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Is serosorting effective in reducing the risk of HIV-infection among men who have sex with men with casual sex partners?

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Abstract

Background—We investigated the prevalence and protective value of serosorting (i.e., establishing HIV-concordance in advance to practice unprotected anal intercourse [UAI]) with casual partners (CP) among HIV-negative MSM using longitudinal data from 2007 to 2011.

Methods—Men of the Amsterdam Cohort Studies (ACS) were tested biannually for HIV-1 antibodies and filled in questionnaires about sexual behavior in the preceding 6 months. HIV-incidence was examined among men who practiced UAI, UAI with serosorting, or consistent condom use, using Poisson regression.

Results—Of 445 MSM with CPs, 31 seroconverted for HIV during a total follow-up of 1107 person-years (PY). Overall observed HIV-incidence rate was 2.8/100PY. Consistent condom use was reported in 64%; UAI in 25%; and UAI with serosorting in 11% of the 2137 follow-up visits. MSM who practiced serosorting were less likely to seroconvert (*adjusted* Incidence Rate Ratio [aIRR]=0.46; 95% confidence interval [95%CI]=0.13–1.59) than MSM who had UAI, but more likely to seroconvert than MSM who consistently used condoms (aIRR=1.32; 95%CI=0.37–4.62), although differences in both directions were not statistically significant. MSM who consistently used condoms were less likely to seroconvert than MSM who had UAI (aIRR=0.37; 95%CI=0.18–0.77).

Discussion—The protective effect for serosorting we found was not statistically significant. Consistent condom use was found to be most protective against HIV infection. Larger studies are needed to demonstrate whether serosorting with CPs offers sufficient protection against HIV-infection, and if not, why it fails to do so.

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AUTHOR CONTRIBUTIONS

Wijnand Van den Boom and Roos Konings analyzed and interpreted the data, and wrote the draft manuscript. Theo Sandfort and Maria Prins gave substantial contributions to the analyses and interpretation of the data. Udi Davidovich and Ineke Stolte designed and supervised the overall study, and contributed to the analyses and interpretation of the data. All authors contributed to subsequent drafts and approved the final version of the manuscript.

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Keywords

Men who have sex with men; HIV incidence; Cohort study; Serosorting; Sexual risk behavior

INTRODUCTION

Men who have sex with men (MSM) have adopted several HIV risk-reduction strategies in order to reduce the risk of HIV transmission when engaging in unprotected anal intercourse (UAI) ^{1;2}. One of these strategies is “serosorting”. For HIV-negative MSM, serosorting means having UAI only with partners who are also known to be HIV-negative ³. Some studies demonstrated that serosorting is common among HIV-negative MSM who engage in UAI with casual sex partners (with proportions of serosorting >20%), and that this practice is increasing ^{4;5}.

The validity of serosorting in reducing the risk of HIV is dependent on the knowledge of one's own and partner's HIV-status. Therefore, serosorting is vulnerable to potential misperception of HIV status, especially in the context of casual sex when it may not be possible for the partners to know each other well ⁶. Also, MSM who test infrequently for HIV might incorrectly assume they are HIV-negative when in fact they have (recently) been infected with HIV ⁷. Modeling studies have shown that the effectiveness of serosorting depends on the frequency of HIV testing: in populations where testing is done infrequently, serosorting can lead to an increased risk of HIV-infection ⁸. HIV-positive MSM, on the other hand, might not accurately or honestly disclose their HIV status because of stigma or fear of rejection involved with that disclosure ⁹. Despite these difficulties in practicing serosorting, some studies suggest that serosorting is effective in preventing HIV infection ^{4;10}. However, the effectiveness of serosorting seems to be lower when compared to consistent condom use ^{4;10}.

The Amsterdam Cohort Study (ACS) among MSM collects extensive behavioral data and tests for HIV every 6 months, and thus provides a good opportunity to investigate the association between serosorting and HIV-infection. We conducted the present study to determine whether the proportion of serosorting has changed over the years and to investigate whether its practice is effective in lowering the risk of HIV-infection, using longitudinal analyses. Most studies that have investigated serosorting in relation to HIV infection have assessed ad hoc reports of participants' and partners' HIV serostatus and matched HIV serostatus between partners to establish seroconcordance (e.g., Jin et al ⁴). These studies failed to assess the conscious practice of serosorting by MSM as an HIV risk-reduction strategy. For our study we adopted serosorting measures from a previous cross-sectional ACS study, that assessed *intentional* serosorting among MSM ¹¹. We specifically asked our participants whether they had decided to engage in UAI because they knew in advance that their casual partner was HIV-negative and therefore had the *a priori* intention to engage in serosorting as an HIV risk-reduction strategy.

METHODS AND MATERIALS

Study population and study procedure

The ACS among MSM started in 1984 and is an open, ongoing prospective cohort study to investigate the epidemiology, psychosocial determinants, course of infection, and pathogenesis of HIV ^{12;13}. Men can participate in the cohort if they are living in or around Amsterdam and had at least 1 male sexual partner in the preceding 6 months. Men are recruited into the ACS by ‘convenience sampling’ (e.g., brochures at the STI clinic,

advertisements in the gay scene) and ‘chain referral sampling’ (participants recruited by other participants) ¹⁴.

Participants visit the Public Health Service of Amsterdam every 6 months to complete a self-administered questionnaire regarding their sexual (risk) behavior in the preceding 6 months; questions are asked regarding demographics at intake. At each visit, blood is drawn to test for HIV and for storage. Two commercially available enzyme-linked immunosorbent assays are used to test for HIV antibodies (AxSYM; Abbot Laboratories, North Chicago, IL, USA; Vironostika, Organon Teknika, Boxtel, the Netherlands). HIV-1 seroconversion is confirmed by Western blot analysis. For further details on ACS methods and recruitment, see Jansen et al ¹⁴.

During the study period (May 2007 - December 2011), detailed questions were asked about sexual behavior with casual partners in the preceding 6 months. Men were included in the present study if they were HIV-negative at start of the study period, had at least 2 visits during the study period, and reported having engaged in anal sex with casual partners.

Demographics

Demographic variables included age at the first visit in the study period, nationality (Dutch versus non-Dutch), educational level, and sexual preference. Educational level was dichotomized into ‘high’ (completed higher vocational education or university) and ‘low-middle’ (completed high school, basic vocational education, primary school or secondary vocational level). Sexual preference score was measured using a 7-point Kinsey scale ranging from ‘exclusively heterosexual’ (1) to ‘exclusively homosexual’ (7).

Sexual (risk) behavior with casual partners

Participants were asked whether they had had insertive and/or receptive anal intercourse with their casual partners (yes/no). If participants reported anal intercourse with a casual partner, they were asked about their condom use with those partners (ranging on a 5-point scale from ‘never’ to ‘always’). Reporting no or no consistent condom use was defined as unprotected anal intercourse (UAI). If participants reported no or no consistent condom use, they were also asked whether they had decided to engage in UAI because they knew in advance that their casual partner was also HIV-negative (UAI with serosorting). Subsequently, participants were also asked whether they had decided to engage in UAI because they knew in advance that their casual partner was positive (yes/no), and whether they had decided to engage in UAI because they did not know his HIV status (yes/no). If participants responded ‘yes’ to either one or both questions, this was also considered as a case of ‘UAI without serosorting’.

Each participant was placed in only 1 category, which corresponded to his highest risk behavior with casual partners in the preceding 6 months. For example, participants who reported both serosorting and UAI (without serosorting) were consequently placed in the latter category. This resulted in our main variable of interest that consisted of 3 mutually exclusive categories; ‘UAI (without serosorting)’, ‘serosorting’, and ‘consistent condom use’, ranging from high to low risk.

Number of casual sex partners

If participants reported that they had had anal intercourse with casual sex partners, they were asked about the number of partners they had had anal intercourse with in the preceding 6 months.

Statistical analyses

We used descriptive statistics to describe baseline characteristics and the proportions of sexual (risk) behavior with casual partners. To investigate whether the proportion of serosorting among those who practiced anal intercourse with casual partners had changed during the study period, we used univariate logistic regression analysis. To account for within-participant correlations of the repeated behavioral measures over time, we used generalized estimating equations (GEE), assuming an exchangeable covariance matrix. For the whole period (2007-2011), an overall HIV incidence rate was calculated using person-time techniques.

Univariate and multivariate Poisson regression analyses were conducted to investigate the effect of sexual (risk) behavior with casual partners on HIV-seroconversion. The logarithm of person-years was used as the offset value. As our questionnaires relate to the sexual behavior reported in the previous 6 months, individual follow-up time was calculated from 6 months prior to the first visit of the study period to the moment of HIV-infection, the end of HIV negative follow-up, or the end of the study period (i.e., 31 December 2011), whichever occurred first. The estimated moment of seroconversion was defined as the midpoint between the last ACS visit at which the participant tested HIV-1-negative and the first HIV-1-positive visit.

All variables subject to change were treated as time-dependent variables. HIV status at every visit was linked to sexual (risk) behavior reported at that visit, since HIV-infection is assumed to have occurred in the preceding 6 months and the behavior reports refer to that same period. This resulted in a study sample of 445 HIV-negative MSM with a total of 2137 visits.

Our main determinant of interest was sexual (risk) behavior with casual partners. Educational level and number of casual sex partners were considered potential confounders as they were found to be associated with HIV-infection in a previous study¹⁴ and are also possibly associated with our main variable of interest. It could be that men who have a lower level of education might be less able to communicate about their HIV status with their casual partners. With increasing numbers of casual sex partners, it may be more difficult to discuss HIV seroconcordance with each of the casual partners.

We tested 2 models to investigate the effect of sexual (risk) behavior with casual partners on HIV-seroconversion: (1) a model that only included sexual (risk) behavior, and (2) a model that included both sexual (risk) behavior and potential confounders of the association between sexual (risk) behavior and HIV seroconversion (i.e., educational level and number of casual sex partners). We also checked for interaction between sexual behavior with casual partners and the other variables in the second model. A *p*-value of less than 0.05 was considered to be statistically significant.

All statistical analyses were performed using the statistical packages SPSS version 18.0 (SPSS Inc., Chicago, Illinois, USA) and STATA Intercooled 11 (STATA Corp. LP, College Station, Texas, USA).

RESULTS

In total, 445 MSM were HIV-1-negative at study entry and met our inclusion criteria. Their median age was 33.9 years (IQR=29.7-38.8), 90% (399/443) were Dutch, and 72% (313/437) were highly educated (Table 1). The mean sexual preference score was 6.7 (SD=0.7). The median number of casual sex partners was 19 (IQR=7-46). The median HIV-negative follow-up time during the study period was 2.5 years (IQR=1.2-3.6). The median

number of visits during the study period was 5 visits (IQR=2-7), with a median time between visits of 6.0 months (IQR=5.8-6.4).

Sexual (risk) behavior

Consistent condom use with casual partners was reported at 63.5% (1358/2137) of the visits, followed by UAI at 25.1% (537/2137), and serosorting at 11.3% (242/2137). The proportions of visits at which MSM reported serosorting remained relatively stable over time ($P=0.33$), with 10.2% (20/196), 11.4% (56/485), 10.0% (48/472), 10.0% (50/492), and 13.9% (68/492), respectively, of the visits in the years 2007-2011.

Sexual (risk) behavior in relation to HIV-seroconversion

Total follow-up time was 1107 person-years. Thirty-one MSM seroconverted for HIV during follow-up (overall observed incidence rate of 2.8/100 person-years). In model 1, Poisson analyses revealed that, compared to men who practiced UAI, men who reported consistent condom use were less likely to seroconvert for HIV (IRR=0.34; 95% CI=0.16-0.72), as were men who practiced serosorting (IRR=0.45; 95% CI=0.13-1.54), although the latter was not statistically significant ($p=0.24$) (Table 2). Additional analysis revealed that, compared to those who used condoms, men who practiced serosorting were more likely to seroconvert for HIV (IRR=1.30; 95% CI=0.37-4.57), although not statistically significant. In model 2, when adding potential confounders (i.e., educational level and number of casual sex partners), the effect of sexual (risk) behavior on HIV seroconversion we found in model 1 was retained.

DISCUSSION

Using longitudinal data from the ACS, we found that in terms of incidence risk ratios, serosorting positioned itself in between condom use and unprotected anal intercourse: the practice of serosorting seemed riskier than condom use but not as risky as unprotected anal intercourse, however, differences in both directions were not statistically significant. The lack of significance in both directions might be due to lack of power as there was a limited number of HIV seroconverters in our study.

Our findings suggest that some of our participants were not successful in effectively practicing serosorting. Their failure to distinguish in some cases between HIV-negative and HIV-positive casual partners could be, for example, attributed to their sex partners not knowing their correct HIV-status, not honestly disclosing their HIV-positive status, or that the sex partners had not discussed their HIV-status at all^{6,9;15}. This is not surprising considering the context of casual sex in which communication about HIV is likely to be problematic. It would be of interest to investigate whether knowing a casual partner better would lead to more effective serosorting and thus in more effectively reducing the risk of HIV-infection. A previous study found that MSM are more likely to practice intentional serosorting with partners they regularly contact to have sex with (sex buddies) than with partners they have occasionally met and had sex with only once (one-night stands)¹¹. We did, however, not have the statistical power in the current study to stratify our analyses by type of casual partner, such as sex buddies versus one-night stands.

Other constraints to the protective effect of serosorting should be discussed. For example, on the population level, HIV testing rates can play a role in undermining effective serosorting. In the Netherlands, rates of recent HIV-testing (in the last 6 months) among MSM, which range from 49% nation-wide¹⁶ to 79% at STI centers¹⁷, might be too low to make serosorting effective in preventing HIV. Mathematical models have indicated that under conditions of low HIV-testing frequency in the MSM population, any potential benefit of

serosorting could be undermined by undiagnosed HIV-infections^{7;8}. However, on the individual level, it is clear that in order for serosorting to become an effective strategy for causal partners, the HIV test on which the HIV status appraisal is made should be as close as possible to the moment of the sexual encounter and the window period of the test should be as small as possible, thereby increasing the likelihood that the knowledge of the HIV status is valid.

The relatively low (11%) and stable proportions of serosorting among HIV-negative MSM with casual partners in the ACS seems to be in line with a recent study among North American MSM (7.5-10.6%¹⁸). Relatively higher proportions were found by studies conducted in Sydney (24.6%⁵), France (26%¹⁹), San Francisco (27.5%²⁰), and Switzerland (41.9%²¹). Differences between those studies and ours might partly be explained by the different study populations (e.g., study population characteristics, rates of HIV-testing) investigated, or by how serosorting was assessed or inferred from the data. In contrast to our approach, in which we measured intentional (planned) serosorting with casual partners, most studies assessed HIV-seroconcordance by matching ad hoc reports of participants' and partners' HIV-serostatus, but did not assess whether participants used that information in advance of the sexual act in order to decide to engage in UAI (e.g., Mao et al; Golden et al^{5;22}). Therefore, in these studies, the practice of intentional serosorting as a conscious strategy among HIV-negative MSM might have been overestimated.

Some limitations of the present study should be mentioned. First, as MSM participating in the ACS tend to be strongly gay-identified, are relatively highly educated and are mostly from Dutch descent, generalization of our results must be made cautiously. Nevertheless, the data on risk behavior of the cohort have often been similar to larger nation-wide monitoring studies such as the Schorer Monitor¹⁶, and therefore have good external validity. Second, we did not assess whether our participants practiced any HIV risk-reduction strategies other than serosorting, such as seropositioning. As a previous study⁴ has shown that HIV-negative MSM who practice serosorting are not likely to practice any other strategy, this may only apply to the men in our study who had UAI (without serosorting). If such strategies have a protective value against HIV infection and are indeed practiced by those who had UAI without serosorting, we may have therefore underestimated the effect we found of serosorting in relation to UAI.

In conclusion, our findings highlight the need for the continuing encouragement of condom use for anal intercourse with casual partners, as in the present study consistent condom use was found to be most protective against HIV infection. While serosorting has the potential to be an effective HIV risk-reduction strategy, in our study we did not find conclusive evidence of its protective effect in the context of casual sex. The failure of serosorting to offer better protection most likely concerns the problematic process of establishing valid HIV-negative seroconcordance between causal partners. If serosorting is to ever fulfill its protective potential in that context, a significantly better process of establishing HIV-negative seroconcordance must be achieved. This could be done by improving negotiation skills and realistic information exchange between sex partners, and likely most important, by increasing the frequency of HIV testing, especially for high-risk MSM. In addition, it is likely that the quality of rapid (home) HIV tests will improve in the future and will offer more sensitive test results with shorter window periods. If such a test becomes widely available to the public, we might see an increase of self-testing for HIV before engaging in sexual activity in order to properly serosort. In this way serosorting might emerge in the future as an effective and valuable additional HIV risk-reduction strategy against HIV-infection among MSM.

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Characteristics and sexual behavior of 445 MSM accounting for 2137 visits with reported events of anal sex with casual partners in the Amsterdam Cohort Studies (ACS), May 2007-December 2011, The Netherlands.

TABLE 1

	Risk categories ^a				P value
	N=445 MSM	UAI (N=537 visits)	Serosorting (N=242 visits)	Consistent condom use (N=1358 visits)	
Median age (IQR)	33.9 (29.7-38.8)	37.0 (32.1-40.9)	37.0 (32.5-41.2)	36.4 (32.5-41.2)	0.795
Dutch nationality (%) ^b (vs. non-Dutch)	90.1	90.3	92.1	90.0	0.592
High educational level (%) ^b (vs. low-middle)	71.6	70.5	75.0	75.4	0.090
Sexual preference, Kinsey scale (mean; SD)	6.7 (0.7)	6.6 (0.7)	6.6 (0.8)	6.7 (0.6)	0.000
Number of casual sex partners (median; IQR)	19 (7-46)	6 (2-12)	5 (2-12)	4 (2-8)	0.000
Follow-up time in years (median; IQR)	2.5 (1.2-3.6)				
Number of visits (median; IQR)	5 (2.0-7.0)				
Months between visits (median; IQR)	6.0 (5.8-6.4)				

IQR, inter quartile range.

^aNote that as these are longitudinal data, men can change their behavior and therefore change between risk categories over time.

^bIn calculation of percentages, missing values were excluded.

Association between sexual (risk) behavior with casual partners and HIV infection among 445 MSM, accounting for 2137 visits with reported events of anal sex with casual partners in the Amsterdam Cohort Studies, May 2007-December 2011, The Netherlands.

TABLE 2

	HIV sc	Person-years	Model 1		Model 2	
			IRR (95% CI)	P value	(a)IRR (95% CI) ^a	P value
Overall	31	1106.77				
Sexual (risk) behavior with casual partners						
UAI	13	277.94	1	0.016	1	0.027
Serosorting	3	124.78	0.45 (0.13-1.54)		0.46 (0.13-1.59)	
Consistent condom use	15	704.05	0.34 (0.16-0.72)		0.37 (0.18-0.77)	

Sc, seroconverter; (a)IRR, (adjusted) incidence rate ratio; CI, confidence interval; UAI, unprotected anal intercourse.

^a Adjusted for educational level and number of casual sex partners.