HIV Incidence Among Men With and Those Without Sexually Transmitted Rectal Infections: Estimates From Matching Against an HIV Case Registry

Preeti Pathela,[1] Sarah L. Braunstein,[2] Susan Blank,[1,3] and Julia A. Schillinger[1,3]

[1]Bureau of Sexually Transmitted Disease Control and [2]Bureau of HIV/AIDS Prevention and Control, New York City Department of Health and Mental Hygiene, New York; and [3]Division of STD Prevention, Centers for Disease Control and Prevention, Atlanta, Georgia

Background. Sexually transmitted bacterial rectal infections are objective markers of HIV risk behavior. Quantifying HIV risk among men who have sex with men (MSM) who have had these infections can inform prevention efforts. We measured HIV risk among MSM who have and those who have not been diagnosed with rectal *Chlamydia trachomatis* (CT) and/or rectal *Neisseria gonorrhoeae* (GC).

Methods. HIV incidence among a cohort of 276 HIV-negative MSM diagnosed with rectal CT and/or GC in New York City sexually transmitted disease (STD) clinics was compared to HIV incidence among HIV-negative MSM without these infections. Matches against the citywide HIV/AIDS registry identified HIV diagnoses from STD clinics, and by other providers. Cox proportional hazards models were used to explore factors associated with HIV acquisition among MSM with rectal infections.

Results. HIV-negative MSM with rectal infections (>70% of which were asymptomatic) contributed 464.7 person-years of follow-up. Among them, 31 (11.2%) were diagnosed with HIV, of whom 14 (45%) were diagnosed by non-STD clinic providers. The annual HIV incidence was significantly higher among MSM with rectal infections (6.67%; 95% confidence interval [CI], 4.61%–9.35%) than among MSM without rectal infections (2.53%; 95% CI, 1.31%–4.42%). Black race (hazard ratio, 4.98; 95% CI, 1.75–14.17) was associated with incident HIV among MSM with rectal CT/GC.

Conclusions. One in 15 MSM with rectal infections was diagnosed with HIV within a year, a higher risk than for MSM without rectal infections. Such data have implications for screening for rectal STD, and may be useful for targeting populations for risk-reduction counseling and other HIV prevention strategies, such as preexposure prophylaxis.

Keywords. HIV; rectal *Chlamydia*; rectal gonorrhea; MSM.

In the developed world, human immunodeficiency virus (HIV) infection disproportionately affects gay men and other men who have sex with men (MSM) [1, 2]. In New York City (NYC), an epicenter of the US HIV/AIDS epidemic, 48% of the 3481 new HIV/AIDS diagnoses in 2010 were among MSM [3]. NYC surveillance data indicate that MSM also have a high burden of bacterial sexually transmitted diseases (STDs), such as *Neisseria gonorrhoeae* (GC) and syphilis [4, 5]. Biological and physiological mechanisms have been proposed to explain how STDs increase HIV risk [6–8], and numerous studies have suggested that STDs are associated with an increased risk for HIV acquisition [9–13].

Some STD and HIV surveillance laws prohibit the data sharing necessary to identify individuals across registries

Received 14 March 2013; accepted 17 June 2013; electronically published 25 June 2013.

Correspondence: Preeti Pathela, DrPH, MPH, Bureau of Sexually Transmitted Disease Control, New York City Department of Health and Mental Hygiene, Gotham Center, 42-09 28th St, Queens, New York 11101-4132 (ppathela@health.nyc.gov).

Clinical Infectious Diseases 2013;57(8):1203–9

DOI: 10.1093/cid/cit437

and maximize use of data for public health action. In 2010, New York State enacted regulatory changes that enhanced the ability of HIV surveillance programs to share data on reported cases with other disease programs within its state or local health departments [14]. Specifically, patient identifiers can be shared to assess comorbidity and completeness of reporting or to meet program needs.

Rectal infections with bacterial STD can indicate unprotected anal intercourse, a risk factor for HIV acquisition [11, 15]. To estimate HIV incidence among MSM reporting anal intercourse, and the additional risk of HIV among those diagnosed with a rectal STD, we measured HIV incidence following infection with rectal *Chlamydia trachomatis* (CT) and/or GC (CT/GC) among a clinic-based cohort of HIV-negative MSM, and among a clinic-based sample of HIV-negative MSM without rectal CT/GC. For MSM who had rectal CT/GC, we identified risk factors for HIV acquisition. We matched both groups against the citywide HIV surveillance registry, which enabled us to quantify the added value of matching to ascertain all incident HIV infections over using only cases diagnosed in the NYC STD clinic system.

METHODS

All persons attending NYC public STD clinics are offered HIV testing with a rapid point-of-care HIV antibody test, and asked whether they have had receptive anal intercourse (RAI) in the prior 3 months. MSM whose rapid HIV tests are negative have further testing done using a pooled HIV-1 nucleic acid amplification test (NAAT). Persons reporting RAI are offered rectal testing using GC culture and CT NAAT.

HIV Incidence Among MSM With Rectal STDs

We constructed a retrospective cohort of all MSM diagnosed with rectal CT, rectal GC, or both at NYC STD clinics from 1 January 2008 through 31 March 2010 who tested HIV-negative by NAAT at the same visit (ie, confirmed HIV-negative). Men with multiple rectal infections diagnosed during this period entered the cohort at the time of their last diagnosis.

The outcome of interest was time from rectal infection to HIV diagnosis; we conducted survival analysis to account for varying times to HIV diagnosis. For MSM with rectal CT/GC who acquired HIV, HIV-free time at risk was the interval between rectal test collection date and HIV diagnosis date; those not reported with HIV were classified as uninfected during the analytic period and were censored on 31 March 2011 to allow all at least 1 year of follow-up. To ascertain all newly diagnosed HIV infections, including those diagnosed outside STD clinics, in May 2011 we matched the cohort against the HIV surveillance registry with an automated matching algorithm that uses up to 36 combinations of available patient information (eg, name, date of birth, social security number) to identify confirmed and probable matches. Probable matches were manually reviewed.

Factors Associated With HIV Acquisition Among MSM With Rectal CT/GC

For MSM with rectal infections, Cox proportional hazards models were used to explore associations between HIV diagnosis and demographic and behavioral characteristics that are routinely collected during clinic visits. Covariates included rectal STD diagnosis at cohort entry (CT, GC, or both) and age at that diagnosis, race/ethnicity, early syphilis diagnosis (concurrently or in the past 2 years as documented in the citywide STD surveillance registry), and reported number of sex partners and consistency of condom use with receptive anal sex (always, sometimes, never) in the 3 months prior to CT/GC diagnosis.

HIV Incidence Among MSM Without Rectal CT/GC

To estimate HIV risk among MSM without rectal CT/GC, we created a sample of 276 MSM (equal to the number with rectal infections) from among MSM who reported RAI, were tested for rectal CT, rectal GC, and HIV (as described above) at the same visit between 1 January 2008 and 31 March 2010, and tested negative for all 3 infections. MSM with any previous rectal CT/GC documented in STD clinic records were excluded from the sample.

We selected MSM without rectal CT/GC to be demographically and behaviorally similar to MSM with these infections; they were individually matched on age (within 5 years), race/ethnicity, reported number of sex partners in the past 3 months, and history of early syphilis. For men with ≥1 visit at which all 3 tests were negative during this time period, follow-up for HIV started at the time of their last such visit. Acquisition of HIV was ascertained in the same manner as for MSM with rectal infections. Kaplan-Meier survival estimates of time to HIV diagnosis were examined. We used the McNemar test to account for pairwise matching in the comparison of HIV outcomes among MSM with and those without rectal infections.

HIV testing is voluntary; therefore, MSM were not required to take an HIV test during the follow-up period. In NYC STD clinics, the standard of care is to offer a test to all HIV-negative patients who have not been tested for HIV in the previous 3 months, and to patients suspected of acute HIV infection. To assess the extent to which MSM in the study were repeatedly tested for HIV, we calculated the proportion of all patients who were not reported with HIV during follow-up that had repeat negative HIV tests in the NYC STD clinics during the period. We could not account for patients who tested for HIV in non-STD clinic settings and had only negative results, as negative tests are not reportable to any surveillance registry.

Analyses were conducted using Intercooled Stata 7.0 (Stata Corp, College Station, Texas). After STD-HIV matching was performed, all analyses were conducted on deidentified records. The study was determined to be exempt research by the NYC Department of Health and Mental Hygiene Institutional Review Board.

RESULTS

During January 2008–March 2010, there were 3370 visits made by MSM that included a negative HIV pooled NAAT result. Among these visits, 2345 rectal CT and 2391 rectal GC tests were performed. Rectal CT positivity was 9.6% (226/2345 tests) and rectal GC positivity was 4.6% (109/2391 tests). Eighty-five percent (192/226) of rectal CT and 72% (78/109) of rectal GC infections were asymptomatic. Ninety-eight percent of MSM with rectal CT/GC were treated at the STD clinics within 60 days of their positive test(s).

All 276 HIV-negative MSM with diagnosed rectal CT (n = 177), rectal GC (n = 69), or both (n = 30) comprised the analytic cohort. Eleven (5.1%) had multiple rectal infections during the period (9 had 2 diagnoses, and 2 had 3 diagnoses). Of the 276 MSM, 69.6% (190/273) reported no or occasional condom use during anal sex and a mean of 3.5 sex partners (range, 1–30) in the previous 3 months. Altogether, they contributed 464.7 person-years of follow-up (median follow-up, 1.63 years; range, 0.27–3.21 years). Of the cohort, 11.2% (31/276) were diagnosed and reported with HIV during follow-up, yielding an annual HIV incidence of 6.67% (95% confidence interval [CI], 4.61%–9.35%; Table 1). Among those acquiring HIV, 17 (55%) were diagnosed with HIV in STD clinics and an additional 14 (45%) were diagnosed by other providers and identified only by matching against the HIV registry. The median time from rectal infection diagnosis to HIV diagnosis was 309 days (interquartile range, 224–564 days).

HIV incidence was particularly high among certain subgroups with rectal infections: black MSM, 15.34% (95% CI, 8.31%–26.08%); MSM with both CT and GC, 10.67% (95% CI, 3.91%–23.66%); and MSM aged <20 years, 10.46% (95% CI, 3.83%–23.19%) (Table 1). In univariate regression analysis, race/ethnicity was the only characteristic associated with an increased risk of HIV; black MSM with rectal CT/GC were 5 times as likely to acquire HIV than white MSM with rectal CT/GC (hazard ratio, 4.98; 95% CI, 1.75–14.17; Table 2).

The comparison group of 276 MSM without diagnosed rectal CT/ GC was selected from among 1757 MSM who reported RAI and tested negative for rectal CT, rectal GC, and HIV at the same visit from 1 January 2008 through 31 March 2010. As a result of the matching scheme, this group was similar to MSM with rectal CT/GC with regard to age, race/

Table 1. Annual HIV Incidence Among 276 HIV-negative Men Who Have Sex With Men Diagnosed With Rectal Chlamydia or Gonorrhea Infection at New York City Sexually Transmitted Disease Clinics Between January 2008 and March 2010

Characteristic	No. of Patients	%	Person-Years at Risk	Total No. of New HIV Diagnoses	Annual HIV Incidence	95% CI (HIV Incidence)
Overall	276	100	464.71	31	6.67	4.61–9.35
Age, y						
<20	30	11	47.79	5	10.46	3.83–23.19
20–29	183	66	306.11	21	6.86	4.36–10.31
30–39	47	17	83.37	5	6.00	2.20–13.29
≥40	16	6	27.43	0	0.00	
Race/ethnicity						
Non-Hispanic white	95	34	159.24	5	3.14	1.15–6.96
Non-Hispanic black	51	18	78.21	12	15.34	8.31–26.08
Hispanic	96	35	168.88	8	4.74	2.20–8.99
Asian	12	4	22.13	1	4.52	.22–22.29
Other/multiple	22	8	36.25	5	13.79	5.05–30.57
Rectal infection						
Chlamydia	177	64	305.24	18	5.90	3.60–9.14
Gonorrhea	69	25	112.61	8	7.10	3.30–13.49
Chlamydia & gonorrhea	30	11	46.85	5	10.67	3.91–23.66
Early syphilis at cohort entry or in last 2 y						
Yes	35	13	59.23	5	8.44	3.09–18.71
No	241	87	405.48	26	6.41	4.28–9.26

Abbreviations: CI, confidence interval; HIV, human immunodeficiency virus.

Table 2. Univariate Hazard Ratios for HIV Infection Among 276 HIV-Negative Men Who Have Sex With Men Diagnosed With Rectal Chlamydia/Gonorrhea at New York City Sexually Transmitted Disease Clinics, January 2008–March 2010

Characteristic	Univariate HR	95% CI	*P* Value
Age, y			
<20	2.39	.69–8.26	.17
20–29	1.56	.59–4.15	.37
≥30	1		
Race/ethnicity			
Non-Hispanic white	1		
Non-Hispanic black	4.98	1.75–14.17	.003
Hispanic	1.51	.49–4.63	.47
Asian/other/multiple	3.24	.99–10.61	.05
Disease			
Chlamydia	1		
Gonorrhea	1.22	.52–2.82	.63
Chlamydia & gonorrhea	1.86	.69–5.03	.22
No. of male partners, past 3 mo			
1	1		
2	0.98	.33–2.93	.97
3	1.86	.69–5.00	.22
≥4	1.09	.41–2.94	.86
Condom use during anal intercourse, past 3 mo			
Always	1		
Sometimes	1.35	.61–2.97	.45
Never	0.42	.09–1.97	.27
Early syphilis at cohort entry or in last 2 y			
No	1		
Yes	1.27	.49–3.33	.61

Abbreviations: CI, confidence interval; HR, hazard ratio.

ethnicity, prevalence of early syphilis history (13% vs 10%, $P = .24$), no or occasional condom use during anal sex (69.6% vs 68.6%), and reported number of partners in the past 3 months (mean, 3.5 vs 3.4). The comparison group contributed 473.8 person-years of follow-up; 12 (4.3%) were diagnosed and reported with HIV (STD clinics: 6, other providers: 6), for an annual HIV incidence of 2.53% (95% CI, 1.31%–4.42%; Table 3). Having had rectal CT/GC was associated with an increased risk of HIV infection (Figure 1). MSM with rectal infections were significantly more likely to be diagnosed with HIV (relative risk, 2.58; 95% CI, 1.33–5.03) compared to MSM without rectal infections.

STD clinic record reviews showed that 232 (45.6%) of the 509 MSM categorized as HIV negative had at least 1 more HIV test in STD clinics during the follow-up period; the proportion with repeat tests did not vary by rectal CT/GC status. Additionally, of all 20 MSM diagnosed with HIV at non-STD clinic sites, 7 (35%) had documented negative tests in STD clinics during their HIV-free time at risk.

DISCUSSION

HIV incidence rates in our study were high, and significantly elevated among MSM with a history of rectal infections, with 1 in 15 of them being diagnosed with HIV within only a year. Among those with rectal infections, incidence was highest among young MSM and black MSM, subgroups that are disproportionately affected by HIV in NYC [4, 16] and have the largest increases in rates of new infections nationally [17]. Cross-matching patients with STD against the HIV registry markedly improved our ascertainment of incident HIV by identifying almost double the diagnoses that would have been identified using STD clinic records alone. Our findings have implications for medical care, prevention interventions, and the sharing of public health surveillance data.

Unprotected anal intercourse carries a risk for HIV acquisition, and it is commonly reported among the general population of NYC MSM, with only 41% reporting always using a condom during anal sex [18]. Although HIV acquisition also depends on the HIV prevalence in sexual networks from which MSM select partners, findings from 2 large prospective cohorts showed that at least 1 unprotected RAI act in 6 months was associated with high seroconversion rates over 3–4 years (2.5% in one cohort and 5.3% in the other). In that study, unprotected RAI constituted the most impactful score on a screening index that could be used by clinicians to determine which MSM patients are at highest risk of acquiring HIV [19]. In our study, on an annual basis, 2.5% of MSM reporting RAI but without rectal CT/GC acquired HIV, and almost 7% of MSM who had acquired 1 or both infections were subsequently diagnosed with HIV. MSM with concurrent rectal CT and GC had a particularly high annual HIV incidence. Our results demonstrate that rectal CT/GC infections are objective markers for identifying persons at an exceptionally high risk for HIV.

We found that most bacterial rectal infections (>70%) were asymptomatic, underscoring the need for routine rectal screening of patients who report unprotected anal intercourse. To provide appropriate care, providers must take a nonjudgmental and confidential sexual history that ascertains the sex of a patient's sex partners and anatomic sites of sexual exposure; however, this is often not done [20]. There are other recognized barriers to STD care, including providers' lack of time and insufficient staff to address STDs, counsel patients, and follow up with sex partners [21]. These barriers may have an increased impact on STD diagnoses in coming years, as public STD clinics are closing or their services are being reduced [22] and provision of services is shifting into general practice and urgent care centers. Another substantial barrier to optimal care is that no CT and GC NAATs have been approved by the US Food and Drug Administration for use on oral and rectal specimens. Extragenital CT and GC NAATs, favorable tests due to short

Table 3. Annual HIV Incidence Among 276 HIV-Negative Men Who Have Sex With Men Who Tested Negative for Rectal Chlamydia and Gonorrhea Infection at New York City Sexually Transmitted Disease Clinics Between January 2008 and March 2010

Characteristic	No. of Patients	%	Person-years at Risk	Total No. of New HIV Diagnoses	Annual HIV Incidence	95% CI (HIV Incidence)
Overall	276	100	473.78	12	2.53	1.31–4.42
Age, y						
<20	16	6	23.86	2	8.38	1.40–27.69
20–29	194	70	233.31	8	3.43	1.59–6.51
30–39	50	18	90.20	2	2.22	.37–7.33
≥40	16	6	26.40	0	0.00	
Race/ethnicity						
Non-Hispanic white	95	34	175.18	2	1.14	.19–3.77
Non-Hispanic black	51	18	77.20	5	6.48	2.37–14.36
Hispanic	96	35	127.53	4	3.14	1.00–7.57
Asian	12	4	21.89	0	0.00	
Other/multiple	22	8	37.33	1	2.68	.13–13.21
Early syphilis at study entry or in last 2 y						
Yes	29	10	48.26	4	8.29	2.63–19.99
No	247	90	425.52	8	1.88	.87–3.57

Abbreviations: CI, confidence interval; HIV, human immunodeficiency virus.

turnaround times for results and high sensitivity and specificity, are available through a limited number of laboratories that have performed verification studies of NAATs for extragenital specimens. These tests must be made widely available to improve the quality of health care for MSM.

Patient encounters that include STD testing, diagnosis, and treatment are opportune times to educate patients about the risk for HIV acquisition and, ideally, to intervene to decrease risk. Our findings support the continuing need for counseling around condom use and reducing numbers of sex partners. Our results also point to using rectal CT/GC infection as a possible criterion for recommending HIV preexposure chemoprophylaxis (PrEP). Following the publication of a recent clinical trial that showed a reduction in HIV incidence of 44% among MSM on daily tenofovir-emtricitabine therapy (and 73% for MSM with high adherence) [23], the US Centers for Disease Control and Prevention (CDC) published interim guidance for using it as PrEP for MSM [24]. A number of cost-effectiveness studies have shown that PrEP use by MSM at high risk of HIV acquisition could have a substantial impact on the US HIV epidemic [25–27]. Our findings may be useful to clinicians and policymakers considering how to target PrEP. MSM who have been diagnosed with rectal CT/GC are at an extremely high risk and would be a group to consider. Additionally, given the substantial HIV incidence we measured among MSM without these infections, a recommendation for PrEP could be expanded to all MSM reporting RAI in settings serving populations with high HIV detection rates, such as STD clinics.

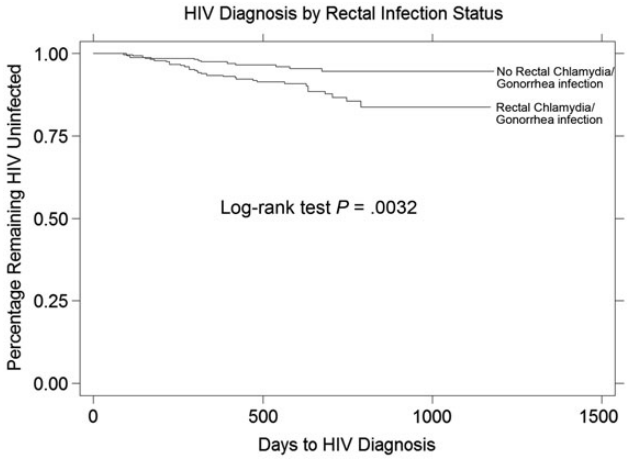

Figure 1. Kaplan-Meier survival function estimates of time to human immunodeficiency virus diagnosis among 276 HIV-negative men who have sex with men diagnosed with rectal chlamydia/gonorrhea at New York City sexually transmitted disease clinics, January 2008–March 2010. Abbreviation: HIV, human immunodeficiency virus.

Matching clinic-based STD case data with HIV registry case data yielded fully 80% more HIV diagnoses compared to the number that would have been identified through STD clinic records alone. Our overall HIV incidence among MSM with rectal CT/GC was almost 3 times the incidence found in a San Francisco study [15], in which subsequent HIV diagnoses were ascertained through STD clinic records or via self-report. The CDC has recently recommended common standards for securing and protecting HIV, viral hepatitis, STD, and tuberculosis

surveillance data, which should facilitate data sharing, collaboration, and service integration among funded programs [28]. STD/HIV data matching and integration permit more accurate incidence estimates and definition of affected populations for informing STD/HIV prevention activities, especially in areas such as NYC, where there are many different provider practices and testing sites where HIV can be diagnosed, and the majority of diagnoses citywide (approximately 85%) occur in non-STD clinic settings.

There are limitations to our analysis. First, our outcome of interest was diagnosed HIV infection, and as with other observational studies, some MSM may not have had an HIV test during the follow-up period; this could have resulted in a lack of detection and an underestimate of true HIV incidence. However, we found that a substantial proportion of MSM categorized as negative had additional tests in our clinics during follow-up. Furthermore, one-third of the MSM who eventually tested positive at non-STD clinics also had documented negative tests at the STD clinics, which suggests that our population tests for HIV at a variety of venues. Hence, it is likely that the majority of HIV infections were diagnosed. Second, rectal CT/GC diagnoses were identified only from STD clinic records; we did not use the STD surveillance registry of all CT and GC diagnosed by NYC providers due to the incompleteness of anatomic site of specimen collection on provider and laboratory reports in the registry. Thus, we may have missed counting rectal infections diagnosed by non-STD clinic providers. For MSM with rectal infections diagnosed in STD clinics who may have had subsequent rectal infections diagnosed elsewhere, not starting their follow-up time at the time of the last infection may have (1) overestimated their time at risk for HIV and (2) underestimated the cohort's true HIV incidence. For MSM in the CT/GC-negative comparison group, failure to count diagnoses by non-STD clinic providers could have resulted in their erroneous assignment to the CT/GC-negative group, and an overestimation of HIV risk among persons without rectal CT/GC. Third, rectal GC was diagnosed by culture; given the lower sensitivity of culture compared to NAAT, some GC infections may have been missed. Fourth, for MSM with multiple rectal infections, using the date of their last instead of first diagnosis shortened their HIV-free time at risk. However, only 5% had multiple rectal infections, and counting their last one would not have appreciably reduced the aggregate follow-up time or estimate of HIV incidence for the cohort. Finally, HIV incidence rates and predictors of HIV among STD clinic patients may not be generalizable to other patient populations. Visits to STD clinics are typically prompted by patient recognition of high-risk behaviors [29] and result in a high yield of HIV and other STD diagnoses. However, we believe that our finding of an elevated risk of HIV infection among those who have had rectal CT/GC infections may apply to many other settings, given the high per-act probability of HIV infection with RAI [30] and host inflammatory responses and alterations in immune defenses that occur with STDs [31].

With the HIV/AIDS epidemic in its third decade and the prospect of effective HIV vaccines as yet unrealized, it remains important to focus on developing and applying new HIV prevention strategies. Identifying and treating rectal infections may reduce HIV incidence, to the extent that rectal STDs increase biological susceptibility to HIV infection through epithelial erosions and alteration of host immune defenses. Furthermore, rectal infections, as markers of behavioral risk, can be used to identify a subset of patients who may benefit from intensive risk reduction counseling and other interventions designed to reduce the risk of HIV transmission.

Notes

Acknowledgments. The authors thank Mayra Ortiz Molina and Kimberly Johnson, MSc (NYC Department of Health and Mental Hygiene [DOHMH] Bureau of STD Control), for extracting data from the NYC STD surveillance registry and NYC STD clinic records, and Sonny Ly, BBA (NYC DOHMH Bureau of HIV Prevention), for conducting the STD-HIV matches.

Disclaimer. The findings and conclusions are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

Potential conflicts of interest. All authors: No reported conflicts.

All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Jaffe HW, Valdiserri RO, De Cock KM. The reemerging HIV/AIDS epidemic in men who have sex with men. JAMA **2007**; 298:2412–4.
2. Sullivan PS, Hamouda O, Delpech V, et al.; Annecy MSM Epidemiology Study Group. Reemergence of the HIV epidemic among men who have sex with men in North America, Western Europe, and Australia, 1996–2005. Ann Epidemiol **2009**; 19:423–31.
3. New York City Department of Health and Mental Hygiene. HIV Epidemiology and Field Services Program semiannual report. Available at: http://www.nyc.gov/html/doh/downloads/pdf/dires/2011_2nd_semi_rpt.pdf. Accessed 20 April 2012.
4. Pathela P, Braunstein SL, Schillinger JA, Shepard C, Sweeney M, Blank S. Men who have sex with men have a 140-fold higher risk for newly diagnosed HIV and syphilis compared with heterosexual men in New York City. J Acquir Immune Defic Syndr **2011**; 58:408–16.
5. New York City Department of Health and Mental Hygiene, Bureau of Sexually Transmitted Disease Control. Quarterly report (vol 8, No. 4, December 2010). Available at http://www.nyc.gov/html/doh/html/std/std.shtml. Accessed 20 April 2012.
6. Lukehart SA, Baker-Zander SA, Cheri Lloyd RM, Sell S. Characteristics of lymphocyte responsiveness in early experimental syphilis. J Immunol **1980**; 124:461–7.
7. Stamm WE, Handsfield HH, Rompalo AM, Ashley RL, Roberts PL, Corey L. The association between genital ulcer disease and acquisition of HIV infection in homosexual men. JAMA **1988**; 260:1429–33.
8. Hirsch MS, Schooley RT, Ho DD, Kaplan JC. Possible viral interaction in the acquired immunodeficiency syndrome (AIDS). Rev Infect Dis **1984**; 6:726–31.
9. Dickerson MC, Johnston J, Delea TE, White A, Andrews E. The causal role for genital ulcer disease as a risk factor for transmission of human

immunodeficiency virus. An application of the Bradford Hill criteria. Sex Transm Dis **1996**; 23:429–40.
10. Coates RA, Calzavara LM, Read SE, et al. Risk factors for HIV infection in male sexual contacts of men with AIDS or an AIDS-related condition. Am J Epidemiol **1988**; 128:729–39.
11. Craib KJ, Meddings DR, Strathdee SA, et al. Rectal gonorrhoea as an independent risk factor for HIV infection in a cohort of homosexual men. Genitourin Med **1995**; 71:150–4.
12. Moss AR, Osmond D, Bacchetti P, Chermann JC, Barre-Sinoussi F, Carlson J. Risk factors for AIDS and HIV seropositivity in homosexual men. Am J Epidemiol **1987**; 125:1035–47.
13. Zetola N, Bernstein KT, Wong E, Louie B, Klausner JD. Exploring the relationship between sexually transmitted diseases and HIV acquisition by using different study designs. J Acquir Immune Defic Syndr **2009**; 50:546–51.
14. New York State Department of Health. Amendment of Part 63 of Title 10 (HIV/AIDS Testing, Reporting, and Confidentiality of HIV Related Information). Available at http://www.health.ny.gov/diseases/aids/testing/. Accessed 23 April 2012.
15. Bernstein KT, Marcus JL, Nieri G, Philip SS, Klausner JD. Rectal gonorrhea and chlamydia reinfection is associated with increased risk of HIV seroconversion. J Acquir Immune Defic Syndr **2010**; 53:537–43.
16. Neaigus A, Jenness SM, Hagan H, et al. Estimating HIV incidence and the correlates of recent infection in venue-sampled men who have sex with men in New York City. AIDS Behav **2012**; 16:516–24.
17. Prejean J, Song R, Hernandez A, et al. Estimated HIV incidence in the United States, 2006–2009. PLoS One **2011**; 6:e17502.
18. New York City Department of Health and Mental Hygiene. Epiquery: NYC Interactive Health Data System—Community Health Survey, **2010**. Available at: http://nyc.gov/health/epiquery. Accessed 5 October 2012.
19. Smith DK, Pals SL, Herbst JH, Shinde S, Carey JW. Development of a clinical screening index predictive of incident HIV infection among men who have sex with men in the United States. J Acquir Immune Defic Syndr **2012**; 60:421–7.
20. Petroll AE, Mosack KE. Physician awareness of sexual orientation and preventive health recommendations to men who have sex with men. Sex Transm Dis **2011**; 38:63–7.
21. Mark H, Irwin K, Sternberg M, Anderson L, Magid D, Stiffman M. Providers' perceived barriers to sexually transmitted disease care in 2 large health maintenance organizations. Sex Transm Dis **2008**; 35:184–9.
22. Wong W, Miller S, Rabins C, et al. STD program capacity and preparedness in the United States: results of a national survey, 2009. In: The National STD Prevention Conference, Atlanta, GA, March 2010. Abstract D2a.
23. Grant RM, Lama JR, Anderson PL, et al.; iPrEx Study Team. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. N Engl J Med **2010**; 363:2587–99.
24. Centers for Disease Control and Prevention (CDC). Interim guidance: preexposure prophylaxis for the prevention of HIV infection in men who have sex with men. MMWR Morb Mortal Wkly Rep **2011**; 60: 65–8.
25. Desai K, Sansom SL, Ackers ML, et al. Modeling the impact of HIV chemoprophylaxis strategies among men who have sex with men in the United States: HIV infections prevented and cost-effectiveness. AIDS **2008**; 22:1829–39.
26. Juusola JL, Brandeau ML, Owens DK, Bendavid E. The cost-effectiveness of preexposure prophylaxis for HIV prevention in the United States in men who have sex with men. Ann Intern Med **2012**; 156:541–50.
27. Chesson HW, Bernstein KT, Gift TL, Marcus JL, Pipkin S, Kent CK. The cost-effectiveness of screening men who have sex with men for rectal chlamydial and gonococcal infection to prevent HIV infection. Sex Transm Dis **2013**; 40:366–71.
28. Centers for Disease Control and Prevention (CDC). Data security and confidentiality guidelines for HIV, viral hepatitis, sexually transmitted disease, and tuberculosis programs: standards to facilitate sharing and use of surveillance data for public health action. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, **2011**.
29. Centers for Disease Control and Prevention (CDC). HIV prevalence trends in selected populations in the United States: results from national serosurveillance, 1993–1997. Atlanta, GA: Centers for Disease Control and Prevention, **2001**: 1–51.
30. Baggaley RF, White RG, Boily MC. HIV transmission risk through anal intercourse: systematic review, meta-analysis and implications for HIV prevention. Int J Epidemiol **2010**; 39:1048–63.
31. Cohen CR, Plummer FA, Mugo N, et al. Increased interleukin-10 in the endocervical secretions of women with non-ulcerative sexually transmitted diseases: a mechanism for enhanced HIV-1 transmission? AIDS **1999**; 13:327–32.