Estimating HIV incidence among young women in HPTN082 using baseline HIV risk scores

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BACKGROUND

HPTN 082 BACKGROUND

Oral pre-exposure prophylaxis (PrEP) is an antiviral drug taken daily effective in decreasing HIV acquisition if taken as prescribed. High adherence has been hard to achieve especially among young women. HPTN 082 is a clinical trial aimed at **increasing PrEP adherence among young women** in sub-Saharan Africa.

MODELING OBJECTIVES

As the study is aimed at boosting adherence and not evaluating PrEP effectiveness, all study arm receive PrEP. **Therefore we use mathematical modeling to simulate HIV incidence in a counterfactual arm in which no participants receive PrEP.** In other words our model allows us to ethically estimate PrEP effectiveness without denying anyone treatment.

VOICE TRIAL AND RISK SCORE

As a basis for our estimate, we use incidence data from the VOICE trial (MTN 3), a clinical trial carried out in sub-Saharan Africa from 2009-2012. Although this trial showed no effectiveness it provided valuable data on the relationship between participant characteristics and HIV acquisition risk. This HIV risk has been formalized as the **VOICE HIV Risk Score (see below and Balkus, 2016).** We use the HIV risk scores of individuals in the HPTN 082 trial to predict their HIV incidence.

VOICE TRIAL VS HPTN 082

VOICE TRIAL

Although both the VOICE trial and HPTN 082 studied PrEP use among women in sub-Saharan Africa, the two trials have important differences: the risk profile of the participants, their geographic location, as well as the time of the trial. Notably, HPTN 082 was restricted to women with a risk score of at least 5 (see below for the risk score calculation).

VOICE TRIAL

Years: 2009-2012
Intervention: Oral and topical PrEP
Ages: 21-29
Risk Score: 0-10
Population by site:
- 62% Durban, SA
- 20% Johannesburg, SA
- 12% Harare, Zimbabwe
- 6% Kampala, Uganda

Annual Incidence: 6%
No effectiveness detected: None

HPTN 082 TRIAL

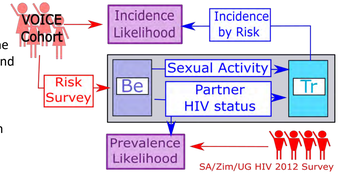
Years: 2016-Present
Intervention: Oral PrEP+Adherence Assistance
Ages 16-25
Risk Score: 5-10
Population by site:
- 33% Harare, Zimbabwe
- 33% Cape Town, South Africa
- 33% Johannesburg, South Africa

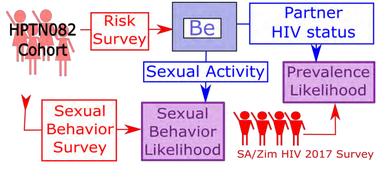
Annual Incidence without PrEP: ??%
Effectiveness: Unknown

MODEL CALIBRATION

VOICE CALIBRATION

We calibrate our model to ensure that the relationship between HIV infection risk and risk score matches that observed in the VOICE trial. We also make sure that simulated partner prevalence approximately matches the prevalence in the male 15-49 populations.



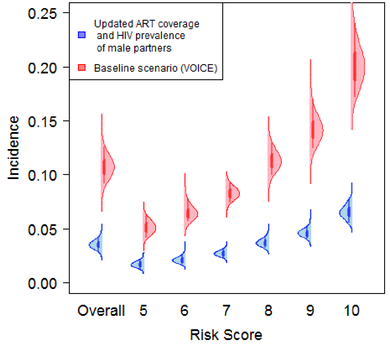


HPTN082 CALIBRATION

We also calibrate the model so that the relationship between sexual activity and risk score matches what is reported from HPTN082 survey data. This allows a refinement of the relationship between risk score and HIV risk.
The partner prevalence must also be adjusted to match newer national surveys.

HIV INCIDENCE

Simulated incidence in HPTN082 without PrEP use



EFFECT OF MALE PARTNERS

We simulate HIV acquisition in HPTN082 assuming HIV/ART prevalence is unchanged from the VOICE trial (red) or with updated HIV/ART prevalence (blue).

VOICE MALE PARTNERS

Partner HIV Prevalence:12-18%
Partner ART Coverage: 20-30%
Resulting HIV Incidence: **9-12%**

HPTN082 MALE PARTNERS

Partner HIV Prevalence:6-8%
Partner ART Coverage: 60-67%
Resulting HIV Incidence: **3-4%**

SIMULATION PROCEDURE

MODEL INPUTS

1) HIV and ART prevalence in the 15-49 year old population at the time and geographic location(s) of the study.
2) The responses the HIV risk score survey of the participants.

BEHAVIORAL MODEL

Translates the risk score and male partner population into sexual activity parameters (such as frequency/type of sex acts and condom usage) as well as HIV partner prevalence.

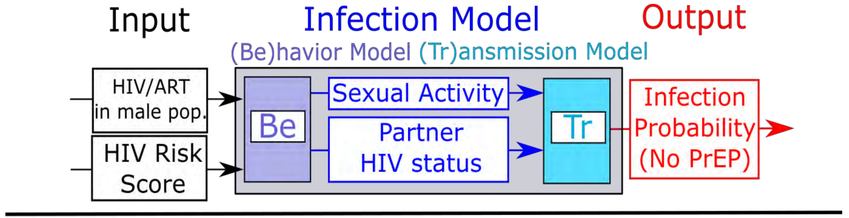
TRANSMISSION MODEL

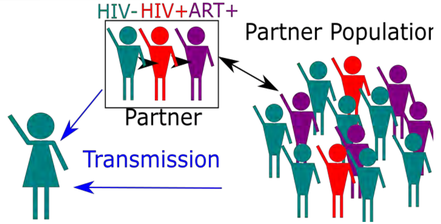
Uses a probabilistic model to translate sexual activity and partner prevalence into a probability of infection.

SIMULATION PROCEDURE

Women have main partners, which update slowly, as well as casual partners which update daily. The sex rate with each partner depends on the risk score of the woman.

HIV risk depends strongly on the HIV status of the partners which is updated daily. This includes become infected, initiating/interrupting ART, becoming virally suppressed, or advancing through the stages of HIV.

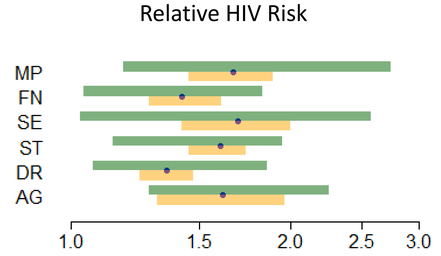




VOICE HIV RISK SCORE

MP: Not married/living with main partner (+2)
FN: Receives financial support from partner (+1)
DR: One or more drinks per week (+1)
ST: Treatable STI (at enrollment) (+2)
SE: Main partner has other sex partners (+2)
AG: Under age 25 (+2)

HIV RISK SCORE COMPONENTS



VOICE RISK SCORE COMPONENTS

The relative risk associated with each component of the risk score (green=prior from VOICE trial). Orange=calibrated posterior from VOICE trial and HPTN 082 survey data. Black dot is posterior mean.

CONCLUSIONS

Mathematical modeling can provide a useful counterfactual when a clinical trial lacks a control arm. In the case of HPTN 082, we predict a 3-4% incidence in the absence of PrEP.

Our model uses the HIV risk score derived from the VOICE trial to predict HIV incidence. However, our incidence estimate also strongly depends on the male partner population that the trial participants interact with: specifically the levels of HIV prevalence and viral suppression. It is therefore important to consider the timing of the trial and geographic distribution of the participants in addition to their HIV risk scores.

REFERENCES

LITERATURE
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GOVERNMENT SOURCES FOR HIV/ART PREVALENCE
South African National HIV Prevalence, Incidence and Behaviour Survey, 2012 and 2017
HIV and AIDS Uganda Country Progress Report 2013
Uganda Phia/ZimPhia/UNAIDS

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