Informing the path towards HIV elimination in Montreal among men who have sex with men through HIV combination prevention: a mathematical modelling approach

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Credits to: AIDS Awareness Ribbon (NIH, NIAID)

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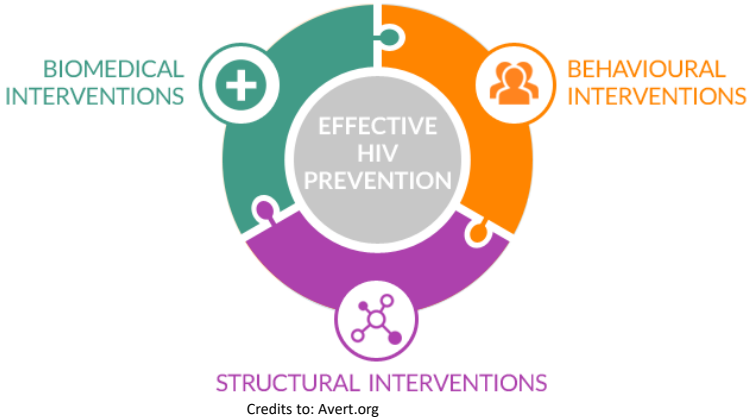
Background and objectives

Background:

- Men who have sex with men (MSM) continue to represent the highest proportion of reported cases of the human immunodeficiency virus (HIV).
- Combined HIV prevention strategies have the potential to eliminate HIV as a public health threat.
- Mathematical models can be used to effectively test the impact of different prevention strategies.
- The model results can be used to inform health policy, enabling Montreal, a UNAIDS Fast-track city, to attain its goal of HIV elimination by 2030.



Credits to: Avert.org

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Ending the HIV, TB, HBV, and HCV Epidemics

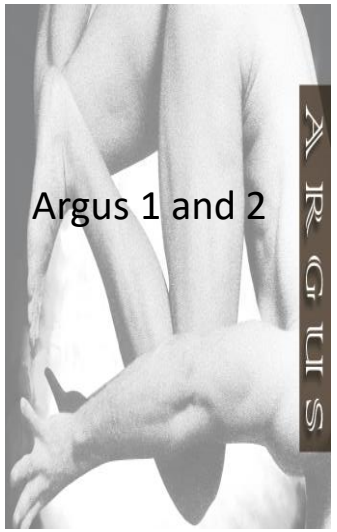
Objectives:

- Develop an individual based model (IBM) of HIV transmission for MSM in Montreal.
- Use the model to quantify the characteristics of the past HIV endemic.

Methods

Data analysis

- 3 Montreal based surveys were analyzed, among other data sources:



Argus 1 and 2

*Standardized;
2005; n=1957,
2008; n=1873

engage
Advancing gay and bisexual men's sexual health

*RDS adjusted; 2017; n= 1179

- The analysis characterised temporal trends and population-level parameters that were used to inform the model structure and parameterization.

Model building and calibration

Individual based model (Fig. 1)

- MSM aged 15 and up in Montreal.
- Time horizon: 1975-2017.
- Included partnership formation, sexual behaviours, and disease progression.

Calibrated using an Approximate Bayesian Computation- Sequential Monte Carlo technique.

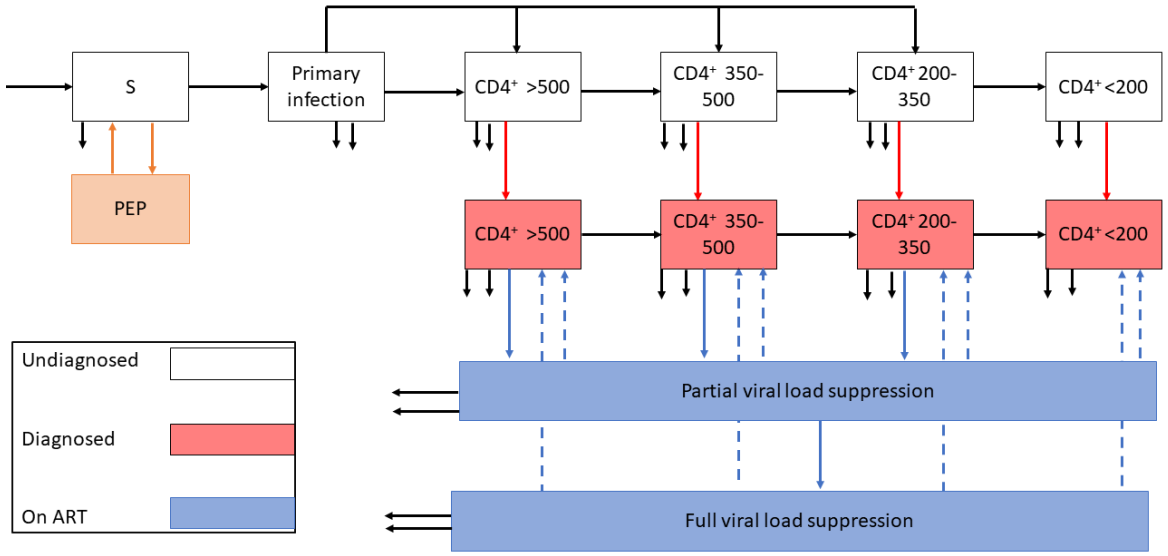


Figure 1: HIV natural history and intervention structure. ART naïve people living with HIV (PLHIV) can progress through the natural history of HIV. PLHIV can be tested and start ART at any time. Men with partial or full viral load suppression do not progress through the various stages of HIV natural history.

Results

Data analysis

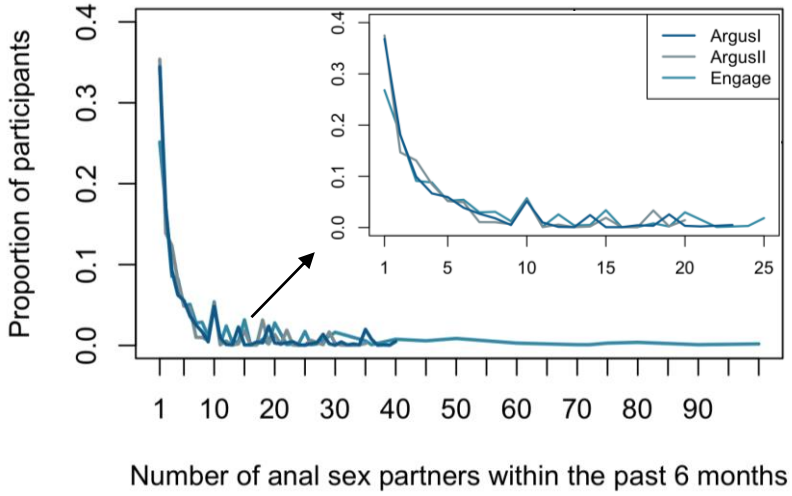


Figure 2: Number of reported anal sex partners over the past 6 months. Participants included men who had anal sex at least once within the past 6 months. There were minimal temporal changes between 2005 (Argus I), 2008 (Argus II), and 2017 (Engage).

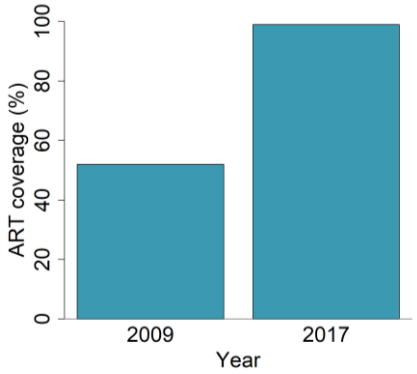


Figure 3: The proportion of people living with HIV who had ever taken ART in 2009 and 2017.

Preliminary calibration outcomes

Calibration targets

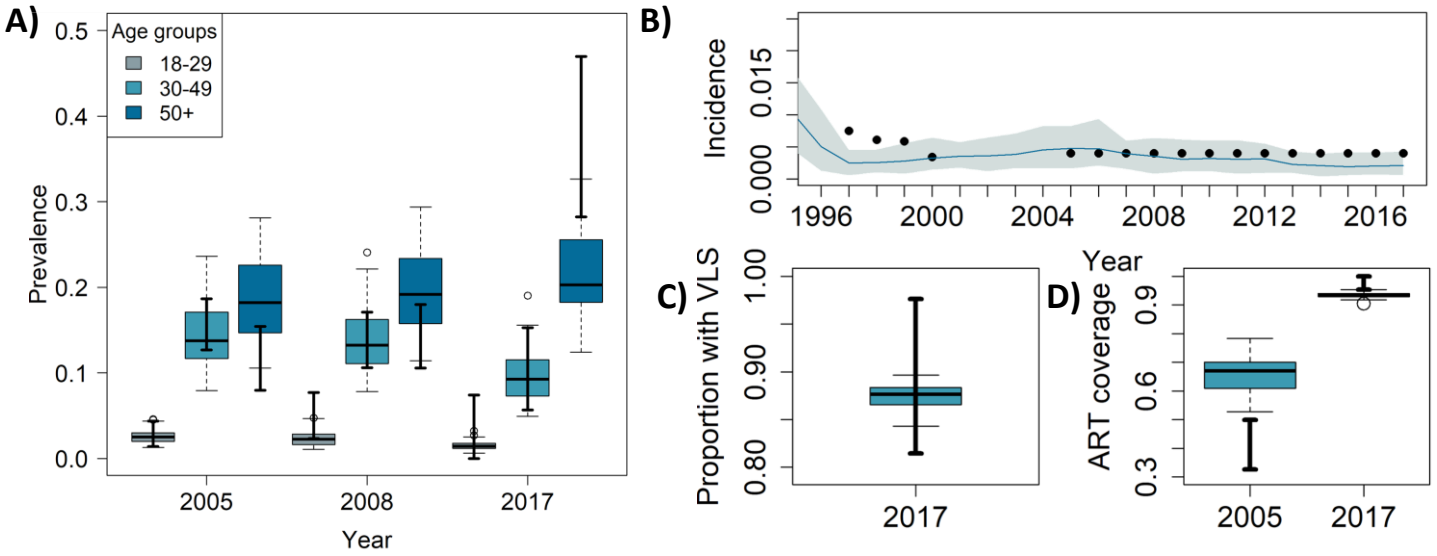


Figure 3: Calibration outcomes. A) The model was calibrated to age-stratified prevalence. B) The model predicted HIV incidence, C) the proportion with a suppressed viral load, and D) the proportion on ART.

Model analysis

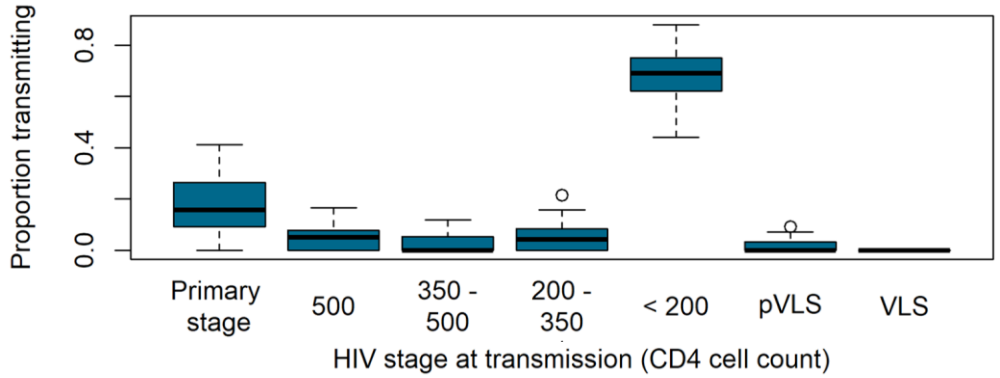


Figure 4: HIV transmission characteristics. The majority of transmission in 2017 occurred among men at the late stage of infection. Up to ~40% of transmission occurred among men at the primary stage of infection

Discussion

- The calibrated IBM was able to reproduce population level trends in HIV dynamics.
- The model suggests that in 2017, a high proportion of transmission could occurred among untreated men at later stage of infection, followed by men in the primary stage of infection.
- Future work includes:
  - Re-calibrating the model with additional calibration outcomes
  - Using the model to assess the impact of various combination prevention strategies in achieving HIV elimination.

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