelihood of each parameter value and the likelihood of each prevalence point, as defined by their respective CDFs. The posterior parameter distribution was obtained by randomly sampling 1,000 times over the original simulations,

with each simulation weighted by its likelihood. This resulted in 100 unique simulations being used for the final analysis. The values and interquartile ranges (IQRs) are derived from this posterior distribution of simulations (see Tables S2 and S3).

Results

A summary of the model-derived results of the potential cost-effectiveness and return on investment of NSPs is shown in Tables 1 and 2 for Cebu and all of the Philippines, respectively. The expected HIV prevalence and total cumulative number of new HIV infections among IDUs in Cebu and the rest of the Philippines associated with different levels of NSP scale-up is shown in the Figure 3.

Figure 3. HIV prevalence and total cumulative number of new HIV infections among IDUs in Cebu and All of the Philippines.
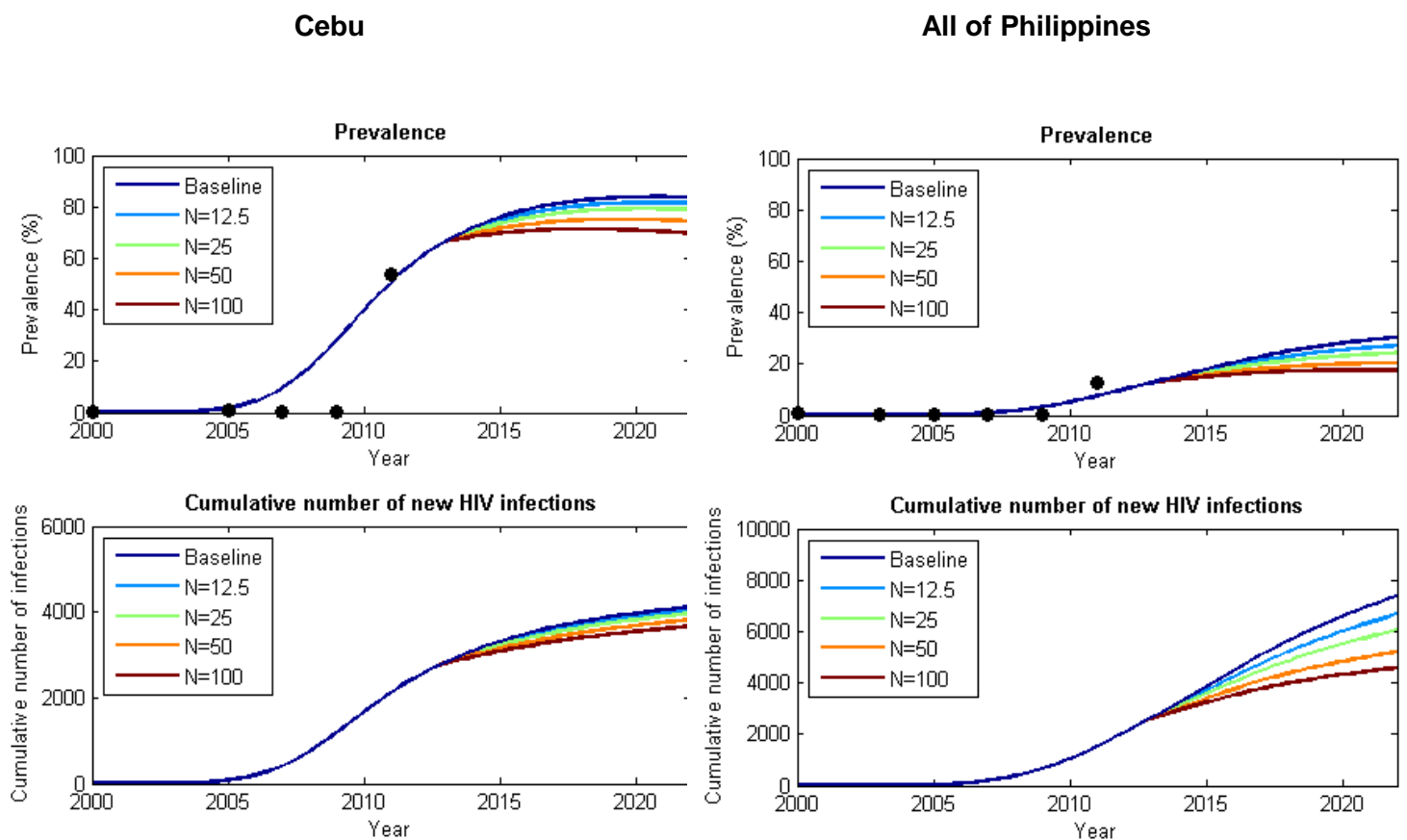
Table 1: Epidemiological and economic indicators for the scenarios in Cebu

Number of needle-syringes distributed per IDU per year	N=0	N=12.5	N=25	N=50	N=100
2013-2018					
Total needle-syringes distributed:	N/A	237,687 (220,567 - 244,166)	475,684 (441,301 - 488,642)	952,350 (883,136 - 978,236)	1,906,396 (1,767,241 - 1,958,119)
Total NSP cost ($):	N/A	35,653 (33,085 - 36,625)	71,353 (66,195 - 73,296)	142,853 (132,470 - 146,735)	285,959 (265,086 - 293,718)
Cumulative new infections:	1,002 (551 - 1,228)	918 (491 - 1,100)	828 (438 - 980)	705 (357 - 796)	589 (300 - 651)
Infections averted:	N/A	79 (44 - 111)	154 (87 - 219)	282 (150 - 392)	402 (210 - 549)
Prevalence (%):	75 (64 - 84)	73 (61 - 82)	70 (58 - 80)	66 (54 - 77)	63 (49 - 75)
Cumulative deaths:	455 (379 - 575)	450 (375 - 571)	445 (372 - 568)	438 (366 - 563)	432 (360 - 558)
Cumulative started 1st-line:	718 (588 - 878)	708 (578 - 873)	699 (568 - 869)	685 (553 - 862)	675 (541 - 856)
Cumulative started 2nd-line:	8 (6 - 13)	8 (6 - 13)	8 (6 - 13)	8 (6 - 13)	8 (6 - 13)
Total DALYs averted:	N/A	48 (26 - 64)	92 (51 - 124)	166 (93 - 217)	235 (133 - 300)
Total health care costs saved ($):	N/A	37,161 (20,202 - 49,861)	71,770 (40,092 - 96,910)	129,659 (73,063 - 169,867)	183,422 (104,230 - 234,069)
ICER ($/DALY):	N/A	Cost-saving (Cost-saving - 451)	Cost-saving (Cost-saving - 461)	40 (Cost-saving - 640)	392 (181 - 1,302)
Return on investment ($/$):	N/A	1.07 (0.64 - 1.39)	1.05 (0.63 - 1.34)	0.95 (0.55 - 1.17)	0.67 (0.38 - 0.81)
2013-2113 (Lifetime)					
Cumulative deaths:	2,168 (1,854 -	2,115 (1,816 - 2,239)	2,047 (1,755 - 2,193)	1,924 (1,670 - 2,101)	1,804 (1,536 - 2,012)
Cumulative started 1st-line:	2,060 (1,704 -	1,984 (1,678 - 2,108)	1,915 (1,651 - 2,055)	1,787 (1,538 - 1,948)	1,695 (1,492 - 1,852)
Cumulative started 2nd-line:	1,295 (1,148 -	1,266 (1,109 - 1,336)	1,215 (1,070 - 1,314)	1,124 (973 - 1,264)	1,049 (890 - 1,208)
Total DALYs gained:	N/A	194 (127 - 290)	395 (265 - 580)	746 (491 - 1,040)	1,117 (678 - 1,493)
Total health care costs saved ($):	N/A	420,896 (277,481 - 642,678)	846,766 (573,540 - 1,288,208)	1,553,002 (1,033,322 - 2,274,189)	2,261,187 (1,397,676 - 3,235,997)
ICER ($/DALY):	N/A	Cost-saving	Cost-saving	Cost-saving	Cost-saving
Return on investment ($/$):	N/A	6.21 (4.59 - 9.00)	6.33 (4.37 - 9.04)	6.02 (3.74 - 8.12)	4.27 (2.75 - 5.84)

Table 2: Epidemiological and economic indicators for the scenarios in all of the Philippines

Number of needle-syringes distributed per IDU per year	N=0	N=25	N=50	N=100	N=200
2013-2018					
Total needle-syringes distributed:	N/A	1,237,280 (1,151,004 - 1,258,203)	2,475,139 (2,303,039 - 2,516,526)	4,951,965 (4,609,273 - 5,033,391)	9,906,691 (9,224,135 - 10,067,329)
Total NSP cost ($):	N/A	185,592 (172,651 - 188,731)	371,271 (345,456 - 377,479)	742,795 (691,391 - 755,009)	1,486,004 (1,383,620 - 1,510,099)
Cumulative new infections:	3,098 (701 - 4,244)	2,685 (596 - 3,919)	2,330 (510 - 3,548)	1,833 (394 - 2,973)	1,448 (308 - 2,447)
Infections averted:	N/A	309 (104 - 427)	612 (191 - 815)	1,088 (307 - 1,413)	1,519 (393 - 1,908)
Prevalence (%):	26 (5 - 72)	24 (5 - 70)	22 (4 - 67)	20 (4 - 64)	18 (3 - 61)
Cumulative deaths:	226 (37 - 897)	221 (36 - 889)	216 (35 - 881)	209 (34 - 869)	203 (33 - 859)
Cumulative started 1st-line:	2,464 (475 - 7,761)	2,340 (448 - 7,592)	2,230 (426 - 7,432)	2,074 (395 - 7,183)	1,949 (370 - 6,964)
Cumulative started 2nd-line:	24 (4 - 96)	24 (4 - 95)	24 (4 - 95)	23 (4 - 94)	23 (4 - 93)
Total DALYs averted:	N/A	166 (38 - 198)	315 (71 - 373)	524 (117 - 651)	692 (152 - 908)
Total health care costs saved ($):	N/A	163,664 (37,238 - 198,836)	306,965 (69,127 - 384,420)	512,682 (113,825 - 682,362)	677,894 (148,878 - 949,913)
ICER ($/DALY):	N/A	131 (Cost-saving - 3,948)	204 (Cost-saving - 4,338)	439 (1 - 5,495)	1,168 (470 - 8,942)
Return on investment ($/$):	N/A	0.88 (0.20 - 1.16)	0.83 (0.18 - 1.14)	0.69 (0.15 - 1.00)	0.46 (0.10 - 0.68)
2013-2113 (Lifetime)					
Cumulative deaths:	3,535 (691 - 7,958)	3,168 (595 - 7,669)	2,853 (520 - 7,372)	2,423 (429 - 6,874)	2,103 (366 - 6,495)
Cumulative started 1st-line:	7,038 (1,564 -	6,255 (1,330 - 12,638)	5,586 (1,150 - 12,202)	4,670 (928 - 11,524)	3,990 (778 - 10,886)
Cumulative started 2nd-line:	4,450 (1,075 -	3,968 (918 - 7,508)	3,556 (797 - 7,187)	2,993 (648 - 6,647)	2,575 (548 - 6,333)
Total DALYs averted:	N/A	819 (369 - 1,367)	1,632 (695 - 2,529)	2,802 (1,181 - 4,115)	3,820 (1,472 - 5,312)
Total health care costs saved ($):	N/A	2,673,748 (1,238,894 - 4,793,797)	5,338,922 (2,398,640 - 8,865,259)	9,707,835 (4,062,186 - 14,413,034)	12,946,558 (5,346,713 - 18,546,550)
ICER ($/DALY):	N/A	Cost-saving	Cost-saving	Cost-saving	Cost-saving
Return on investment ($/$):	N/A	8.03 (3.71 - 12.84)	8.00 (3.52 - 11.86)	6.82 (2.81 - 9.63)	4.68 (1.74 - 6.19)

The results suggest that if NSPs were implemented in Cebu to a **low-to-moderate level, at N=12.5** needle-syringes distributed per IDU per year, for five years then

- The programs would cost an estimated US$35,653 (33,085 - 36,625)
- Approximately 79 (44 - 111) HIV infections may be averted (at a cost of $451 per infection averted)
- The financial return in healthcare costs by 2018 that do not need to be spent due to infections averted would amount to $1.07 (0.64 - 1.39) for every $1 invested

Furthermore, the HIV infections averted during the program implementation would yield further benefits in the longer-term of reduced HIV-related healthcare costs. With 3% discounting, it was estimated that for every $1 invested in low-to-moderate coverage NSPs in Cebu that $1 would be returned plus an additional $5.21 (3.59 - 8.00) in healthcare costs that are saved.

If NSPs were implemented in Cebu to a **moderate-to-high level, at N=50** needle-syringes distributed per IDU per year, for five years then

- The programs would cost an estimated US$142,853
- Approximately 282 (150 - 392) HIV infections may be averted

Over a lifetime horizon, $6.02 (3.74 - 8.12) would be returned in healthcare savings for every $1 invested. Although the return on investment ratio is less for greater NSP coverage, the absolute total healthcare costs savings are greater ($1.6 million for N=50 compared with $420,000 for N=12.5).

o The results for national Philippines are qualitatively similar to results for Cebu, but with larger magnitudes in costs and savings.
  o The estimated return on investment is slightly greater for all of the Philippines than Cebu over long time horizons but the cost-effectiveness ratio is lower for Cebu than all of the Philippines for short time horizons due to the currently high incidence among IDUs in Cebu.
o Over short time horizons, of a 5-year period of program implementation, NSPs were estimated to be cost-saving for scenarios with N<=25 for both Cebu and national Philippines. NSPs with N=50-100 were estimated to cost $131-1168 per DALY averted in the Philippines and $40-392 per DALY averted in Cebu.
  o Whether these ratios are deemed to be cost-effective may be questionable according to some willingness to pay thresholds. However, according to the WHO-CHOICE criteria (cost-effective if less than 3 times per capita GDP and very cost-effective if less than 1 times per capita GDP) these programs are cost-effective over short time horizons [48].
  o The longer NSPs are operating the lower the cost-effectiveness ratio (more cost-effective).
o Over a lifetime horizon, all NSP implementation scenarios were deemed to be cost-saving with considerable healthcare cost savings.
  o High-level NSPs (N>=50) would likely be cost-effective in the short-term and become cost-saving within 10-20 years of their commencement.

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Supplementary figures and tables

Figure S1. Relationship between number of needle-syringes distributed and sharing among IDUs. The IDU Reference Group estimates that there are 30 (7-68) needle-syringes distributed among 10 countries in South/South-east Asia where NSPs are implemented[49].
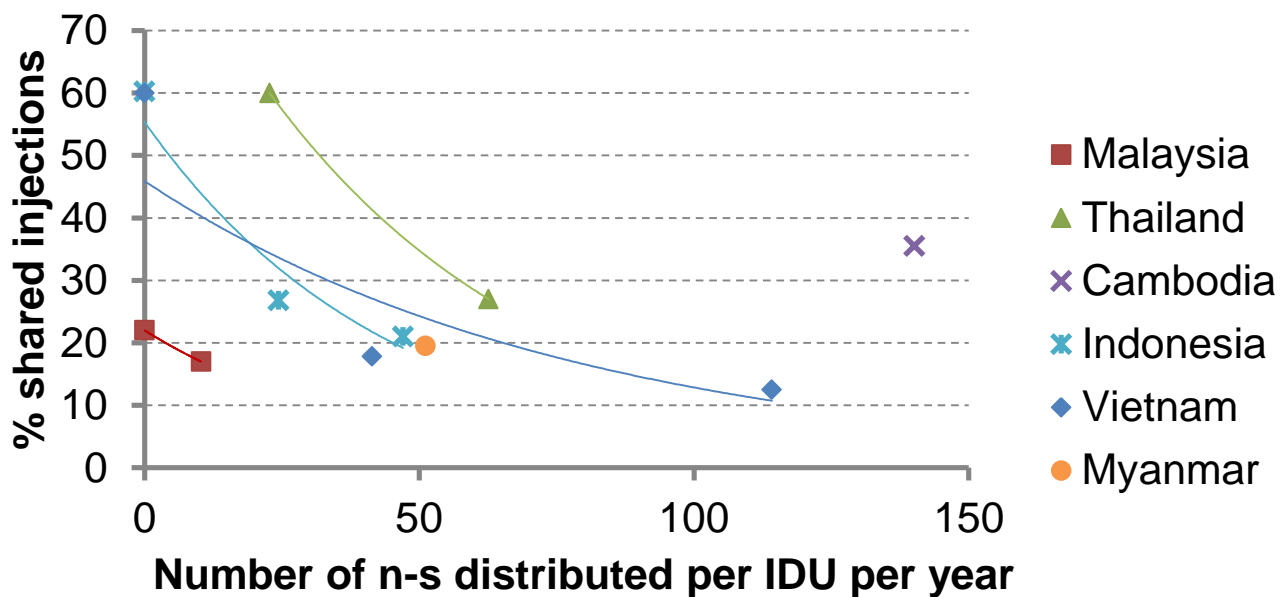
Figure S2. Expected level of shared injections among IDUs over time according to different NSP coverage and intensity levels. N = number of needle-syringes distributed per IDU per year
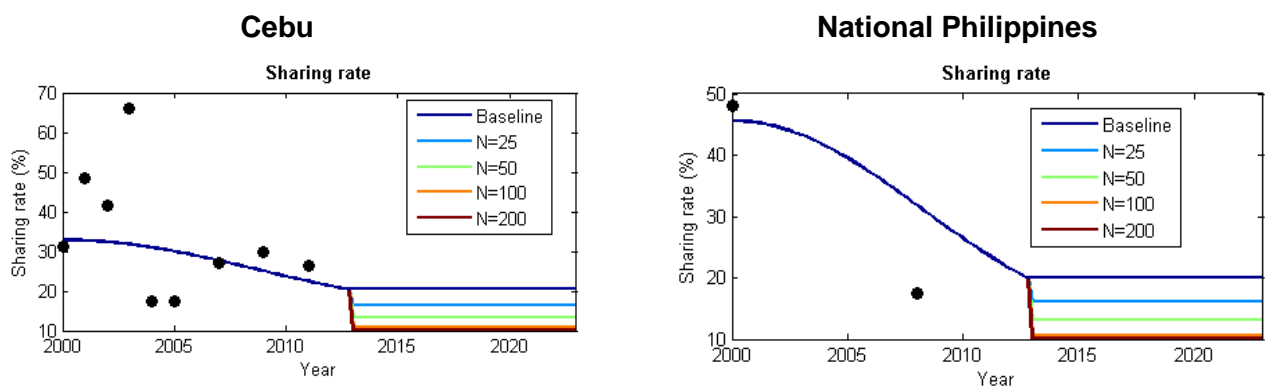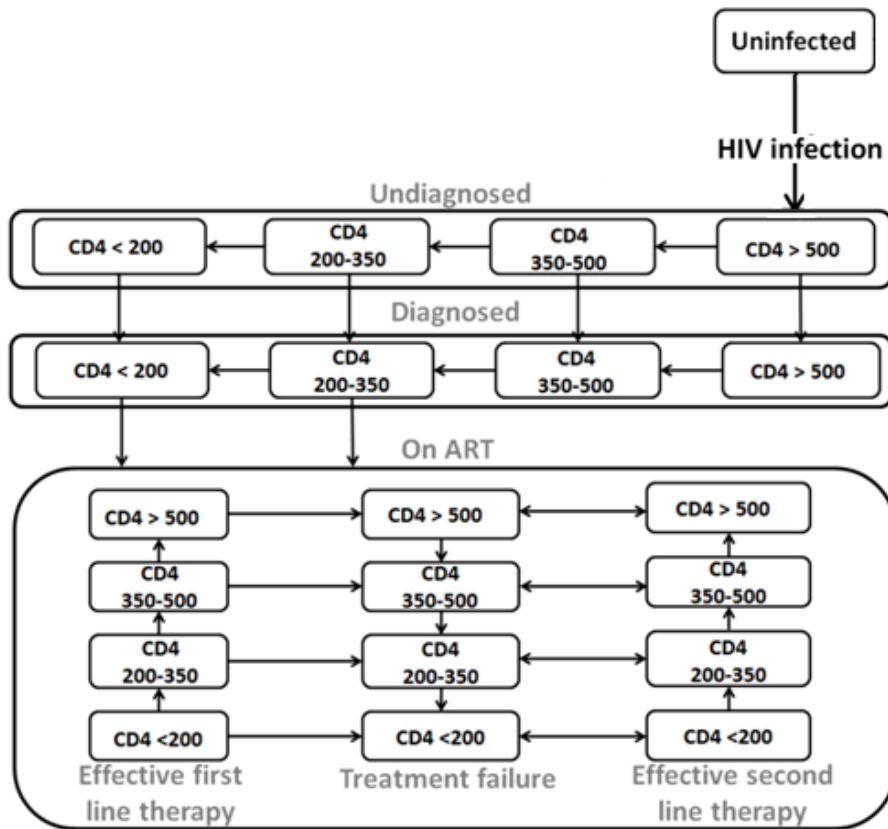
Figure S3. Mathematical model of HIV transmission

Table S1. Constants

Parameter		Values	Footnotes
Sexual interaction-related transmissibility	Male & female (insertive)	0.04% (0.01 - 0.05)	[1-4]
	Male & female (receptive)	0.08% (0.05 - 1)	[1-7]
	Injecting	0.8% (0.5 - 5)	[15-21]
Disease-related transmissibility	CD4>500	1.6% (1.2 - 1.8)	[22]
	350<CD4<500	1% (0.8 - 1.2)	[22]
	200<CD4<350	1% (0.8 - 1.2)	[22]
	CD4<200	3.8% (3.6 - 4)	[22]
	Treatment	0.04% (0.02 - 0.1)	[23]
Disease progression rate: (% per year)	CD4>500) to 350<CD4<500	24.5% (22.6 - 26.4)	[24]
	350<CD4<500 to 200<CD4<350	51% (47 - 55)	[24]
	200<CD4<350 to CD4<200	51% (47 - 55)	[24]
Treatment recovery rate: (% per year)	350<CD4<500 to CD4>500	45% (14 - 93)	[25]
	200<CD4<350 to 350<CD4<500	70% (29 - 90)	[25]
	CD4<200 to 200<CD4 <350	36% (28 - 43)	[25]
Death rate: (% mortality per year)	Background	1.45% (0.94 - 1.96)	[26]
	Injecting	1% (0.75 - 1.25)	[27]
	CD4>500	0.0515% (0.035 - 0.068)	[28]
	350<CD4<500	0.128% (0.092 - 0.164)	[28]
	200<CD4<350	1.1% (0.2 - 2)	[28]
	CD4<200	50% (40 - 66)	*Assumption
	Treatment (CD4<200)	4% (1 - 10)	*Assumption
Treatment failure rate: (% per year)	1st-line	4.5% (3 - 6)	[29]
	2nd-line	4.5% (3 - 6)	[29]
Protective effectiveness of per-exposure:	Condom	95% (85 - 99)	[30-31]
	Circumcision	60% (50 - 65)	[32-35]
	Increase STI cofactor	3.5% (2 - 5)	[36-42]
Drug use:	Syringe cleaning effectiveness	75% (70 - 80)	[43-45]

Footnotes:

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Table S2. Parameters for Cebu

Parameter	Year	Values	Comments and footnotes	
Population size of male IDUs	2007	4500 (3,000-6,000)		
	2009	1,800 (1,400 - 2,300)		
	2011	6,000 (5,000 - 8,000)	Assumption: 90% are male and 10% are female [4]	[1-4]
Population size of female IDUs	2007	500 (400 - 600)		
	2009	200 (150 - 250)		
	2011	670 (500 - 830)		
HIV prevalence among IDUs	2000	0		
	2005	0.83% (0.6% - 5%)		
	2007	0.40% (0.3% - 5%)	Prevalence in year 2000 is assumed to be zero.	[5,6]
	2009	0.59% (0.44% - 5%)		
	2011	53.8% (40.4% - 67.3%)		
STI prevalence among IDUs	2000	1.3% (1% - 5%)		
	2005	2.7% (2% - 10%)	Estimated STI prevalence from syphilis; lower limit-Gonorrhea. Higher limit-Chlamydia	[7]
	2009	3.2% (2.4% - 4%)		
Testing rate per year	2009	3.8% (2.9% - 4.8%)	Ever tested for HIV	[8]
	2010	4.8% (3.6% - 5.9%)		[9]
Number of HIV diagnosis - male IDUs	2008	1		
	2009	1		[1]

	2010	142		
Number of HIV diagnosis - female IDUs	2008	0		
	2009	6		
	2010	26		
Number of patients on first-line ART	2008	6	Cebu has ~13% of the national IDU population. Estimated IDU on ART in National is 66.65 (1.05-179) people. Hence, we may estimate there are 8.7 (0.14-23.4) IDUs on ART in Cebu.	[1,7,10]
Number of patients on second-line ART	2008	1		
Average number of injections per IDU per year	2009	475 (356 - 594)	A mean of 1.3 injections per day, or 475 injections in a year (median 0.1 injection per day or 3x a month).	[11]
% of IDUs who share needles	2000	52% (39% - 65%)	Proportion of IDUs who shared injecting equipments	[12]
	2001	81% (61% - 99%)		[12]
	2002	69% (52% - 86%)		[12]
	2003	66% (49.5% - 99%)		[12]
	2004	29% (22% - 36%)	Among all IDU in Cebu, 29% reported that they injected with a previously used needle or syringe the last time they injected.	[13]
	2007	45% (34% - 99%)		[1]
	2009	49.85% (41% - 59%)	% who ever shared needles/syringes in the last injection	[1,14]
	2011	44% (33% - 55%)		[1]
% of reused syringes that are cleaned	2004	48% (36% - 60%)	Percentage of IDUs who reported using sterile injecting equipment the last time they injected	[15]
	2011	85% (64% - 99%)		[16]

Footnotes

1   HIV situation in Cebu City
2   Poblete 2012, p.9, Figure 1
3   PNAC 2011 p.10 - Table 2. National Population Size Estimates for Most At-Risk Populations by Area & MARP, 2011
4   2011 Philippine MARP and PLHIV Estimates p.9.
5   Poblete 2012, p.11 Fig 4
6   IHBSS 2005, p.6 Fig. 5 n=243
7   IHBSS 2009, p.14
8   IHBSS 2009 - p.14
9   PNAC 2012 p.11, n=1278
10   IDU reference group http://www.idurefgroup.unsw.edu.au/contest-data-and-maps/Philippines/23

11   DOH 2011(a) p.19 - Number of partners per IDU per year, and number of acts per partner.
12   DOH 2003 p.22, BSS, 1997-2003
13   IHBSS 2005, p.13
14   IHBSS 2009, p.14
15   Mateo R, Sarol JN, Poblete R: HIV/AIDS in the Philppines. AIDS Education and Prevention 2004, 16:43-52 (2004 report by the Philippines National AIDS Council)
16   PNAC 2010 p.13 - 21. Percentage of IDUs who reported using sterile injecting equipment the last time they injected

Table S3. Parameters for National Philippines

Parameter	Year	Values	Comments and footnotes	
Population size of male IDUs	2000	14,000 (9,000 - 18,000)	A review of the 2009, 2010 and 2011 IHBSS showed that around 10% of respondents had female partners who were also IDU. It was assumed that 10% of the estimated number of IDUs were female, and 90% were male. IDU population in 1998 is assumed equal to 2000. A nationwide study by the Dangerous Drug Board (DDB) of the Philippines reported that 2% to 4% of the general population use illegal drugs, and 0.89% of these drug users were IDUs (this rate is similar to a DOH study cited by the Asian Harm Reduction Network (AHRN) in 1998, showing that 0.1% of drug users are IDUs). Based on these estimates, there are 9,078 to 18,155 IDUs in the Philippines.	[1-7]
	2005	23,000 (16,000 - 31,000)		
	2007	14,000 (7,000 - 20,000)		
	2009	17,000 (13,000 - 22,000)		
	2010	20,000 (15,000 - 25,000)		
	2011	14,000 (12,000 - 17,000)		
Population size of female IDUs	2000	1,500 (1,000 - 2000)		
	2009			
	2011			
HIV prevalence among male IDUs	2003	0% (0% - 0.01%)	Percentage of MARP who are HIV-infected. Males and female are distinct in the mathematical model to emphasize the difference in estimated prevalence between male and female IDUs in 2011.	[8-13]
	2005	0.1% (0.06% - 5%)		
	2007	0.13% (0.1% - 5%)		
	2009	0.21% (0.2% - 5%)		
	2011	12.87% (10% - 16%)		
HIV prevalence among female IDUs	2003	0% (0% - 0.01%)		

	2005	0.1% (0.06% - 5%)		
	2007	0.13% (0.1% - 5%)		
	2009	0.21% (0.2% - 5%)		
	2011	27% (20% - 34%)		
STI prevalence among IDUs	2000	12% (9% - 15%)	Proportion of HRG Who Reported Signs and Symptoms of STI	[14,15]
	2002	5% (4% - 7%)		
	2003	10% (7.5% - 12.5%)		
Testing rate per year	2007	3.6% (1.5% - 4.9%)	received an HIV test in the last 12 months and who know the results	[16-19]
	2008	4% (3% - 5%)		[20]
	2009	5.97% (1.4% - 15%)		[21-23]
	2010	30% (23% - 38%)		[24]
Number of HIV diagnosis - male IDUs	2008	10	Assumption, slightly higher than Cebu data	NA
	2009	10		
	2010	200		
Number of HIV diagnosis - female IDUs	2008	1		
	2009	6		
	2010	50		
Number of patients on first-line ART	2008	67		[25]
Number of patients on second-line ART*	2008	7	Assumed 10% of first-line	NA
Average number of injections per IDU per year	2009	475 (356 - 594)	A mean of 1.3 injections per day, or 475 injections in a year (median 0.1 injection per day or 3x a month).	[26]
% of IDUs who share needles	2000	80% (60% - 99%)		[27]
	2008	29% (22% - 36%)		[28]
% of reused syringes that are cleaned	2004	48% (36% - 60%)	Percentage of IDUs who reported using sterile injecting	[29]

	2011	85% (64% - 99%)	equipment the last time they injected	[30]

Footnotes:

1   PNAC 2011(b) p.9
2   PNAC 2011 p.8
3   DOH 2005, p.24 - Table 15.
4   Philippines Country Review 2008 - AIDS Data Hub p.3 ; Also see - PNAC 2011 - Table 9.
5   5th AIDS Medium Term Plan (2011- 2016) p.50 - Table 5; Also see - PNAC 2011 p.8; Also see - IHBSS 2009(a)
6   PNAC 2011(a), p.3
7   PNAC 2011 p.9 - Table 1.
8   (2) DOH 2005, p.12 - Table 10. HIV Prevalence Estimates Among Injecting Drug Users: 0% (0/230)
9   (1) EFS 2006 - HIV sentinel surveillance prevalence - IDU, 2005 = 0.1%
10   (2) DOH 2005, p.24Table 15. Country estimates of the size and prevalence of HIV infection in the HRG: 0.1%-2.9%, p.12 - Table 10. HIV Prevalence Estimates Among Injecting Drug Users: mean = 0.8%(2/243)
11   IHBSS 2009 (PPT) p.49 - Prevalence Rates per 100,000 population. HIV Prev 2007 = 133/10000 = 0.00133 = 0.133%
12   (3) Also see - PNAC 2008, p. 23 - 23. Percentage of most-at-risk populations who are HIV infected - DU: 0.13% (1/752)
13   (1) PNAC 2012 - p.12 - 2.5 Percentage of people who inject drugs who are living with HIV - 13.56% (174/1,283); Male PWID: 12.87% (157/1220); Female PWID: 26.98% (17/63)
14   DOH 2003 p.23 - Figure 10. Proportion of HRG Who Reported Signs and Symptoms of STI BSS, 1997-2003
15   UNAIDS 2005 Table 10
16   "(1) Philippines Country Review 2008 - AIDS Data Hub, p. 7 Figure 7: 4%"
17   (2) "IHBSS 2007 - IDU: 4% (33/752)"
18   "(3) PNAC 2010, p.10 8. Percentage of most-at-risk populations that have received an HIV test in the last 12 months and who know the results: IDU: 1.5% (14/958) "
19   "(4) 5th AMTP (final version for printing) as of April 29 2011.pdf - 4.9%; 5th AIDS Medium Term Plan (2011- 2016) p.22 Table 2. National Scorecard of Selected Key Indicators for the United Nations General Assembly Special Session on HIV and AIDS (UNGASS) Report "
20   PNAC 2011(b) p. 13 - The tables in the succeeding pages show program performance targets during 2009 and 2010 against the country's UA /AMTP IV targets.- 4% (813) UNGASS07
21   "(1) 5th AIDS Medium Term Plan (2011- 2016) p.22 Table 2. National Scorecard of Selected Key Indicators for the United Nations General Assembly Special Session on HIV and AIDS (UNGASS) Report - 1.4%"
22   (2) PNAC 2010, p.10 - 8. Percentage of MARPs that have received an HIV test in the last 12 months and who know the results - - IDU: 1.5% (14/958)
23   "(3) PNAC 2011(b) p. 13 - The tables in the succeeding pages show program performance targets during 2009 and 2010 against the country's UA /AMTP IV targets.- HIV Tested and know the results: 2009: 15%; 2010: 30%"
24   PNAC 2011(b) p. 13 - The tables in the succeeding pages show program performance targets during 2009 and 2010 against the country's UA /AMTP IV targets.- HIV Tested and know the results: 2009: 15%; 2010: 30%
25   IDU reference group website http://www.idurefgroup.unsw.edu.au/contest-data-and-maps/Philippines/24
26   DOH 2011(a) p.19 - Number of partners per IDU per year, and number of acts per partner.
27   EFS 2006, p.4 - Behavioural surveillance data in 1997 and 2001 indicated high prevalence of HIV/STI risk behaviour. Sharing of needles was reported by 80% of IDUs in 2001 and consistent use of condom for the past week was generally low (<35%) for all high risk groups for 2001
28   Wilson 2010 - p.3 - "A 2008 report published by the Joint United Nations Programme on HIV/AIDS (UNAIDS) indicated that the prevalence of sharing injecting equipment is still\ very high, with 29% of IDUs self-reporting use of an unsterile needle/syringe the last time they injected [39]"
29   Mateo R, Sarol JN, Poblete R: HIV/AIDS in the Philpines. AIDS Education and Prevention 2004, 16:43-52 (2004 report by the Philippines National AIDS Council)
30   PNAC 2010 p.13 - 21. Percentage of IDUs who reported using sterile injecting equipment the last time they injected