

# HIV Seroconversion Among Public Sexually Transmitted Disease Clinic Patients

## *Analysis of Risks to Facilitate Early Identification*

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**Objectives:** We identified risks for HIV seroconversion among public sexually transmitted disease (STD) clinic patients.

**Design:** This was a retrospective cohort study conducted January 1993 through October 2002 of STD clinic attendees aged  $\geq 12$  years in Baltimore, Maryland.

**Methods:** A negative HIV enzyme immunoassay (EIA) test was required for staggered cohort entry. Observation time was 30 days to 3 years. The outcome for multivariate Poisson regression was HIV seroconversion (positive EIA and/or Western blot test) compared among patients with or without sexual risk behaviors, drug use, an STD diagnosis, and signs and symptoms at an initial HIV test.

**Results:** One hundred twenty-five HIV seroconversions occurred among 10,535 individuals and 13,693 person-years of observation, for an incidence of 0.91 HIV seroconversions per 100 person-years (95% confidence interval [CI]: 0.76 to 1.09). Median time to HIV seroconversion was 1.54 years (95% CI: 1.11 to 1.73). In multivariate analysis, increased HIV seroconversion risk was associated with older age, drug use, a sexual partner with syphilis or HIV, genital ulcers, and gonorrhea. HIV incidence per 100 person-years was 4.86 for subjects with an HIV-positive sexual partner, 3.06 for those with injection drug use, and 2.40 for those with genital ulcers.

**Conclusions:** We found a high rate of HIV seroconversion among STD clinic patients with specific risks. Algorithms with HIV RNA testing targeted to patients at the highest risk for seroconversion may optimize prevention and resource utilization.

**Key Words:** HIV, seroconversion, risk factors, sexually transmitted disease clinic, HIV testing, cohort

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There are an estimated 40,000 incident HIV cases annually in the United States. This number has remained constant over the past decade despite intense national prevention efforts, demonstrating the need for new approaches in addressing the HIV epidemic.<sup>1</sup> Studies find that the probability of HIV transmission increases with increasing viral load.<sup>2,3</sup> During HIV seroconversion, individuals have a high viral load in blood and genital secretions.<sup>4</sup> A study of HIV-discordant couples found that the rate of HIV transmission was the highest within the first few months of infection.<sup>5</sup> Thus, identifying those who are seroconverting and intervening during this period of hyperinfectiousness may be a useful component of optimal disease control. The approach of pooled HIV RNA testing linked to serologic testing and to partner notification may be useful toward these ends.<sup>6</sup> Defining local risks for seroconversion in high-volume HIV testing sites may assist in implementing targeted prevention strategies in different settings.

Although all sexually transmitted disease (STD) clinic attendees may have elevated risk for HIV seroconversion, the cost and availability of HIV RNA testing may limit its application to all patients, especially in high-volume testing sites. There may be readily identifiable risk factors for HIV seroconversion that may aid in the development of laboratory testing algorithms. Few studies have examined risks for HIV seroconversion or recent HIV infection in STD clinic attendees specifically, although these studies found that risks varied by site.<sup>7–9</sup> We sought to determine rate of HIV seroconversion in our public STD clinics and to identify demographic, behavioral, and clinical factors that may predict HIV seroconversion.

## METHODS

### Study Setting

This study was a record-based historical cohort study. The cohort consisted of patients aged 12 to 79 years with HIV testing at either of the 2 public STD clinics in Baltimore, Maryland between January 1993 and October 2002. Risks at the time of the first HIV test were compared for patients who

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S. D. Mehta developed the statistical analysis plan, analyzed the data, and wrote the first draft of the paper. K. G. Ghanem participated in clinical data collection and assisted S. D. Mehta with interpretation of the variables in the data set and results of analysis as well as reviewing and revising the manuscript. A.M. Rompalo assisted S. D. Mehta with interpretation of the variables in the data set and results of analysis as well as reviewing and revising the manuscript. E. J. Erbelding originated the objective of the paper, obtained the data for analysis, assisted with interpretation and presentation of data analysis and results, and reviewed and revised the manuscript.

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**TABLE 1.** Trends Over Time in Characteristics of STD Clinic Patients With Repeat HIV Testing by Year of Initial Test, Baltimore, Maryland, 1993 Through 2002

	1993 N = 1668	1994 N = 940	1995 N = 812	1996 N = 780	1997 N = 792	1998 N = 1157	1999 N = 1435	2000 N = 1318	2001 N = 1288	2002 N = 345	P (Nonparametric Trend Test)
Median age (y)	28	28	28	28	27	25	25	24	25	23	<0.01
Male	66.8%	64.0%	61.7%	64.1%	60.9%	57.8%	54.4%	55.5%	54.1%	47.0%	<0.001
Ever injected drugs	1.92%	4.68%	3.94%	4.23%	4.42%	3.46%	5.02%	4.86%	8.77%	7.25%	<0.001
Ever inhaled cocaine	9.89%	21.1%	18.1%	17.8%	17.1%	16.5%	18.0%	17.7%	20.2%	14.4%	<0.001
Ever engaged in “exchange sex”	1.76%	3.33%	2.88%	2.94%	4.43%	3.38%	3.99%	4.72%	9.38%	9.22%	<0.001
Sexual contact ever with injection drug user	10.8%	10.5%	8.61%	10.2%	10.0%	11.9%	11.7%	9.74%	10.7%	10.0%	0.978
Reason for visit: HIV contact	1.98%	3.40%	1.72%	0.51%	2.27%	1.04%	1.11%	1.21%	0.62%	0.29%	<0.001
Reason for visit: syphilis contact	2.04%	3.19%	4.06%	5.13%	6.44%	4.06%	2.09%	2.28%	1.01%	1.16%	0.003
Sexual contact ever with HIV-positive sexual partner	2.88%	3.30%	2.09%	2.56%	2.90%	2.51%	2.58%	2.58%	2.17%	1.74%	<0.001
Early syphilis	1.63%	2.36%	4.96%	6.84%	5.82%	2.56%	1.23%	1.06%	1.00%	1.94%	0.008
Late syphilis	1.58%	1.56%	2.09%	4.09%	3.48%	2.56%	1.64%	1.89%	1.16%	1.94%	0.695
Gonorrhea	17.1%	20.2%	18.2%	15.5%	15.7%	15.7%	13.6%	12.5%	10.2%	9.28%	<0.001

seroconverted from HIV-negative to HIV-positive with those of patients who tested repeatedly in the same interval but did not seroconvert. This analysis was granted an exemption from human subjects review by the Institutional Review Boards of the Johns Hopkins Medical Institutions and Baltimore City Health Department.

**Data Collection**

Information regarding demographics, reason for visit, and patient and sexual partner behavioral risks was collected using a standardized clinical encounter form. Clinic staff entered behavioral data on this form, which were scanned into a clinic database and then linked to laboratory results obtained on specimens collected that day. Behavioral risks reported by the patient were recorded by clinicians as follows: number of sexual partners in the past 1 month (<2 or ≥2), exchanged sex for drugs or money ever (“exchange sex”), injection drug use (IDU) ever, and noninjection cocaine and other drug use ever. Reported risk of sexual contacts was also recorded, which included IDU exchange sex in a partner and known HIV infection of a partner. More than 95% of clinic attendees are African American; therefore, we did not analyze race.

Clinicians recorded findings from a structured physical examination and the STD clinical diagnosis on the encounter form. Early syphilis was defined as the clinician’s diagnosis of primary or secondary syphilis based on physical findings and laboratory results available that day or as a laboratory diagnosis of early latent syphilis (no previous history of syphilis, nontreponemal test titer reactive ≥1:16, and a reactive treponemal test). Late syphilis was defined as laboratory evidence of newly identified syphilis (no previous history of syphilis, nontreponemal test titer reactive at 1:1 to 1:8, and a reactive treponemal test). Gonorrhea was diagnosed by a positive laboratory test (culture, a licensed nucleic acid amplification test, or Gram stain secretions with

visualization of gram-negative intracellular diplococci) obtained from the urethra or cervix. For analysis, genital ulcer disease was defined as physical examination findings of penile, vulvar, or cervical ulcerations with or without vesicles.

**Data Analysis**

The observation period was from January 4, 1993 through October 28, 2002. Patients had to have at least 2 HIV tests within this period to be included in this analysis. The number of repeat tests per individual ranged from 1 to 26. Entry in to the cohort was staggered and began with the first date of an HIV-negative test. Persons were categorized as HIV-negative if they had a nonreactive enzyme-linked immunoassay (EIA) and as HIV-positive if they had a reactive EIA and/or Western blot test for HIV-1. HIV seroconversion was defined as a positive HIV test occurring after a negative HIV test. For the main analysis, the date of HIV seroconversion was defined as the date of the visit on which the individual tested HIV-positive. A separate analysis using the midpoint between both HIV tests was also performed. Inclusion in the cohort extended to patients with at least 30 days separating their first and last HIV tests. The end of analytic observation for individuals was the date that HIV seroconversion was documented by laboratory testing or the date of the last visit with an HIV-negative test result. Observation time was censored at 3 years. The following were excluded from contributing to person-years at risk: patients who tested HIV-positive at their initial test (n = 488), patients less than 12 years of age (n = 5), and patients with missing information on gender (n = 41).

Changes in patient characteristics over time were evaluated using a nonparametric trend test. In an exploratory analysis for Poisson regression, we calculated incidence per 100 person-years, incidence rate ratio (IRR), and 95%

**TABLE 2.** Incidence and Time to HIV Seroconversion by Patient Characteristics and Risk

Variable	N (%)	No. (%) HIV Seroconversions	No. Person-Years	HIV Seroconversions per 100 Person-Years (95% CI)
Overall	10,535	125	13,693	0.91 (0.76 to 1.09)
Age (y)				
Age 12–21	3368 (32.0)	14 (11.2)	4386	0.32 (0.17 to 0.53)
Age 22–29	2855 (27.1)	29 (23.2)	3691	0.79 (0.53 to 1.12)
Age 30–37	2203 (20.9)	42 (33.6)	2914	1.44 (1.04 to 1.94)
Age 38–45	1346 (12.8)	21 (16.8)	1739	1.21 (0.75 to 1.84)
Age >45	763 (7.2)	19 (15.2)	962	1.97 (1.19 to 3.07)
Gender				
Female	4296 (40.8)	49 (39.2)	5384	0.91 (0.67 to 1.20)
Male	6239 (59.2)	76 (60.8)	8309	0.91 (0.72 to 1.14)
Patient IDU ever				
No	9299 (95.0)	95 (84.1)	12,216	0.78 (0.63 to 0.95)
Yes	490 (5.0)	18 (15.9)	589	3.06 (1.82 to 4.79)
Noninjection cocaine use ever				
No	7624 (81.4)	61 (59.2)	9954	0.61 (0.47 to 0.79)
Yes	1743 (18.6)	42 (40.8)	2272	1.85 (1.34 to 2.49)
Reason for visit: sexual contact with HIV-positive partner				
No	10,381 (98.5)	116 (92.8)	13,508	0.86 (0.71 to 1.03)
Yes	154 (1.5)	9 (7.2)	185	4.87 (2.25 to 9.03)
Reason for visit: sexual contact with syphilis-positive partner				
No	10,223 (97.0)	110 (88.0)	13,273	0.83 (0.68 to 1.00)
Yes	312 (3.0)	15 (12.0)	420	3.57 (2.01 to 5.82)
Sex ever with HIV-positive partner				
No	7707 (73.2)	70 (56.0)	10,029	0.70 (0.54 to 0.88)
Yes	273 (2.6)	13 (10.4)	341	3.81 (2.05 to 6.43)
Unknown	2555 (24.3)	42 (33.6)	3322	1.26 (0.91 to 1.71)
Sex ever with someone who engages in exchange sex				
No	7721 (81.2)	79 (68.7)	10,079	0.78 (0.62 to 0.98)
Yes	1792 (18.8)	36 (31.3)	1449	1.38 (0.85 to 2.12)
Gender of men's sexual partners				
Women	5218 (98.1)	56 (93.3)	6950	0.81 (0.61 to 1.05)
Men and/or women	100 (1.9)	4 (6.7)	127	3.14 (0.86 to 7.87)
Sex partners in past month				
Less than 2	5644 (65.7)	47 (50.0)	7466	0.63 (0.46 to 0.84)
2 or more	2952 (34.3)	47 (50.0)	3811	1.23 (0.91 to 1.63)
Previous syphilis infection				
No	9890 (93.9)	111 (88.8)	12,846	0.86 (0.71 to 1.04)
Yes	645 (6.1)	14 (11.2)	847	1.65 (0.91 to 2.76)
Previous trichomoniasis infection				
No	9076 (86.2)	98 (78.4)	11,754	0.83 (0.68 to 1.02)
Yes	1459 (13.8)	27 (21.6)	1939	1.39 (0.92 to 2.02)
Past history of gonorrhea				
No	7009 (66.5)	68 (54.4)	8965	0.76 (0.59 to 0.96)
Yes	3526 (33.5)	57 (45.6)	4728	1.21 (0.91 to 1.56)
Early syphilis				
No	10,243 (97.2)	113 (90.4)	13,304	0.85 (0.70 to 1.02)
Yes	292 (2.8)	12 (9.6)	389	3.08 (1.60 to 5.33)
Genital ulcer				
No	10,248 (97.3)	116 (92.8)	13,318	0.87 (0.72 to 1.04)
Yes	287 (2.7)	9 (7.2)	375	2.40 (1.10 to 4.51)
Gonorrhea				
No	8962 (85.1)	96 (76.8)	11,564	0.83 (0.67 to 1.01)
Yes	1573 (14.9)	29 (23.2)	2129	1.36 (0.91 to 1.95)

TABLE 2. (Continued)

Variable	N (%)	No. (%) HIV Seroconversions	No. Person-Years	HIV Seroconversions per 100 Person-Years (95% CI)
Prior HIV test				
No	2293 (24.8)	15 (14.9)	3017	0.50 (0.28 to 0.82)
Yes	6960 (75.2)	86 (85.1)	9062	0.95 (0.76 to 1.17)
Clinician impression: HIV exposure				
No	10,421 (98.9)	121 (96.8)	13,554	0.89 (0.74 to 1.07)
Yes	114 (1.1)	4 (3.2)	139	2.87 (0.79 to 7.20)
Year of initial HIV test				
1993–1995	3420 (32.5)	65 (52.0)	4603	1.41 (1.09 to 1.80)
1996–1998	2729 (25.9)	38 (30.4)	3885	0.98 (0.69 to 1.34)
1999–2000	4386 (41.6)	22 (17.6)	5206	0.42 (0.27 to 0.64)
Number of repeat tests within analytic period				
1 repeat test	7165 (68.0)	57 (45.6)	7841	0.73 (0.55 to 0.94)
2 repeat tests	2170 (20.6)	42 (33.6)	3435	1.22 (0.88 to 1.65)
3 or more repeat tests	1200 (11.4)	26 (20.8)	2417	1.07 (0.70 to 1.57)

confidence intervals (CIs) to assess statistical significance and direction of differences in the number of HIV seroconversions between groups. We calculated incidence by dividing the number of persons with HIV seroconversion by the number of person-years at risk. Statistically significant variables ( $P < 0.05$ ) were entered in multivariate analyses, in which the risk of HIV seroconversion was analyzed using Poisson regression. In addition to analyzing the sample population as a whole, men and women were analyzed separately. To assess the Poisson distribution assumption,<sup>10</sup> we examined the mean and variance of HIV seroconversion as well as the likelihood ratio test of the overdispersion parameter  $\alpha$ , both indicating that the Poisson regression was appropriate. The assessment of the goodness-of-fit using the deviance statistic showed the final multivariate models to be appropriate. Data were analyzed using STATA/SE 8.2 for Windows (Stata Corporation, College Station, TX).

## RESULTS

### Study Population

From January 1993 through October 2002, a total of 125 HIV seroconversions meeting our definition occurred among 10,535 individuals and 13,693 person-years of observation, for an overall incidence of 0.91 seroconversions per 100 person-years (95% CI: 0.76 to 1.09). Median time to HIV seroconversion was 1.54 years (95% CI: 1.11 to 1.73).

The proportion of clinic visits with HIV testing made by male subjects decreased from 69.1% in 1993 to 46.8% in 2002 ( $P < 0.001$ , nonparametric trend test; Table 1). Over this same period, the median age decreased from 28 years to 23 years ( $P < 0.001$ ). The prevalence of IDU and exchange sex both increased over time, whereas report of an HIV-positive partner as the reason for a clinic visit and the diagnosis of gonorrhea decreased over time. Trends in presenting to a clinic for reactive syphilis serology and a clinical diagnosis of syphilis seem to coincide with a well-described syphilis outbreak that occurred in Baltimore from 1994 through 1998.<sup>11,12</sup>

Of patients included in the Poisson regression analysis, almost 60% were male and more than half presented to a

clinic because of symptoms (Table 2). One third had a previous history of gonorrhea, 15% had gonorrhea on the day of the visit, and 34% of patients reported 2 or more sexual partners in the past month. Noninjection cocaine use was common among the cohort (18.6%). Ninety-six percent of patients had 3 or fewer repeat tests: 68% had 1 repeat test (ie, total of 2 tests), 21% had 2 repeat tests, and 7% had 3 repeat tests.

Table 2 shows HIV seroconversion per 100 person-years and results of univariate IRRs and 95% CIs. The risk of HIV seroconversion was increased for age; reason for clinic visit as symptoms, HIV, or syphilis exposure; drug use; having  $\geq 2$  sexual partners or sexual partners with risks (HIV or IDU); findings of a genital ulcer; diagnosis of gonorrhea; and diagnosis of syphilis. Other statistically significant risks for HIV seroconversion included previous syphilis infection, previous trichomoniasis infection, prior HIV test, and sex ever with someone who engaged in exchange sex. Risk of HIV seroconversion decreased over time, as indicated by IRR by year of initial HIV test, and was increased for those with more than 1 repeat test. There was no difference in the IRRs by clinic (IRR = 0.91 at each), patient complaints (eg, discharge, dysuria, lesion, rash), rectal exposure, or having a new sexual partner in the past 30 days. Using the midpoint of the interval from the date of the initial HIV-negative test to the date testing HIV-positive (EIA and/or Western blot analysis) as the time to HIV seroconversion identified the same significant and nonsignificant factors.

### Multivariate Poisson Regression

In multivariate Poisson regression, increasing age, sexual contact with an HIV-positive or syphilis-positive partner as a reason for a clinic visit, sexual contact ever with someone HIV-positive, IDU, cocaine use, number of sexual partners, gonorrhea, early syphilis, and a genital ulcer on physical examination remained statistically significant predictors of HIV seroconversion (Table 3). Using the midpoint of the interval from the date of the initial HIV-negative test to the date testing HIV-positive (EIA and/or Western blot analysis) as the time to HIV seroconversion produced a model

with the same variables of similar magnitude and statistical significance. There were 2 statistically significant interaction terms. IDU patients who were older than 45 years of age were at decreased risk of HIV seroconversion (IRR = 0.08, 95% CI: 0.06 to 1.18;  $P = 0.067$ ). Also, patients who reported sex ever with an HIV-positive partner and  $\geq 2$  sexual partners in the past month were at decreased risk of HIV seroconversion (IRR = 0.13, 95% CI: 0.03 to 0.67;  $P = 0.012$ ).

### Gender-Stratified Poisson Regression

Among women, exploratory analysis identified several factors associated with HIV seroconversion: increasing age, year of initial HIV test, HIV or syphilis contact as the reason for a clinic visit, positive syphilis results from a previous visit as current reason for a clinic visit, IDU, cocaine, sex ever with an HIV-positive partner, past history of gonorrhea or syphilis, exchange sex, needle sharing, sex ever with a bisexual partner, results from physical examination of skin, a genital ulcer on physical examination, and early syphilis. All variables remained statistically significant at  $P < 0.05$  in univariate Poisson regression. In multivariate Poisson regression (Table 4), factors predicting future HIV seroconversion were HIV or syphilis exposure as a reason for a clinic visit, previous syphilis infection, sexual contact ever with an HIV-positive partner, IDU, cocaine use, physical examination findings of a genital ulcer, gonorrhea, and early syphilis. There were no statistically significant interaction terms.

Among men, older age, having  $\geq 2$  sex partners in the past month, same-sex preference, drug use, partner risks (eg, IDU, HIV, bisexual), needle sharing, prior STD, previous HIV test, and multiple HIV tests within the analytic period predicted future HIV seroconversion in univariate exploratory analysis. A diagnosis of early syphilis or HIV contact was predictive, as were findings of epididymitis, balanitis, and clinical impression of HIV contact. All variables from exploratory analysis remained statistically significant at  $P < 0.05$  in univariate Poisson regression. In multivariate Poisson regression (Table 5), older age, having  $\geq 2$  sex partners in the past month, same-sex preference, non-IDU and noncocaine drug use, multiple HIV tests, and findings from physical examination (eg, epididymitis, balanitis, inguinal tenderness) remained risks for HIV seroconversion, whereas time of the initial HIV test was protective. There were no statistically significant interaction terms.

### DISCUSSION

We found an overall incidence of 0.91 HIV seroconversion events per 100 person-years in STD clinic patients. This measure of HIV incidence was higher than that observed among STD clinic attendees in New Orleans, where seroconversion was 0.49 per 100 person-years.<sup>7</sup> The incidence we report is also high within the range reported for STD clinic attendees in 9 US cities (0.09–1.2 per 100 person-years),<sup>8</sup> and our observed incidence remained high over time. Furthermore, certain characteristics identified at the baseline testing visit in our clinics predicted a higher relative risk of seroconversion. In particular, an HIV-positive partner (IRR = 4.86), injection drug use (IRR = 3.06), gen-

**TABLE 3.** Multivariate Poisson Regression Results: IRR of HIV Seroconversion

Variable	IRR (N = 8388)	95% CI
Age (y)*		
12–21	Ref	—
22–29*	2.33	1.06 to 5.09
30–37*	3.47	1.58 to 7.55
38–45*	2.77	1.17 to 6.50
>45*	4.51	1.86 to 10.9
Reason for visit: sexual contact with HIV-positive partner		
No	Ref	—
Yes*	2.56	1.07 to 6.12
Reason for visit: sexual contact with syphilis-positive partner		
No	Ref	—
Yes*	3.05	1.62 to 5.75
Sex ever with HIV-positive partner		
No	Ref	—
Yes*	2.61	1.21 to 5.62
Unknown	0.89	0.52 to 1.54
Number of sexual partners in past month		
Less than 2	Ref	—
2 or more*	1.87	1.22 to 2.84
IDU ever		
No	Ref	—
Yes*	1.91	1.02 to 3.55
Noninjection cocaine use ever		
No	Ref	—
Yes*	1.83	1.15 to 2.91
Gonorrhea		
No	Ref	—
Yes†	1.67	0.99 to 2.80
Early syphilis		
No	Ref	—
Yes*	2.25	1.08 to 4.67
Physical examination: genital ulcer		
No	Ref	—
Yes†	2.16	0.99 to 4.73
Year of initial HIV test		
1993–1995	Ref	—
1996–1998	0.73	0.45 to 1.18
1999–2002*	0.41	0.23 to 0.73

\* $P < 0.05$ .

† $0.05 < P < 0.10$ .

Ref indicates reference condition.

ital ulcer disease (IRR = 2.40), and incident syphilis (IRR = 2.25) were associated with a much higher HIV seroconversion risk.

This study had some limitations. We did not include time-dependent variables for behavioral risks or STD infection. We limited our observation of individuals to 3 years maximum, however, so as not to overextend our interpretation of baseline characteristics. Results of the analysis were limited by data collected through the individual medical record, and risks of sexual networks cannot be readily inferred. Furthermore, given the limited data on partnerships and partner behavior available from a clinical

record, it is impossible to assess the impact of community-level behavior change on the risk of our sample accurately. Risk factor analysis may have produced different results had other variables been measured or had risks been measured differently (eg, frequency responses or restricted recall period instead of “ever”). Additionally, we did not have a valid measure of frequency of condom use, which may have led to the observed protective effect on HIV seroconversion of the interaction of sex with a known HIV-positive partner and 2 or more sexual partners. It is possible that those individuals may have been more likely to use condoms. In our analysis, there was a higher rate of HIV seroconversion among patients with 2 repeat tests than among patients with 1 repeat test, although this was not statistically significant in multivariate analysis. The repeat HIV testers included in this analysis may have risks not representative of STD clinic attendees as a whole. There is evidence to suggest that patients who undergo repeat HIV testing are at higher risk for HIV infection,<sup>6,13,14</sup> which would lead to an overestimated risk of HIV seroconversion, and the observed associations would be biased away from the null. In keeping with this, we found an increased risk of HIV seroconversion among men who had multiple repeat

**TABLE 4.** Multivariate Poisson Regression for Women: IRR of HIV Seroconversion

Variable	IRR N = 3827	95% CI
Reason for visit: sexual contact with HIV-positive partner		
No	Ref	—
Yes†	3.04	1.06 to 8.70
Reason for visit: sexual contact with syphilis-positive partner		
No	Ref	—
Yes*	3.05	1.32 to 7.03
Previous syphilis infection		
No	Ref	—
Yes*	2.65	1.28 to 5.47
Ever injected drugs		
No	Ref	—
Yes*	3.56	1.51 to 8.41
Ever used noninjection cocaine		
No	Ref	—
Yes†	1.93	0.97 to 3.82
Sexual contact ever with an HIV-positive sexual partner		
No	Ref	—
Yes†	2.77	0.99 to 7.77
Unknown	1.07	0.45 to 2.52
Physical examination: vulvar or cervical ulcer or vesicle		
No	Ref	—
Yes†	2.53	0.92 to 6.93
Gonorrhoea		
No	Ref	—
Yes*	2.78	1.21 to 6.39
Early syphilis		
No	Ref	—
Yes*	2.82	1.08 to 7.36

\* $P < 0.05$ .

† $0.05 < P < 0.10$ .

Ref indicates reference condition.

**TABLE 5.** Multivariate Poisson Regression for Men: IRR of HIV Seroconversion

Variable	IRR N = 4654	95% CI
Age (y)		
12–21	Ref	—
22–29	1.58	0.51 to 4.88
30–37*	3.99	1.45 to 11.0
38–45*	3.58	1.19 to 10.8
>45*	5.13	1.62 to 16.3
Number of sexual partners in past month		
Less than 2	Ref	—
2 or more*	3.11	1.66 to 5.81
Sexual preference		
Opposite	Ref	—
Both or same*	5.33	1.88 to 15.1
Other drug use		
No	Ref	—
Yes*	1.96	1.06 to 3.62
Physical examination: balanitis		
No	Ref	—
Yes*	5.47	1.64 to 18.2
Physical Examination: epididymitis		
No	Ref	—
Yes*	5.67	1.61 to 20.0
Year of initial HIV test		
1993–1995	Ref	—
1996–1998	0.71	0.37 to 1.35
1999–2002*	0.21	0.08 to 0.52
Number of repeat tests		
1	Ref	—
2*	2.50	1.31 to 4.79
3 or more†	2.19	0.96 to 4.98

\* $P < 0.05$ .

† $0.05 < P < 0.10$ .

Ref indicates reference condition.

HIV tests. It is also possible that patients with observed single-time testing may have tested previous to 1993 or subsequent to 2002, however, and were not included in our analysis.

We used the date that the patient tested HIV-positive as the date of HIV seroconversion rather than the midpoint of the interval, because of the retrospective and “passive surveillance” nature of the cohort. This calculation of time to HIV seroconversion is in keeping with other retrospective analyses of HIV seroconversion<sup>7,8</sup> and has a conservative effect on the measure of association because it leads to an overestimation of the time to HIV seroconversion. Our analysis produced similar results when using the midpoint of the interval for time to HIV seroconversion, however. Although several risks declined over time (see Table 1), the decreased risk associated with having a baseline HIV test in 1999 through 2002 may also be the result of a shorter observation period. By year of the baseline HIV test, median observation times were 1.16 years for 1993 through 1995, 1.33 years for 1996 through 1988, and 1.02 years for 1999 through 2002.

HIV seroconversion is a period of acute hyperinfectiousness and an important event to detect while occurring or, better still, to preempt. Modeling data from a large cohort in Rakai District, Uganda, Wawer et al<sup>5</sup> estimate that the risk of HIV transmission during seroconversion may be as high as 1 case per 50 coital acts. Transmission efficacy during the seroconversion period is further increased in the presence of STD infection and high-risk sexual behavior.<sup>15</sup> These estimates of transmission efficacy during the seroconversion period emphasize the need for identifying those at highest risk as early as possible so as to institute measures to prevent further HIV transmission. Laboratory systems that identify HIV RNA in those testing antibody-negative have been developed and tested and may enhance HIV prevention in STD clinics serving populations with high morbidity rates of HIV and other STDs. An examination of locally derived data on seroconverters may aid in developing appropriate laboratory testing algorithms.

Public health strategies to identify individuals at highest risk of HIV seroconversion may be essential to HIV prevention. Decreasing national HIV incidence requires application of HIV RNA and serologic testing algorithms linked to interventions that prevent further spread of HIV.

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