Achieving NHAS 90/90/80 Objectives by 2020: 
An Interactive Tool Modeling Local HIV Prevalence Projections

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Introduction

- Tools using local data to help jurisdictions estimate future demand for HIV medical and support services are needed.
- We present an interactive prevalence projection model using data obtained from jurisdictional HIV surveillance and publicly available data to predict HIV incidence and prevalence under conditions varying from status quo to achievement of NHAS 90/90/80 objectives.

Objectives

- To describe a model using Georgia data to predict the number of people living with HIV (PLWH), and number in care, by 2024 under varying conditions of percent diagnosed, retention in care, and mortality.
- To introduce an interactive, user-friendly, online tool to create estimates for other jurisdictions.

Methods

We created a model to estimate HIV prevalence projections through 2024 based on the following parameters:

- Published per capita HIV transmission rates:
  - $u$ = 0.066 undiagnosed PLWH
  - $r_n$ = 0.022 in care but not virally suppressed (NVS)
  - $r_n$ = 0.004 in care and virally suppressed (VS)
  - $r_m$ = 0.053 individuals with no VL in 12 months and presumably out of care (Missing VL)

- Mortality rates for PLWH in Georgia:
  - $\mu_u$ = 0.0025 undiagnosed
  - $\mu_n$ = 0.0066 in care but not virally suppressed
  - $\mu_n$ = 0.0117 in care and virally suppressed
  - $\mu_m$ = 0.015 individuals out of care (Missing VL)

Transition rates between categories from Georgia enhanced HIV/AIDS Reporting System (eHARS) data 2013-2014:

- $\delta$ rate of transition from undiagnosed to diagnosed = 0.23
- $\omega$ rate of transition from in care, NVS to VS = 0.38
- $\rho$ rate of recidivism, or transition from VS to NVS = 0.077
- $\sigma$ rate of transition from NVS to out of care (Missing VL) = 0.25
- $\omega$ rate of transition from VS to out of care (Missing VL) = 0.12
- $\zeta$ rate of re-entry from Missing VL to NVS = 0.07
- $\epsilon$ rate of re-entry from Missing VL to VS = 0.11

Transitions between VL category in Georgia 2013 — 2014

<table>
<thead>
<tr>
<th>Year</th>
<th>VS (VL&lt;200)</th>
<th>Not VS (VL&lt;200)</th>
<th>Missing VL (No VL in 12 months)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>18089</td>
<td>1729</td>
<td>2723</td>
<td>22541</td>
</tr>
<tr>
<td>2014</td>
<td>2762</td>
<td>2720</td>
<td>1791</td>
<td>7273</td>
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<td>2382</td>
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<tr>
<td></td>
<td>23233</td>
<td>6006</td>
<td>22313</td>
<td>48994</td>
</tr>
</tbody>
</table>

Results

- Initial conditions in this model included the number of HIV+ persons in Georgia who are undiagnosed, or diagnosed with viral load <200, >200, or missing in 2014. The dynamic evolution of these subpopulations can be modeled with a differential equation of the form.

$$ \frac{d}{dt} \begin{bmatrix} u \\ n \\ s \\ m \\ \mu \\ \sigma \\ \delta \\ \epsilon \\ \omega \\ \rho \end{bmatrix} = \begin{bmatrix} \tau_u - \delta - \mu_u \\ -\sigma - \delta - \mu_n \\ -\rho - \delta - \mu_s \\ -\rho - \delta - \mu_x \\ -\rho - \delta - \mu_o \\ -\rho - \delta - \mu_z \\ -\rho - \delta - \mu_{\omega} \\ -\rho - \delta - \mu_{\epsilon} \\ -\rho - \delta - \mu_{\mu} \end{bmatrix} u + \begin{bmatrix} 0 \\ \sigma \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} n + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} s + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} m + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \mu + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \sigma + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \delta + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \epsilon + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \omega + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \rho $$

- Figure 1. Status quo scenario. Current rates as of 2014 of diagnosis, transition between compartments, mortality, and transmission estimates unchanged projected to 2024.
- Figure 2. HIV prevalence projections using same initial conditions with diagnosis rate doubled to 0.46.
- Figure 3. HIV prevalence projections with rates of $\epsilon$ (rate of re-entry from Missing VL to NVS) and $\rho$ (rate of re-entry from Missing VL to VS) tripled.
- Figure 4. HIV prevalence projections with multiple interventions.
  - Increase the diagnosis rate (8) by 10%.
  - Triple the rates of $\epsilon$ and $\rho$.
  - Halve the rates $\omega$ (rate of transition from NVS to Missing VL) and $\epsilon$ (rate of transition from VS to Missing VL).
  - Double rate $\omega$ (rate of transition from NVS to VS to VS).
  - Halve the recidivism rate of $\rho$ (rate of recidivism, or transition from VS to NVS)

Conclusions

- Neither doubling the diagnosis rate nor tripling rates of re-engaging out of care PLWH into care alone was adequate to reach 90/90/80 by 2020.
- A multicomponent scenario that achieved NHAS goals resulted in 63,989 PLWH, 57,546 in care, and continued annual prevalence increase through 2024 in Georgia.
- In this model, achieving 90/90/80 by 2020 in Georgia slowed but did not reverse increases in HIV prevalence, and the number of HIV-infected persons needing care and support services more than doubled.

Discussion

- Meeting the NHAS goals will be much more challenging than what has been achieved thus far in HIV care and prevention.
- Realistic goal-setting must recognize that we need be prepared for an increase in the number of HIV-infected persons needing care.
- Decision-makers must understand that achieving an AIDS-free generation is not the same as the end of HIV nor will it mean a decrease in HIV care funding needs.
- This modeling tool can be used by other jurisdictions to predict HIV prevalence and HIV care needs for future years under varying conditions of HIV diagnosis, retention in care, and viral suppression.
- Improving the HIV care infrastructure is imperative.

Limitations

- Estimates based on HIV surveillance are subject to ascertainment bias.
- VL values may be missing because the test was not done, not reported, or that the patient moved to another jurisdiction or died yet the death has not been reported.
- Missing VL data could lead to an overestimation of transmission since these persons are assumed to be not virally suppressed.
- Death rates may change over time as the population of PLWH age or more effective HIV treatments (e.g., long-acting injectable agents) are found.
- The simulations in this model assume steady-state rates of movement PLWH into one model compartment to another whereas rates of diagnosis and viral suppression will likely change with time.

References


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