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Reducing HIV Transmission Risk by Increasing Serostatus Disclosure: A Mathematical Modeling Analysis

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Abstract

Persons living with HIV infection are encouraged to disclose their HIV-positive serostatus to prospective sex partners to decrease the likelihood of unsafe sex and HIV transmission. However, the effectiveness of serostatus disclosure as a preventive measure is not known. We developed a mathematical framework for assessing the HIV transmission risk reduction effectiveness of serostatus disclosure, examined how increasing the disclosure rate affects the transmission risk reduction effectiveness of disclosure, and explored the interaction between condom use and disclosure effectiveness. Under base-case assumptions, serostatus disclosure reduced the risk of HIV transmission by between 17.9% and 40.6% relative to no disclosure. Increasing the disclosure rate from the base-case value of 51.9–75.7% produced a 26.2–59.2% reduction in risk. The findings of this modeling study strongly support intervention efforts to increase both serostatus disclosure and condom use by persons living with HIV.

Keywords

Serostatus disclosure; Effectiveness; Condom use; Prevention; Mathematical model

Introduction

The Centers for Disease Control and Prevention encourages all sexually-active persons to learn their HIV serostatus, with the expectation that persons who are aware they are infected will take precautions to reduce the risk of HIV transmission to their sexual and drug injection-equipment sharing partners (CDC, 2001; Janssen et al., 2001). A substantial literature documents the often significant reductions in sexual risk behaviors associated with learning one's HIV-positive serostatus (Marks, Crepaz, Senerfitt, & Janssen, 2005; Weinhardt, Carey, Johnson, & Bickham, 1999).

Persons who are aware of their HIV-positive serostatus are encouraged to disclose their HIV-status to prospective sex partners. Disclosure can reduce HIV transmission risk in two ways. First, some proportion of prospective sex partners may decline to have sex with an HIV-positive person or may agree only to engage in very low-risk activities, and second, those who agree to intercourse may be more likely to use condoms after learning that their partner has HIV. Although no published estimates exist of the proportion of persons who decline to have sex with someone after learning that he or she is HIV-positive, several studies have examined the relationship between serostatus disclosure and condom use. For example, a study of HIV-positive men and women enrolled in a behavior modification program found that using a condom during the last sex act was significantly associated with self-disclosure of positive serostatus to sex partners (Niccolai, Dorst, Myers, & Kissinger, 1999). Specifically, condoms were used for 89.9% of sex acts that followed serostatus disclosure compared to 76.6% of sex acts in the absence of disclosure. Similarly, among gay and bisexual men, the incidence of

safer sex increased from 72.7% to 77.6% following serostatus disclosure, though this difference was not statistically significant (Marks & Crepaz, 2001).

Other studies of the relationship between disclosure and condom use report only global correlations, rather than event-level associations. For instance, a study of prevention counseling for HIV-positive men found a significant association between disclosing to all seronegative partners and exclusively practicing safer sex with those partners (De Rosa & Marks, 1998). Conversely, not disclosing one's serostatus to all partners has been identified as a predictor of unsafe sex with at-risk primary and casual partners among HIV-positive men who have sex with men (Morin et al., 2005; see also Kalichman & Nachimson, 1999).

The relationship between positive serostatus disclosure and condom use or safer sex is complicated by issues of partner serostatus (Prestage et al., 2001). Among men who have sex with men, disclosure of HIV-positive serostatus often is associated with an increase in condom use with seronegative or unknown serostatus partners, but a decrease in condom use with seropositive partners (Wolitski, Rietmeijer, Goldbaum, & Wilson, 1998).

Presuming that positive serostatus disclosure enhances the likelihood of safer sex with uninfected partners, the critical question is: How *effective* is increasing serostatus disclosure at reducing HIV transmission risk? This is a somewhat complicated question because the effectiveness of serostatus disclosure as an HIV risk reduction strategy depends on the proportion of at-risk persons who agree to sex after learning that their partner has HIV and on the relative rates of condom use following disclosure and in the absence of disclosure. To our knowledge, this important question has not been addressed by any previous study.

In the present paper we describe an analytic framework for assessing the HIV transmission risk reduction effectiveness of serostatus disclosure, examine how increasing the disclosure rate affects the transmission risk reduction effectiveness of disclosure, and explore the interaction between condom use and disclosure effectiveness. Main findings are illustrated using previously-published empirical data on HIV-positive men and women's disclosure and condom use behaviors.

Mathematical Model

The analyses focus on sexual relationships between HIV-positive persons and their at-risk (uninfected) partners. Let D denote the likelihood that an HIV-positive person discloses his or her serostatus to a prospective sex partner. Following disclosure, the at-risk person might decline to have sex altogether, the couple might chose to practice a low-risk sexual activity, or the couple might elect to have vaginal or anal intercourse, either with or without a condom. Let S denote the probability that the couple decides to have intercourse and K denote the probability that a condom is used during post-disclosure sex. Similarly, let C denote the probability that a condom is used in the absence of disclosure. For simplicity, we assume that the risk of HIV transmission for activities other than unprotected or condom-protected intercourse is negligible and that the couple engages in, at most, a single act of intercourse.

Let α denote the probability of HIV transmission for unprotected intercourse and let ϵ denote the effectiveness of condoms at preventing HIV transmission, so that the probability of transmission for condom-protected intercourse equals $(1 - \epsilon)\alpha$. The probability of HIV transmission following disclosure is then $S[K(1 - \epsilon)\alpha + (1 - K)\alpha] = S(1 - \epsilon K)\alpha$, whereas in the absence of disclosure it is $[C(1 - \epsilon)\alpha + (1 - C)\alpha] = (1 - \epsilon C)\alpha$. Both of these expressions take into account the impact of condom use; the former expression also accounts for the possibility that some at-risk persons might decline to have sex with a partner who is HIV-positive. The overall probability of HIV transmission, as a function of the disclosure rate D , the post-disclosure condom use rate K , and the non-disclosure condom use rate C , is

$$P(D, K, C) = DS(1 - \epsilon K)\alpha + (1 - D)(1 - \epsilon C)\alpha \quad (1)$$

Thus, in this model, HIV transmission risk is a linear function of the disclosure rate.

Disclosure Effectiveness

As discussed above, disclosure reduces the probability of HIV transmission from $(1 - \epsilon C)\alpha$ to $S(1 - \epsilon K)\alpha$, an absolute reduction of $(1 - \epsilon C)\alpha - S(1 - \epsilon K)\alpha$ and a relative reduction of $[(1 - \epsilon C)\alpha - S(1 - \epsilon K)\alpha] / (1 - \epsilon C)\alpha = 1 - S(1 - \epsilon K) / (1 - \epsilon C)$. By analogy to the concept of condom effectiveness, define the risk reduction effectiveness of serostatus disclosure to be the relative risk reduction due to disclosure:

$$E(K, C) = 1 - S(1 - \epsilon K) / (1 - \epsilon C) \quad (2)$$

The analogy to condom effectiveness is explicated in Table 1.

Serostatus disclosure is maximally effective as a risk reduction strategy when condoms are used consistently for post-disclosure sex and not at all in the absence of disclosure ($K = 100\%$, $C = 0\%$), and is minimally effective when condom use is no more likely following disclosure than in the absence of disclosure (i.e., $K = C$). The corresponding maximum and minimum disclosure effectiveness values are $1 - S(1 - \epsilon)$ and $1 - S$, respectively.

Increasing Disclosure Rates

Increasing the disclosure rate from zero to a non-zero value D reduces HIV transmission risk by $100 \times E(K, C) \times D\%$, as shown in the appendix. More generally, an intervention that increases the disclosure rate from a baseline level D_0 to a higher level D_1 reduces HIV transmission risk by the following proportion:

$$\frac{P(D_0, K, C) - P(D_1, K, C)}{P(D_0, K, C)} = (D_1 - D_0) \times \frac{E(K, C)}{1 - E(K, C)D_0} \quad (3)$$

The greater the effectiveness of disclosure, the larger the proportionate risk reduction produced by increasing the disclosure rate from D_0 to D_1 . Thus, disclosure effectiveness is an important indicator of the potential risk reduction effectiveness of interventions that seek to increase serostatus disclosure by persons living with HIV.

Increasing Condom Use Rates

Increasing the post-disclosure condom use rate increases the effectiveness of serostatus disclosure, whereas increasing the non-disclosure condom use rate decreases the effectiveness of disclosure (see Eq. 2). Simultaneous increases in the two condom use rates can either enhance or diminish the effectiveness of serostatus disclosure. The overall reduction in HIV transmission risk produced by an intervention that increases the disclosure rate from D_0 to D_1 , the post-disclosure condom use rate from K_0 to K_1 , and the non-disclosure condom use rate from C_0 to C_1 , equals the sum of the independent reductions in risk obtained by increasing disclosure and condom use, and a term reflecting their interaction (see Appendix). The interaction term is positive—indicating that the overall reduction in risk is greater than the sum of the independent reductions in risk due to increasing disclosure and condom use—if and only if the “agree to sex” rate exceeds $(C_1 - C_0) / (K_1 - K_0)$. In particular, a positive interaction is possible only when the condom use changes enhance the effectiveness of serostatus disclosure (i.e., $E(K_1, C_1) > E(K_0, C_0)$), as shown in the appendix.

Parameter Values

Illustrative disclosure and condom use rates were based on Marks and Crepaz's (2001) empirical study of the sexual behavior of HIV-positive heterosexual, gay, and bisexual men.

In this study, 51.9% of participants disclosed their serostatus to their most recent at-risk sex partner, and 77.6% of the men who had disclosed practiced safer sex versus 72.7% of the men who had not disclosed. Safer sex was defined as any sexual behavior other than unprotected vaginal or anal intercourse. For simplicity, and because the HIV transmission risk associated with these “other” sexual activities (e.g., oral sex) is likely to be much closer to the risk associated with condom-protected intercourse than to the risk for unprotected intercourse, we equated safer sex with condom use for the purposes of the illustrative examples (i.e., we set $K = 77.6\%$ and $C = 72.7\%$). Marks and Crepaz did not report the proportion of at-risk persons who declined to have intercourse after learning that their prospective sex partner was HIV-positive; indeed, we are not aware of any published estimates of this important parameter. Therefore, the analyses presented below examined the entire range of possible values for the “agree to sex” rate S , with particular attention to the seemingly most plausible range, $S = 25\text{--}75\%$. These analyses assumed that condoms are 90% effective at preventing HIV transmission (Pinkerton & Abramson, 1997); an estimate of the per-act probability of transmission, α , was not needed. The post-disclosure and non-disclosure condom use rates (89.8% and 76.6%, respectively) reported by Niccolai et al. (1999) for participants in a sexual behavior modification program were used to model the impact of a hypothetical intervention for HIV-positive persons. The disclosure rate in the Niccolai et al. study was 75.7%.

Mathematical Modeling Results

The effectiveness of disclosure as an HIV risk reduction strategy depends on the post-disclosure condom use rate K , the non-disclosure condom use rate C , and quite critically, on the “agree to sex” rate S , as illustrated in Fig. 1. As shown, the largest reductions in HIV transmission risk are obtained when the “agree to sex” rate is small (the less sex, the smaller the chance of HIV transmission). At one hypothetical extreme, if prospective sex partners universally declined to have sex after learning the HIV-positive person's serostatus, then disclosure would be 100% effective and the reduction in risk would equal the disclosure rate (e.g., 50% disclosure would reduce transmission risk by 50%).

Conversely, if all partners agreed to intercourse following serostatus disclosure, the risk reduction associated with disclosure would be due solely to the greater use of condoms following disclosure than in the absence of disclosure. In this scenario, the effectiveness of serostatus disclosure critically depends on the difference in the post-disclosure and non-disclosure condom use rates. For the somewhat similar post-disclosure and non-disclosure condom use rates ($K = 77.6\%$ and $C = 72.7\%$) from Marks & Crepaz's study, 100% disclosure would produce only a 12.8% reduction in HIV transmission risk if all partners agreed to sex.

The maximum disclosure effectiveness value, $1 - S(1 - \epsilon)$, is obtained when condoms are used consistently during post-disclosure sex but not at all in the absence of disclosure, whereas the minimum effectiveness value, $1 - S$, is obtained whenever the post-disclosure and non-disclosure condom use rates are equal (hence, disclosure provides no additional risk reduction benefit). As indicated in Fig. 1, disclosure would be 25–92.5% effective if three-quarters of prospective sex partners agreed to intercourse following disclosure and 75–97.5% effective if only one-quarter of prospective sex partners agreed to intercourse. For the base-case condom use rates, the effectiveness of serostatus disclosure ranges from 34.6% ($S = 75\%$) to 78.2% ($S = 25\%$) for intermediate values of the “agree to sex” rate. Combining these estimates with the 51.9% disclosure rate from Marks and Crepaz's study, disclosure can be credited with reducing HIV transmission risk by 17.9% ($S = 75\%$) to 40.6% ($S = 25\%$) compared to no disclosure.

Increasing Disclosure Rates

Figure 2 illustrates the impact of increasing the disclosure rate from the baseline value $D_0 = 51.9\%$ reported by Marks and Crepaz (2001) to a higher, post-intervention level D_1 , assuming that 50% of prospective sex partners agree to intercourse after learning the HIV-positive person's serostatus. Increasing disclosure to its maximal 100% value reduces HIV transmission risk by between 32.5% and 74.0%. For the base-case condom use rates, a maximum reduction of 38.3% is obtained when the “agree to sex” rate equals 50% (as in Fig. 2). In contrast, increasing the disclosure rate from 51.9% to 100% produces a maximum risk reduction of 63.3% when $S = 25\%$, but a maximum reduction of only 20.3% when $S = 75\%$ (not shown).

Larger proportionate reductions in risk would be obtained if the baseline disclosure rate were less than 51.9%, as indicated in Fig. 2, which also illustrates the proportionate risk reduction obtained by increasing disclosure from $D_0 = 0\%$ to the specified D_1 target levels. These risk reduction “curves” represent the maximum reductions in risk that could be achieved by increasing serostatus disclosure.

Increasing Condom Use Rates

Figure 3 shows the proportionate risk reduction produced by a hypothetical intervention that increases the disclosure rate from $D_0 = 51.9\%$ to a higher rate D_1 , and the post-disclosure and non-disclosure condom use rates from $K_0 = 77.6\%$ and $C_0 = 72.7\%$ (Marks and Crepaz, 2001) to $K_1 = 89.9\%$ and $C_1 = 76.6\%$ (Niccolai et al., 1999). For these condom use rates a positive interaction between the increases in condom use and disclosure is obtained if and only if the “agree to sex” rate exceeds 31.7%. Figure 3 illustrates this interaction for an “agree to sex” rate of 75% and also indicates what proportion of the overall reduction in risk is due to increasing disclosure, increasing condom use, or the interaction between condom use and disclosure. As expected, disclosure accounts for an increasing proportion of the overall reduction in HIV transmission risk as the disclosure rate grows. For the 75.7% disclosure rate among intervention participants in Niccolai et al.'s (1999) study, the overall reduction in risk is 35.2%; the increase in disclosure accounts for 28.5% of the total reduction in risk, the increase in condom use for 60.1% of this total, and the interaction between these increases for the remaining 11.4%.

Discussion

The preceding analyses demonstrate the usefulness of the risk reduction effectiveness of serostatus disclosure concept for assessing the HIV transmission risk reduction potential of interventions to increase serostatus disclosure among persons living with HIV. The concepts and general findings from the analytic modeling framework were illustrated using disclosure and condom use rate estimates derived from Marks and Crepaz's (2001) study of the sexual behaviors of HIV-positive heterosexual, gay, and bisexual men. For these parameters, serostatus disclosure can be credited with reducing the risk of HIV transmission by between 17.9% and 40.6% relative to no disclosure, assuming that one-quarter to three-quarters of prospective sex partners agreed to intercourse after learning the HIV-positive person's serostatus. If the men in this study had disclosed their serostatus 75.7% of the time (Niccolai et al., 1999) rather than only 51.9%, a 26.2–59.2% reduction in risk could have been achieved. If, in addition, the post-disclosure and non-disclosure condom use rates had been increased to 89.9% and 76.6% (Niccolai et al., 1999), respectively, even more substantial 40.8%–64.1% reductions in risk, relative to no disclosure, could have been obtained. These illustrative examples strongly support intervention efforts to increase both serostatus disclosure and condom use by persons living with HIV.

The effectiveness of disclosure as an HIV risk reduction strategy critically depends on the proportion of at-risk persons who agree to intercourse after learning that their prospective sex partner is HIV-positive. This proportion is likely to differ between affected populations; one might suspect, for example, that a larger proportion of at-risk persons would agree to have intercourse with an HIV-positive partner in communities in which the prevalence of HIV is high and therefore sex seeking is inherently more risky. We are not aware of any published estimates of this critical parameter. Indeed, to our knowledge, no published study has examined how disclosure, per se, affects partners' willingness to engage in sex of any sort, or to practice lower-risk activities such as oral sex or non-penetrative sexual activities rather than vaginal or anal intercourse. Likewise, very few studies report event-level condom use rates, with or without disclosure. Research is needed into at-risk persons' behavioral responses to serostatus disclosure to refine estimates of the effectiveness of serostatus disclosure as an HIV prevention strategy and to identify ways in which the effectiveness of disclosure can be enhanced.

The present analyses assume that only a single act of intercourse occurs between the HIV-positive person and his or her sex partner. However, the general framework proposed here for assessing the effectiveness of serostatus disclosure—in which the risk of HIV transmission equals $(1 - ED)\gamma$, where D is the disclosure rate, E is the risk reduction effectiveness of serostatus disclosure, and γ is the risk of HIV transmission in the absence of disclosure—is applicable regardless of how transmission probabilities are quantified (see Appendix).

The ultimate impact of an intervention that increases both disclosure and condom use is determined by the independent reductions in risk produced by increasing disclosure and condom use, and by their interaction. The findings of the present study suggest that moderate reductions in HIV transmission risk can be achieved by increasing serostatus disclosure, irrespective of accompanying changes in condom use, though increases in condom use may further enhance the effectiveness of serostatus disclosure.

Despite the potential epidemiological significance of serostatus disclosure, increasing disclosure by HIV-positive persons is not a primary objective of existing interventions for persons living with HIV. Of the 12 studies included in a recent meta-analysis of controlled trials of HIV prevention interventions for persons living with HIV (Crepaz et al., 2006), only five appear to have addressed disclosure of positive serostatus to sex partners (Kalichman et al., 2001; Kelly et al., 1993; Rotheram-Borus et al., 2001; Patterson, Shaw, & Semple, 2003; Wolitski, Gómez, Parsons & Sumit Study Group, 2005), and only one of the five included changes in disclosure behavior as a primary intervention outcome (Wolitski et al., 2005).

Whether interventions can increase disclosure of seropositive status to sex partners remains unclear. Disclosing positive serostatus prior to engaging in sex is emotionally risky and interpersonally difficult. Some persons may be unwilling or unable to summon the requisite inner resources to disclose their serostatus to prospective sex partners. Underlying deficits in empathy, personal insight, or ability to risk rejection are not likely to be modified through behavioral intervention alone. However, others may benefit from skill building, contingency planning, and social support for positive serostatus disclosure. Increased attention to the issue of serostatus disclosure is needed to increase the autonomy of prospective sex partners to make fully-informed decisions regarding their sexual health, as well as to reduce the risk of HIV transmission in HIV-discordant relationships.

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Appendix

Let D denote the likelihood that an HIV-positive person discloses his or her serostatus to a prospective sex partner, S the probability that the partner agrees to intercourse, K the probability that a condom is used for intercourse following serostatus disclosure, and C the probability of condom use in the absence of disclosure. The overall probability of HIV transmission is

$$P(D, K, C) = DS(1 - \epsilon K)\alpha + (1 - D)(1 - \epsilon C),$$

where α denotes the probability of HIV transmission for unprotected intercourse and ϵ represents the effectiveness of condoms at preventing HIV transmission. $P(D, K, C)$ also can be written as

$$P(D, K, C) = (1 - E(K, C) \times D)(1 - \epsilon C),$$

where $E(K, C) = 1 - S(1 - \epsilon K)/(1 - \epsilon C)$ is the risk reduction effectiveness of serostatus disclosure.

Increasing the disclosure rate from a baseline level D_0 to a higher level D_1 reduces HIV transmission risk by the following proportion:

$$\begin{aligned} \frac{P(D_0, K, C) - P(D_1, K, C)}{P(D_0, K, C)} &= \frac{(1 - E(K, C) \times D_0)(1 - \epsilon C) - (1 - E(K, C) \times D_1)(1 - \epsilon C)}{(1 - E(K, C) \times D_0)(1 - \epsilon C)} \\ &= (D_1 - D_0) \times \frac{E(K, C)}{1 - E(K, C) \times D_0} \end{aligned}$$

The derivative of this expression with respect to $E(K, C)$ equals $(D_1 - D_0) / (1 - E(K, C) \times D_0)^2$, which is greater than zero. It follows that the greater the effectiveness of disclosure, $E(K, C)$, the larger the proportionate risk reduction produced by increasing the disclosure rate from D_0 to D_1 . Notice in particular that increasing the disclosure rate from $D_0 = 0$ (no disclosure) to D_1 reduces HIV transmission risk by $100 \times E(K, C) \times D_1\%$.

The HIV transmission risks associated with the two condom use rate combinations $\langle K_0, C_0 \rangle$ and $\langle K_1, C_1 \rangle$ are equal if and only if $DS(1 - \epsilon K_0)\alpha + (1 - D)(1 - \epsilon C_0)\alpha = DS(1 - \epsilon K_1)\alpha + (1 - D)(1 - \epsilon C_1)\alpha$, or equivalently, $DS(K_1 - K_0) + (1 - D)(C_1 - C_0) = 0$. Thus, there are an infinite number of post-disclosure/non-disclosure condom use rate combinations that produce any particular risk reduction target (up to the maximum reduction that can be achieved through consistent condom use). Some of these combinations increase the effectiveness of serostatus disclosure, and some of them decrease it. Specifically, serostatus disclosure is more effective for the condom use rate combination $\langle K_1, C_1 \rangle$ than for $\langle K_0, C_0 \rangle$ (i.e., $E(K_1, C_1) > E(K_0, C_0)$) if and only if $1 - S(1 - \epsilon K_1)/(1 - \epsilon C_1) > 1 - S(1 - \epsilon K_0)/(1 - \epsilon C_0)$, or equivalently, $(K_1 - K_0) - (C_1 - C_0) > \epsilon(K_1 C_0 - K_0 C_1)$.

By itself, increasing the disclosure rate from D_0 to D_1 reduces HIV transmission risk by $\Delta_D = P(D_0, K_0, C_0) - P(D_1, K_0, C_0)$, whereas increasing the condom use rates from K_0 to K_1 and from C_0 to C_1 produces an independent reduction in risk, $\Delta_C = P(D_0, K_0, C_0) - P(D_0, K_1, C_1)$. The overall reduction in HIV transmission risk obtained by simultaneously increasing the disclosure and condom use rates, $\Delta = P(D_0, K_0, C_0) - P(D_1, K_1, C_1)$, equals the sum of the independent risk reductions due to increasing disclosure and increasing condom use, as well as an interaction term, $x = \Delta - \Delta_D - \Delta_C$. The interaction term is positive—indicating that the overall reduction in risk is greater than the sum of the independent reductions in risk due to increasing disclosure and condom use—if and only if the “agree to sex” rate exceeds $(C_1 - C_0) / (K_1 - K_0)$. (Proof: The interaction term can be written $x = (D_1 - D_0) \times [E(K_1, C_1)(1 - \epsilon C_1) - E(K_0, C_0)(1 - \epsilon C_0)]$. The desired result follows from basic arithmetic and the definition, $E(K, C) = 1 - S(1 - \epsilon K)/(1 - \epsilon C)$. In particular, a positive interaction is possible only when the condom use changes enhance the effectiveness of serostatus disclosure (i.e., $E(K_1, C_1) > E(K_0, C_0)$). (Proof: $S > (C_1 - C_0) / (K_1 - K_0) = > (S - \epsilon SK_0) - (S - \epsilon SK_1) > (1 - \epsilon C_0) - (1 - \epsilon C_1) = > E(K_1, C_1)(1 - \epsilon C_1) > E(K_0, C_0)(1 - \epsilon C_0) = > E(K_1, C_1) > E(K_0, C_0)$ since $C_1 > C_0$.)

For convenience, the main analyses assume that sexual relationships consist of a single act of intercourse. To model multiple-act relationships, let R_D denote the probability of transmission if the HIV-positive person discloses his or her serostatus and R_N denote the transmission probability if he or she does not. (For a single act of intercourse, $R_N = 1 - \epsilon C$ and $R_D = S(1 - \epsilon K)$.) Define the risk reduction effectiveness of serostatus disclosure to be the proportionate risk reduction, $E = (R_N - R_D) / R_N$. The main analytic findings hold for this more general definition of disclosure effectiveness (cf. Table 1).

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Fig. 1.

Risk reduction effectiveness of serostatus disclosure as a function of the proportion of prospective sex partners who agree to intercourse after learning the HIV-positive partner's serostatus. The base-case results assumed a 77.6% post-disclosure condom use rate and a 72.7% non-disclosure condom use rate. Disclosure effectiveness is maximal when condoms are used consistently during post-disclosure sex ($K = 100\%$) but not at all in the absence of disclosure ($C = 0\%$), and is minimal when condom use is no more likely following disclosure than in the absence of disclosure ($K = C$)

Fig. 2.

Proportion reduction in risk obtained by increasing disclosure from a baseline of 0% or 51.9% to indicated post-intervention values assuming that half of prospective sex partners agree to intercourse following disclosure. In the maximum risk reduction scenario the post-disclosure condom use rate is $K = 100\%$ and the non-disclosure condom use rate is $C = 0\%$; in the base-case scenario, $K = 77.6\%$ and $C = 72.7\%$; and in the minimum risk reduction scenario the post-disclosure condom use rate equals the non-disclosure condom use rate (i.e., $K = C$). The corresponding disclosure effectiveness values are 85.5% (maximum), 56.4% (base-case), and 50.0% (minimum)

Fig. 3.

Proportionate risk reduction produced by a hypothetical intervention that increases the disclosure rate from $D_0 = 51.9\%$ to a higher rate D_1 , and the post-disclosure and non-disclosure condom use rates from $K_0 = 77.6\%$ and $C_0 = 72.7\%$ to $K_1 = 89.9\%$ and $C_1 = 76.6\%$. The 75.7% disclosure rate is from Niccolai et al.'s (1999) study, whereas the 51.9% baseline disclosure rate is from Marks and Crepaz (2001)

Table 1

Correspondence between condom effectiveness and serostatus disclosure effectiveness

	Condom effectiveness	Disclosure effectiveness
Effectiveness	ϵ	$E = 1 - S(1 - \epsilon K) / (1 - \epsilon C)$
<i>Probability of transmission</i>		
— No condom/disclosure (P_0)	α	$(1 - \epsilon C) \alpha$
— With condom/disclosure (P_1)	$(1 - \epsilon) P_0$	$(1 - E) P_0$
Risk reduction ($\Delta P = P_0 - P_1$)	ϵP_0	EP_0
Proportionate risk reduction ($\Delta P / P_0$) ^a	ϵ	E
Overall transmission ^b	$(1 - \epsilon C) P_0$	$(1 - ED) P_0$

^a Effectiveness = proportionate risk reduction^b C = % condom use; D = % disclosure