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Replacing Clinic-Based Tests With Home-Use Tests May Increase HIV Prevalence Among Seattle Men Who Have Sex With Men: Evidence From a Mathematical Model

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Abstract

Background—Home-use tests have potential to increase HIV testing but may increase the rate of false-negative tests and decrease linkage to HIV care. We sought to estimate the impact of replacing clinic-based testing with home-use tests on HIV prevalence among men who have sex with men (MSM) in Seattle, Washington.

Methods—We adapted a deterministic, continuous-time model of HIV transmission dynamics parameterized using a 2003 random digit dial study of Seattle MSM. Test performance was based on the OraQuick In-Home HIV Test (OraSure Technologies, Inc, Bethlehem, PA) for home-use tests and, on an average, of antigen-antibody combination assays and nucleic acid amplification tests for clinic-based testing.

Results—Based on observed levels of clinic-based testing, our baseline model predicted an equilibrium HIV prevalence of 18.6%. If all men replaced clinic-based testing with home-use tests, prevalence increased to 27.5% if home-use testing did not impact testing frequency and to 22.4% if home-use testing increased testing frequency 3-fold. Regardless of how much home-use testing increased testing frequency, any replacement of clinic-based testing with home-use testing increased prevalence. These increases in HIV prevalence were mostly caused by the relatively long window period of the currently approved test. If the window period of a home-use test were 2 months instead of 3 months, prevalence would decrease if all MSM replaced clinic-based testing with home-use tests and tested more than 2.6 times more frequently.

Conclusions—Our model suggests that if home-use HIV tests replace supplement clinic-based testing, HIV prevalence may increase among Seattle MSM, even if home-use tests result in increased testing.

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In July 2012, the US Food and Drug Administration approved the first over-the-counter home-use HIV test, the OraQuick In-Home HIV Test (OraSure Technologies, Inc, Bethlehem, PA). Home-use tests, which allow testers to use rapid HIV tests on self-collected specimens to learn their status at home, have been proposed as a method to increase testing^{1–3} and thereby increase opportunities for HIV-infected individuals to enter care and engage in behaviors to reduce ongoing transmission. However, there are concerns about the relatively long window period of available rapid tests, the potential for test misinterpretation, reduced access to counseling, and missed opportunities to link HIV-infected persons into care and prevention services.^{3–5}

In premarketing studies for the OraQuick In-Home HIV Test, 47% of men who have sex with men (MSM) reported that they would definitely or probably buy a home-use HIV test.² The test's sensitivity and specificity in the hands of untrained users in uncontrolled settings were 91.7% and 99.98%, respectively, and the test is reported to have a window period of 3 months.⁶ In our experience among MSM in Seattle, however, the OraQuick ADVANCE Rapid HIV-1/2 Antibody Test, which uses the same technology as the home-use test, identifies fewer than 80% of HIV-infected MSM diagnosed through the Public Health–Seattle & King County pooled nucleic acid amplification testing (NAAT) program.⁷

The risks and benefits of introducing home-use HIV tests depend not only on the characteristics of the test but also on how it affects testing behavior and linkage to care, particularly among those at highest risk for acquiring HIV infection. However, no studies have been conducted to evaluate the impact of introducing home-use tests in at-risk populations. Using population-based behavioral surveillance data and mathematical modeling, we aimed to estimate the impact of replacing clinic-based HIV tests with home-use tests on population-level HIV prevalence among MSM in Seattle, Washington.

Materials and Methods

We adapted a previously published, deterministic, continuous-time model that was developed to understand HIV transmission dynamics among MSM in Seattle.⁸ Figure 1 depicts how the population has been divided into compartments whose size through time is specified with a system of ordinary differential equations. We used this model because it includes parameters that address 2 important potential effects of home-use testing: changes in HIV testing behavior (type of test and testing frequency) and linkage to HIV care (antiretroviral therapy [ART] coverage and effects, including reduction in infectiousness, disease progression, and death). The model is not intended to capture the full temporal trajectory of the HIV epidemic among MSM, but rather to obtain population-level HIV equilibrium prevalence under each behavioral scenario we consider. The model's general structure and assumptions are explained here; additional technical details are available in the previously published model.⁸

Model Framework

Compartments are defined by anal sexual activity level A (none; 1, low; 2, high), true HIV serostatus, and HIV testing site C (0 [home-use tests] vs. 1 [clinic-based tests]). HIV-infected men are further subdivided by disease stage and detectability by clinic-based or home-use testing. The resulting categories are as follows: primary HIV infection (PHI) clinic–/home–, PHI clinic+/home–, PHI clinic+/home+, chronic infection, and AIDS. The last 4 categories are divided by diagnosis status, and diagnosed men are further subdivided by ART status. These attributes define 53 compartments, including 1 for men forgoing all anal sex, used only to calculate prevalence. Men remained in 1 sexual activity level for the duration of their sexual lifespan, and we assumed assortative mixing by perceived serostatus and random mixing by sexual activity class.

Data Sources

The model was parameterized using a 2003 random digit dial study of Seattle MSM⁹ and publicly available data from the literature (Table 1).

HIV Testing

All compartments that include HIV-infected men are separated into men who test using home-use HIV tests and men who test at clinics. This allows men pursuing different testing strategies to differ with respect to the window period and sensitivity of the test they receive, testing frequency, and ART initiation. The model does not account for men who test at home and at clinics. The characteristics of home-use tests are based on the OraQuick In-Home HIV Test, a rapid HIV-1/2 antibody test performed on oral fluids that has a window period of 3 months and 91.7% sensitivity after the window period.² Clinic-based testing includes either pooled NAAT or antigen-antibody combination assays, which represent most HIV tests received by MSM in King County. We assume that these tests have an average window period of 15 days and an approximated 100% sensitivity after the window period.^{8,10} Our base model assumes 100% clinic-based testing and that low-activity men average 1 test per year and high-activity men average 2.⁹ Testing rates (θ) are multiplied by test sensitivity.

Other Updates to the Model

We have also updated several parameters in response to developments since the original model was published in 2009. First, because ART is now recommended for all HIV-infected individuals and may have benefits during acute infection,¹¹ men may now enter treatment during primary infection. We estimated the proportion of days that MSM diagnosed as having HIV infection were on ART during primary infection based on data from MSM enrolled in the University of Washington Primary Infection Clinic cohort from 2009 to 2012 (J. Maenza, personal communication). Second, based on results from HPTN 052, we estimated that ART results in a 96% reduction in infectiousness.¹² Third, because changing treatment guidelines and public health efforts have increased access to ART since 2003, we have used population-based estimates from Public Health–Seattle & King County surveillance to update the proportion of men with diagnosed HIV infection who are on ART during chronic infection or AIDS from 67% to 74% (J. Dombrowski, personal communication). We then calculated the rate of ART initiation necessary to achieve 74% coverage. Fourth, the transmission probability per act of receptive unprotected anal intercourse during primary infection has been revised from 2% to 6% to better reflect the estimated increase in transmission risk during primary infection versus chronic infection.^{13,14}

Initial Conditions

We modeled a population of 40,000 men seeded with 10 infected men in primary infection. Four are aware of their HIV status, and half are low-activity and half high-activity men. All other men are HIV negative and distributed according to the activity class distribution described in Table 1. The proportion of the population testing at home versus clinic varies by scenario.

Parameterization and Analysis

The baseline model was parameterized by our data. All parameters were fixed, except for the transmission probability per act of receptive unprotected anal intercourse. For this parameter, we identified the value that best reflected the estimated increase in transmission risk during primary versus chronic infection but still achieved an equilibrium HIV prevalence within the range estimated for MSM in Seattle through trial and error. We then ran the model varying parameter values reflecting hypothetical scenarios of interest and

determined equilibrium HIV prevalence for each scenario. To evaluate the effects of changes in testing behavior, we varied the proportions of men who test at home versus a clinic as well as the testing frequency of home testers relative to clinic testers. We examined the combined effects of the window period of the home-use test and testing frequency by varying both parameters in a scenario with 100% home-use testing. We also examined the effects of replacing clinic-based testing with home-use tests in settings where the average testing frequency and window period of available clinic-based tests differ. Finally, to examine the impact of potential reductions in linkage to care among those diagnosed using home-use tests, we varied the rate of ART initiation among men diagnosed as having HIV infection. We then repeated these analyses with HIV incidence at equilibrium as the outcome to explore the potentially different impacts of home-use tests on transmission versus survival.

The system is coded and solved using Berkeley Madonna 8.3.14 (Berkeley Madonna, Inc, Berkeley, CA). This research received ethical approval from the University of Washington Human Subjects Division.

Results

Our baseline model considers the epidemic using our observed data with all HIV testing occurring in a clinic. Equilibrium prevalence is 18.6%, which falls within the range estimated for Seattle MSM (15%; 95% confidence interval, 11%–19%).¹⁵

Figure 2 shows equilibrium prevalence when varying the proportion of the population who test at home and the testing frequency among those testing at home. By replacing all clinic-based testing with home-use testing, prevalence rises to 27.5%, assuming no changes in testing frequency or ART coverage. If home-use tests increase testing frequency by 3-fold, the prevalence is 22.4% when all tests occur at home.

Figure 3 depicts the equilibrium prevalence at various testing frequencies when all testing occurs at home, while varying the window period of the home-use test. With a window period of 90 days, equilibrium prevalence is greater than the 18.6% observed in the baseline scenario regardless of how much home-use testing increases testing frequency (empirically tested up to a 100-fold increase). If the window period were 60, 42, 28, or 15 days, equilibrium prevalence would equal 18.6% if home-use testing increased testing frequency by 2.6, 1.6, 1.2, or 1.1 times, respectively.

Figure 4 demonstrates the increase in equilibrium HIV prevalence that occurs when clinic-based testing is completely replaced with home-use tests in scenarios with varying rates of HIV testing and different clinic-based test window periods. In the model scenario representing Seattle, replacing clinic-based testing with home-use tests results in an 8.9% increase in prevalence (18.6%–27.5%). In a setting where low- and high-activity MSM average 1 test every 2 years and clinic-based tests have a 42-day window period, replacing clinic-based testing with home-use tests results in only a 1.0% increase in prevalence (33.6%–34.6%).

Altering the rate at which men diagnosed as having HIV infection initiate ART affects equilibrium HIV prevalence by changing the proportion of men who are receiving treatment, which reduces the likelihood of transmission and the rate of disease progression. We therefore examined the equilibrium prevalence at varying rates of ART initiation among men diagnosed as having HIV infection via home-use tests (see Supplemental Digital Content 1, <http://links.lww.com/OLQ/A79>, which depicts equilibrium prevalence and incidence at varying rates of ART initiation among men testing at home). If men who receive their initial reactive HIV tests at home initiate ART at the same rate as those who

receive their initial reactive tests in a clinic, the proportion of diagnosed men on treatment decreases from 73% when all tests occur in a clinic to 71% when all tests occur at home, and equilibrium prevalence increases from 18.6% to 27.5%. If home-use testing reduces the rate of ART initiation by 50% and the entire population tests at home, the proportion of diagnosed men on treatment falls to 56% and prevalence increases to 29.0%. If no one who tests at home initiates ART, the prevalence rises to 31.4% when all men test at home.

If we vary the sensitivity of the home-use test to reflect the lower and upper bounds of the 95% confidence interval reported by OraSure (84.2%–96.3%), the equilibrium prevalence at 100% home-use testing is 28.0% and 27.2%, respectively, assuming a 3-month window period and no changes in testing frequency or ART coverage.

Equilibrium HIV incidence in the baseline scenario is 1.18 per 100 person-years and increases to 1.79 per 100 person-years when all testing occurs at home. The impact of replacing clinic-based testing with home-use tests on incidence at varying testing frequencies and in different settings is proportionally similar to the impact on prevalence (data not shown). However, reducing the rate of ART initiation among men testing at home has effects on equilibrium incidence of greater magnitude than on equilibrium prevalence. If the entire population tests at home and home-use testing reduces the rate of ART initiation by 25%, 50%, 75%, and 100%, equilibrium incidence increases to 1.92, 2.10, 2.42, and 3.08 per 100 person-years, respectively (Supplemental Digital Content 1, <http://links.lww.com/OLQ/A79>).

Discussion

Home-use tests have the potential to reach HIV-infected persons who would not otherwise test for HIV infection. However, our model suggests that replacement of clinic-based testing with home-use tests may increase HIV prevalence among Seattle MSM, even if home-use tests allow MSM to test more frequently. This potential increase in prevalence seems to be driven primarily by the relatively long window period of the approved home-use test when compared with available laboratory-based tests, such as NAAT and antigen-antibody combination assays. To a lesser extent, challenges in linking individuals who receive reactive tests at home into HIV care may also increase HIV prevalence among MSM according to our model.

In practice, home-use tests may impact individual testing behavior in several ways: some MSM who have never tested may test themselves at home, some who previously tested in clinics may test entirely at home instead or may combine clinic and home-use tests, and some may continue to test in clinics only. Our model includes 2 groups, one that tests entirely at home and one that tests entirely in clinics, and therefore does not address men who combine clinic and home-use tests. As demonstrated by our model, any replacement of clinic-based tests with home-use tests that have a 3-month window period has the potential to increase HIV prevalence. However, if MSM continue to test in clinics as they do now and supplement these tests with home-use tests, the introduction of home-use testing may reduce HIV prevalence in this population. The net effect of home-use tests on the HIV epidemic in MSM will depend on how this population chooses to use home-use tests, which is not fully understood but will likely depend on willingness to purchase the \$40 kit.¹⁶

In this model, the length of the window period, or time during which HIV tests are negative in infected persons, contributed substantially to the differences we observed in equilibrium HIV prevalence when men tested at home instead of clinics. The OraQuick In-Home HIV Test is reported to have a window period of 90 days.² As a result, this test cannot detect HIV during primary infection, a period when individuals may be 10 or more times more likely to

transmit HIV,^{13,14} and HIV-infected individuals testing at home are unable to change their seroadaptive behaviors or initiate ART during this highly infectious stage. Regardless of how much more often MSM tested for HIV infection when testing at home, any replacement of clinic-based testing with home-use testing increased equilibrium prevalence. However, if the true window period of the OraQuick device were closer to 42 days,¹⁷ replacing clinic-based testing with home-use testing would have the potential to reduce prevalence if home-use tests increased testing by at least 1.6-fold. In addition, although NAAT and antigen-antibody combination assays are widely available to MSM in Seattle, they are not available in all settings. Our model suggests that replacing clinic-based tests with home-use tests results in smaller increases in HIV prevalence when tests with longer window periods are the norm. Developing home-use tests with shorter window periods or using these tests in settings where only early generation tests are available would improve the likelihood that home-use testing will reduce HIV prevalence among MSM.

In Seattle, more than 90% of MSM have previously tested for HIV infection and tend to test at least once per year.^{9,18} As a result, tests with long window periods are likely to miss a substantial proportion of undiagnosed infections.⁷ However, MSM in other locations often test less frequently,¹⁹ and in our model, replacing clinic-based tests with home-use tests results in much smaller increases in HIV prevalence in scenarios with lower average testing rates. Home-use tests may have more potential for benefit where incidence is low or the population tests less frequently because infected individuals would be less likely to test during the window period by chance and receive a false-negative result.

Concerns have been raised that individuals who receive their first reactive HIV test at home will be less likely to engage in timely medical care for their infection than individuals who learn their status in health care settings.^{3–5} Delaying care can adversely impact the HIV-infected individual's health²⁰ and contribute to ongoing transmission.¹² In our model, we approximated delays in linkage to care by reducing the rate of ART initiation for men testing at home and saw modest increases in equilibrium HIV prevalence, assuming no changes in HIV testing or sexual behavior. Reduced rates of ART initiation among home-use testers had an even greater impact on equilibrium incidence, which suggests that delays in linkage to care in this group may result in both increased transmission and reduced survival. It will be important to develop methods for ensuring that individuals with reactive home-use tests link to care immediately to reduce risks to their health and prevent additional transmission.

To our knowledge, this is the first model to describe the potential impact of home-use tests on HIV prevalence in an at-risk population. Previous models of home-use tests have described the effect of testing with sex partners by MSM to inform condom use on individual-level risk of HIV acquisition²¹ and test results in the population who would not otherwise test for HIV infection.² The former model suggested that, in most scenarios, individual MSM would be less likely to acquire HIV during a 1-year period if they used home-use tests with partners to inform condom use than if they did not use their partners' HIV status to inform condom use and used condoms for fewer than half of anal sex acts.²¹ The impact of such “point-of-sex testing” on HIV transmission in the population was not assessed. The latter model was developed by the Food and Drug Administration as part of the review process for the OraQuick In-Home HIV Test.² This model estimated that 1 false-negative test would be expected for every 13 true positives and 1 false positive for every 3750 true negatives. However, it did not evaluate the effects of these false test results, focused only on those individuals who would otherwise not test, and did not consider the window period of the test.

Our study has several limitations. First, the model does not include men who supplement clinic-based testing with home-use tests and therefore can only estimate the impact of

replacing clinic-based testing with home-use tests. Second, because this is a compartmental model, it approximates the effects of home-use tests on HIV testing by altering the average rate of exit from undiagnosed to diagnosed. It therefore does not explicitly account for home-use testing among MSM who would not otherwise have an HIV test. In addition, in the absence of up-to-date population-based data from Seattle, we relied on estimates from the 2003 random digit dial study for HIV testing and sexual behavior parameters, which are likely to have changed. Fourth, MSM are likely to test with partners before sex to inform decisions regarding what sex acts to engage in and whether to use condoms.^{22–24} We were unable to model the effects of this point-of-sex testing, which may affect HIV prevalence by changing the rate and accuracy of serosorting. In addition, in the absence of data from MSM, we relied on estimates of the relative likelihood of HIV transmission during primary versus chronic infection from heterosexuals, and equilibrium prevalence was very sensitive to the probability of transmission to an uninfected receptive partner per act of unprotected anal intercourse during primary infection. However, varying the relative increase in the likelihood of transmission during primary versus chronic infection from 5- to 10-fold had a relatively limited impact on the increase in prevalence observed when home-use testing replaced clinic-based testing (9.0% vs. 7.3%, respectively). There is also uncertainty regarding the impact of ART on the likelihood of HIV transmission among MSM. We varied the reduction in infectiousness associated with ART use from 60% to 96%^{12,25,26} and found that smaller reductions in infectiousness resulted in smaller increases in prevalence when home-use tests replaced clinic-based testing. If ART reduced the likelihood of transmission by only 60%, replacing clinic-based testing with home-use tests would increase prevalence by 5.7%. Finally, men in the model remained in 1 sexual activity level for the duration of their lifespan.

This model illustrates potential concerns about how the characteristics of home-use tests and difficulties in linkage to care among individuals who receive reactive tests at home will affect the HIV epidemic among MSM. With the introduction of home-use tests, studies will be necessary to understand how home-use tests impact HIV testing, sexual behaviors, and linkage to care and to develop effective methods for mitigating any identified risks. To provide a more complete picture of how home-use tests will affect the HIV epidemic, future models should consider the impact on HIV prevalence if home-use tests are used to supplement instead of replace clinic-based testing, if they affect sexual risk behavior, and if they are used in different populations and settings. Despite their potential to reach individuals who would not otherwise test for HIV infection, it is unclear how effective home-use tests will be at increasing knowledge of HIV status among the approximately one fifth of HIV-infected persons in the United States who are unaware of their infection.²⁷

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Flowchart of a mathematical model of home-use testing among MSM in Seattle.

Compartments are defined by anal sexual activity level A (none; 1, low; 2, high), true HIV serostatus, and HIV testing site C (0 [home-use tests] vs. 1 [clinic-based tests]). HIV-infected men are further subdivided by disease stage, detectability by clinic-based or home-use tests, and (if diagnosed) by ART use.

Figure 2.

Equilibrium HIV prevalence for various proportions of home-use testing (vs. clinic-based testing) in the population at varying testing frequencies among those testing at home. As the proportion of MSM who test at home instead of in a clinic increases, equilibrium HIV prevalence rises. If home-use tests replace clinic-based testing completely, prevalence increases from 18.6% to 27.5%, assuming no changes in testing frequency. Increasing testing frequency among men testing at home reduces this effect on prevalence but does not reverse it completely. Note: a 3-fold increase in testing frequency results in an average of 3 and 6 tests per year among low- and high-activity men, respectively.

Figure 3.

Equilibrium HIV prevalence at varying testing frequencies and home-use test window periods when all testing occurs at home. The gray line represents the equilibrium prevalence in the baseline scenario of 100% clinic-based testing: 18.6%. Average testing frequency in the figure ranges from 1 to 6 tests per year among low-activity men and 2 to 12 tests per year among high-activity men. With a 90-day window period, if clinic-based testing is replaced completely by home-use tests, equilibrium prevalence is greater than 18.6% regardless of how much home-use tests increase testing frequency. If the window period of a home-use test were 60, 42, 28, or 15 days, equilibrium prevalence would equal 18.6% if home-use tests increased testing frequency by 2.6, 1.6, 1.20, or 1.1 times, respectively.

Figure 4.

Increases in equilibrium HIV prevalence as a result of replacing clinic-based testing with home-use tests varying the rate of HIV testing and the window period of clinic-based tests. The impact of replacing clinic-based testing with home-use tests on equilibrium HIV prevalence depends on the average testing frequency among MSM as well as the window period of the tests. The more frequently MSM test for HIV infection and the shorter the window period of clinic-based tests, the greater the increase in HIV prevalence when clinic-based testing is replaced with home-use tests. For example, in the model scenario representing Seattle, low-activity men average 1 test per year, high-activity men average 2, and the window period of clinic-based testing is 15 days. Replacing clinic-based testing with home-use tests in this scenario results in an 8.9% increase in equilibrium HIV prevalence (18.6%–27.5%). On the other hand, in a setting where low- and high-activity MSM average 1 test every 2 years and clinic-based tests have a 42-day window period, replacing clinic-based testing with home-use tests results in only a 1.0% increase in prevalence (33.6%–34.6%).

Table 1
Inputs for a Mathematical Model of Home-Use Testing Among MSM in Seattle

Parameter	Value	Source
Population dynamics		
Proportion of men with no anal sex contacts in the prior year	0.39	Derived from Brewer et al.9
Proportion of low-activity men	0.26	Derived from Brewer et al.9
Proportion of high-activity men	0.35	Derived from Brewer et al.9
Duration of sexual activity ($1/\mu$ y)	50	
HIV disease dynamics		
Duration of primary infection: clinic-/home- ($1/\nu$ d)	15	10
Duration of primary infection: clinic+/home- ($1/\rho$ d)	75	2
Duration of primary infection: clinic+/home+ ($1/\kappa$ d)	0*	13,27,28
Duration of chronic infection ($1/\gamma$ y)	10	29,30
Duration of AIDS ($1/\alpha$ y)	2	13,31
HIV treatment		
Proportion of men with primary infection who are on treatment	0.2	$\dagger$
Proportion of men with chronic infection or AIDS who are on treatment	0.74	$\dagger$
Rate of withdrawal from treatment (ω y ⁻¹)	0.02	32
Reduction in rate of disease progression from chronic infection to AIDS as a result of ART (ε_P)	0.6	29
Reduction in rate of death after an AIDS diagnosis as a result of ART (ε_M)	0.6	29
Reduction in infectiousness as a result of ART (ε_T)	0.96	12
HIV testing frequency		
Clinic-based testing (range)		
Low-activity men (θ_L y ⁻¹)	1 (1–2)	Derived from Brewer et al.9
High-activity men (θ_H y ⁻¹)	2 (1–4)	Derived from Brewer et al.9
Sensitivity of home-use HIV test	0.92	6
HIV transmission		
Transmission probability per receptive UAI act, primary infection (β_A)	0.06	13,33
Transmission probability per receptive UAI act, chronic infection (β_A)	0.008	13,33
Transmission probability per receptive UAI act, AIDS (β_A)	0.01	13,33
Transmission probability per insertive UAI act, primary infection (β_A)	0.008	13,33
Transmission probability per insertive UAI act, chronic infection (β_A)	0.0007	13,33
Transmission probability per insertive UAI act, AIDS (β_A)	0.001	13,33
Sexual risk behavior		
Mean number of anal sex contacts per year (c)		
Low-activity men (c_L)	1	Derived from Brewer et al.9
High-activity men (c_H)	10	Derived from Brewer et al.9
Mean number of anal sex acts per perceived concordant anal sex contacts reported by HIV-negative men		
Low-activity men (n_L^1)	32	Derived from Brewer et al.9
High-activity men (n_H^1)	22	Derived from Brewer et al.9

Parameter	Value	Source
Mean number of anal sex acts per perceived discordant anal sex contacts reported by HIV-negative men		
Low-activity men (n_L^0)	14	Derived from Brewer et al.9
High-activity men (n_H^0)	6	Derived from Brewer et al.9
Proportion of anal sex acts in which the negative partner is insertive, for perceived discordant contacts		
Low-activity men (p_{ins})	0.64	Derived from Brewer et al.9
High-activity men (p_{ins})	0.41	Derived from Brewer et al.9
Proportion of acts of insertive anal sex with perceived concordant partners during which HIV-negative men use condoms		
Low-activity men (C_{ins})	0.54	Derived from Brewer et al.9
High-activity men (C_{ins})	0.34	Derived from Brewer et al.9
Proportion of acts of insertive anal sex with perceived discordant partners during which HIV-negative men use condoms		
Low-activity men (C_{ins})	0.36	Derived from Brewer et al.9
High-activity men (C_{ins})	0.14	Derived from Brewer et al.9
Proportion of acts of receptive anal sex with perceived concordant partners during which HIV-negative men use condoms		
Low-activity men (C_{rec})	0.54	Derived from Brewer et al.9
High-activity men (C_{rec})	0.34	Derived from Brewer et al.9
Proportion of acts of receptive anal sex with perceived discordant partners during which HIV-negative men use condoms		
Low-activity men (C_{rec})	0.29	Derived from Brewer et al.9
High-activity men (C_{rec})	0.22	Derived from Brewer et al.9
Effectiveness of condoms (ϵ_C)	0.8	34
Sexual mixing [‡]		
Serosorting odds ratio derived from reports by low-activity men (OR_L)	68	Derived from Brewer et al.9
Serosorting odds ratio derived from reports by high-activity men (OR_H)	12	Derived from Brewer et al.9
Serosorting odds ratio in contacts between low-activity and high-activity men ($OR_{L,H}$)	60	Derived from Brewer et al.9

* In the primary model of home-use tests, the window period of the home-use test equaled the duration of primary infection (90 days); therefore, the duration of primary infection during which HIV was detectable by home tests was 0 days.

[†] The proportions of Seattle MSM who are on treatment during primary infection and chronic infection or AIDS were derived from data from the University of Washington Primary Infection Clinic cohort (J. Maenza, personal communication) and Public Health–Seattle & King County HIV/STD Program (J. Dombrowski, personal communication), respectively.

[‡] For these parameters, our data provide us with 2 estimates: one for low-activity men and high-activity men. However, our model requires 3 parameters defined on activity levels for actor pairs (HH, HL, LL). The method we use to derive these 3 parameters from the 2 observed data points is identical for each parameter class and is described in detail in the previously published model.⁸

UAI indicates unprotected anal intercourse.