Potential Impact on HIV Incidence of Increasing Viral Suppression among HIV-positive MSM in Baltimore: Mathematical Modelling for HPTN 078

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London, UK
19th October 2016

Conflicts of Interest

- In the past 2 years I have been an employee of: Imperial College London, London School of Hygiene and Tropical Medicine
- In the past 2 years I have received research support (grants) from: NIH

- I have no conflicts of interest to declare

Introduction: HIV epidemic among MSM in Baltimore

- HIV prevalence: 30% in 2014 (NHBS*)
- Virally suppressed: 37% of diagnosed in 2013 (Maryland Health Dept)
- PrEP use: 2.4% in 2014 (NHBS)

*CDC National HIV Behavioral Surveillance

Introduction: HPTN 078

- HPTN 078: Enhancing Recruitment, Linkage to Care and Treatment for HIV-Infected Men Who Have Sex with Men (MSM) in the United States
- Recruiting MSM at 4 sites including Baltimore
- Mathematical modelling is being used:
  1. **Before/during the trial - to estimate levels of viral suppression that must be reached to attain HIV incidence reduction targets**
  2. After the trial - to estimate reduction in HIV incidence achieved by trial interventions

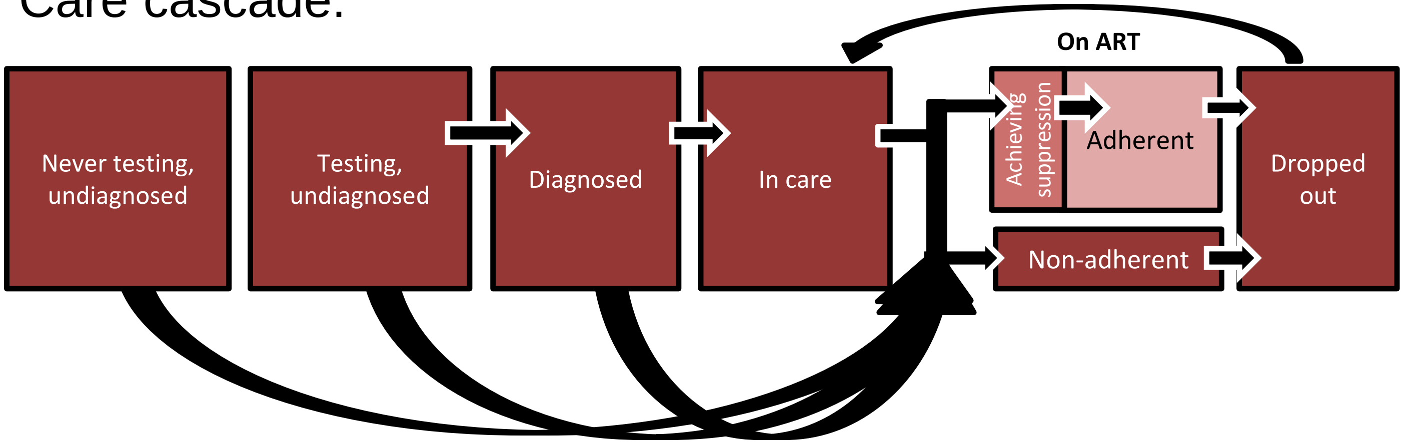
Research Questions

1. How much does the level of viral suppression need to be increased by to reduce HIV incidence among Baltimore MSM by 10, 20, 30 or 50% after 2, 5 and 10 years?

2. By how much could HIV incidence be reduced if US National HIV/AIDS strategy (NHAS) targets met by 2020:
   – 90% diagnosed
   – 90% of diagnosed retained in care
   – 80% of diagnosed virally suppressed

Methods: Model

- Deterministic compartmental model
- Sexual HIV transmission
- HIV disease progression: CD4 decline stratified by viral load
- Risk groups: age (<25, 25+) x race (black, white)
- Care cascade:



Model Inputs (Parameters)

Domain	Examples	Data source
Disease progression	• Initial CD4 and viral load distribution • HIV-related mortality • CD4 progression rates	Published studies: cohorts in North America and Europe
Infection probabilities	• Per-sex-act transmission probability • Relative infectiousness different disease stages	Published studies: meta analyses, study of Australian MSM
Intervention efficacy	• Reduction in per-sex-act HIV transmission risk: condoms, ART	Published studies: clinical trials, meta-analyses
Sexual risk behaviour	• Number and type of partners • Condom use • Age and race of partners	NHBS surveillance data, *(eventually 078 trial)*
Intervention behaviour	• HIV testing • Linkage/dropout from HIV care • ART linkage and dropout	NHBS surveillance data, clinical cohorts, state health department data, *(eventually 078 trial)*

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Model Fitting

- Ensure that model outputs can reproduce observed data:
  - **HIV prevalence trends** - by age and race (NHBS)
  - **MSM demography -** age and race (NHBS, census)
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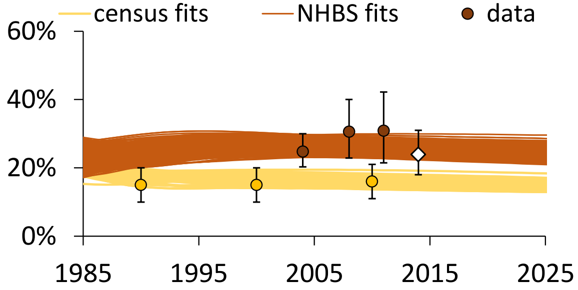
% aged 18-24



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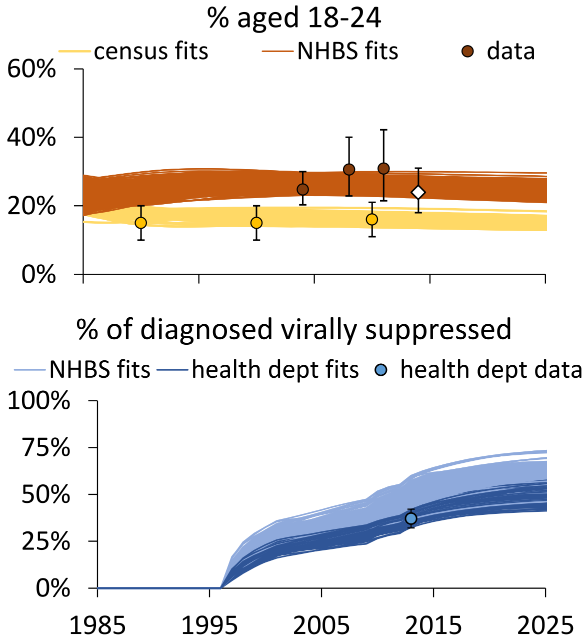
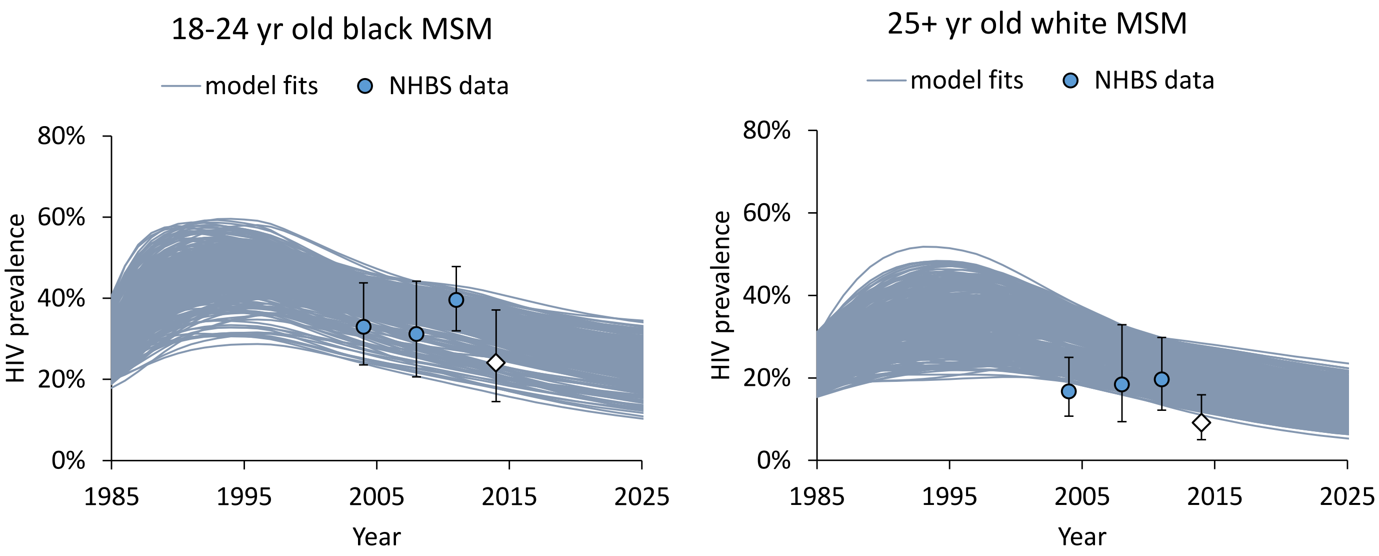
Differences explored in sensitivity analysis



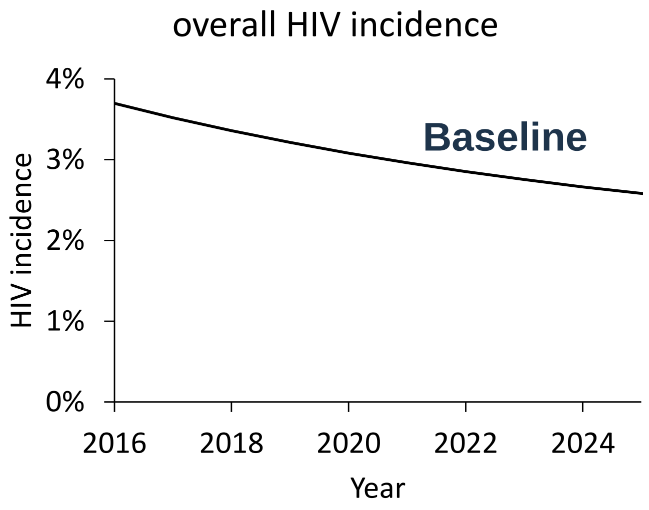
HPTN HIV Prevention Trials Network

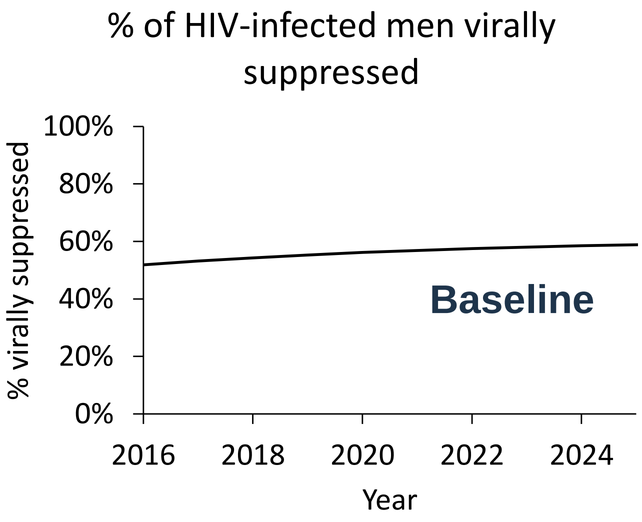
Model Fits

HIV prevalence by age and race



Analysis – Meeting Incidence Reduction Targets





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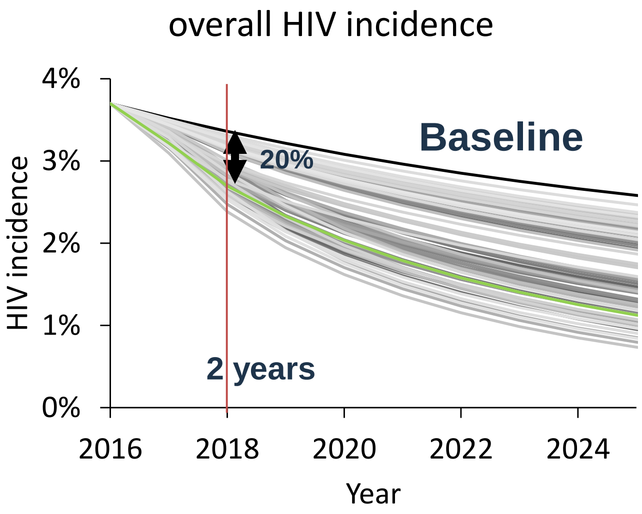
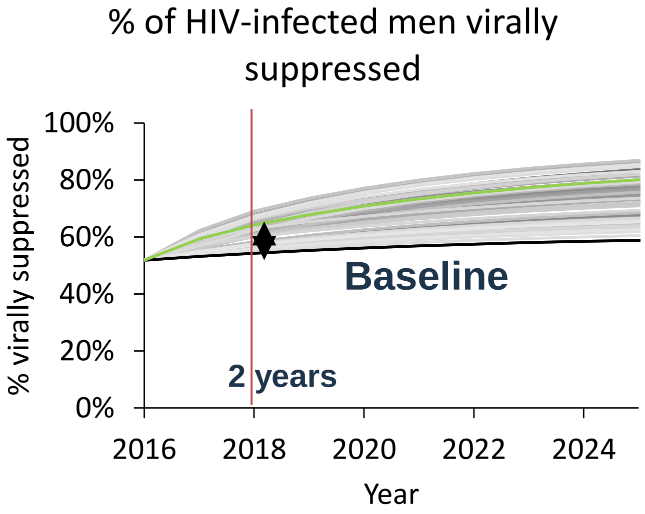
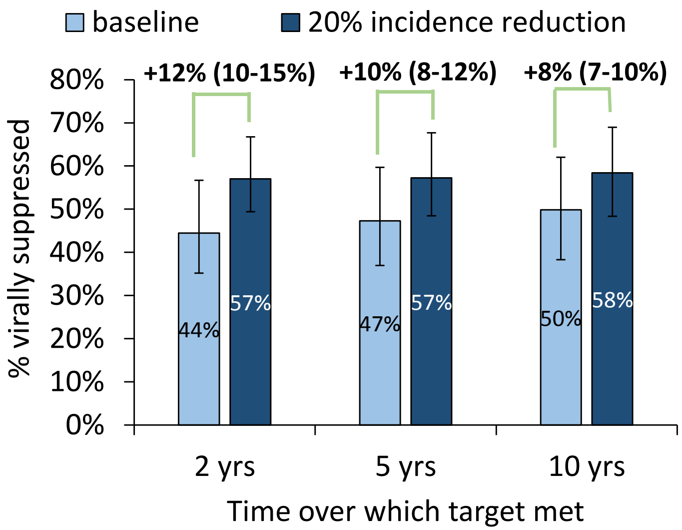




Results: Required Increase in Viral Suppression Level

Target: reduce HIV incidence by 20%



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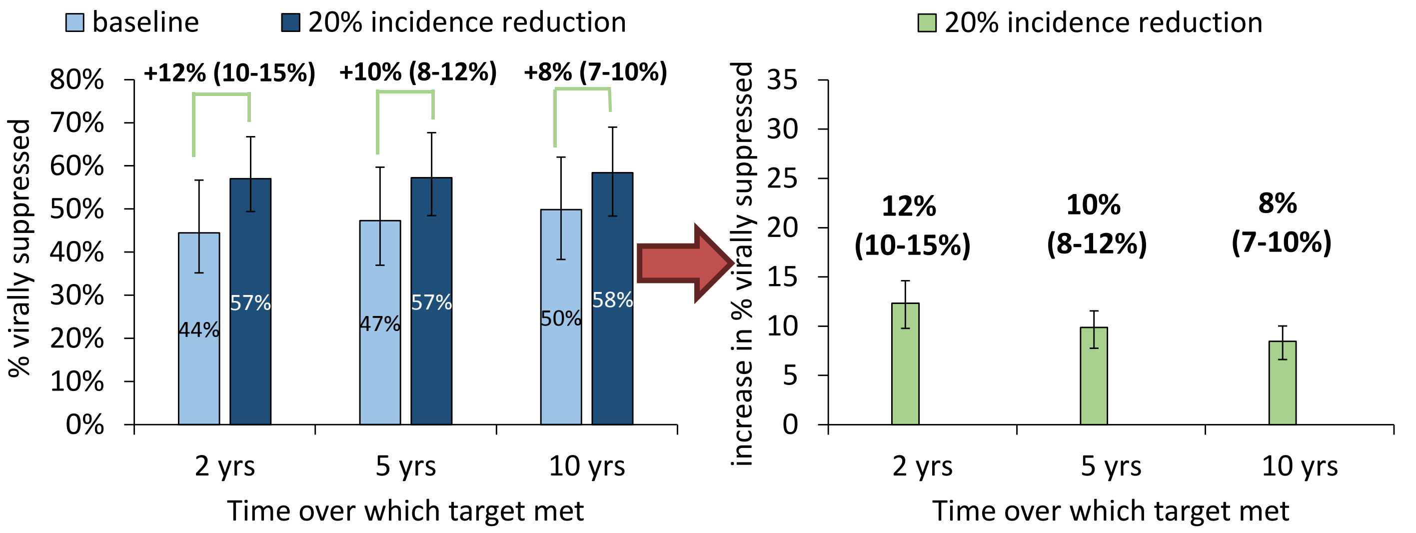

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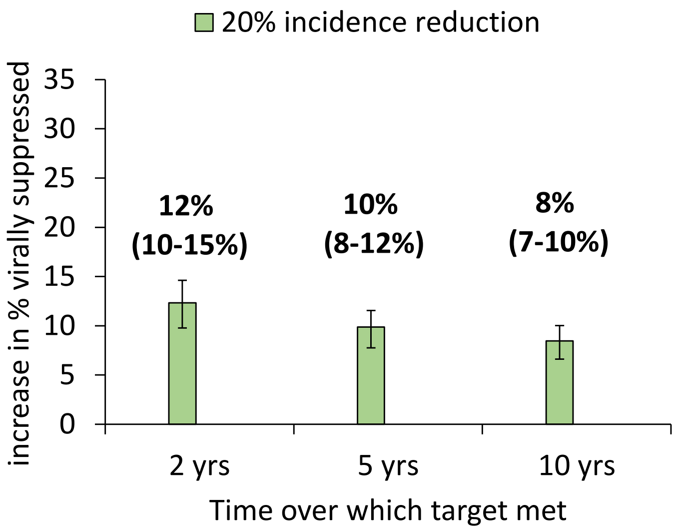
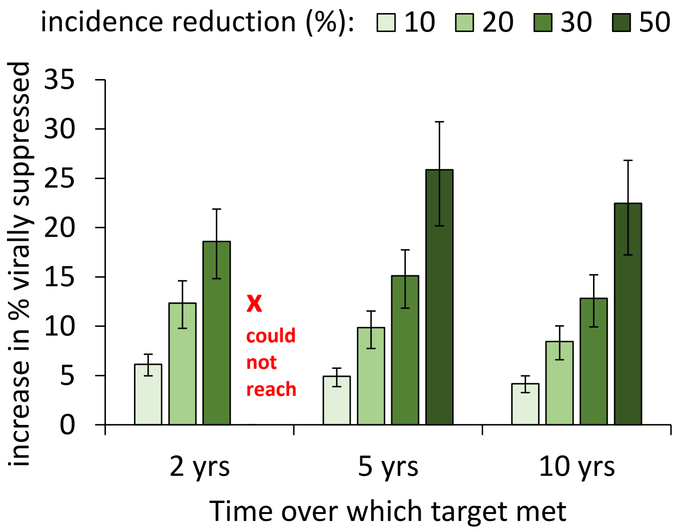


Results: Required Increase in Viral Suppression Level

Target: reduce HIV incidence by 10, 20, 30, 50%

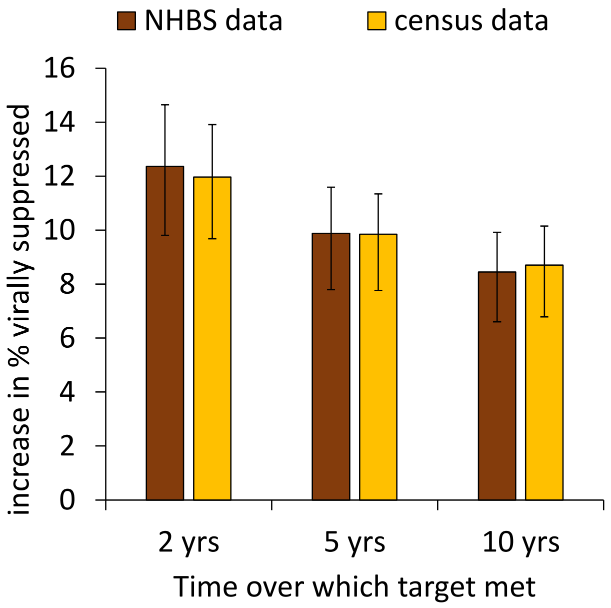
- To reduce HIV incidence by 50% after 5 years, need to:
  - Increase viral suppression by 26 percentage points
  - Achieve 73% virally suppressed after 5 years

- Not possible to reach 50% incidence reduction target after 2 years



Results: Sensitivity Analysis

To reduce incidence 20% - by demography scenario



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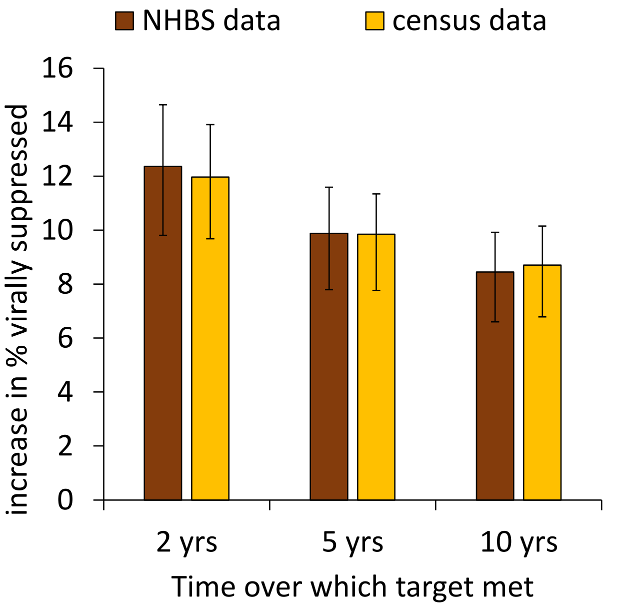
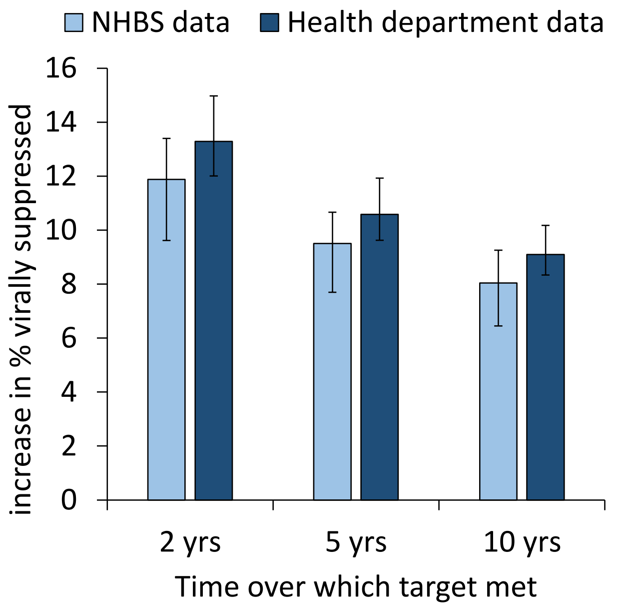


To reduce incidence 20% - by care cascade data source

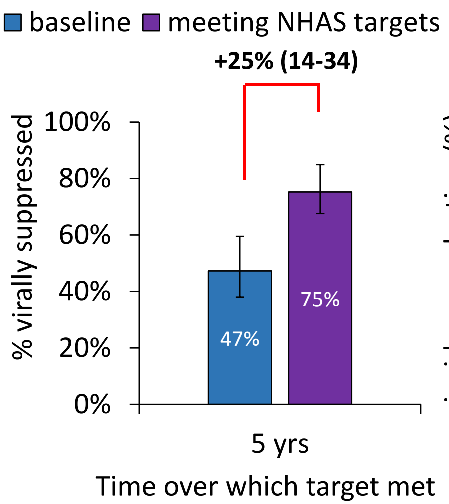


Results: Impact of Meeting NHAS Targets

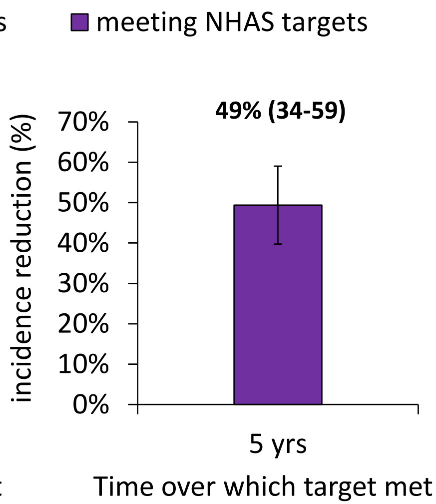
If targets all met in 2020:

- 90% diagnosed
- 90% of diagnosed retained in care
- 80% of diagnosed virally suppressed

Increase in viral suppression



Incidence reduction



i.e. very similar effect to reaching 50% incidence reduction target after 5 years

Discussion

- Large increases in viral suppression are needed to achieve moderate reductions in HIV incidence among Baltimore MSM, especially short-term
- Achieving NHAS targets on diagnosis, retention in care and viral suppression by 2020 is projected to reduce HIV incidence in 2020 by ~50%
- Results are robust to uncertainty in MSM demography but somewhat influenced by uncertainty in current levels of viral suppression
- In future modelling, the impact of increased PrEP coverage should also be considered

ACKNOWLEDGEMENTS

The HIV Prevention Trials Network is sponsored by the National Institute of Allergy and Infectious Diseases, the National Institute of Mental Health, and the National Institute on Drug Abuse, all components of the U.S. National Institutes of Health.

The HPTN Modelling Centre is funded through the HPTN Statistical and Data Management Centre (UM1 AI068617)

HPTN Modelling Centre: Marie-Claude Boily, Dobromir Dimitrov, Tim Hallett, Christophe Fraser

NHBS data: Gabriela Paz-Bailey, Brooke Hoots, Danielle German, Colin Flynn

HPTN 078: Chris Beyrer, Robert Remien, Theresa Gamble, Protocol and site teams

Imperial College London: Anne Cori, Mike Pickles