**Cost-Effectiveness of Alternative Strategies for Provision of HIV Pre-Exposure Prophylaxis for People Who Inject Drugs**

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**SUPPLEMENT**

**Table S1. Values and Sources for Model Parameters\***

| **Parameter** | **Value** | **Range** | **Source** |
| --- | --- | --- | --- |
| **Demographics** |  |  |  |
| Number of male PWID | 5,000 | -- | Assumed |
| Number of female PWID | 3,503 | -- | Calculated |
| Annual entry rate | 0.012 | -- | [[2](#_ENREF_2)] |
| Non-HIV annual mortality rate |  |  |  |
| PWID not on OAT | 0.011 | -- | [[3](#_ENREF_3), [4](#_ENREF_4)] |
| PWID on OAT | HR 0.39 | -- | [[2](#_ENREF_2), [3](#_ENREF_3)] |
| **Initial HIV conditions** |  |  |  |
| HIV prevalence | 9.8% | -- | [[5](#_ENREF_5)] |
| Fraction aware of HIV status | 69.9% | -- | [[5](#_ENREF_5), [6](#_ENREF_6)] |
| Initial ART enrollment given aware | 40.9% | -- | [[7](#_ENREF_7), [8](#_ENREF_8)] |
| **HIV health states (average duration)** |  |  |  |
| Acute HIV | 12 weeks | -- | [[9](#_ENREF_9), [10](#_ENREF_10)] |
| Asymptomatic HIV | 5.3 years | -- | [[10-12](#_ENREF_10)] |
| Symptomatic HIV | 7.1 years | -- | [[10-12](#_ENREF_10)] |
| Symptomatic HIV on ART | 20.0 years | -- | [[10](#_ENREF_10), [13](#_ENREF_13), [14](#_ENREF_14)] |
| AIDS | 1.7 years | -- | [[10](#_ENREF_10)] |
| AIDS on ART | 5.3 years | -- | [[10](#_ENREF_10), [13](#_ENREF_13), [14](#_ENREF_14)] |
| **ART** |  |  |  |
| Transmission reduction if injecting partner is on ART | 59% | -- | [[15](#_ENREF_15), [16](#_ENREF_16)] |
| Transmission reduction if sexual partner is on ART | 90% | -- | [[10](#_ENREF_10), [16](#_ENREF_16), [17](#_ENREF_17)] |
| **PrEP** |  |  |  |
| Weekly infection reduction | 48.9% | 10%-90% | [[15](#_ENREF_15)] |
| Screening frequency | 3 months | -- | [[18](#_ENREF_18)] |
| **Injecting behavior** |  |  |  |
| Long-term needle-sharing partnership duration | 36 months | -- | [[19](#_ENREF_19), [20](#_ENREF_20)] |
| Long-term partnership distribution |  |  | [[21](#_ENREF_21)] |
| 0 partners | 64% | -- |  |
| 1 partner | 21% | -- |  |
| 2 partners | 11% | -- |  |
| 3 partners | 3% | -- |  |
| 4 partners | 1% | -- |  |
| Distribution of long-term sharing frequency |  |  | [[22](#_ENREF_22)] |
|  1 time per month | 38% | -- |  |
|  1 time per week | 45% | -- |  |
|  1 time per day | 17% | -- |  |
| One-time sharing frequency | 0.14 times/week | -- | Estimated\*\* |
| Transmission rate per injection |  |  |  |
| Asymptomatic HIV | 0.05% | -- | [[10](#_ENREF_10), [23](#_ENREF_23)] |
| Symptomatic HIV | HR 2.85 | -- | [[10](#_ENREF_10), [23](#_ENREF_23)] |
| AIDS | HR 7.10 | -- | [[10](#_ENREF_10), [23](#_ENREF_23)] |
| Acute HIV | HR 24.50 | -- | [[9](#_ENREF_9), [10](#_ENREF_10), [23](#_ENREF_23)] |
| **Opioid agonist therapy** |  |  |  |
| Initial PWID enrollment  | 25% | 25%-60% | [[6](#_ENREF_6), [24](#_ENREF_24), [25](#_ENREF_25)] |
| Percent of PWID who quit annually | 31.5% | -- | [[24](#_ENREF_24)] |
| **Sexual behavior** |  |  |  |
| Percent of male PWID having a regular sex partner | 58% | -- | [[21](#_ENREF_21)] |
| Percent of female PWID having a regular sex partner | 82% | -- | Calculated |
| Partnership duration |  |  |  |
|  Regular sex partner | 24 months | -- | [[26](#_ENREF_26)] |
|  Casual sex partner | 6 months | -- | Estimated\*\* |
| Concurrent sexual partnership distribution, male and female |  |  | [[21](#_ENREF_21)] |
|  0 partners | 26%, 15% | -- |  |
|  1 partner | 51%, 48% | -- |  |
|  2 partners | 17%, 12% | -- |  |
|  3 partners | 6%, 25% | -- |  |
| Transmission rate per coital act |  |  |  |
| Asymptomatic HIV | 0.06% | -- | [[27](#_ENREF_27)] |
| Symptomatic HIV | HR 2.85 | -- | [[10](#_ENREF_10), [23](#_ENREF_23)] |
| AIDS | HR 7.10 | -- | [[10](#_ENREF_10), [23](#_ENREF_23)] |
| Acute HIV | HR 24.50 | -- | [[9](#_ENREF_9), [10](#_ENREF_10), [23](#_ENREF_23)] |
| Transmission reduction due to condom use | 80% | -- | [[28](#_ENREF_28), [29](#_ENREF_29)] |
| Fraction of coital acts with consistent condom use |  |  |  |
| Regular partnership | 16% | -- | [[26](#_ENREF_26), [30](#_ENREF_30), [31](#_ENREF_31)] |
| Casual partnership | 50% | -- | [[32](#_ENREF_32)] |
| Relative risk of condom use, HIV aware | 1.66 | -- | [[25](#_ENREF_25)] |
| **Annual costs (2016 US dollars)** |  |  |  |
| Healthcare for uninfected PWID | 3,000 | -- | [[2](#_ENREF_2), [24](#_ENREF_24)] |
| Opioid agonist therapy | 7,000 | -- | [[2](#_ENREF_2), [24](#_ENREF_24)] |
| PrEP drug | 10,000 | 4,000-10,000 | [[33-36](#_ENREF_33)] |
| PrEP screening services§ | 800 | -- | [[33](#_ENREF_33), [37](#_ENREF_37)] |
| ART | 15,000 | -- | [[12](#_ENREF_12), [16](#_ENREF_16), [37](#_ENREF_37), [38](#_ENREF_38)] |
| HIV care |  |  |  |
|  Asymptomatic HIV | 4,000 | -- | [[12](#_ENREF_12), [16](#_ENREF_16), [24](#_ENREF_24), [37](#_ENREF_37), [38](#_ENREF_38)] |
|  Symptomatic HIV, not on ART | 7,000 | -- | [[12](#_ENREF_12), [16](#_ENREF_16), [24](#_ENREF_24), [37](#_ENREF_37), [38](#_ENREF_38)] |
|  Symptomatic HIV, on ART§§ | 6,500 | -- | [[12](#_ENREF_12), [16](#_ENREF_16), [24](#_ENREF_24), [37](#_ENREF_37), [38](#_ENREF_38)] |
|  AIDS, not on ART | 20,040 | -- | [[12](#_ENREF_12), [16](#_ENREF_16), [24](#_ENREF_24), [37](#_ENREF_37), [38](#_ENREF_38)] |
|  AIDS, on ART | 10,000 | -- | [[12](#_ENREF_12), [16](#_ENREF_16), [24](#_ENREF_24), [37](#_ENREF_37), [38](#_ENREF_38)] |
| Annual discount rate | 3% | -- | [[39](#_ENREF_39), [40](#_ENREF_40)] |
| **Additional PrEP program parameters** |  |  |  |
| PrEP coverage level (percent of eligible PWID) | 25% | 5%-50% | Assumed |
| Cost of contact tracing (2016 US dollars) | 400 | 0-1000 | [[41](#_ENREF_41)] |
| Success rate of contact tracing | 30% | 10%-100% | [[41](#_ENREF_41)] |
| Cost of partnership information, per person (2016 US dollars) | 0 | 0-600 | Assumed |
| **Quality-of-life multipliers** |  |  |  |
| PWID  | 0.90 | -- | [[16](#_ENREF_16), [42](#_ENREF_42)] |
| PWID on opioid agonist therapy  | 0.95 | -- | [[2](#_ENREF_2), [24](#_ENREF_24), [42](#_ENREF_42)] |
| Asymptomatic HIV | 0.94 | -- | [[16](#_ENREF_16), [43](#_ENREF_43)] |
| Symptomatic HIV | 0.81 | -- | [[16](#_ENREF_16), [43](#_ENREF_43)] |
| AIDS | 0.7 | -- | [[16](#_ENREF_16), [43](#_ENREF_43)] |
| ART multiplier | 1.15 | -- | [[12](#_ENREF_12), [16](#_ENREF_16), [33](#_ENREF_33), [42](#_ENREF_42)] |

\* ART = antiretroviral therapy, HR = hazard ratio, OAT = opioid agonist therapy, PWID = people who inject drugs

\*\* Estimated through calibration

§ Individuals on PrEP are screened for HIV every three months

§§ Disease costs while on ART exclude cost of ART

**References**

1. Fu R, Gutfraind A, Brandeau ML. **Modeling a dynamic bi-layer contact network of injection drug users and the spread of blood-borne infections**. *Math Biosci* 2016; 273:102-113.

2. Cipriano LE, Zaric GS, Holodniy M, Bendavid E, Owens DK, Brandeau ML. **Cost effectiveness of screening strategies for early identification of HIV and HCV infection in injection drug users**. *PLoS One* 2012; 7(9):e45176.

3. Degenhardt L, Hall W, Warner-Smith M. **Using cohort studies to estimate mortality among injecting drug users that is not attributable to AIDS**. *Sex Transm Infect* 2006; 82 Suppl 3:iii56-63.

4. Arias E. **United States life tables, 2010**. *Natl Vital Stat Rep* 2014; 63(7):1-63.

5. Spiller MW, Broz D, Wejnert C, Nerlander L, Paz-Bailey G. **HIV infection and HIV-associated behaviors among persons who inject drugs--20 cities, United States, 2012**. *MMWR Morb Mortal Wkly Rep* 2015; 64(10):270-275.

6. Broz D, Wejnert C, Pham HT, DiNenno E, Heffelfinger JD, Cribbin M, et al. **HIV infection and risk, prevention, and testing behaviors among injecting drug users -- National HIV Behavioral Surveillance System, 20 U.S. cities, 2009**. *MMWR Surveill Summ* 2014; 63(6):1-51.

7. Westergaard RP, Ambrose BK, Mehta SH, Kirk GD. **Provider and clinic-level correlates of deferring antiretroviral therapy for people who inject drugs: a survey of North American HIV providers**. *J Int AIDS Soc* 2012; 15(1):10.

8. Spire B, Lucas GM, Carrieri MP. **Adherence to HIV treatment among IDUs and the role of opioid substitution treatment (OST)**. *Int J Drug Policy* 2007; 18(4):262-270.

9. Pilcher CD, Tien HC, Eron JJ, Jr., Vernazza PL, Leu SY, Stewart PW, et al. **Brief but efficient: acute HIV infection and the sexual transmission of HIV**. *J Infect Dis* 2004; 189(10):1785-1792.

10. Hollingsworth TD, Anderson RM, Fraser C. **HIV-1 transmission, by stage of infection**. *J Infect Dis* 2008; 198(5):687-693.

11. Tempalski B, Pouget ER, Cleland CM, Brady JE, Cooper HL, Hall HI, et al. **Trends in the population prevalence of people who inject drugs in US metropolitan areas 1992-2007**. *PLoS One* 2013; 8(6):e64789.

12. Sanders GD, Bayoumi AM, Sundaram V, Bilir SP, Neukermans CP, Rydzak CE, et al. **Cost-effectiveness of screening for HIV in the era of highly active antiretroviral therapy**. *N Engl J Med* 2005; 352(6):570-585.

13. Samji H, Cescon A, Hogg RS, Modur SP, Althoff KN, Buchacz K, et al. **Closing the gap: increases in life expectancy among treated HIV-positive individuals in the United States and Canada**. *PLoS One* 2013; 8(12):e81355.

14. Wada N, Jacobson LP, Cohen M, French A, Phair J, Munoz A. **Cause-specific mortality among HIV-infected individuals, by CD4(+) cell count at HAART initiation, compared with HIV-uninfected individuals**. *AIDS* 2014; 28(2):257-265.

15. Choopanya K, Martin M, Suntharasamai P, Sangkum U, Mock PA, Leethochawalit M, et al. **Antiretroviral prophylaxis for HIV infection in injecting drug users in Bangkok, Thailand (the Bangkok Tenofovir Study): a randomised, double-blind, placebo-controlled phase 3 trial**. *Lancet* 2013; 381(9883):2083-2090.

16. Long EF, Brandeau ML, Owens DK. **The cost-effectiveness and population outcomes of expanded HIV screening and antiretroviral treatment in the United States**. *Ann Intern Med* 2010; 153(12):778-789.

17. Castilla J, Del Romero J, Hernando V, Marincovich B, Garcia S, Rodriguez C. **Effectiveness of highly active antiretroviral therapy in reducing heterosexual transmission of HIV**. *J Acquir Immune Defic Syndr* 2005; 40(1):96-101.

18. Centers for Disease Control and Prevention (CDC). **Preexposure prophylaxis for the prevention of HIV infection in the United States – 2014, a clinical practice guideline**. In: *US Public Health Service* Atlanta, GA; 2014.

19. Hellard M, McBryde E, Davis RS, Rolls DA, Higgs P, Aitken C, et al. **Hepatitis C transmission and treatment as prevention - The role of the injecting network**. *Int J Drug Policy* 2015; 26(10):958-962.

20. Sacks-Davis R, Daraganova G, Aitken C, Higgs P, Tracy L, Bowden S, et al. **Hepatitis C virus phylogenetic clustering is associated with the social-injecting network in a cohort of people who inject drugs**. *PLoS One* 2012; 7(10):e47335.

21. Huo D, Ouellet LJ. **Needle exchange and injection-related risk behaviors in Chicago: a longitudinal study**. *J Acquir Immune Defic Syndr* 2007; 45(1):108-114.

22. Shaw SY, Shah L, Jolly AM, Wylie JL. **Determinants of injection drug user (IDU) syringe sharing: the relationship between availability of syringes and risk network member characteristics in Winnipeg, Canada**. *Addiction* 2007; 102(10):1626-1635.

23. Public Health Agency of Canada. **HIV transmission risk: a summary of the evidence**. In. Ottawa; 2012.

24. Zaric GS, Barnett PG, Brandeau ML. **HIV transmission and the cost-effectiveness of methadone maintenance**. *Am J Public Health* 2000; 90(7):1100-1111.

25. Bernard CL, Brandeau ML, Humphreys K, Bendavid E, Holodniy M, Weyant C, et al. **Cost-effectiveness of HIV preexposure prophylaxis for people who inject drugs in the United States**. *Ann Intern Med* 2016; 65(1):10-19.

26. Kapadia F, Latka MH, Hudson SM, Golub ET, Campbell JV, Bailey S, et al. **Correlates of consistent condom use with main partners by partnership patterns among young adult male injection drug users from five US cities**. *Drug Alcohol Depend* 2007; 91 Suppl 1:S56-63.

27. Bernard CM, Owens DK, Goldhaber-Fiebert JD, Brandeau ML. **Estimation of the cost-effectiveness of HIV prevention portfolios for people who inject drugs in the United States: a model-based analysis**. *PLoS Med* 2017; 14(5):e1002312.

28. Del Romero J, Castilla J, Hernando V, Rodriguez C, Garcia S. **Combined antiretroviral treatment and heterosexual transmission of HIV-1: cross sectional and prospective cohort study**. *Bmj* 2010; 340:c2205.

29. Weller S, Davis K. **Condom effectiveness in reducing heterosexual HIV transmission**. *Cochrane Database Syst Rev* 2002; (1):CD003255.

30. Marshall BDL, Wood E, Zhang R, Tyndall MW, Montaner JSG, Kerr T. **Condom use among injection drug users accessing a supervised injecting facility**. *Sex Transm Infect* 2009; 85(2):121-126.

31. Tyndall MW, Patrick D, Spittal P, Li K, O'Shaughnessy MV, Schechter MT. **Risky sexual behaviours among injection drugs users with high HIV prevalence: implications for STD control**. *Sex Transm Infect* 2002; 78 Suppl 1:i170-175.

32. Public Health Agency of Canada Centre for Communicable Diseases and Infection Control. **I-Track: Enhanced surveillance of HIV, hepatitis C and associated risk behaviours among people who inject drugs in Canada: Phase 2 report**. In. Toronto; 2014.

33. Juusola JL, Brandeau ML, Owens DK, Bendavid E. **The cost-effectiveness of preexposure prophylaxis for HIV prevention in the United States in men who have sex with men**. *Ann Intern Med* 2012; 156(8):541-550.

34. Paltiel AD, Freedberg KA, Scott CA, Schackman BR, Losina E, Wang B, et al. **HIV preexposure prophylaxis in the United States: impact on lifetime infection risk, clinical outcomes, and cost-effectiveness**. *Clin Infect Dis* 2009; 48(6):806-815.

35. New York State Department of Health. **Pre-exposure prophylaxis (PrEP) to prevent HIV infection: questions and answers**. In; 2012.

36. U.S. Department of Veterans Affairs Office of Acquisitions and Logistics. **Pharmaceutical prices**. In; 2017.

37. Paltiel AD, Weinstein MC, Kimmel AD, Seage GR, 3rd, Losina E, Zhang H, et al. **Expanded screening for HIV in the United States--an analysis of cost-effectiveness**. *N Engl J Med* 2005; 352(6):586-595.

38. Barnett PG, Chow A, Joyce VR, Bayoumi AM, Griffin SC, Sun H, et al. **Effect of management strategies and clinical status on costs of care for advanced HIV**. *Am J Manag Care* 2014; 20(5):e129-137.

39. Weinstein MC, O'Brien B, Hornberger J, Jackson J, Johannesson M, McCabe C, et al. **Principles of good practice for decision analytic modeling in health-care evaluation: report of the ISPOR Task Force on Good Research Practices--Modeling Studies**. *Value Health* 2003; 6(1):9-17.

40. Gold M. **Panel on cost-effectiveness in health and medicine**. *Med Care* 1996; 34(12 Suppl):DS197-199.

41. Lewis S. **Estimates of partner notification cost and success rate. Personal communication.** In. Santa Clara County Public Health Department, Santa Clara, CA. ; 2017.

42. Alistar SS, Owens DK, Brandeau ML. **Effectiveness and cost effectiveness of oral pre-exposure prophylaxis in a portfolio of prevention programs for injection drug users in mixed HIV epidemics**. *PLoS One* 2014; 9(1):e86584.

43. Tengs TO, Lin TH. **A meta-analysis of utility estimates for HIV/AIDS**. *Med Decis Making* 2002; 22(6):475-481.