Assessing the combined Impact of Interventions on the HIV and Syphilis epidemics among gbMSM in British Columbia: a co-interaction model

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Background and Objectives:

- The population of gay, bisexual and other men who have sex with men (gbMSM) remain the most affected by HIV infection in British Columbia (BC)
- Majority of infectious syphilis cases (over 80% of all cases) in BC were among gbMSM
- Currently, HIV Treatment as Prevention (TasP), Condom use, and Pre-Exposure Prophylaxis (PrEP) have been highly effective for HIV prevention and control in gbMSM
- Similarly, Condom use, Test&Treat diagnosed cases of syphilis have also been effective
- This study assesses how the combination of TasP, Condom use, PrEP, and Test & Treat syphilis can be used to prevent/eliminate further HIV-syphilis transmission and co-interaction among the gbMSM population in BC

Methods:

- We developed a mathematical model of the co-interaction of HIV/syphilis transmission and progression among gbMSM in BC

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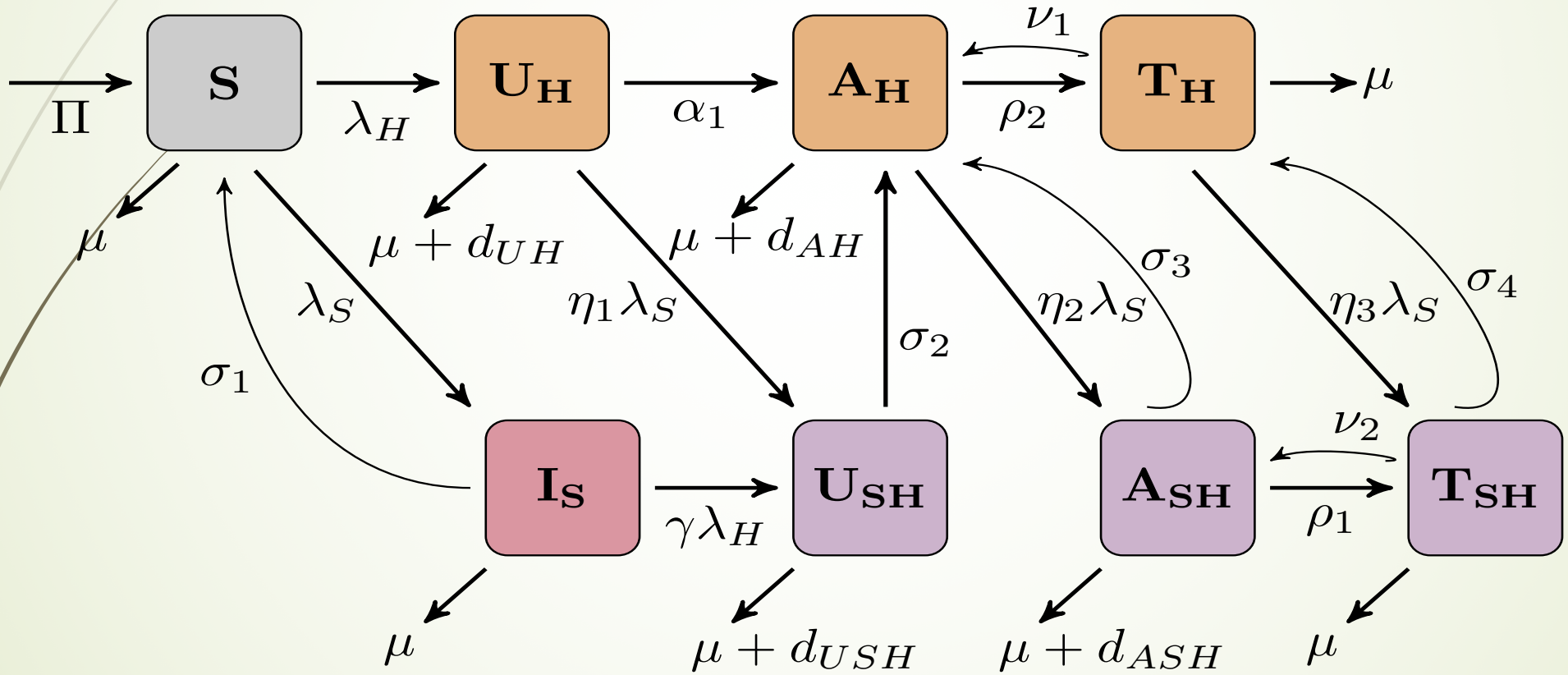


Deterministic model of HIV-syphilis co-interaction

Methods:

- Modeling the force of HIV/syphilis infection

$$\lambda_S = \beta_S(1-\epsilon\xi)((1-\psi)+\psi R_P)\frac{(I_S+\phi_1 U_{SH}+\phi_2 A_{SH}+\phi_3 T_{SH})}{N}$$

$$\lambda_H = \beta_H(1-\epsilon\xi)((1-\psi)+(1-\theta)\psi R_P)\frac{(U_H+\kappa_1 A_H+\kappa_2 U_{SH}+\kappa_3 A_{SH})}{N}$$

Methods:

- The transmission parameters were fitted and calibrated on:
  - Public Health Agency of Canada (PHAC) estimates of HIV incidence and Prevalence for gbMSM in BC,
  - Annual HIV diagnoses from HIV Cascade of Care in British Columbia Centre for Excellence in HIV/AIDS (BC-CfE), and
  - Annual syphilis diagnoses from British Columbia Centre for Disease Control

Methods:

- We studied the impact of optimizing:
  - TasP
  - Test & Treat syphilis,
  - Condom use
  - PrEP.

TasP:

- ✓ decreasing the time to HIV diagnosis
- ✓ decreasing time to antiretroviral (ART) treatment
- ✓ increasing the time retained on ART

Test & Treat syphilis:

- ❖ decreasing the time from syphilis infection to treatment

Methods:

- We measure the impact of intervention at the end of 10 years (from 2019 until 2028) on:

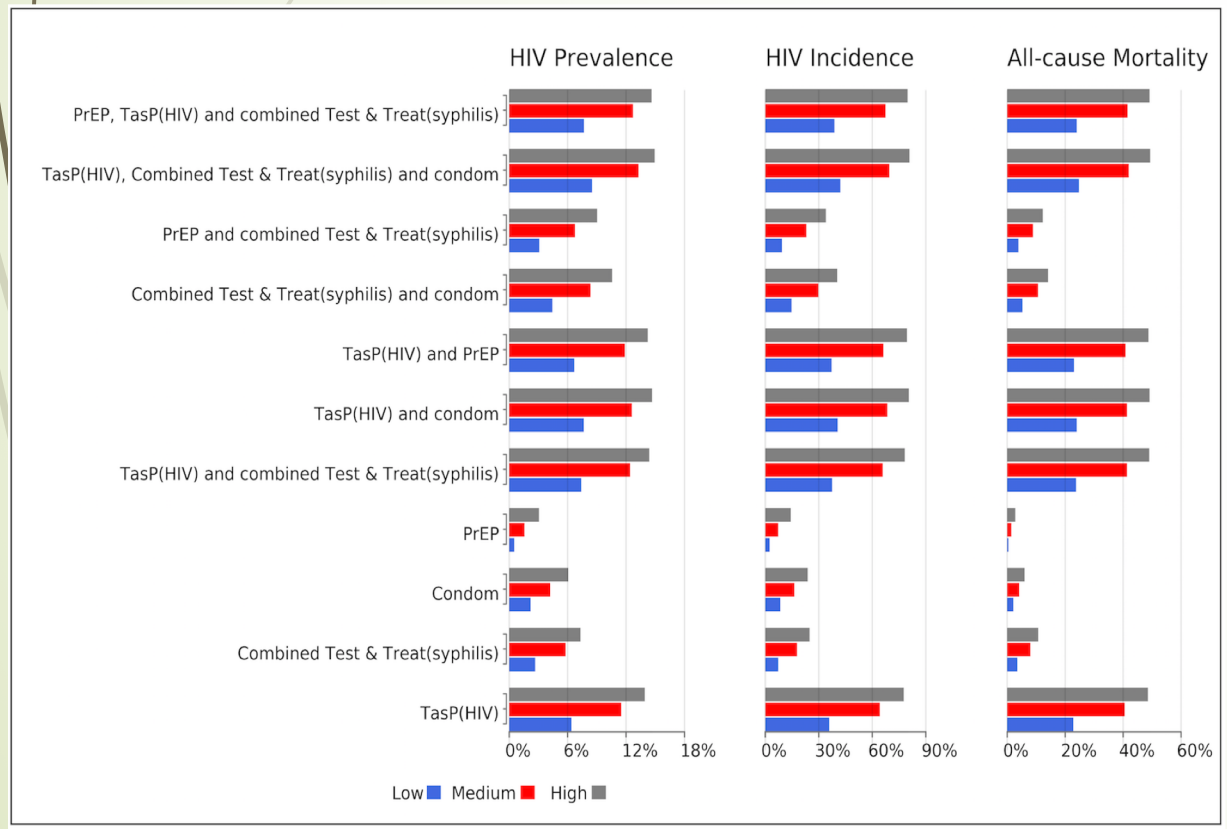
  - HIV point prevalence and incident cases
  - All-cause mortality cases among PLWH
  - syphilis incident cases
  - WHO threshold for disease elimination: <1 HIV and/or syphilis new case per 1000 susceptible gbMSM
  - univariate sensitivity coefficients for HIV and syphilis incidence changes under three PrEP uptake scenarios at the end of 2028
  - percent change in the number of cumulative HIV and syphilis incident cases with respect to the Status Quo scenario from 2019 to 2028

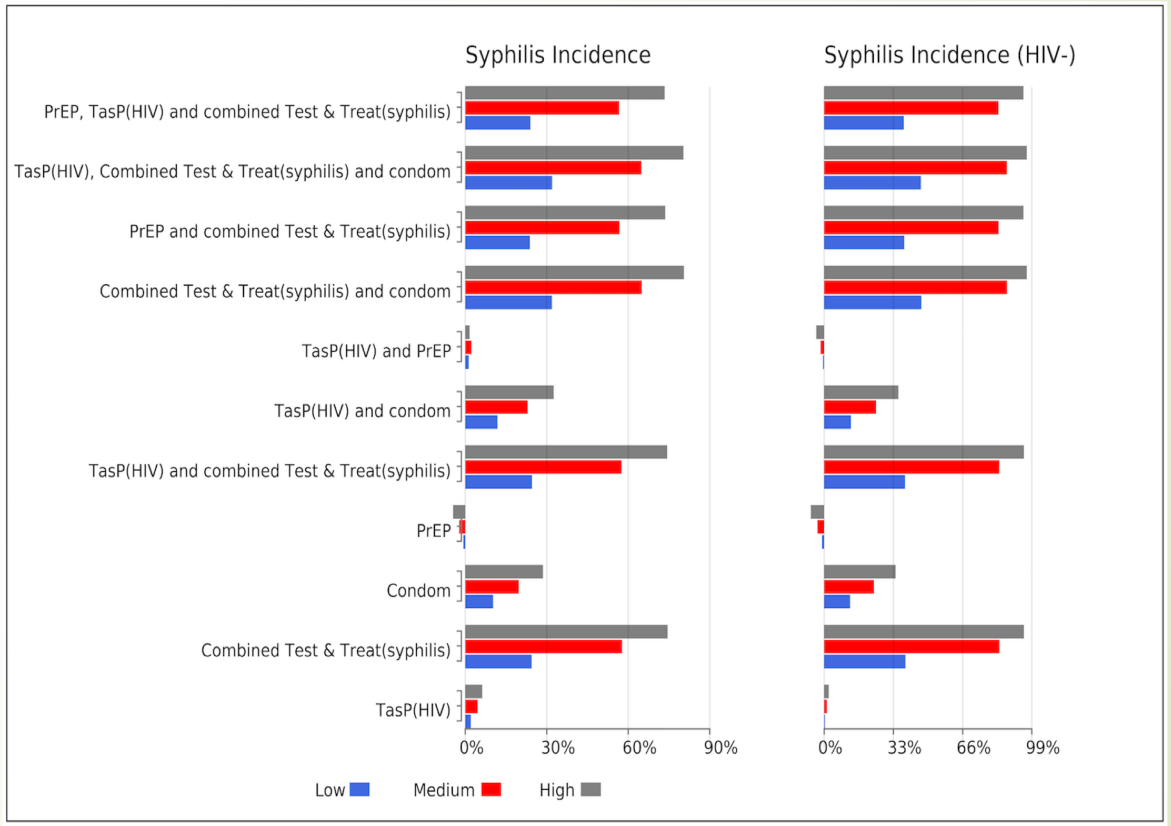
Intervention scenarios:

- **TasP:**
  - Status Quo: based on model calibration
  - Intervention:
    - **Low**: test every **2**years, treat within **3**months and retain on treatment for atleast **3.5**years
    - **Medium**: test every year, treat within **45**days and retain on treatment for atleast **4.5**years
    - **High**: test every **6**months, treat within **21**days and retain on treatment for atleast **6**years
- **PrEP:**
  - Status Quo: 4000
  - Intervention: linearly increase to maximum PrEP uptake in 2028
  - **Low**: 5000; **Medium**: 7000; **High**: 10,000
- **Condom use(%):**
  - Status Quo: 65
  - Intervention: linearly increase to maximum condom use in 2028
  - **Low**: 70; **Medium**: 75; **High**: 80
- **Test & Treat Syphilis:**
  - Status Quo: based on model calibration
  - Intervention (mono-infected individuals):
    - **Low**: test & treat within **2**years
    - **Medium**: test & treat **8**months
    - **High**: test & treat **3**months
  - Intervention (co-infected individuals):
    - **Low**: test & treat within **10**years
    - **Medium**: test & treat **5**years
    - **High**: test & treat **3**years

Model outcomes:

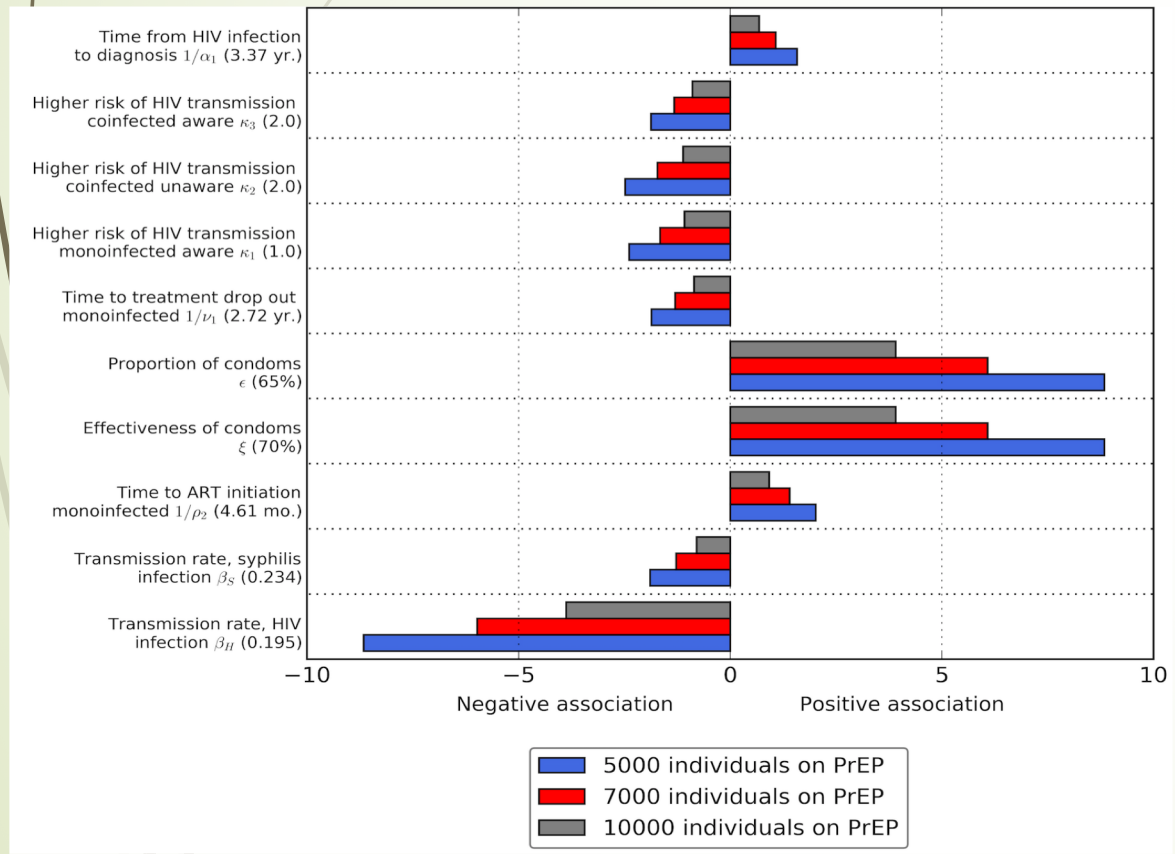
Reduction in HIV point prevalence, incident cases, and all-cause mortality cases (left), and syphilis incident cases (right), among gbMSM after 10 years of TasP, PrEP, condom use, and Test & Treat (syphilis) interventions

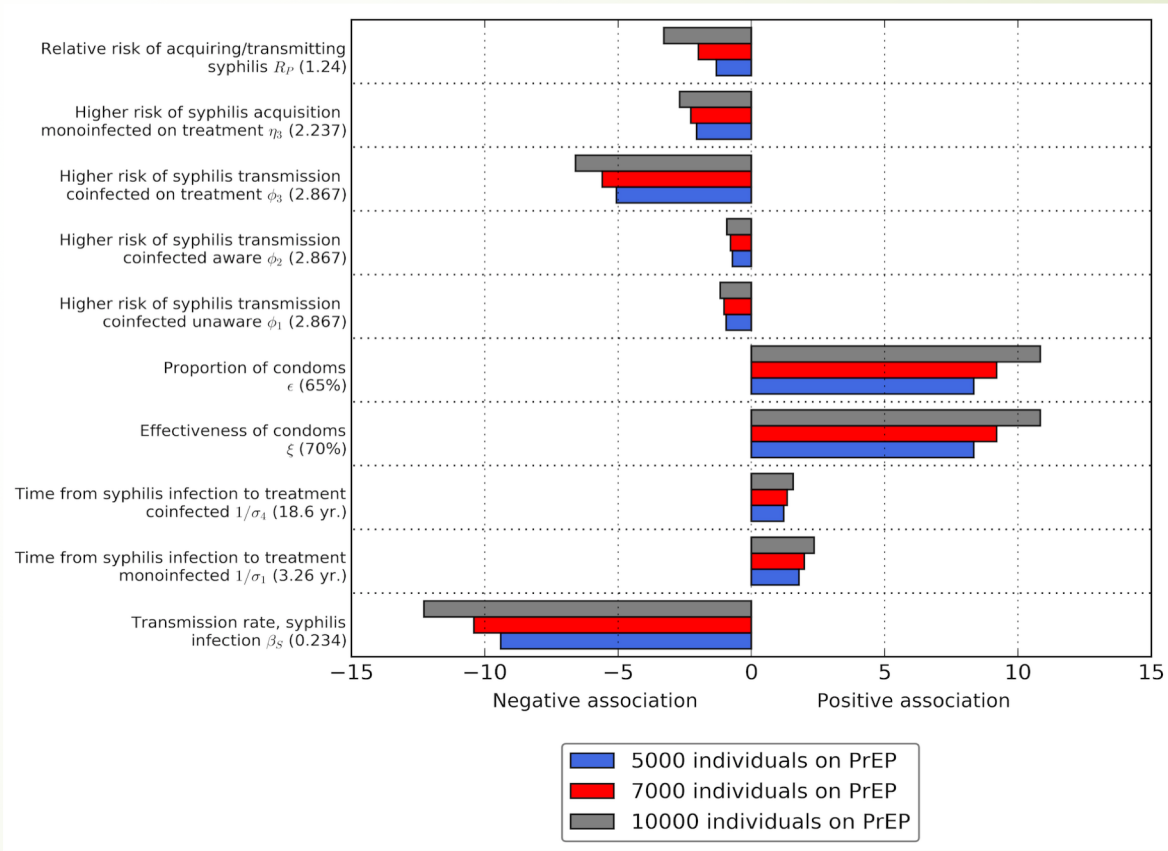




Model outcomes:

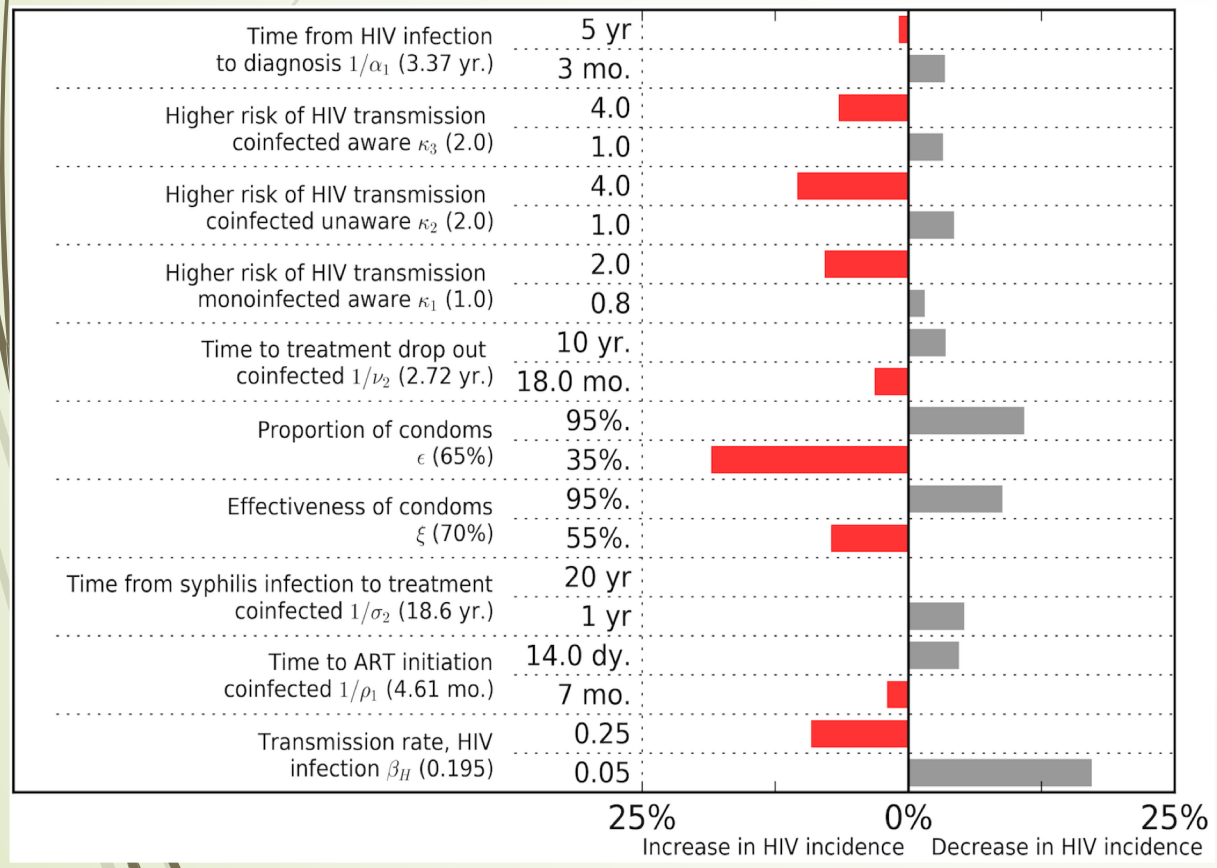
Univariate Sensitivity Analysis on HIV incidence (left column) and syphilis incidence (right column) for various PrEP strategies

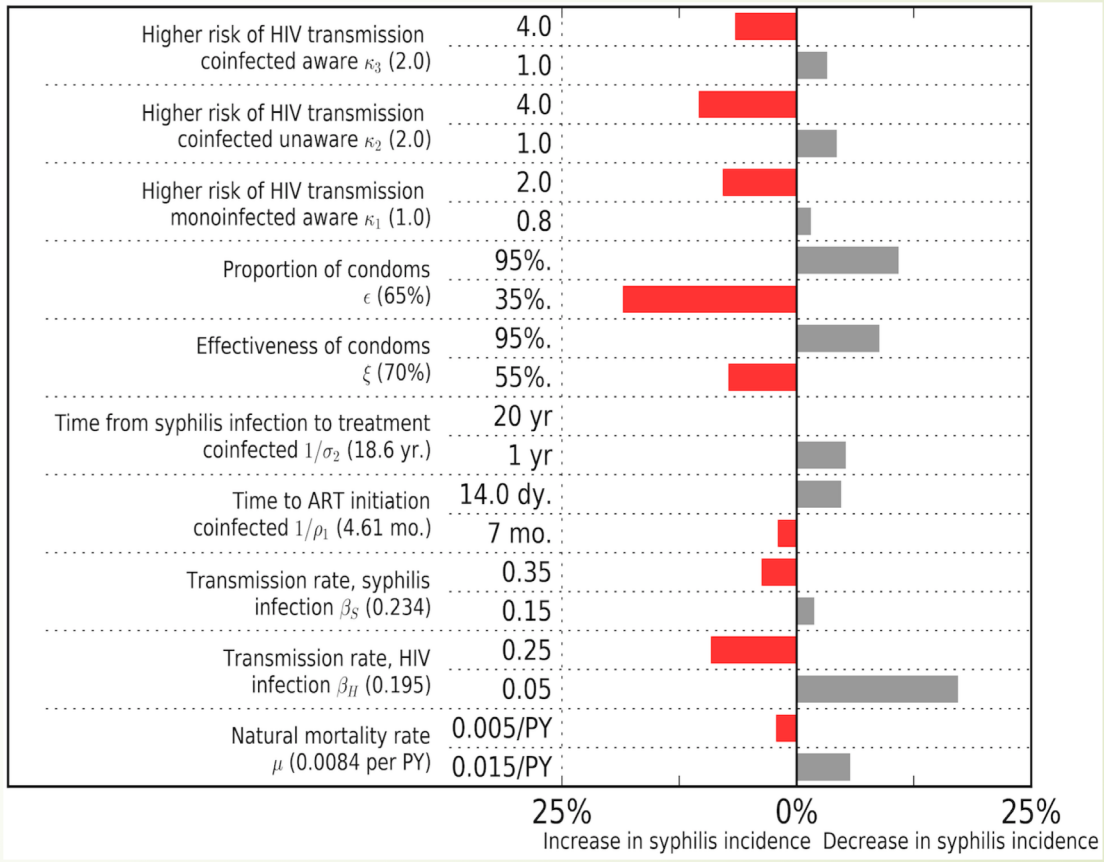




Model outcomes:

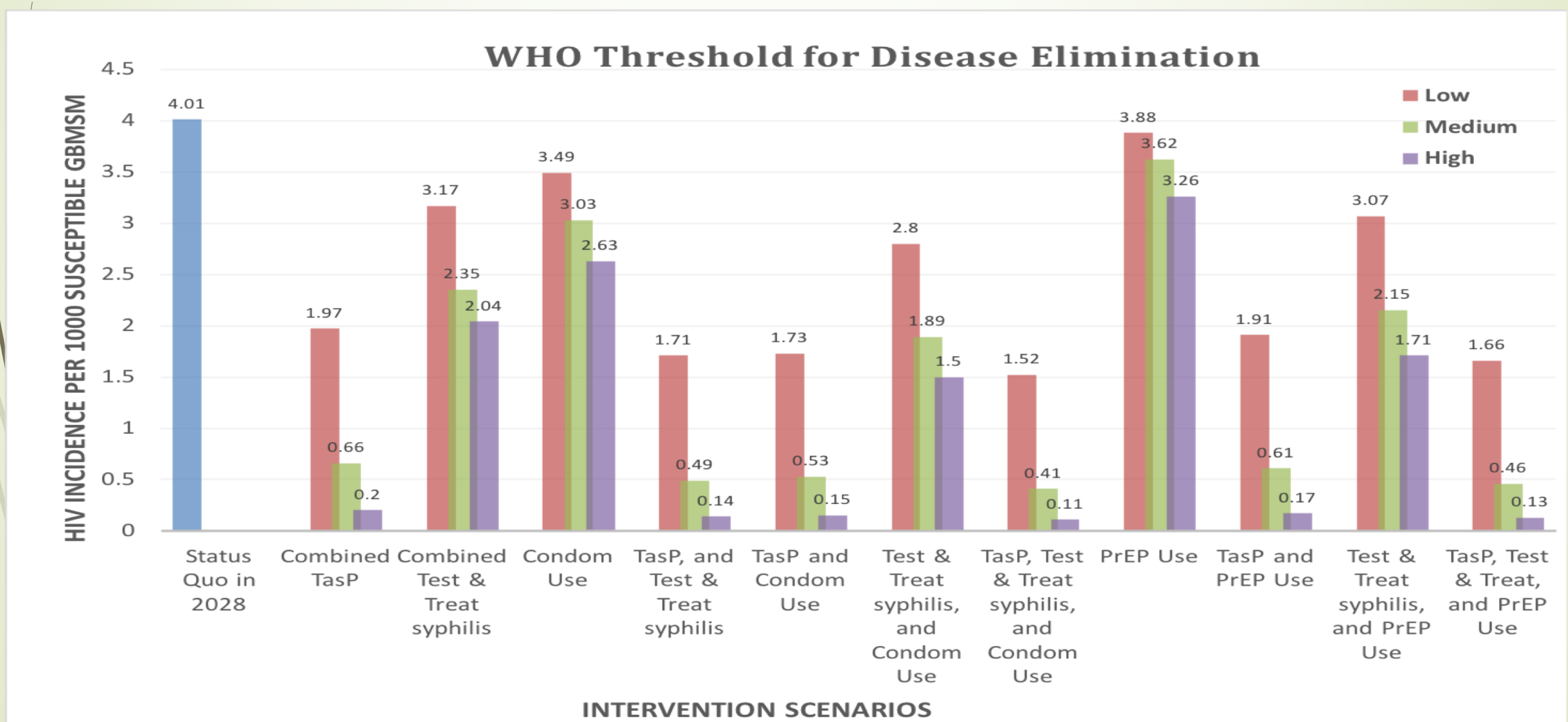
Sensitivity Analysis on HIV incidence (left column) and syphilis incidence (right column) for the top 10 parameters with the most uncertainty





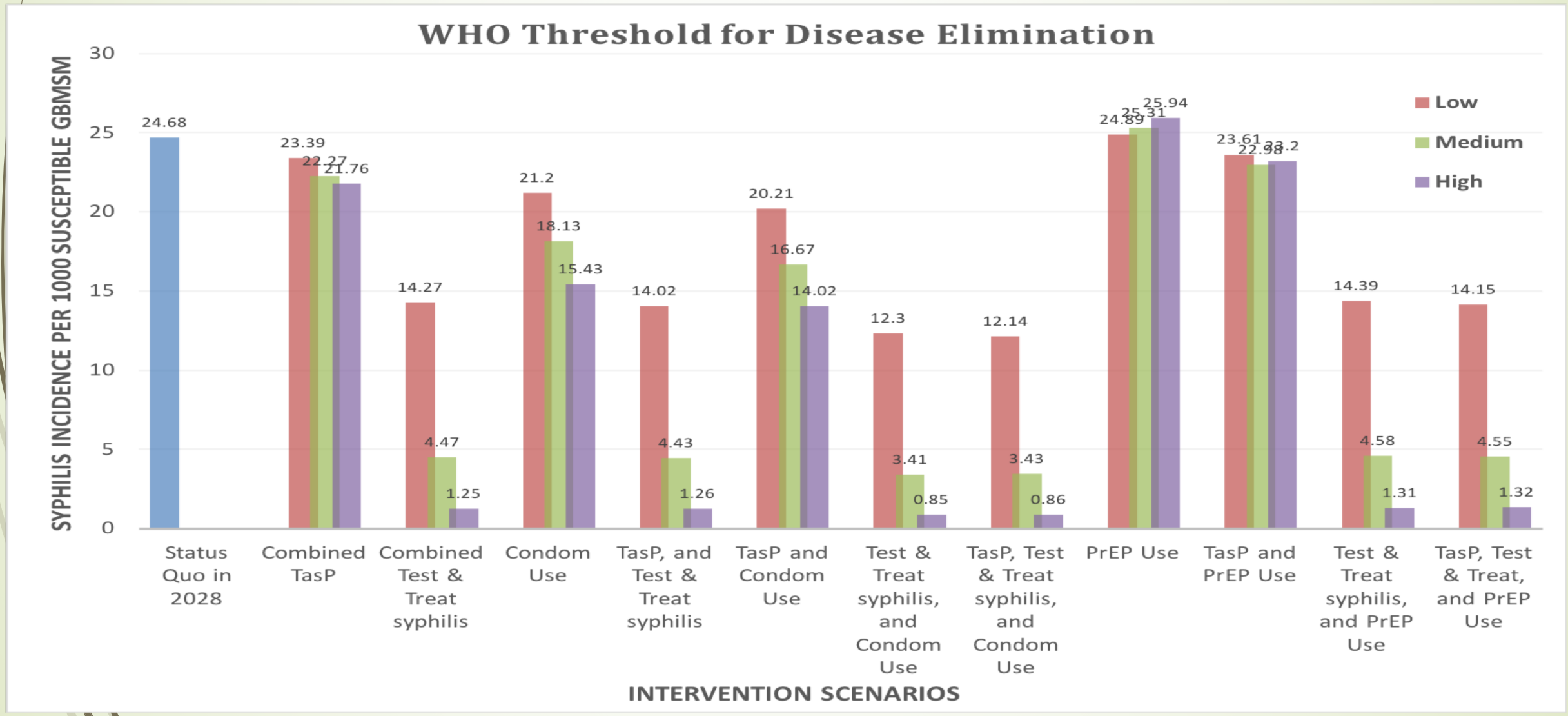
WHO Threshold for HIV Elimination

(<1 new HIV case per 1000 susceptible gbMSM):



WHO Threshold for syphilis Elimination

(<1 new syphilis case per 1000 susceptible gbMSM):



Summary:

- Optimizing TasP, Test&Treat syphilis, and increased provision of PrEP resulted in about 88% reduction in HIV incidence, and HIV incident rate as low as 0.13 per 1000 susceptible gbMSM
- Optimizing Test&Treat syphilis, and increased proportion of condom use resulted in about 80% reduction in syphilis incidence, and syphilis incident rate as low as 0.85 per 1000 susceptible gbMSM
- Optimizing TasP, Test&Treat syphilis, combined with condom use resulted in HIV & syphilis incident rate as low as 0.11 & 0.86 respectively and elimination of both diseases was possible
- Only TasP significantly decreased mortality while PrEP increased syphilis incidence by about 5%

Conclusions:

- Optimizing TasP, through promotion of timely HIV diagnosis, treatment initiation and higher retention, and improving time from syphilis infection to treatment, combined with the distribution of PrEP was the most successful strategy to control the HIV epidemic

- Optimizing Test & Treat syphilis, and increased condom use was the most successful strategy to control the syphilis epidemic

- Frequent testing of syphilis and other STIs, particularly among gbMSM using PrEP should be prioritized to control the syphilis epidemic

- Consistent use of condoms should continue to be encouraged and promoted to simultaneously reduce HIV and syphilis transmission particularly among those who may not be eligible for PrEP

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Thank you!