

## Does doubling the per-sex-act risk of HIV infection increase incidence?

Hayden Eastwood - Former postdoctoral research fellow at SACEMA

One question repeatedly arises at meetings in which HIV risk and prevention are discussed: should health authorities be concerned by factors that increase the per-sex-act risk of HIV infection by 2-3 fold?

The rationale by some health practitioners is that the risk of acquiring HIV infection is low, in the region of 0.04% and 1.7% per sex act (1), and that an increase of this low level of risk from, say 1 in 1000 to 2 in 1000, makes little difference to the infection risk of an individual for a given sex act, and by extension, does not appreciably increase incidence at a population level.

Health authorities often invest in barrier method preventative measures because the infection risk per sex act is reduced by orders of magnitude (2). However, the case for investing in factors that may reduce HIV infection risk by a mere 2-3 fold is less clear. In the case of female hormonal contraception, for example, should the South African government alter its policy on administering contraception if such contraception is shown to double the per-sex-act risk of infection?

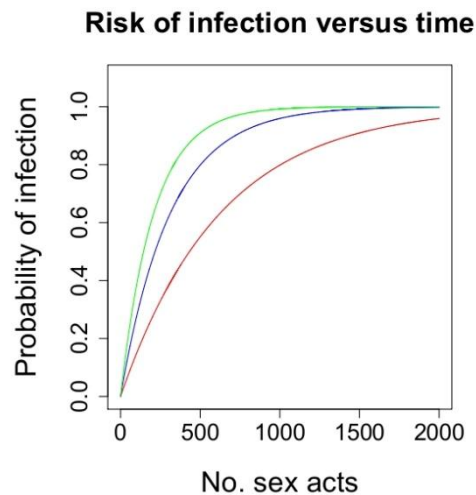
The question of whether or not doubling or tripling infection risk warrants concern is best considered with a straightforward mathematical description of infection probability. Let  $R$  be the overall risk of infection, let  $P$  be the probability of HIV infection per sex act, and let  $n$  be the number of sexual events per day. With these parameters, the risk of infection for a seronegative individual performing one or more sex acts with an HIV positive partner, is given as follows:

$$R = [1 - (1 - P)^n]$$

Figure 1 shows a plot of the resulting probability of infection for three different risk scenarios. Line 1 (red) shows baseline risk (assumed to be 0.0016 probability of infection per sex act), while line 2 (blue) and line 3 (green) show a 2 fold and 3 fold increase on the baseline, respectively. In each case the probability of infection begins to approach unity as the number of sexual events increases.

This simple probabilistic treatment of sexual events shows that a 2 and 3 fold increase in infection

Figure 1. Probability of HIV infection versus number of sex acts. Infection probability per act is assumed to be 0.0016.



risk does indeed translate into an appreciable increase in infection likelihood. The risk is perhaps best contextualised by making assumptions about the number of sex acts per day, and then examining the subsequent infection risk over time. When assuming one sex act every five days, for example, an individual in the baseline risk group has an 11% chance of contracting HIV over the course of a year and a 95% probability of infection within 5 years of sexual activity. Individuals at double and triple the baseline risk have, respectively, a 21% and 31% probability of contracting HIV within the year, and a 95% probability of becoming HIV infected within 2.56 and 1.7 years, respectively (Table 1).

This cursory analysis shows that, while a doubling or tripling of infection risk may not warrant concern given a single sex act, many such higher-risk sex acts do potentially increase overall infection risk significantly. The choice of parameters in this investigation suggest that subtle changes in risk at the per sex act level can make large differences to epidemic dynamics. This is because individuals in high risk groups tend to become infected faster, and in turn infect other people faster, thereby amplifying the growth of the epidemic.

Table 1. Risk profiles for baseline, 2x and 3x risk groups. In each case it is assumed that there are 0.2 sexual events per day.

	Risk in 1st year	Time to 95% infection probability
baseline	11%	5 years
2x	21%	2.56 years
3x	30%	1.7 years

Those in low level risk groups may not infect other people during the course of their infection, while those in higher risk groups, are likely to infect one or more.

The above analysis of the problem indicates that health authorities should take small (2-4 fold) increases in HIV infection risk at the per-sex-act level seriously.

**Hayden Eastwood**, Former postdoctoral research fellow at SACEMA. Areas of interest: HIV incidence estimation, HIV dynamics, sexual networks. *hayden.eastwood@gmail.com*

**References:**

1. Boily MC, Baggaley RF, Wang L, et al. Heterosexual risk of HIV-1 infection per sexual act: systematic review and meta-analysis of observational studies. *Lancet Infect Dis.* 2009; 9 (2):118-129.
2. Varghese B, Maher J, Peterman AT, Branson BM, Steketee RW. Reducing the risk of sexual HIV transmission: quantifying the per-act risk for HIV on the basis of choice of partner, sex act, and condom use. *Sex Transm Dis.* 2002; 29 (1): 38-43.