Where Should We Focus?

PrEP retention vs. PrEP uptake: Results from an agent-based network model of HIV transmission


June 9, 2018
Study Motivation

• The annual number of new HIV infections has been <1000 since 2013 in Chicago, a reduction of 28% from 2006-2015.

• A plan for “Getting to zero” (G2Z) new HIV infections is being developed in Chicago and Illinois by the Health Departments and convened by the AIDS Foundation of Chicago.

• Many of the new HIV infections are concentrated among young Black men who have sex with men (YBMSM), where overall prevention successes have had limited effect.

• G2Z efforts among YBMSM require expanded uptake of preexposure prophylaxis (PrEP) and antiretroviral treatment (ART).
Overall, about 10% of individuals who can benefit from PrEP in Chicago are using it.

Data indicate that about 13% of HIV-negative Black MSM are using PrEP.

The “Getting to Zero” initiative aims to increase ART and PrEP use by about 20% over the next 10 years.
The BARS Agent-Based Model (ABM)

• The BARS ABM incorporates empirical data on micro-level behaviors and sexual network structure to aggregate population-level outcomes.

• Additionally, we account for a number of process that impact transmission, including demography, biology, antiretroviral treatment (ART), preexposure prophylaxis (PrEP).

• We use data from empirical studies* and the published literature to parameterize these processes.

• We use computational tools to conduct sensitivity analyses and aggregate outcomes from model runs.

- Add agents due to births
- Age existing agents by 1 timestep
- Remove existing agents due to death (natural and infection-related)

- Agents form partnerships, consistent with empirical parameters
- Partnerships dissolve, consistent with mean partnership length

- Update viral load in HIV-infected agents
- Update of CD4 counts in HIV-infected agents (both parameters contingent upon ART-status)

- HIV-infected agents initiate ART (with testing or time since diagnosis) consistent with data on initiation
- Partners of HIV-infected initiate PrEP

- List serodiscordant partners
- Compute infectivity of positive partner, adjusted by:
  - viral load
  - stage of infection
  - ART status
  - PrEP status (of uninfected partner)
  - circumcision of susceptible partners

Initialization with model inputs

Demography

Network Behavior

Biology

Treatment/PrEP

Infection Transmission

Max Time?

Yes

Simulation End

No
Implementing the ABM

https://github.com/khanna7/BARS/

- Dynamic network modeling tools in the statnet project to simulate sexual networks.
  http://www.statnet.org/

- Agent behaviors are simulated using the Repast High Performance Computing toolkit.
  https://repast.github.io/repast_hpc.html

- Large parameter spaces are searched using tools from the EMEWS project.
  http://emews.org
Modeling Objectives

• To project, if current levels of PrEP uptake and other parameters do not change, what the simulated incidence among young Black MSM after 10 years will be.

• If PrEP is scaled up to higher levels of uptake according to G2Z targets, what will the incidence be after 10 years?

• If the average retention of PrEP uptake is increased, what will the incidence be after 10 years?

• Where should G2Z initiatives focus – levels of uptake or retention periods?
Modeling Assumptions: PrEP Uptake and Targets

Current Use

• We focus on 18-34 year-old Black MSM.
• We assume that 12.7% of HIV-negatives in the 18-25 year bracket and 14.7% of HIV-positives in the 26-34 year bracket currently use PrEP. (uConnect)
• We assume that PrEP initiators use PrEP for an average of 6 months.

Targets

• We consider PrEP uptake to reach levels from 20% to 60% in 10% point increments. These occur uniformly over the first 5 years, and stay constant over the next five.
• We increase average PrEP retention from 6 months to 24 months in discrete increments.
### Results: HIV outcomes in the 10th year of intervention

#### Increase PrEP Uptake

<table>
<thead>
<tr>
<th>% negatives on PrEP</th>
<th>Prevalence (%)</th>
<th>Incidence (per 100 py)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>27.1</td>
<td>3.5</td>
</tr>
<tr>
<td>20</td>
<td>25.8</td>
<td>3.2</td>
</tr>
<tr>
<td>30</td>
<td>25.2</td>
<td>2.9</td>
</tr>
<tr>
<td>40</td>
<td>23.4</td>
<td>2.3</td>
</tr>
<tr>
<td>50</td>
<td>22.1</td>
<td>2.0</td>
</tr>
<tr>
<td>60</td>
<td>21.1</td>
<td>1.8</td>
</tr>
</tbody>
</table>

#### Increase PrEP Retention

<table>
<thead>
<tr>
<th>Average retention on PrEP</th>
<th>Prevalence (%)</th>
<th>Incidence (per 100 py)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months (Base)</td>
<td>27.2</td>
<td>3.5</td>
</tr>
<tr>
<td>9 months</td>
<td>25.9</td>
<td>3.1</td>
</tr>
<tr>
<td>12 months</td>
<td>25.1</td>
<td>3.2</td>
</tr>
<tr>
<td>18 months</td>
<td>24.6</td>
<td>2.8</td>
</tr>
<tr>
<td>24 months</td>
<td>24.5</td>
<td>2.9</td>
</tr>
</tbody>
</table>
Results: HIV incidence in the 10\textsuperscript{th} year of intervention

PrEP Retention: 6 months (avg).

PrEP Uptake: 12.7\% in 18-25; 14.7\% in 26-34
Discussion

• Increasing PrEP uptake and PrEP retention for young Black MSM both appear to have substantial effects on HIV incidence in the 10th year.

• Increasing PrEP uptake from base levels to 30% appears to have about the same effect as increasing average retention from 6 months to 18 months.

• One important consideration is the effort required to increase PrEP uptake versus PrEP retention.
Limitations and Future Directions

• PrEP retention behavior is complex – one average statistic may not describe behavioral complexity in PrEP retention. We are using clinic data from Howard Brown Health to investigate more complex models of PrEP retention.*

• We are considering other interventions to increase PrEP uptake, where PrEP is prioritized to serodiscordant couples and to individuals in key positions in the HIV transmission network.

• We are building in structural factors (for instance, mass incarceration) that are known to adversely impact HIV outcomes.

Acknowledgments

Building Agent-Based Models for Racialized Justice Systems
R01 DA 039 934 (Fujimoto, Harawa, Schneider)
https://github.com/khanna7/BARS/

Repast Suite of ABM Toolkits
Project Lead: Ozik
https://repast.github.io/

Extreme Scale Model Exploration with Swift
Project Lead: Ozik. Funding: R01 GM 115839 (An, Macal), R01 DA 039 934
http://emews.org