Acute HIV Infection Transmission Among People who Inject Drugs in an Established Epidemic Setting

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Introduction

• Estimates suggest that 16 million people worldwide inject drugs, and comprise approximately 0.2% of the global population. Despite the relatively modest portion of the world population, people who inject drugs (PWID) account for about 10% of incident HIV infections annually.

• There are significant barriers to the wide-scale detection of early HIV infections (EH), including acute HIV infection (AHI), which is characterized by high viral replication and other factors that increase transmission potential.

• Estimating the proportion of AHI-attributable infections among a population of PWID is important in understanding the potential impact and limitations of prevention efforts.

Methods

• The AHI was previously calibrated to reproduce the sociodemographics, risk behavior, and HIV epidemic trajectory observed in the New York metropolitan statistical area (MSA) population between 1992-201212.

• Agents interact in a mixed, dynamic sexual and injecting network, representing a 100,000-person population, which is scaled upward to represent the NYC MSA between 1992-2012.

• Each agent has a unique, time-updated probability of acquiring or transmitting HIV determined by their:
  - risk behavior,
  - partnerships,
  - engagement in simulated prevention interventions (i.e., HAART), and
  - HIV disease stage.

• Using stochastic microsimulations, we calculated transmission events based on the disease stage of the index agent to determine the proportion of infections transmitted during AHI (defined as the three month period following infection).

• Estimates from the main analysis represent the means of results from 10 Monte Carlo simulations run on a supercomputer administered by the Center for Computation and Visualization at Brown University.

Objective

To use agent-based modeling (ABM) to estimate the contribution of AHI-attributable transmission to total transmission events arising from PWID in a large urban setting with a mature HIV epidemic.

Results

• The calibrated model produced the following epidemic trajectory among PWID in the NYC MSA between 1992 and 2012:
  - PWID comprised 1.3% of the general population in 1992 which decreased to 1.2% by 2012.
  - Average annual incidence over this period was 0.06% for the general population, and 2.1% for PWID (see Figure 2 for annualized incidence for each monthly time-step).
  - Prevalence of HIV among PWID decreased from approximately 43% in 1992 to 14% in 2012 (Figure 3).

• By 2012, 35% of PWID were currently enrolled on HAART.

• Sensitivity analyses revealed that adjusting the assumed length of AHI from 1 month to 4 months, and then 6 months, yielded the following AHI-attributable proportions, respectively: 3%, 15%, and 20%.

Conclusions

• The results suggest that although AHI may have a significant role in overall HIV transmission among PWID in an established epidemic setting, estimates appear to be less than attributable-proportions estimated for other high-risk populations (e.g., men who have sex with men).

Recommendations

• We recommend that further research be conducted to determine the effect of specific prevention modalities on preventing AHI-attributable transmission, including treatment as prevention (TasP), pre-exposure prophylaxis (PrEP), and needle and syringe programs (NSP).

Specific model assumptions such as the relative infectiousness of transmission modes, risk behavior/network distribution during AHI, and effect of prevention modalities on this population are either either not well understood. Additionally, certain model estimates may differ substantially from empirical estimates (i.e., HIV incidence among PWID).

References


Figure 1. Annualized Proportion of Total HIV Infections Attributable to Acute HIV Infection

Figure 2. Annualized HIV Incidence (per 100 person-years)

Figure 3. Prevalence of HIV

Note: All figures correspond to the populations of people who inject drugs (PWID) within the AHI window. Figure 2 and 3 depict annualized estimates for the period 1994-2012, because annualized estimates for the first two simulation years could not be calculated using current methods.