Modeling the Impact of Increased PrEP Use on Sexually-Acquired HIV Incidence in the United States

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BACKGROUND

- In 2015, the CDC estimated that 1.2 million Americans could benefit from PrEP (1).
- This estimate may now be outdated, particularly given ambitious HIV elimination goals and a shift from using group-based risk to behavior-based risk in PrEP prescribing.

Significant increases in PrEP uptake in the US, beyond existing US CDC targets, may be required to achieve HIV elimination goals

METHODS

Figure 1: Methods Overview

NHANES Survey Data (2015/16)
Most recent with needed data available

Survey respondent characteristics and sexual practices

- Extract: Age and sex, number and sex of sexual partners, number of times having sex, condom use frequency, prior anal sex, partners 5+ years older/younger
- Stochastically Impute: Partner characteristics (age, sex), sexual acts (count, nature and condom use) with each partner
- Apply CDC per sexual act risk estimates to derive each respondent's HIV acquisition risk conditioned on partner HIV/STI status

Respondent's HIV risk conditioned on partner HIV/STI status

- Estimate the probability distribution for each HIV/STI status for each partner using age, sex and state specific CDC epidemiology data with calibration to overall HIV incidence
- Aggregate respondent conditional HIV risk over partner status probabilities

Overall HIV risk for each respondent

- Scale to US population 18-59 using census data and survey weights

Population distribution of sexually-acquired HIV risk

- Consider varying numbers of people on PrEP with varying PrEP distribution efficiencies; assume no HIV transmission among those on PrEP

Overall PrEP impact as a function of PrEP utilization and distribution efficiency

Repeated Simulations: We ran the simulation model described in this flowchart 100 times, bootstrapping survey responses

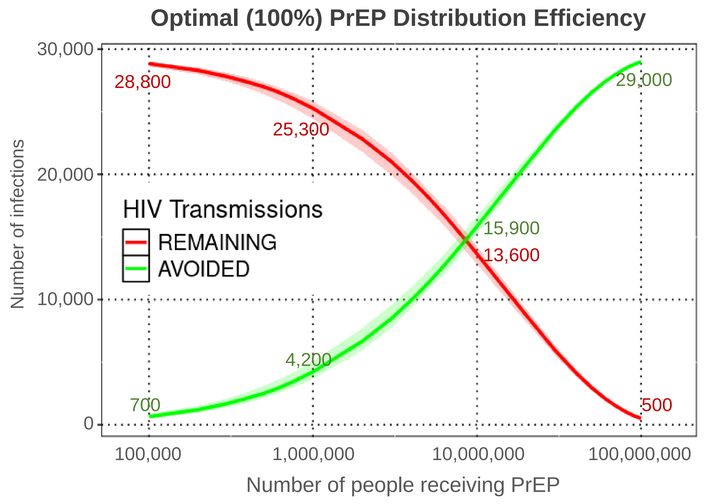
Assumption Regarding Partner Risk

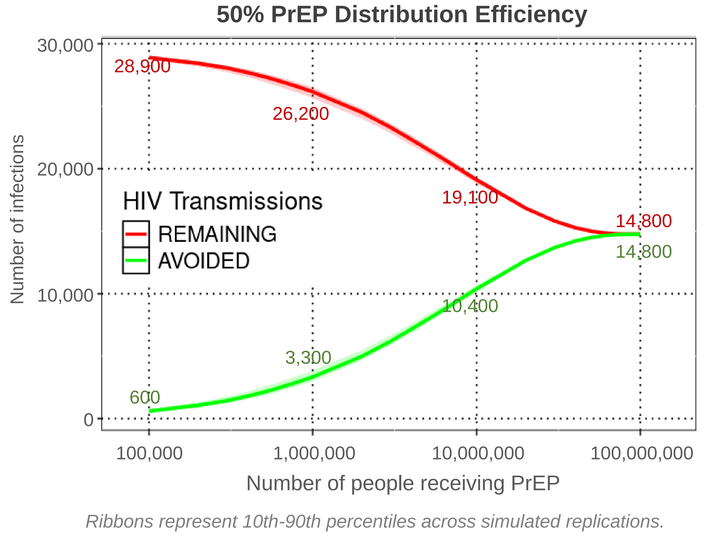
- Odds of HIV in a survey respondent's sexual partner is proportional to prevalence (expressed as an odds) for the partner's age, sex and state
- In our primary analysis, we assume partner risk is not correlated with respondent sexual practices (assumption evaluated in sensitivity analysis).

Explanation of PrEP Distribution Efficiency

- A 100% means all individuals at highest risk receive PrEP until the "available" number of prescriptions is exhausted
- A 50% means N prescriptions are spread across 2*N individuals at highest risk (e.g., 1 million prescriptions for 2 million individuals at highest risk).

Figure 2: Modelled impact of PrEP at varying levels of adoption and distribution





Ribbons represent 10th-90th percentiles across simulated replications. Only includes HIV transmitted through sexual contact.

RESULTS (**Figure 2**)

- The model predicted PrEP use by 1 million and 10 million individuals would prevent ~4,200 and ~15,900 sexually-acquired HIV cases, respectively, when distributed optimally and ~3,300 and ~10,400 cases, respectively, with 50% PrEP distribution efficiency.
- A sensitivity analysis, in which we allowed partner HIV risk to be correlated with survey respondent sexual practice, predicted a slightly greater number of HIV cases avoided for each level of PrEP adoption and distribution efficiency.

Limitations:

- Representativeness and accuracy of the underlying of NHANES data may be imperfect
- The required imputation steps could introduce bias
- Estimation of HIV likelihood in the partners of survey respondents was imprecise and required use of a calibration factor
- The use of state-level HIV prevalence may have overlooked local HIV prevalence and assertive mixing patterns

CONCLUSIONS

- Our model provides a framework to estimate the population impact of PrEP and its implications for public health policy.
- Our model aligns with the growing trend of basing PrEP-use decisions on individualized risk assessments
- While model results vary depending on assumptions, findings strongly suggest that increases in PrEP uptake, substantially beyond prior CDC targets, may be required to achieve HIV elimination goals.

ADDITIONAL INFORMATION

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References

1. Smith DK, et al. 2015. MMWR Morb Mortal Wkly Rep. 2015;64(46):1291-5

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