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Appendix to Assessing HIV Acquisition Risk among MSM in the United States

A. Methods

We used a Bernoulli process model to estimate the cumulative risk of HIV acquisition among MSM over 1 and 10 years. In the basic Bernoulli process model, each act of sexual intercourse is treated as an independent event with a small probability of HIV acquisition by an HIV uninfected person from an infected partner.(1, 2) Although the acquisition probabilities per act seem small, they compound rapidly as the number of sex acts increase over time. The prevention strategies are used to modify the acquisition probabilities and lower HIV acquisition risk. Thus, for each type of sex act *i*, the risk adjusted probability of HIV acquisition per act (α_i) may be expressed as,

$$\alpha_i = b_i * \prod_j r_j \quad (1)$$

where, b_i is HIV acquisition probability per sex act, r_j is HIV acquisition risk modifier.

The per-act HIV acquisition probability is the risk of exposure from a single sex act with a potentially HIV-infected partner. For each type of sex act, the cumulative risk of HIV acquisition (p_i) may be defined as:

$$p_i = \pi(1 - (1 - \alpha_i)^{n_i} \quad (2)$$

where n_i is the number of exposures to a specific type of sex act *i* within a 1-year or 10-year period. We accounted for the possibility that the transmission probability could be lower if the infected partner is on antiretroviral therapy (ART) and is virally suppressed, by adjusting HIV prevalence (π) with the proportion of MSM who have a suppressed HIV RNA viral load (*w*).

The cumulative risk of HIV acquisition for all types of sex acts performed within a partnership (*P)* is estimated as:

$$P = 1 - \prod_i (1 - p_i) \quad (3)$$

The cumulative HIV acquisition risks are estimated for the base case with no prevention strategies and for various single and combination prevention strategies. We analyzed the stability of the base case results in univariate sensitivity analysis by varying the input values within the upper and lower bounds of the parameter ranges or 95% confidence interval (Table 1).

B. Model Inputs

We used the input values reported in Table 1 to estimate the cumulative HIV acquisition risk among MSM over 1 and 10 years. The input values and data sources used for the per-act HIV transmission probability associated with condomless insertive and receptive anal sex, the average number of sex acts per month, and the efficacy of male circumcision applied to only insertive anal acts were discussed in Lasry et al. 2014.(2)

Table 1. **Model parameters and input values used in assessing HIV acquisition risk among HIV-uninfected MSM**

Parameter	Value [95% CI, Range]	Source
Probability of HIV acquisition per unprotected sex act with an HIV infected partner (b_j)		
Insertive anal sex	0.0062 [0.0007-0.0168]	(3)
Receptive anal sex	0.014 [0.002-0.025]	(4)
Risk ratio associated with HIV transmission risk modifiers (r_j)		
Male circumcision in HIV-uninfected person[a]	0.27 [0.17-0.44]	(5)

PrEP use with average adherence[b]	0.56 [0.37-0.85)	(6)
PrEP use with high adherence[c]	0.27 [0.12-0.59]	(6)
PrEP use with very high adherence[d]	0.08 [0.01-0.60]	(6)
Consistent condom use (100% of the time)	0.30 [0.21-0.42]	(7)
Antiretroviral therapy (ART) among HIV-infected person	0.04 (0.01-0.27)	(8)
Number of monthly sex acts (n)	6 [2, 20]	(2)
HIV prevalence in MSM population (π)	0.18 [0.03, 0.43]	(9)
Viral load suppression among HIV-infected MSM on ART (*w*)	0.30 (0.28, 0.35)	(10)

[a] Circumcision efficacy 0.73 (resulting in a risk ratio of 0.27) reflected men practicing primarily or exclusively insertive anal sex with men, based on a meta-analysis.

[b] PrEP efficacy 44% (resulting in a risk ratio of 0.56) with average adherence as reported in the intention-to-treat analysis in iPrEx study.(6)

[c] PrEP efficacy 73% (risk ratio: 0.27) with high adherence (≥90%), based on self-reported pill counts.(6)

[d] PrEP efficacy 92% (risk ratio: 0.04) with very high adherence, based on study drug (emtricitabine and tenofovir disoproxil fumarate (FTC/TDF)) detection in blood samples.(6)

C. Sensitivity Analysis

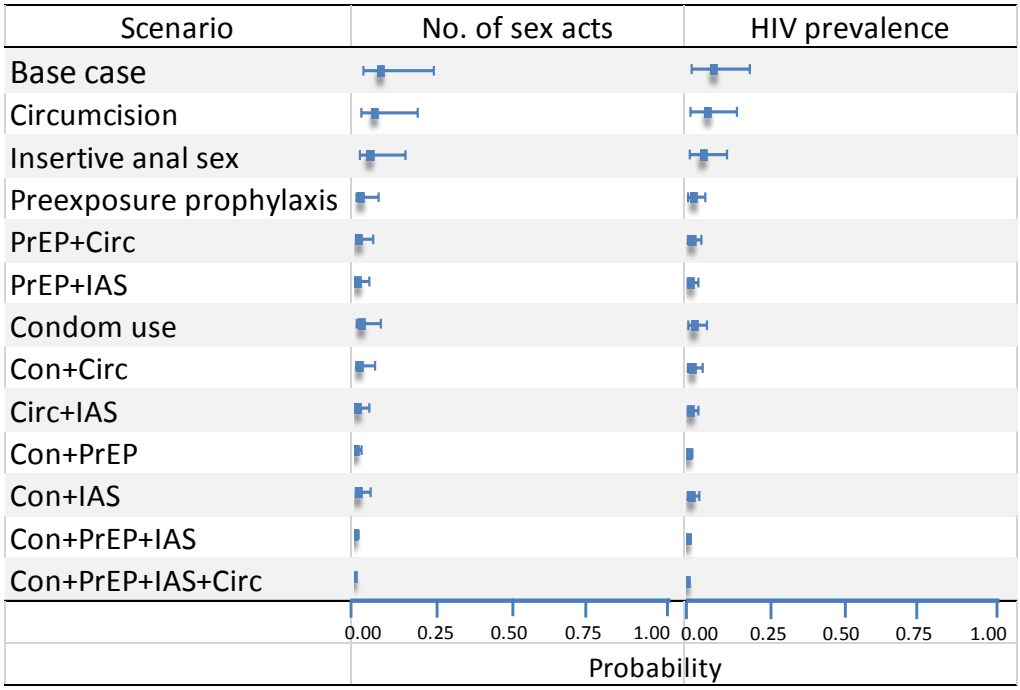
We conducted univariate sensitivity analysis on key parameters to explore potential variation in our risk estimates. We explored the variation in prevalence (range: 3.1%-19.9%, base case risk: 8.8%) among the communities from which MSM may select their partners. In addition, previous analyses have demonstrated that number of HIV exposures – sex acts in our analysis – has a large effect on the risk of acquiring HIV. Therefore, similar to Lasry et al. 2014 [3], we varied the number of sex acts from 2 to 20 per month, compared with a base case value of 6. The results show that the changes in these

inputs have largest effect at base case and increasingly lower effects when more efficacious prevention strategies are used (Table 2, Figure 1).

Table 2. Sensitivity analysis on 1-year risk of HIV acquisition among HIV-uninfected MSM with varying combination of prevention strategies

Scenario	Base Case	No. of Sex Acts		HIV Prevalence	
		Lower Bound	Upper Bound	Lower Bound	Upper Bound
Base case	8.82%	3.06%	25.70%	1.52%	19.85%
Circumcision	6.91%	2.38%	20.51%	1.18%	15.77%
Insertive sex only	5.49%	1.88%	16.58%	0.93%	12.66%
Preexposure prophylaxis	2.48%	0.84%	7.95%	0.42%	5.82%
PrEP+Circ	1.93%	0.65%	6.22%	0.32%	4.55%
PrEP+nsert	1.53%	0.51%	4.95%	0.26%	3.61%
Condom use	2.70%	0.91%	8.65%	0.46%	6.35%
Con+Circ	2.10%	0.71%	6.77%	0.35%	4.96%
Con+Insert	1.53%	0.51%	4.95%	0.26%	3.61%
Circ+Insert	0.74%	0.25%	2.44%	0.12%	1.76%
Con+PrEP	1.67%	0.56%	5.39%	0.28%	3.94%
Con+PrEP+Insert	0.45%	0.15%	1.50%	0.08%	1.08%
Con+PrEP+Insert+Circ	0.12%	0.04%	0.41%	0.02%	0.29%

Note: Base case, no strategies; Circumcision (Circ); Insertive anal sex only (IAS); Preexposure prophylaxis (PrEP); Condom use (Con). Numeric results are available from the 1st author upon request.



Note: Base case, no strategies; Circumcision (Circ); Insertive anal sex only (IAS); Preexposure prophylaxis (PrEP); Condom use (Con).

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