Published in final edited form as:

AIDS Care. 2011 March ; 23(3): 261–268. doi:10.1080/09540121.2010.507748.

HIV seroadaptation among individuals, within sexual dyads, and by sexual episodes, men who have sex with men, San Francisco, 2008

Willi McFarland^{a,b,*}, Yea-Hung Chen^a, H Fisher Raymond^a, Binh Nyugen^a, Grant Colfax^a, Jason Mehrkens^a, Tyler Robertson^a, Ron Stall^c, Deb Levine^d, and Hong-Ha M Truong^b

^a San Francisco Department of Public Health, San Francisco, CA, USA

^b University of California, San Francisco, CA, USA

^c University of Pittsburgh, PA, USA

^d ISIS, Inc, Oakland, CA, USA

Abstract

“Seroadaptation” comprises sexual behaviors to reduce the risk of HIV acquisition and transmission based on knowing one’s own and one’s sexual partners’ serostatus. We measured the prevalence of seroadaptive behaviors among men who have sex with men (MSM) recruited through time-location sampling (TLS) across three perspectives: by individuals (N=1,207 MSM), among sexual dyads (N=3,746 partnerships), and for sexual episodes (N=63,789 episodes) in the preceding six months. Seroadaptation was more common than 100% condom use when considering the consistent behavioral pattern of individuals (adopted by 39.1% vs. 25.0% of men, respectively). Among sexual dyads 100% condom use was more common than seroadaptation (33.1% vs. 26.4%, respectively). Considering episodes of sex, not having anal intercourse (65.0%) and condom use (16.0%) were the most common risk reduction behaviors. Sex of highest acquisition and transmission risks (unprotected anal intercourse with a HIV serodiscordant or unknown status partner in the riskier position) occurred in only 1.6% of sexual episodes. In aggregate, MSM achieve a high level of sexual harm reduction through multiple strategies. Detailed measures of seroadaptive behaviors are needed to effectively target HIV risk and gauge the potential of serosorting and related sexual harm reduction strategies on the HIV epidemic.

Introduction

Serosorting is recognized as common among men who have sex with men (MSM) throughout the Industrialized World (Eaton, Kalichman, O’Connell, & Karchner, 2009; Elford, Bolding, & Hart, 2007; Mao et al., 2006; Parsons et al., 2005; Velter, Bouyssou-Michel, Arnaud, & Semaille, 2009; Xia et al., 2006). However, there is debate on how effective serosorting is as a prevention strategy for the individual and on serosorting’s net impact on the HIV epidemic.

On one hand, serosorting should theoretically reduce HIV transmission. Mathematical modeling and observational data support that it can and has reduced HIV transmission in some places. For example, serosorting appears to explain a rise in unprotected anal

Correspondence to: Willi McFarland, MD, PhD, Director, HIV Epidemiology Section, San Francisco Department of Public Health, 25 Van Ness Avenue, Suite 500, San Francisco, CA, USA, 94102-6033; Phone: (415) 554-9016; Fax: (415) 431-0353; Willi_McFarland@hotmail.com.

intercourse (UAI) and sexually transmitted infections (STI) yet level HIV incidence among MSM in San Francisco (Truong et al., 2006). A mathematical model based on parameters from a probability-based sample of MSM in Seattle predicts that HIV prevalence would be substantially higher without the level of serosorting observed in that city (Cassels, Menza, Goodreau, & Golden, 2009).

On the other hand, serosorting's benefits have been questioned. The preventive theory breaks down when persons do not have accurate information of their own or their partners' serostatus. Serosorting's correct implementation often does not hold up to scrutiny, can result in increased risk behavior, and is a risk factor for HIV seroconversion (Golden, Stekler, Hughes, & Wood, 2008; Jin et al., 2009). Another model points out that acute infection, when persons are HIV antibody negative, can make presumptive serosorting more risky than UAI without regard to partner serostatus (Pinkerton, 2008). Serosorting's net impact on the HIV epidemic therefore remains uncertain.

Part of the uncertainty lies in differing definitions of serosorting. A definition offered by the US Centers for Disease Control and Prevention (CDC) is "a person choosing a sexual partner known to be of the same HIV serostatus, often to engage in unprotected sex, in order to reduce the risk of acquiring or transmitting HIV" (CDC, 2009). However, multiple criteria implied by this definition are open to discussion, including whether serosorting occurs at the level of choosing partners or condom use, which sexual practices, how serostatus is known, how certain a person is of their own or their partner's serostatus, and whether it includes regular or casual partners. Some classifications of serosorting emphasize highly accurate serostatus disclosure within the definition, likely to occur only in main partnerships (Crawford, Rodden, Kippax, and van de Ven, 2001; Kippax, Crawford, Davis, Rodden, & Dowsett, 1993; Zablotska et al., 2009). Other definitions describe serosorting as a phenomenon of casual partnerships (Velter et al., 2009).

"Seroadaptation" has been offered as a broader term to encompass a wide range of sexual harm reduction practices based on knowledge of own and partner serostatus (Le Talec & Jablonski, 2008; Snowden, Raymond, & McFarland, 2009; van de Ven et al., 2002). A survey conducted in 2004 in San Francisco found that collectively seroadaptation was the most common preventive strategy used by MSM. However, seroadaptation used to describe the pattern of sexual behavior for individuals over all their partners belied the fact that men engaged in different behaviors with different partners. The present study extends the framework of seroadaptive behaviors in a recent survey of MSM to compare three perspectives: the individual (i.e., behavioral patterns across all partners and all episodes), the sexual dyad (i.e., behavioral patterns with each partner), and the episode (i.e., the specific sexual behavior with each act).

Methods

Study subjects and sampling design

MSM were recruited for a study of HIV seroadaptive behaviors using time-location sampling (TLS) methods identical to those of the Centers for Disease Control and Prevention (CDC) for National HIV Behavioral Surveillance and to those of several previous studies in San Francisco and elsewhere (MacKellar et al., 2007; Magnani, Sabin, Saidel, & Heckathorn, 2005; Katz, et al., 1998; Snowden et al., 2009; Valleroy et al., 2000). The theory and methods have been described in detail previously (MacKellar et al., 2007). In brief, the study began with a formative phase that identified the venues where MSM congregate and associated time periods. Venues included bars, dance clubs, cruising areas, gyms, bookstores, social organizations, churches, street locations, and other places where the clientele were primary MSM. A sampling frame comprised all venue-day-time (VDT)

periods where at least eight MSM could be found in a four-hour time period from which a random sample of VDT was drawn. At the VDT, all potentially eligible men were counted to construct survey weights that adjust point estimates for venue sampling fractions and standard errors for homogeneity by venue. Staff intercepted men crossing a predetermined zone around the venue and assessed eligibility. Eligible men were invited to participate and written informed consent was obtained. Intercepts were done consecutively without choice on the part of the field team until all staff were occupied, resuming when staff was available.

Men were eligible if they were over 18 years of age and resident of ten Bay Area counties. Sexual orientation and male-male sexual behavior were not eligibility criteria for initial enrollment; for the present analysis, we included all men who had sex with men. Demographic and behavioral data were collected by a structured, computer-based, self-administered questionnaire in the field. Upon completion, staff conducted pre-test counseling and collected oral fluid for HIV testing, also in the field. Results disclosure counseling was done by appointment at the San Francisco Department of Public Health or by phone according to participant choice. The protocol was reviewed and approved by the internal review boards of the University of California, San Francisco and University of Pittsburgh.

Measures

Sexual behaviors reported by MSM were classified according to their own HIV serostatus, the HIV serostatus of partners as reported by the participant, and the type of sex they had with each partner for up to five sex partners (i.e., sexual dyads) in the preceding six months. The means of improving recall and collecting such a high level of detailed information comprised the following process. First, respondents provided initials or nicknames of their five most recent partners. Taking one partner at a time, they were then asked about the partner's relationship status and HIV serostatus. They were then asked to reflect on how long they were having sex with the partner working backwards from the present up to the last six months (e.g., one night only, or from the current month back to the first month of having sex) and frequency of oral sex and insertive and receptive anal sex. For longer term partnerships, this was generally estimated by a typical monthly or weekly frequency. After establishing the number of episodes of sex, respondents were asked for how many they used a condom. For partners' serostatus, we used what the respondent answered when directly asked. Subsequent to the answer, we asked how they know the serostatus. In greater than four-fifths of partnerships, the partner reported it to the respondent unsolicited or when asked; the remainder assumed it indirectly by other things the partner said, through acquaintances, through seeing antiretroviral medicines, or made an assumption on appearance or other means. We also asked how certain the respondent was of the information, whether they ask how long ago the test was, and if any risk occurred since the test. The level of certainty held in the partners' responses and time from and risk since last test varied within and between partnerships. Given the myriad complexities and uncertainties in making our own judgment on the information, we opted to use the answer provided by the respondent regardless of how they knew their partners' serostatus or their level of certainty.

We created mutually exclusive hierarchical categories of behaviors based on previous definitions and relative transmission probabilities (e.g., UAI being more risky than oral sex) (Snowden, Raymond, & McFarland, 2009; Vittinghoff et al., 1999). Safer sex practices included anal sex with a condom, oral sex, and sex other than oral or anal sex. Seroadaptive strategies included "pure serosorting" (UAI with seroconcordant partners), "oral sex serosorting" (UAI with seroconcordant partners, oral sex with serodiscordant or unknown status), "condom serosorting" (UAI with seroconcordant partners, condoms with serodiscordant or unknown status), "seropositioning" (UAI with seroconcordant partners,

receptive UAI by HIV-positive MSM with serodiscordant or unknown status, insertive UAI by HIV-negative MSM with serodiscordant or unknown status), and “condom seropositioning” (UAI with seroconcordant partners, condom use by HIV-negative MSM in the receptive position with serodiscordant or unknown, condom use by HIV-positive MSM in the insertive position with serodiscordant or unknown). Highest acquisition risk was receptive UAI by HIV-negative MSM with serodiscordant or unknown status partners. Highest transmission risk was insertive UAI by HIV-positive MSM with serodiscordant or unknown status partners.

Safer sex practices, seroadaptive behaviors, and highest acquisition and transmission risks were examined considering three perspectives: individual, sexual dyad, and episode. On the individual level, men were classified according their pattern of behavior with all of their partners for all of their episodes of sex. For this perspective, the individual was the unit of analysis. In the second perspective, we classified sexual dyads according to the behaviors occurring consistently within them with the dyad as the unit of analysis. Oral sex serosorting and condom serosorting disappeared as categories because they were defined by what individuals did when they had both serodiscordant and seroconcordant partners (i.e., each sexual dyad can only be of one type). The third perspective classified each act; that is, the sexual episode was the unit of analysis. Condom seropositioning disappeared as a category because it was defined by condom use when in one position or the other; with each separate episode, a condom was either reported as used or not used.

Analysis

Analysis focused on the proportions of individuals, sexual dyads, and episodes that corresponded to the above behaviors, with point estimates weighted for the sampling design. We recognize the non-independence of men with multiple partners and sexual dyads with multiple episodes. However, the framework for the present analysis was to examine each of these levels separately. Behavioral patterns were compiled for all MSM and also stratified by five serostatus categories: HIV-negative MSM whose previous test was HIV-negative (i.e., uninfected MSM who knew their serostatus), HIV-positive MSM with a prior diagnosis (i.e., infected MSM who knew their serostatus), HIV-positive MSM whose previous test was negative (i.e., MSM who seroconverted, were mistaken, or denied prior diagnosis), HIV-negative MSM with no prior test, and HIV-positive MSM with no prior test. To explore the effect of partnership type on seroadaptive behaviors, we stratified analyses by “main” and “other” (i.e., causal, anonymous, exchange) partners.

Results

Men were recruited during 153 randomly selected VDT periods between December 2007 and October 2008. Staff consecutively approached 2,558 men, screened 2,186 (85.5% eligibility determination), found 1,769 to be eligible (80.9% eligibility rate), 1,305 (73.8% participation rate) of whom consented, including 1,207 MSM with complete data. Weighted analyses were done on these 1,207 MSM, the 3,746 sexual dyads they described, and their reported 63,789 sexual episodes in the preceding six months.

More than half (52.4%) were under the age of 35 years (Table 1); 49.9% were white, 19.3% were Latino, 10.6% were Asian, 7.3% were black and 12.9% were other or mixed race/ethnicity. The majority (55.1%) had a college degree, were San Francisco city residents (77.1%), and born in the United States (79.2%). By serological testing, 21.2% were HIV-positive. According to their HIV testing history, 70.9% were HIV-negative on their prior test, 18.6% were HIV-positive on their prior test, 2.0% were currently HIV-positive but HIV-negative on their prior test, 7.3% were HIV-negative but reported no prior test result,

and 1.2% were HIV-positive with no prior test. Therefore, 14.5% of HIV-positive MSM were unaware of their serostatus at the time of the interview.

Table 2 classifies the 1,207 respondents according to their pattern of sexual behavior for all their sexual episodes with all partners. For safer sex practices, 12.3% only had oral sex and 25.0% consistently used condoms with anal sex. For men who knew their HIV status, 41.0% of HIV-negative MSM and 46.7% of HIV-positive MSM consistently engaged in some form of seroadaptive behavior. For HIV-negative MSM, pure serosorting predominated (25.8%). For HIV-positive MSM, forms of seropositioning were more common than pure serosorting (21.1% vs. 16.1%, respectively). Of note, 6.8% of HIV-negative MSM and 15.1% of HIV-positive MSM engaged in highest acquisition and transmission risks, respectively.

Table 3 describes behaviors occurring within 3,746 sexual dyads. Compared to the individual level where 50.9% of individuals consistently engaged in safer sex practices, 69.0% of dyads were characterized as engaging in only safer sex practices, with 35.9% engaging in oral sex only and 33.1% using condoms consistently. Therefore, although any UAI was reported by 62.7% of MSM, UAI occurred in only 31.0% of sexual dyads. Safer sex practices were reported in 74.5% of sexual dyads of men who knew they were HIV-negative and within 51.4% of sexual dyads of men who knew they were HIV-positive. Seroadaptive behaviors occurred in 43.0% of sexual dyads of HIV-positive men who knew their serostatus, and in 22.7% of sexual dyads of HIV-negative MSM who knew their serostatus. Although 9.8% of MSM reported any highest acquisition or transmission risk behaviors, this occurred within 4.6% of sexual dyads.

When stratifying estimates by main and other partnerships, serosorting was the predominant behavior for main partnerships of HIV-negative MSM (53.2%) followed by consistent condom use (25.4%). However, for non-main partnerships, the relationship reversed—consistent condom use was more common (38.9%) than serosorting (13.9%). Moreover, sex other than anal sex was the predominant behavior within non-main partnerships (41.7%). For HIV-positive MSM, behaviors were similar between main and other partners.

Table 4 shows that most sexual episodes were oral sex, accounting for 65.0% of the 63,789 sexual acts reported by MSM. UAI accounted for 19.0% of sexual episodes. Thus, any UAI was reported by 62.7% of MSM, but occurred within only 31.0% of sexual dyads, and only 19.0% of the time. Seroadaptive sex acts accounted for 17.4% of all episodes. The highest acquisition and transmission risk episodes reported by 9.8% of MSM and occurring within 4.6% of sexual dyads happened only 1.6% of the time. Of the 550 highest transmission risk episodes of HIV-infected MSM, the majority (60.3%) were from MSM who knew they were HIV-positive. Of the 435 highest acquisition risk episodes of HIV-uninfected men, the majority (90.1%) were from men who knew they were HIV-negative.

Stratifying sexual episodes by main and other partner types produced results similar to the partnership perspective described above, with two exceptions. For HIV-negative men, seroconcordant UAI was relatively more common with main partners compared to non-main partners (21.1% of episodes vs. 8.0%, respectively), whereas condom use was more common among non-main partners compared to main partners (21.7% vs. 10.4%, respectively).

Discussion

Our survey described HIV serostatus-based sexual behaviors in nearly 64,000 sexual episodes occurring within nearly 4,000 sexual dyads reported by over 1,000 MSM in the preceding six months. Our data reveal that MSM are engaging in preventive behavior the vast majority of the time. Seroadaptation plays a major role in risk reduction, however,

neither as the predominant one nor in isolation of other strategies. Our approach helps gauge the potential impact of serosorting and other seroadaptive strategies on the HIV epidemic. Our analysis also helps quantify which strategies MSM are in reality adopting to reduce their risk, where HIV transmission and acquisition risk are really highest, and where to most effectively target prevention efforts.

Collectively on an individual level, the various seroadaptive strategies appear to be more common than 100% condom use as a risk reduction approach adopted by MSM in San Francisco in 2008. More MSM have UAI with some partners than consistently use condoms. When UAI does occur, it is most often with same serostatus partners or in the context of seropositioning. These results are similar to data from MSM in San Francisco in 2004 using equivalent TLS methods and comparable definitions (Snowden, Raymond, & McFarland, 2009). Then, 37.6% of HIV-negative MSM and 43.4% of HIV-positive MSM engaged in seroadaptive behaviors compared to 41.0% and 46.3%, respectively, four years later. However, when considering sexual episodes, oral sex and condom use predominate over seroadaptation. Over four-fifths of sexual episodes are oral sex or protected anal intercourse, leaving less than 15% of sexual episodes as seroconcordant UAI and less than 3% as seropositioning.

Only 1.6% of sexual episodes would be considered highest risk for acquisition or transmission of HIV. These relatively rare episodes may be the most efficient targets for prevention interventions. Consider, for example, the highest transmission risk episodes of HIV-infected MSM. The majority (60.3%) occurred from MSM who knew they were HIV-positive. This figure implies that prevention with positive interventions could address most transmission risk. The appeal of prevention with positive interventions is even greater considering the body evidence for their efficacy in observational studies and randomized controlled trials (Marks, Crepaz, & Janssen, 2006; Morin et al., 2008). Nonetheless, we recognize that San Francisco has a high level of HIV testing and a relatively low proportion of unknown infection (CDC, 2005). For example, in 2004 the proportion of unaware infection in Baltimore was 60.0% compared to 23.1% in San Francisco in the same TLS study (CDC, 2005). In cities where testing is low, the proportion of transmission risk originating from unknown HIV infections could be substantially higher and the situation may favor more HIV testing over prevention with positives. Moreover, although fewer transmission risk episodes occurred among MSM who were unaware of their HIV-positive status, many could have transmitted during the acute infection phase and account for disproportionate numbers of infections (Pilcher et al., 2004; Pinkerton, 2008).

Extending the logic to HIV-negative MSM who know their serostatus, adoption of the safer sex practices of oral sex and condom use would appear more efficient and more effective in reducing high acquisition risk over seroadaptive strategies. Furthermore, promotion of seroadaptation may have even less appeal as an effective strategy for HIV-negative than for HIV-positive MSM given the uncertainties behind knowing if someone is truly HIV-negative.

The uncertainty around how participants knew the serostatus of their partners is a limitation of our study. While we collected data on disclosure of HIV serostatus, there was variability in what was disclosed and discussed (e.g., how long ago the test was, whether risk occurred after the test) and in the confidence men held in the knowledge of their serostatus regardless of what was discussed. These uncertainties persisted even for main partnerships. We therefore opted to classify partners based on what respondents reported their serostatus to be on the face of it. Severe under-reporting of the highest risk categories is another possible limitation, particularly in how many HIV-positive MSM report knowingly placing HIV-negative MSM at risk. We also recognize differing opinions on the relative risks with our

hierarchy. We also acknowledge that the cross-sectional nature of our study does not permit direct examination of the impact of seroadaptive behaviors on HIV seroconversion. Finally, we recognize the high potential for errors in recall of specific behaviors, for several partners, over several months. Each individual reported, on average, the situation for approximately 53 sexual episodes each or 17 per partnership. Nonetheless, we believe our approach, while prone to recall bias, was able to systematically elicit the relevant information for a large number of their most recent sexual episodes. Other approaches to capturing information, such as generalizing or aggregating across partnerships, would not make the distinctions central to this paper.

Taking the description of 64,000 sexual episodes at face value, our data support that MSM engage in a wide range of preventive behaviors and that the highest HIV acquisition and transmission risk behaviors occurs in very few instances. Our approach and measures help prioritize the types of interventions that may reduce these risks further. Our study contributes to a growing body of international research confirming that serosorting and other seroadaptive behaviors are a reality of how men manage HIV risk in the current era, yet are used in more nuanced ways with different partners at different times rather than consistent or wholesale adoption. However, we wish to end with two caveats. First, seroadaptive behaviors do not offer protection from other STI nor from sexually transmitted hepatitis C infection – and the latter appears to be on the rise in recent years particularly among HIV-positive MSM (Danta & Dusheiko, 2009). Second, if seroadaptation has helped stabilized HIV incidence in San Francisco and Seattle (Truong et al., 2006; Cassels et al, 2009), these instances should not be complacently accepted as the rule in a world where HIV epidemics are resurging among MSM in the West, only recently recognized in sub-Saharan Africa, and newly emerging in the rest of the developing world (van Griensven, Baral, & Grulich, 2009).

Acknowledgments

National Institute of Mental Health (NIMH) Grant R01MH077509 supported this research.

References

- Cassels S, Menza TW, Goodreau SM, Golden MR. HIV serosorting as a harm reduction strategy: evidence from Seattle, Washington. *AIDS*. 2009; 23:2497–2506. [PubMed: 19834319]
- CDC. HIV prevalence, unrecognized infection, and HIV testing among men who have sex with men – five US cities, June 2004 – April 2005. *MMWR*. 2005; 54:597–601. [PubMed: 15973239]
- CDC. 2009. <http://www.cdc.gov/hiv/topics/research/resources/other/serosorting.htm>, retrieved 29 December, 2009
- Crawford JM, Rodden P, Kippax S, van de Ven P. Negotiated safety and other agreements between men in relationships: risk practice redefined. *Int J STD AIDS*. 2001; 12:164–170. [PubMed: 11231869]
- Danta M, Dusheiko GM. Acute HCV in HIV-positive individuals – a review. *Curr Pharm Des*. 2009; 14:1690–1697. [PubMed: 18673193]
- Eaton LA, Kalichman SC, O'Connell DA, Karchner WD. A strategy for selecting sexual partners believed to pose little/no risks for HIV: serosorting and its implications for HIV transmission. *AIDS Care*. 2009; 21:1279–1288. [PubMed: 20024704]
- Elford J, Bolding G, Hart. No evidence of an increase in serosorting with casual partners among HIV-negative gay men in London, 1998–2005. *AIDS*. 2007; 21:243–245. [PubMed: 17197819]
- Golden MR, Stekler J, Hughes JP, Wood RW. HIV serosorting in men who have sex with men: is it safe? *JAIDS*. 2008; 49:212–218. [PubMed: 18769346]

- Jin F, Crawford J, Prestage GP, Zablotska I, Imrie J, Kippax SC, et al. Unprotected anal intercourse, risk reduction behaviours, and subsequent HIV seroconversion in a cohort of homosexual men. *AIDS*. 2009; 23:243–252. [PubMed: 19098494]
- Katz MH, McFarland W, Guillin V, Fenstersheib M, Shaw M, Kellogg T, et al. Continuing high prevalence of HIV and risk behaviors with men: The Young Men's Survey in San Francisco Bay Area in 1992–93 and 1994–95. *JAIDS*. 1998; 19:178–181. [PubMed: 9768628]
- Kippax S, Crawford J, Davis M, Rodden P, Dowsett G. Sustaining safe sex: a longitudinal study of homosexual men. *AIDS*. 1993; 7:257–263. [PubMed: 8466689]
- Le Talc, J.; Jablonski, O. Seroadaptation instead of serosorting: a broader concept and a more precise process model. XVII International AIDS Conference; 3–8 August 2008; Mexico City, Mexico. 2008. Abstract # WEPE 0311
- MacKellar D, Gallagher K, Finelayson T, Sanchez T, Lansky A, Sullivan PS. Surveillance of HIV risk and prevention behaviors of men who have sex with men—a national application of venue based, time-space sampling. *Public Health Reports supplement*. 2007; 122:S39–S47.
- Magnani R, Sabin K, Saidel T, Heckathorn D. Review of sampling hard-to-reach and hidden populations for HIV surveillance. *AIDS supplement*. 2005; 19:S67–S72.
- Mao L, Crawford JM, Hospers HJ, Prestage GP, Grulich AE, Kippax SC. “Serosorting” in casual anal sex of HIV-negative gay men is noteworthy and is increasing in Sydney, Australia. *AIDS*. 2006; 20:1204–1206. [PubMed: 16691075]
- Marks G, Crepaz N, Janssen RS. Estimating sexual transmission of HIV from persons aware and unaware that they are infected with the virus in the USA. *AIDS*. 2006; 20:1447–1450. [PubMed: 16791020]
- Morin S, Shade SB, Steward WT, Carrico AW, Remien RH, Rotheram-Borus MJ, et al. A behavioral intervention reduces HIV transmission risk by promoting sustained serosorting practices among HIV-infected men who have sex with men. *JAIDS*. 2008; 49:554–551.
- Parsons JT, Schrimshaw EW, Wolitski RJ, Halkitis PN, Purcell DW, Hoff CC, et al. Sexual harm reduction practices of HIV-seropositive gay and bisexual men: serosorting, strategic positioning, and withdrawal before ejaculation. *AIDS, supplement*. 2005; 19:S513–S525.
- Pilcher CD, Tien HC, Eron JJ, Vernazza PL, Leu SY, Stewart PW, et al. Brief but efficient: acute HIV infection and the sexual transmission of HIV. *Journal of Infectious Diseases*. 2004; 189:1785–1792. [PubMed: 15122514]
- Pinkerton SD. Acute HIV infection increases the dangers of serosorting. *American Journal of Preventive Medicine*. 2008; 35:184. [PubMed: 18617087]
- Snowden JM, Raymond HF, McFarland W. Prevalence of seroadaptive behaviors of men who have sex with men, San Francisco, 2004. *Sex Transm Infect*. 2009; 85:469–76. [PubMed: 19505875]
- Truong HM, Kellogg T, Klausner JD, Katz MH, Dilley J, Knapper K, et al. Increases in sexually transmitted infections and sexual risk behaviour without a concurrent increase in HIV incidence among men who have sex with men in San Francisco: a suggestion of HIV serosorting? *Sexually Transmitted Infections*. 2006; 82:461–466. [PubMed: 17151031]
- Valleroy LA, MacKellar DA, Karon JM, Rosen DH, Janssen RS, Celantano D, et al. High HIV prevalence and associated risks among adolescent and young adult men who have sex with men in 7 US metropolitan areas in 1994 through 1998. *JAMA*. 2000; 284:198–204. [PubMed: 10889593]
- van de Ven P, Kippax SC, Crawford JM, Rawstorne P, Prestage G, Grulich A, et al. In a minority of gay men, sexual risk practice indicates strategic positioning for perceived risk reduction rather than unbridled sex. *AIDS Care*. 2002; 14:471–480. [PubMed: 12204150]
- van Griensven F, Baral S, Grulich A. The global epidemic of HIV infection among men who have sex with men. *Curr Opin HIV AIDS*. 2009; 4:300–307. [PubMed: 19532068]
- Velter A, Bouyssou-Michel A, Arnaud A, Semaille C. Do men who have sex with men use serosorting with casual partners in France? Results of a nationwide survey (ANRS-EN-Presses Gay 2004). *Euro Surveillance*. 2009; 14:pii, 19416.
- Vittinghoff E, Douglas J, Judson F, McKirnan D, MacQueen K, Buchbinder S. Per-contact risk of human immunodeficiency virus transmission between male sexual partners. *Am J Epidemiol*. 1999; 150:306–11. [PubMed: 10430236]

- Xia Q, Molitor F, Osmond DH, Tholandi M, Pollack LM, Ruiz JD, et al. Knowledge of sexual partner's HIV serostatus and serosorting practices in a California population-based sample of men who have sex with men. *AIDS*. 2006; 20:2081–2089. [PubMed: 17053354]
- Zablotska IB, Imrie J, Prestage G, Crawford J, Rawstorne P, Grulich A, et al. Gay men's current practice of HIV seroconcordant unprotected anal intercourse: serosorting or seroguessing? *AIDS care*. 2009; 21:501–510. [PubMed: 19266409]

Table 1

Study population characteristics, men who have sex with men (MSM), San Francisco, 2008 (N=1,207).

Variable	Weighted N (%)
Age group:	
18 – 24 years	196 (16.2)
25 – 34	437 (36.2)
35 – 44	304 (25.2)
45 – 54	176 (14.6)
55+	93 (7.7)
Race/ethnicity:	
Asian	128 (10.6)
Black	88 (7.3)
Latino	233 (19.3)
White	602 (49.9)
Other, mixed, unknown	156 (12.9)
Highest level of education completed:	
College graduate or more	665 (55.1)
Some college	379 (31.4)
High school graduate	115 (9.5)
Less than high school	35 (2.9)
Don't know, no answer	12 (1.0)
Annual income:	
\$0 – \$9,999	175 (14.5)
\$10,000 – \$29,999	308 (25.5)
\$30,000 – \$49,999	269 (22.3)
\$50,000 – \$69,999	183 (15.2)
\$70,000 – \$89,999	108 (8.9)
\$90,000 and above	162 (13.4)
Missing, no answer	1 (0.1)
Employment:	
Full-time	744 (61.6)
Part-time	290 (24.0)
Unemployed	68 (5.7)
Other	106 (8.8)
Residence in San Francisco county	930 (77.1)
Born in the United States	955 (79.2)
Sexual orientation (note: all had male-male sex)	
Gay, homosexual or queer	1090 (90.3)

Variable	Weighted N (%)
Bisexual	92 (7.6)
Straight, heterosexual	15 (1.2)
Other	9 (0.8)
HIV serostatus, by test result:	
Negative	951 (78.8)
Positive	256 (21.2)
HIV serostatus and self-reported previous test result:	
HIV- and previous test HIV-	856 (70.9)
HIV+ and previous test HIV+	224 (18.6)
HIV+ and previous test HIV-	24 (2.0)
HIV- and no previous test result reported	88 (7.3)
HIV+ and no previous test result reported	14 (1.2)

Table 2

Individual-level analysis: behaviors of respondents defined by knowledge of HIV serostatus for all sexual episodes with all sexual partners, men who have sex with men (MSM), San Francisco, 2008.

Behavior	All MSM N (%)	HIV- and previous test HIV- N (%)	HIV+ and previous test HIV+ N (%)	HIV+ and previous test HIV- N (%)	Did not know serostatus, HIV- N (%)	Did not know serostatus, HIV+ N (%)
Total respondents	1,207 (100)	856 (100)	224 (100)	24 (100)	88 (100)	14 (100)
Safer sex practices (No UAI):						
No oral or anal sex	164 (13.6)	108 (12.6)	23 (10.2)	4 (18.0)	23 (25.6)	6 (44.0)
Only oral sex	149 (12.3)	97 (11.3)	28 (12.4)	4 (17.0)	17 (19.0)	4 (26.3)
100% condom use	302 (25.0)	242 (28.3)	35 (15.5)	2 (9.3)	22 (24.6)	1 (7.0)
Serodaptive behaviors (UAI):						
Pure serosorting	269 (22.3)	221 (25.8)	36 (16.1)	0 (0)	11 (12.7)	1 (10.2)
Oral sex serosorting	42 (3.5)	33 (3.9)	7 (3.1)	0 (0)	2 (2.3)	0 (0)
Condom serosorting	61 (5.0)	46 (5.3)	14 (6.4)	0 (0)	1 (1.1)	0 (0)
Seropositioning	77 (6.3)	40 (4.7)	35 (15.4)	1 (4.6)	<1 (0.5)	0 (0)
Condom seropositioning	25 (2.0)	11 (1.3)	13 (5.7)	<1 (0.4)	0 (0)	0 (0)
Highest acquisition and transmission risks (UAI):						
All partners unknown	8 (0.7)	5 (0.6)	2 (0.7)	0 (0)	2 (2.3)	0 (0)
Partners mixed	94 (7.8)	48 (5.7)	26 (11.8)	6 (26.8)	11 (11.9)	2 (12.6)
All partners serodiscordant	16 (1.3)	5 (0.6)	6 (2.6)	5 (22.6)	0 (0)	0 (0)

Table presents survey weighted population numbers and proportions. UAI: Unprotected anal intercourse.

Table 3

Sexual dyad-level analysis: behaviors within partnerships defined by knowledge of HIV serostatus for all sexual episodes with each partner, men who have sex with men (MSM), San Francisco, 2008.

Behavior	All Sexual dyads* N (%)	Sexual dyads of HIV – MSM N (%)	Sexual dyads of HIV + MSM thought HIV – N (%)	Sexual dyads of HIV – MSM of unknown serostatus N (%)	Sexual dyads of HIV + MSM of unknown serostatus N (%)
Total partnerships	3,746 (100)	2,713 (100)	71 (100)	181 (100)	30 (100)
Safer sex practices (no UAI):					
Only oral sex	1,343 (35.9)	1,022 (37.7)	26 (36.4)	83 (45.5)	13 (43.0)
100% condom use	1,241 (33.1)	999 (36.8)	10 (14.7)	41 (22.7)	4 (13.9)
Seroadaptive behaviors (UAI):					
Seroconcordant	816 (21.8)	539 (19.9)	2 (3.0)	29 (15.8)	8 (26.3)
Seropositivonig	146 (3.9)	65 (2.4)	2 (3.2)	2 (1.0)	<1 (1.1)
Condom seropositioning	24 (0.7)	12 (0.4)	<1 (0.5)	4 (2.4)	0 (0)
Highest acquisition and transmission risks (UAI)					
Partner unknown serostatus	102 (2.7)	56 (2.1)	3 (4.8)	18 (10)	5 (15.6)
Partner serodiscordant	73 (1.9)	20 (0.7)	27 (37.3)	5 (2.5)	0 (0)

Table presents survey weighted population numbers and proportions. UAI: Unprotected anal intercourse.

* Distribution of partnerships per participant in the study: one 18.0%, two 12.1%, three 9.3%, four 7.4%, five 53.2%.

Table 4

Sexual episode-level analysis: behaviors within sexual episodes defined by knowledge of HIV serostatus, men who have sex with men (MSM), San Francisco, 2008.

Behavior	All sexual episodes* N (%)	Episodes of HIV- MSM N (%)	Episodes of HIV+ MSM N (%)	Episodes of HIV+ MSM thought HIV- N (%)	Episodes of HIV- MSM of unknown serostatus N (%)	Episodes of HIV+ MSM of unknown serostatus N (%)
Total episodes	63,789 (100)	46,017 (100)	11,515 (100)	2,307 (100)	3,119 (100)	831 (100)
Safer sex practices (No UAI):						
Oral sex	41,489 (65.0)	30,552 (66.4)	6,911 (60.0)	1,577 (68.3)	1,874 (60.1)	575 (69.2)
Condom use	10,238 (16.0)	6,873 (14.9)	2,276 (19.8)	242 (10.5)	738 (23.7)	107 (12.9)
Seroadaptive behaviors (UAI):						
Seroconcordant	9,312 (14.6)	7,302 (15.9)	1,394 (12.1)	86 (3.7)	415 (13.3)	115 (13.8)
Seropositioning	1,765 (2.8)	897 (1.9)	602 (5.2)	211 (9.2)	48 (1.5)	7 (0.9)
Highest acquisition and transmission risks (UAI)						
Partner unknown serostatus	500 (0.8)	303 (0.7)	108 (0.9)	21 (0.9)	41 (1.3)	27 (3.2)
Partner serodiscordant	485 (0.8)	89 (0.2)	224 (1.9)	170 (7.4)	2 (0.1)	0 (0)

Table presents survey weighted population numbers and proportions. UAI: Unprotected anal intercourse.

* Distribution of episodes per participant in the study: none 15%, one to twenty-four 38.2%, twenty-five to forty-nine 17.8%, fifty to seventy-four 9.8%, seventy-five to ninety-nine 5.6%, one hundred or more 13.5%.