Effectiveness and Cost-effectiveness of Strategies to Expand Antiretroviral Therapy in St. Petersburg, Russia

Technical Appendix

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APPENDIX

Figure A1 presents a schematic of the model, showing notation used in the differential equations that govern transitions in the model. Table A1 lists all model parameters and variables. Let i be an index for compartments, $i = 1, ..., 12$. The number of individuals in compartment i at time t is $X_i(t)$ ($i = 1,\ldots,12$, $t \geq 0$). Individuals transition between compartments according to specific rates defined by the dynamics of disease transmission and progression. All rates are assumed to be annual.

Population Dynamics

Entry into the population (when 14 year olds turn 15) occurs at rate ρ_i (i = 1, 7); all new entrants are assumed to be uninfected. We assumed that the total rate of entry ($\rho_1 + \rho_7$) equals the total rate of maturation into the population, and that the ratio $\rho_1/ (\rho_1 + \rho_7)$ is equal to the initial proportion of the adult population that is an IDU. Individuals may leave the population through maturation (i.e., 49-year-olds turn 50) at rate μ_i ($i = 1,\ldots,12$), non-HIV/AIDS-related death at rate δ_i ($i = 1,\ldots,12$), or HIV/AIDS-related death at rate α_i ($i = 4, 6, 10, 12$). We assumed that only individuals with AIDS can die from HIV/AIDS.

HIV Progression

HIV-infected individuals progress to a more advanced disease stage (i.e., a lower CD4 count) at rate θ_i ($i = 2, 3, 5, 8, 9, 11$). This rate is computed as the reciprocal of the average time spent in each disease stage. IDUs and non-IDUs in the same disease/treatment state are assumed to have the same progression rates; however, disease progression rates are significantly slower for individuals who receive HAART. Individuals are assumed to have decreasing viral loads, regardless of treatment status.

Highly Active Antiretroviral Therapy (HAART)

We assumed that individuals may begin HAART once their CD4 count falls below 350 cells/mm^3. The fraction of individuals in compartment i who enter treatment at time t is $\varphi_{i,j}(t)$ $((i,j)=(3,5), (4,6), (9,11), (10,12))$. By varying these parameters, we can evaluate the effect of placing IDUs, non-IDUs, or a combination of both on HAART. The fraction of individuals in compartment i who discontinue their treatment regimen at time t is $\varphi_{i,j}(t)$ $((i,j)=(5,3), (6,4), (11,9), (12,10))$. If an individual stops treatment, he or she transitions back to the untreated compartment.

HIV Transmission

Let $\lambda_{ij}(t)$ denote the sufficient contact rate at time t between members of (uninfected) compartment i (i = 1, 7) and members of (infected) compartment j (j = 2, ..., 6, 8, ..., 12) at time t. Transmission may occur as a result of needle-sharing, $\gamma_{i,j}(t)$, high-risk sexual contact, $\beta_{i,j}{}^{H}(t)$, or low-risk sexual contact, $\beta_{i,j}{}^{L}(t)$, according to the formula:

$$\lambda_{i,j}(t) = \gamma_{i,j}(t) + \beta_{i,j}{}^{H}(t) + \beta_{i,j}{}^{L}(t). \qquad (i = 1, 7; j = 2,\ldots,6, 8,\ldots,12)$$

We now describe how the terms $\gamma_{i,j}(t)$, $\beta_{i,j}{}^{H}(t)$, and $\beta_{i,j}{}^{L}(t)$ are calculated.

We modeled HIV transmission via injection drug use based on a per injection basis. We estimated the average number of injections per year, I_i, as well as the fraction of injections that are shared, s_i, for all IDUs (i = 1,…,6). These parameters can vary across IDU compartments, to allow for changes in risky injecting behavior as HIV disease progresses. We let R_i denote the average number of risky injections per year for IDUs (i = 1,…,6). A risky injection is defined as an injection involving a needle initially used by an HIV-infected individual and subsequently used by an uninfected individual. This parameter may vary across IDU compartments because injection transmissibility varies according to viral load and whether an individual is undergoing

HAART. R_i is calculated as:

$$R_i = I_i * s_i \qquad (i = 1,\ldots,6)$$

The needle-sharing sufficient contact rate $\gamma_{i,j}(t)$ is calculated as

$$\gamma_{i,j}(t) = R_i \left[\frac{X_j(t)R_j}{\sum_{n=1}^{7} X_n(t)R_n} \right] \tau_{i,j} \qquad (i = 1; j = 2,\ldots,6)$$

where $\tau_{i,j}$ denotes the probability of infection transmission to an individual in (uninfected) compartment i per risky injection shared with an individual in (infected) compartment. The bracketed term is the total number of needles shared by members of compartment j, divided by the total number of needles shared by all IDUs, which equals the probability of sharing a needle with a person in compartment j, given that a needle is shared. The overall transmission rate between each compartment is the product of this term, the number of risky injections, R_i, and the chance of transmission per risky injection, $\tau_{i,j}$.

We modeled HIV transmission via sexual contact on a per partnership basis. All sexual partnerships are assumed to result from random mixing within compartments, regardless of gender or sexual preference. However, the model does allow for preferential mixing between IDUs and non-IDUs. We distinguish two types of sexual partnerships, high risk and low risk, indexed by r = H, L. Low-risk partnerships are those that involve consistent condom use, and high-risk partnerships are those that do not.

The overall rate of sexual transmission from a partnership of type r between an individual in (uninfected) compartment i and an individual in (infected) compartment j at time t is calculated as:

$$\beta_{i,j}^{r}(t) = P_i^{r} * M_{i,j}^{r}(t) * \sigma_{i,j} \qquad (i = 1, 7; j = 2,\ldots,6, 8,\ldots,12, r = \text{H, L})$$

where P_i^r is the annual average number of new sexual partnerships of risk r that could lead to infection transmission to an individual in compartment i, $M_{i,j}^{r}(t)$ is the chance that an individual in compartment i has a sexual partnership of risk type r with a member of compartment j at time t, and $\sigma_{i,j}$ is the chance of transmission per sexual partnership between an individual in compartment i and an individual in compartment j. The term $\sigma_{i,j}$ does not depend on the type of sexual partnership (H or L), since in the former case, no condom was used, and in the latter case, a condom was used but was ineffective at preventing HIV transmission.

The terms P_i^H and P_i^L are calculated as

$$P_i^H = P_i * (1-d_i) \qquad (i = 1,\ldots,12)$$

$$P_i^L = P_i * d_i * (1-ce) \qquad (i = 1,\ldots,12)$$

where P_i is the average number of new sexual partnerships per year for an individual in compartment i, d_i is the proportion of these sexual partnerships that consistently involve condom use, and ce is the condom effectiveness at preventing HIV transmission.

The proportion of sexual partnerships an IDU in compartment i has with other IDUs is G_i ($i = 1,\ldots,6$); the remainder, 1- G_i, is the proportion of sexual partnerships an IDU in compartment i has with non-IDUs. The chance that an IDU in compartment i has a sexual partnership with an IDU in compartment j is:

$$M_{i,j}^{r}(t) = G_i \left[\frac{X_j(t) P_j^r}{\sum_{n=1}^{7} X_n(t) P_n^r} \right] \qquad (i = 1,\ldots,6;\ j = 1,\ldots,6;\ r = \mathrm{H, L})$$

The first term represents the probability that an IDU in compartment i has a sexual partnership with any IDU. The bracketed term represents the total number of sexual partnerships by members of compartment j divided by the total number of sexual partnerships by all IDUs, which equals the probability of having a sexual partnership with a person in compartment j, given that a sexual partnership with an IDU occurs.

The chance that an IDU in compartment *i* has a sexual partnership with a non-IDU in compartment *j* is calculated analogously as:

$$M_{i,j}^{r}(t) = (1-G_i)\left[\frac{X_j(t)P_j^r}{\sum_{n=7}^{12} X_n(t)P_n^r}\right] \qquad (i = 1,\ldots,6;\ j = 7,\ldots,12;\ r = \text{H, L})$$

The chance that a non-IDU in compartment *i* has a sexual partnership with an IDU in compartment *j* is:

$$M_{i,j}^{r}(t) = \left[\frac{\sum_{n=1}^{6}(1-G_n)X_n(t)P_n^r(t)}{\sum_{n=7}^{12} X_n(t)P_n^r(t)}\right] * \left[\frac{X_j(t)P_j^r(t)}{\sum_{n=1}^{6} X_n(t)P_n^r(t)}\right] \qquad (i = 7,\ldots,12;\ j = 1,\ldots,6;\ r = \text{H, L})$$

The first bracketed term represents the probability that a non-IDU in compartment *i* has a sexual partnership with any IDU. The second bracketed term represents the probability of having a sexual partnership with a person in compartment *j*, given that a sexual partnership with an IDU occurs.

The chance that a non-IDU in compartment *i* has a sexual partnership with a non-IDU in compartment *j* is calculated analogously as:

$$M_{i,j}^{r}(t) = \left[1-\frac{\sum_{n=1}^{6}(1-G_n)X_n(t)P_n^r(t)}{\sum_{n=7}^{12} X_n(t)P_n^r(t)}\right] * \left[\frac{X_j(t)P_j^r(t)}{\sum_{n=7}^{12} X_n(t)P_n^r(t)}\right] \qquad (i = 7,\ldots,12;\ j = 7,\ldots,12;\ r = \text{H, L})$$

The first bracketed term represents the probability that a non-IDU in compartment *i* has a sexual partnership with any non-IDU. The second bracketed term represents the probability of having a sexual partnership with a person in compartment *j*, given that a sexual partnership with a non-IDU occurs.

System of Nonlinear Differential Equations

The number of individuals in each compartment, and the flow of individuals between compartments is mathematically modeled by the following system of nonlinear differential equations:

The change over time in the number of uninfected IDUs is given by:

$$\frac{dX_1(t)}{dt} = \rho_1 - X_1(t)\left[\mu_1 + \delta_1 + \sum_{\substack{j=2 \\ j\neq 7}}^{12} \lambda_{1,j}(t)\right] \tag{1}$$

The change over time in the number of IDUs with asymptomatic HIV is given by:

$$\frac{dX_2(t)}{dt} = X_1(t)\left[\sum_{\substack{j=2 \\ j\neq 7}}^{12} \lambda_{1,j}(t)\right] - X_2(t)\left[\mu_2 + \delta_2 + \alpha_2 + \theta_2\right] \tag{2}$$

The change over time in the number of IDUs with symptomatic HIV is given by:

$$\frac{dX_3(t)}{dt} = X_5(t)\phi_{5,3} + X_2(t)\theta_2 - X_3(t)\left[\phi_{3,5} + \mu_3 + \delta_3 + \alpha_3 + \theta_3\right] \tag{3}$$

The change over time in the number of IDUs with AIDS is given by:

$$\frac{dX_4(t)}{dt} = X_6(t)\phi_{6,4} + X_3(t)\theta_3 - X_4(t)\left[\phi_{4,6} + \mu_4 + \delta_4 + \alpha_4\right] \tag{4}$$

The change over time in the number of IDUs with symptomatic HIV undergoing HAART is given by:

$$\frac{dX_5(t)}{dt} = X_3(t)\phi_{3,5} - X_5(t)\left[\phi_{5,3} + \mu_5 + \delta_5 + \alpha_5 + \theta_5\right] \tag{5}$$

The change over time in the number of IDUs with AIDS undergoing HAART is given by:

$$\frac{dX_6(t)}{dt} = X_4(t)\phi_{4,6} + X_5(t)\theta_5 - X_6(t)\left[\phi_{6,4} + \mu_6 + \delta_6 + \alpha_6\right] \tag{6}$$

The change over time in the number of uninfected non-IDUs is given by:

$$\frac{dX_7(t)}{dt} = \rho_7 - X_7(t)\left[\mu_7 + \delta_7 + \sum_{\substack{j=2 \\ j\neq 7}}^{12} \lambda_{7,j}(t)\right] \tag{7}$$

The change over time in the number of non-IDUs with asymptomatic HIV is given by:

$$\frac{dX_8(t)}{dt} = X_7(t)\left[\sum_{\substack{j=2 \\ j\neq 7}}^{12} \lambda_{7,j}(t)\right] - X_8(t)\left[\mu_8 + \delta_8 + \alpha_8 + \theta_8\right] \tag{8}$$

The change over time in the number of non-IDUs with symptomatic HIV is given by:

$$\frac{dX_9(t)}{dt} = X_{11}(t)\phi_{11,9} + X_8(t)\theta_8 - X_9(t)\left[\phi_{9,11} + \mu_9 + \delta_9 + \alpha_9 + \theta_9\right] \tag{9}$$

The change over time in the number of non-IDUs with AIDS is given by:

$$\frac{dX_{10}(t)}{dt} = X_{12}(t)\phi_{12,10} + X_9(t)\theta_9 - X_{10}(t)\left[\phi_{10,12} + \mu_{10} + \delta_{10} + \alpha_{10}\right] \tag{10}$$

The change over time in the number of non-IDUs with symptomatic HIV undergoing HAART is given by:

$$\frac{dX_{11}(t)}{dt} = X_9(t)\phi_{9,11} - X_{11}(t)\left[\phi_{11,9} + \mu_{11} + \delta_{11} + \alpha_{11} + \theta_{11}\right] \tag{11}$$

The change over time in the number of non-IDUs with AIDS undergoing HAART is given by:

$$\frac{dX_{12}(t)}{dt} = X_{10}(t)\phi_{10,12} + X_{11}(t)\theta_{11} - X_{12}(t)\left[\phi_{12,10} + \mu_{12} + \delta_{12} + \alpha_{12}\right] \tag{12}$$

We implemented the model in Microsoft Excel, over a 20-year time horizon, using discrete-time approximations to the continuous-time differential equations.

Outcomes

For the base case and each treatment strategy, we measured total costs incurred and quality-adjusted life years (QALYs) experienced for all members of the population, discounted to the present at 3% annually. The incremental cost-effectiveness ratio for each treatment strategy is calculated as:

$$\textit{Incremental Cost-Effectiveness Ratio} = \left[\frac{Costs_{\text{Treatment Strategy}} - Costs_{\text{Base Case}}}{QALYs_{\text{Treatment Strategy}} - QALYs_{\text{Base Case}}} \right]$$

We also computed HIV prevalence at time *t*:

$$\textit{Overall HIV Prevalence} = \left[\frac{\sum_{i=2}^{6} X_i(t) + \sum_{i=8}^{12} X_i(t)}{\sum_{i=1}^{12} X_i(t)} \right]$$

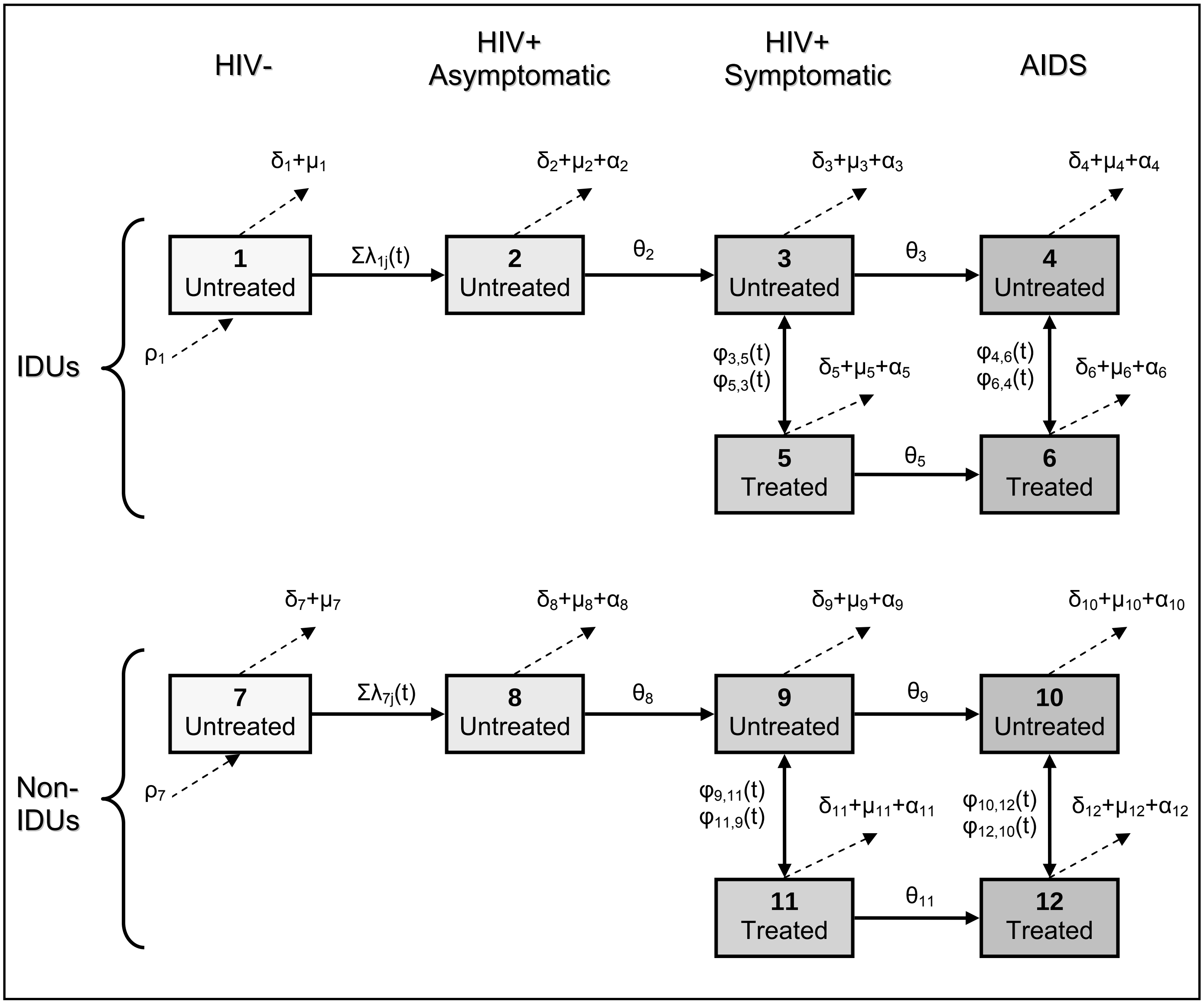
$$\textit{IDU HIV Prevalence} = \left[\frac{\sum_{i=2}^{6} X_i(t)}{\sum_{i=1}^{6} X_i(t)} \right]$$

$$\textit{Non-IDU HIV Prevalence} = \left[\frac{\sum_{i=8}^{12} X_i(t)}{\sum_{i=7}^{12} X_i(t)} \right]$$

Cumulative HIV incidence is computed by summing the total number of new infections occurring during each time period. For each treatment strategy, HIV infections prevented is computed as the incremental difference between cumulative HIV incidence in the base case and cumulative HIV incidence with the corresponding treatment strategy.

For each treatment strategy, the number of people treated is calculated by summing over the 20-year time horizon, the total number of people who begin a HAART regimen in each time period

Figure A1: Schematic of dynamic compartmental model



The boxes represent cohorts of people, and the arrows represent maturation, death, HIV transmission, HIV progression, and entry into and exit from HAART. IDU = injection drug user; Non-IDU = non-injection drug user; HAART = highly active antiretroviral therapy; Asymptomatic HIV = CD4 >350 cells/mm^3; Symptomatic HIV = CD4 200-350 cells/mm^3; AIDS = CD4 <200 cells/mm^3.

Table A1: Summary of notation

Indices

i, j	index for compartments (i = 1,…,12)
t	time index ($t \geq 0$)
r	index for risk level of sexual contacts (H = High Risk, L = Low Risk)

Demographic Parameters

ρ_i	rate of entry into population, into compartment i (i = 1, 7)
μ_i	rate of maturation out of the population from compartment i (i = 1,…,12)
δ_i	non-AIDS death rate for individuals in compartment i (i = 1,…,12)

Disease Parameters

α_i	HIV/AIDS death rate for individuals in compartment i (i = 2,…,6, 8,…,12)
θ_i	HIV/AIDS progression rate for individuals in compartment i (i = 2, 3, 5, 8, 9, 11)
$\varphi_{i,j}(t)$	fraction of individuals entering or exiting treatment at time t ((i,j) = (3,5), (5,3), (4,6), (6,4), (9,11), (11,9), (10,12), (12,10))

Injection Drug Use Parameters

I_i	average number of injections per year for individuals compartment i (i = 1,…,6)
s_i	fraction of injections by individuals in compartment i (i = 1,…,6) that are shared
$\tau_{i,j}$	chance of infection transmission to an uninfected individual in compartment i per risky injection shared with an infected person in compartment j (i = 1; j = 2,…,6)

Sexual Behavior Parameters

P_i	average number of new sexual partnerships per year for individuals in compartment i (i = 1,…,12)
$\sigma_{i,j}$	chance of infection transmission to an uninfected individual in compartment i per unprotected sexual partnership with an infected individual in compartment j (i = 1, 7; j = 2,…,6, 8,…,12)
d_i	condom usage rate by individuals in compartment i (i = 1,…,12)
ce	condom effectiveness in preventing HIV transmission
G_i	proportion of sexual partnerships of individuals in compartment i (i = 1,…,6) that are with other IDUs

Table A1 (Cont.)

Calculated Quantities

$X_i(t)$	number of people (IDUs) in compartment i (i = 1,…,12) at time t
$\lambda_{i,j}(t)$	sufficient contact rate at time t between uninfected members in compartment i and infected members in compartment j (i = 1, 7; j = 2,…,6, 8,…,12)
$\gamma_{i,j}(t)$	sufficient contact rate at time t between uninfected members in compartment i and infected members in compartment j (i = 1; j = 2,…,6) due to drug injection
$\beta_{i,j}^{r}(t)$	sufficient contact rate at time t between members of (uninfected) compartment i (i = 1, 7) and members of (infected) compartment j (j = 2, ..., 6, 8, ..., 12) due to sexual partnerships of risk r (r = H, L)
R_i	average number of risky injections (those with an infected needle) per year for individuals in compartment i (i = 1,…,6)
P_i^{r}	average number of new sexual partnerships per year for individuals in compartment i (i = 1,…,12) of risk type r (r = H, L)
$M_{ij}^{r}(t)$	chance that an individual in compartment i (i = 1,…,12) has a sexual partnership of risk type r (r = H, L) with an individual in compartment j (j = 1,…,12) at time t

Table A2: Model parameters and sources *

Parameter	Value	Range	Source
Demographic Parameters			
Adult population aged 15-49			
St. Petersburg, Russia	2,500,000	---	[41]
Barnaul, Russia	339,200	---	[42]
Proportion of adult population who are IDUs			
St. Petersburg, Russia	4%	2.4% – 4.8%	[17, 19, 43-45]
Barnaul, Russia	6.38%	3.3% – 9.8%	[20]
HIV prevalence among IDUs			
St. Petersburg, Russia	35%	20% – 40%	[17-19]
Barnaul, Russia	1.67%	0.6% – 8.8%	[3, 20]
HIV prevalence among non-IDUs			
St. Petersburg, Russia	0.63%	0.35% – 1%	[3-5]
Barnaul, Russia	0.06%	0.02% – 0.09%	Calculated[3, 20]
Proportion of HIV-infected IDUs on HAART	0%	0% – 0.5%	[6, 46]
Proportion of HIV-infected non-IDUs on HAART	1%	1% – 3%	[6, 47]
Proportion of Prevalent HIV-infection			
Asymptomatic HIV (CD4 >350 cells/mm^3)	75%	50% – 100%	[7, 48-53]
Symptomatic HIV (CD4 200 – 350 cells/mm^3)	15%	0% – 30%	[7, 48-53]
AIDS (CD4 <200 cells/mm^3)	10%	0% – 20%	[7, 48-53]
Annual entry rate into adult population	0.030	0.025 – 0.031	[41]
Annual maturation rate out of adult population	0.029	0.028 – 0.034	[25, 41]
Annual death rate (non-AIDS related)			
IDU	0.035	0.02 – 0.05	[19, 25, 54-57]
Non-IDU	0.005	0.003 – 0.007	[54]
Disease Parameters			
Annual AIDS death rate			
Not on HAART	0.517	0.4 – 0.6	Calculated[7]
On HAART	0.416	0.3 – 0.5	Calculated[7]
Annual HIV/AIDS progression rate to next disease stage			
Asymptomatic HIV (CD4 >350 cells/mm^3)			
Not on HAART	0.136	0.10 – 0.15	Calculated[7]
On HAART	---		
Symptomatic HIV (CD4 200 – 350 cells/mm^3)			
Not on HAART	0.395	0.30 – 0.50	Calculated[7]
On HAART	0.062	0.04 – 0.08	Calculated[7]

Table A2 (Cont.)

Parameter	Value	Range	Source
Quality of life factors			
IDU			
Uninfected	0.90	0.80 – 1.00	[7, 15, 16, 58-61]
Asymptomatic (CD4 >350 cells/mm^3)	0.85	0.75 – 1.00	[7, 15, 16, 58-61]
Symptomatic (CD4 200 – 350 cells/mm^3)	0.73	0.65 – 0.77	[7, 15, 16, 58-61]
AIDS (CD4 <200 cells/mm^3)	0.63	0.56 – 0.72	[7, 15, 16, 58-61]
Non-IDU			
Uninfected	1.00	0.90 – 1.00	[7, 15, 16, 58-61]
Asymptomatic (CD4 >350 cells/mm^3)	0.94	0.85 – 1.00	[7, 15, 16, 58-61]
Symptomatic (CD4 200 – 350 cells/mm^3)	0.81	0.70 – 0.85	[7, 15, 16, 58-61]
AIDS (CD4 <200 cells/mm^3)	0.70	0.50 – 0.80	[7, 15, 16, 58-61]
Injection Drug Use Parameters			
Number of injections per year	250	200 – 300	[15-17, 21, 22, 24]
Proportion of injections that are shared			
St. Petersburg, Russia	15%	8% – 25%	[15-17, 22, 23]
Barnaul, Russia	8%	4% – 12%	[24]
Probability of HIV infection transmission per risky shared injection if not on HAART	0.005	0.0025 – 0.01	[15, 16, 22]
Reduction in infectivity by injection drug use if on HAART	50%	10% – 90%	[7]
Sexual Behavior Parameters			
Number of sexual partnerships per year			
IDU	4.3	3.0 – 10.0	[15, 16, 25]
Non-IDU			
St. Petersburg, Russia	1.3	1.0 – 1.8	[15, 16, 25, 26, 28]
Barnaul, Russia	1.1	0.9 – 1.7	[15, 16, 24, 26, 28]
Proportion of IDU's sexual partnerships with another IDU	45%	20% – 50%	[17, 23]
Proportion of sexual partnerships that involve condom use			
IDU	20%	10% – 30%	[15, 16, 27]
Non-IDU	30%	20% – 40%	[15, 16, 28]
Condom effectiveness	90%	85% – 95%	[15, 16, 29]
Annual probability of HIV infection transmission per unprotected sexual partnership if not on HAART			
Asymptomatic HIV (CD4 >350 cells/mm^3)	0.04	0.01 – 0.05	[15, 16, 62-67]
Symptomatic HIV (CD4 200 – 350 cells/mm^3)	0.05	0.02 – 0.07	[15, 16, 62-67]
AIDS (CD4 <200 cells/mm^3)	0.08	0.05 – 0.11	[15, 16, 62-67]
Reduction in infectivity by sexual contact if on HAART	90%	50% – 99%	[7-10]

Table A2 (Cont.)

Parameter	Value	Range	Source
Cost Parameters			
Annual discount rate	3%	0%-5%	[68, 69]
Annual healthcare costs (non-HIV related)	$115	$80 – $250	[36]
Annual HIV related healthcare costs	$570	$450 – $1,000	[35]
Annual HAART costs	$1,700	$800 - $3,000	[33, 34]
Annual counseling and adherence services costs	$250	$100 – $500	Estimated based on interviews with HIV prevention experts in Russia
Annual ancillary IDU services costs	$500	$300 – $1,000	Estimated based on interviews with HIV prevention experts in Russia

* Parameter values and ranges were estimated based on the sources listed. IDU = injection drug user; Non-IDU = non-injection drug user; HAART = highly active antiretroviral therapy.

Table A3: Results of sensitivity analysis on key parameters *

Parameter	Base Value	Range	Outcome	IDU Targeted Treatment Strategy	Non-IDU Targeted Treatment Strategy	Untargeted Treatment Strategy	Optimistic Untargeted Treatment Strategy
Annual Probability of Sexual Transmission per Partnership			**Infections Averted**				
Asymptomatic HIV	0.04	0.01–0.05	Among IDUs	9,816–11,423	17–72	6,300–7,102	9,847–11,598
Symptomatic HIV	0.05	0.02–0.07	Among Non-IDUs	10,773–45,893	1,974–18,231	8,008–38,948	12,301–58,953
AIDS	0.08	0.05–0.11	**ICER**	$2,265–$1,153	$2,842–$2,328	$2,417–$1,592	$2,390–$1,528
HAART Effect on Transmission			**Infections Averted**				
Reduction in Injection Infectivity	50%	10%–90%	Among IDUs	1,403–20,959	(-35)–62	896–12,443	1,370–21,166
Reduction in Sexual Infectivity	90%	50%–99%	Among Non-IDUs	7,618–37,596	2,767–10,851	6,440–29,753	10,103–45,096
			ICER	$3,090–$1,089	$3,157–$2,466	$3,119–$1,539	$3,123–$1,438
Risky Injecting Behavior			**Infections Averted**				
Number of Injections per Year	250	200–300	Among IDUs	12,478–5,928	282–(-104)	8,263–3,652	12,756–5,875
Proportion of Shared Injections	15%	8%–25%	Among Non-IDUs	24,220–32,017	8,027–10,958	20,026–26,131	30,225–40,231
			ICER	$1,320–$1,739	$2,506–$2,597	$1,737–$2,051	$1,689–$2,013
Risky Sexual Behavior			**Infections Averted**				
Number of Sexual Partnerships per Year, IDU	4.3	3.0–10.0	Among IDUs	10,173–10,613	26–40	6,468–6,448	10,230–10,884
Number of Sexual Partnerships per Year, Non-IDU	1.3	1.0–1.8	Among Non-IDUs	18,401–82,715	5,075–30,400	14,568–68,109	22,317–103,860
			ICER	$1,887–$779	$2,710–$2,407	$2,156–$1,420	$2,121–$1,337
Annual Cost of HAART	$1,700	$800–$3,000	**ICER**	$991–$2,237	$1,590–$3,991	$1,203–$2,850	$1,172–$2,773

* The first outcome value corresponds to the low parameter estimate, and the second outcome value corresponds to the high parameter estimate, assuming all other parameter values are as in the base case. IDU = injection drug user; Non-IDU = non-injection drug user; HAART = highly active antiretroviral therapy; ICER = incremental cost-effectiveness ratio, relative to the Status Quo.

Table A4: Results for Barnaul *

Barnaul, Russia	Status Quo	IDU Targeted Treatment Strategy	Non-IDU Targeted Treatment Strategy	Untargeted Treatment Strategy	Optimistic Untargeted Treatment Strategy
Costs ($1000s)	$1,214,814	$1,227,677	$1,229,276	$1,230,937	$1,237,201
QALYs (1000s)	10,348	10,362	10,354	10,360	10,366
Incremental Cost-Effectiveness Ratio	---	$931	$2,684	$1,343	$1,278
HIV Prevalence After 20 Years					
Among IDUs	7.6%	5.6%	7.4%	6.2%	5.5%
Among Non-IDUs	0.3%	0.1%	0.3%	0.2%	0.2%
Number of People Treated	9	750	666	846	1,173
HIV Infections Averted					
Among IDUs	--- †	766	35	530	789
Among Non-IDUs	--- †	630	106	476	700
Total	--- †	1,396	141	1,006	1,489

* This table shows health and economic outcomes, using data for Barnaul, Russia. IDU = injection drug user; Non-IDU = non-injection drug user; QALYs = quality-adjusted life years. The incremental cost-effectiveness ratio for each strategy is relative to the Status Quo.
† With the Status Quo, a total of 4,072 HIV infections occurred over 20 years, including 2,469 among IDUs and 1,603 among non-IDUs.

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