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

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CROI 2015
Modelling HIV Epidemiology
Poster 1116; Session PZ2

Introduction

• Estimates suggest that 16 million people worldwide inject drugs, and comprise approximately **0.2%** of the global population. Despite this 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 (EHI), 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

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

Methods

• The ABM was previously calibrated to reproduce the sociodemographics, risk behavior, and HIV epidemic trajectory observed in the New York metropolitan statistical area (MSA) population between 1992-2002[1,2].

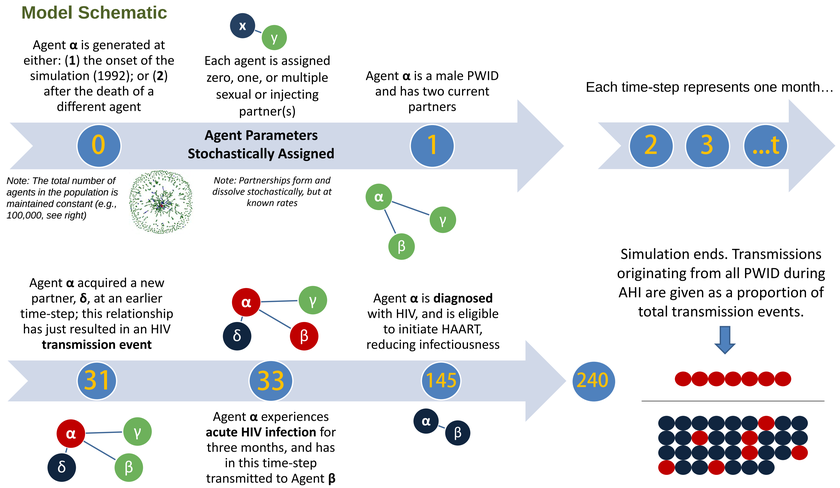
• Agents interact in a mixed, dynamic sexual and injecting network, representing a 100,000 population, which is scaled upward to represent the NYC MSA between 1992-2012.

- 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 catalogued 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

Model Schematic



Results

• The calibrated model produced the following epidemic trajectory among PWID in the NYC MSA between 1992 and 2012:

- PWID comprised **1.9%** 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

• Over the entire period AHI accounted for **10%** of incident HIV cases among PWID, with the following period-specific estimates: **6%** (1992-1996, pre-HAART), **9%** (1997-2004), and **13%** (2005-2012). (**Figure 1**)

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

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

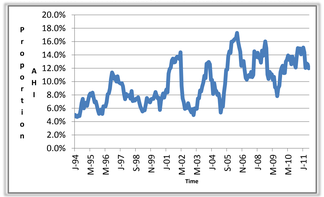


Figure 2. Annualized HIV Incidence (per 100 person-years)

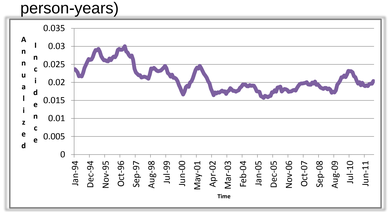
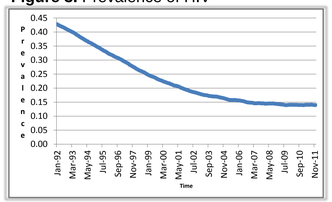


Figure 3. Prevalence of HIV



Note: All figures correspond to the populations of people who inject drugs (PWID) within the ABM population. Figures 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.

Conclusions

• This is the first study to produce an estimate for the proportion of incident HIV infections attributable to AHI among PWID

• 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**)

Limitations

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 untested or poorly understood. Additionally, certain model estimates may differ substantially from empirical estimates (i.e., HIV incidence among PWID).

Acknowledgments
This research was supported in part by an NIH grant (F31-DA037808) to DJ Escudero, and by an NIH grant (R01-DA013336) as part of the Community Vulnerability and Responses to Drug-User Related HIV/AIDS (CVAR) study. This study was also funded in part by a developmental grant from the Lifespan/Tufts/Brown Center for AIDS Research (P30-AI042853). BDL Marshall was supported by a Salomon Faculty Research Award from Brown University.

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