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 obtainable 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, viral suppression, 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[1]:
τ_u = *0.066* undiagnosed PLWH
τ_n = 0.022 in care but not virally suppressed (NVS)
τ_s = 0.004 in care and virally suppressed (VS)
τ_m= 0.053 individuals with no VL in 12 months and presumably out of care (Missing VL)

Mortality rates for PLWH in Georgia:
μ_u = 0.0025 undiagnosed
μ_n = 0.0566 in care but not virally suppressed
μ_s = 0.0117 in care and virally suppressed
μ_m = 0.015 individuals out of care (Missing VL)

Transition rates between categories from Georgia enhanced HIV/AIDS Reporting System (eHARS) data 2013-2014:
δ rate of transition from undiagnosed to diagnosed = 0.23
σ rate of transition from in care, NVS to VS = 0.38
ρ rate of recidivism, or transition from VS to NVS = 0.077
o_n rate of transition from NVS to out of care (Missing VL) = 0.25
o_s rate of transition from VS to out of care (Missing VL) = 0.12
ϵ_n rate of re-entry from Missing VL to NVS = 0.07
ϵ_s rate of re-entry from Missing VL to VS = 0.11

Transitions between VL category in Georgia 2013 — 2014

	2014			
2013	VS (VL<200)	Not VS (VL>200)	Missing VL (No VL in 12 months)	Total
VS (VL<200)	18089	1729	2723	22541
Not VS (VL>200)	2762	2720	1791	7273
Missing VL	2382	1557	17799	21738
Total	23233	6006	22313	48994

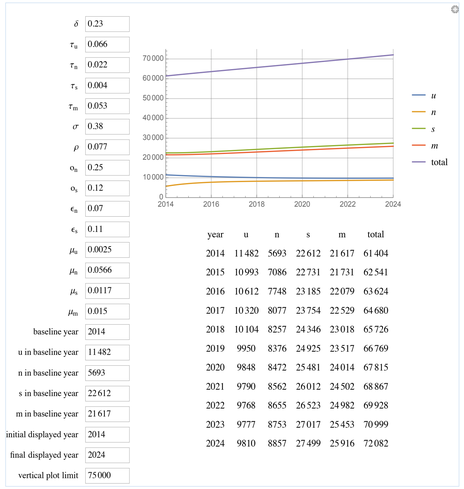
Methods (continued)

Initial conditions in this model included the number of HIV+ persons in Georgia who are undiagnosed,[2] or diagnosed with viral load <200, >200, or missing in 2014.[3] The dynamic evolution of these subpopulations can be modeled with a differential equation of the form

$$\frac{d}{dt}\begin{bmatrix} u \\ n \\ s \\ m \end{bmatrix} = \begin{bmatrix} \tau_u - \delta - \mu_u & \tau_n & \tau_s & \tau_m \\ \delta & -\sigma - o_n - \mu_n & \rho & \epsilon_n \\ 0 & \sigma & -\rho - o_s - \mu_s & \epsilon_s \\ 0 & o_n & o_s & -\epsilon_n - \epsilon_s - \mu_m \end{bmatrix} \begin{bmatrix} u \\ n \\ s \\ m \end{bmatrix}.$$

Results

Figure 1. Status quo scenario. Current rates as of 2014 of diagnosis, transition between compartments, mortality, and transmission estimates unchanged projected to 2024.



year	u	n	s	m	total
2014	11 482	5693	22 612	21 617	61 404
2015	10 993	7086	22 731	21 731	62 541
2016	10 612	7748	23 185	22 079	63 624
2017	10 320	8077	23 754	22 529	64 680
2018	10 104	8257	24 346	23 018	65 726
2019	9950	8376	24 925	23 517	66 769
2020	9848	8472	25 481	24 014	67 815
2021	9790	8562	26 012	24 502	68 867
2022	9768	8655	26 523	24 982	69 928
2023	9777	8753	27 017	25 453	70 999
2024	9810	8857	27 499	25 916	72 082

Figure 2. HIV prevalence projections using same initial conditions with diagnosis rate doubled to 0.46.

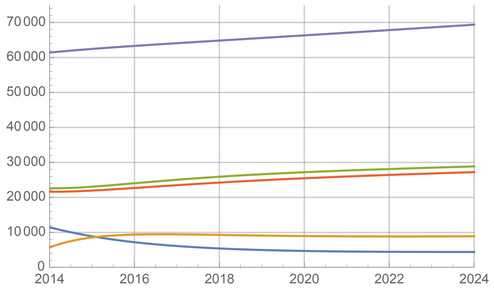


Figure 3. HIV prevalence projections with rates of ϵ_n (rate of re-entry from Missing VL to NVS) and ϵ_s (rate of re-entry from Missing VL to VS) tripled.

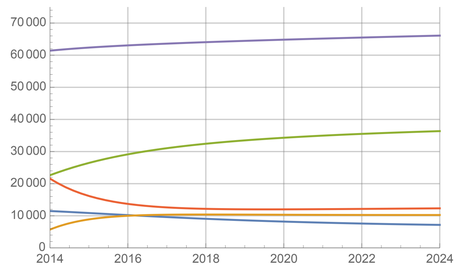
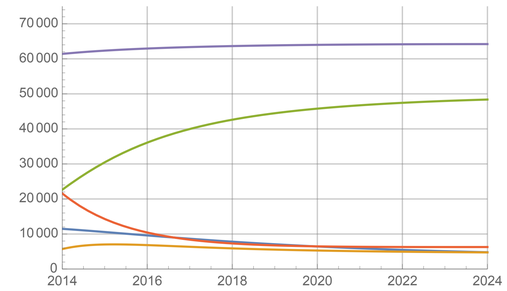


Figure 4. HIV prevalence projections with multiple interventions.

- Increase the diagnosis rate (δ) by 10%.
- Triple the rates of ϵ_n and ϵ_s;
- Halve the rates o_n (rate of transition from NVS to Missing VL) and o_s (rate of transition from VS to Missing VL)
- Double rate σ (rate of transition from in care, NVS to VS)
- Halve the recidivism rate of ρ (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 from one model compartment to another whereas rates of diagnosis and viral suppression will likely change with time.

References

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2. Hall H, An Q, Tang T, Song R, Chen M, Green T, et al. Prevalence of Diagnosed and Undiagnosed HIV Infection — United States, 2008–2012 MMWR Morb Mortal Wkly Rep. 2015 Jun 26;64(24):657 — 62.
3. Georgia Department of Public Health, HIV Care Continuum 2014. https://dph.georgia.gov/hiv-care-continuum

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