



What is the role of STD control in the prevention of HIV? Findings from the STDSIM simulation study

INTRODUCTION

Around 5 million people became infected with HIV in 2002, with the majority infected in Africa through heterosexual transmission. With no vaccine, HIV prevention has focused on the promotion of safer sexual behaviour and improved treatment services for sexually transmitted diseases (STDs) – these are advocated as complementary strategies for HIV control. Evidence shows that the sexual transmission of HIV is enhanced in the presence of STDs, especially those (eg. syphilis, chancroid and genital herpes) that cause genital ulceration. In populations where STDs are prevalent and inadequately treated, better treatment services should result not only in lower STD prevalence, but also in reduced HIV incidence.¹

Three randomised controlled trials have been carried out to evaluate the impact of STD control strategies on HIV:

- ♦ The first, in **Mwanza, Tanzania** involved improved syndromic STD management² implemented through government health units.
- ♦ The second, in **Rakai, Uganda** involved periodic mass STD treatment of all adults at 10-monthly intervals.
- ♦ The third, in **Masaka, Uganda** involved a behaviour change programme directed at the general population, with and without improved syndromic STD management.

All three trials found effects on STDs, but only the Mwanza trial found a significant impact on HIV. It reported a 40% reduction in HIV incidence, and the intervention was shown to be highly cost-effective. The contrasting results have led to confusion regarding the effectiveness of STD control as an HIV prevention strategy.

Various hypotheses have been put forward to explain the different findings, including:

♦ *Differences between the study populations*

Maturity of HIV epidemic: Early in HIV epidemics, infections occur in a core group of highly sexually active individuals, who have high rates of STDs. As an epidemic progresses, more HIV transmissions occur in stable relationships with lower prevalences of STDs. In addition, as a result of selective HIV-attributable mortality among high-risk individuals, STD prevalences decline.

Sexual risk behaviour and prevalence of curable STDs:

There may have been differences in sexual risk behaviour between the populations, leading in turn to differences in STD prevalence. In populations with low prevalences of curable STDs (such as gonorrhoea, chlamydia, syphilis, chancroid and trichomoniasis), fewer HIV infections will result from the enhancing effect of STDs, and so STD treatment interventions would be expected to have less effect on HIV.

♦ *Differences between the interventions*

Continuous provision of syndromic management services may be more effective than periodic mass treatment.

♦ *Random error*

Estimates of HIV impact from the trials have wide confidence intervals due to the limited sample size.

THE STDSIM STUDY

The STDSIM modelling study was undertaken to gain a better understanding of the contrasting trial results. This project involved detailed reanalysis of the trial data, and the use of simulation models fitted to those data. The project used the STDSIM model, which simulates the natural history and transmission of HIV infection and selected STDs in a population. STDSIM simulates the formation and dissolution of sexual partnerships between individuals in a population, and the transmission of STDs between partners. A variety of interventions can be simulated and their impact over time can be evaluated.

The model was fitted separately to each of the three trial populations, using epidemiological (HIV and STD prevalences), demographic and behavioural data from the trials, such that the output from the model accurately represented (or fitted) the characteristics of the three populations.

By using the fitted models to simulate the effects of different interventions in each of the three study populations, we were able to evaluate the various hypotheses regarding the trial outcomes.

Main findings

Satisfactory model fit was achieved, and the simulations correctly predicted a smaller impact of mass treatment in Rakai, and of behaviour change with or without syndromic treatment in Masaka, than of syndromic treatment in Mwanza, in line with trial findings.

The lack of impact of both syndromic management and mass treatment in the two Ugandan trials, contrasted with the positive impact of syndromic management in Mwanza, suggests that the trial findings are explained by differences between the study populations, rather than between the intervention strategies. This is supported by reanalysis of the

¹ Prevalence denotes the proportion of people with HIV or STDs at a given point in time. Incidence denotes the rate of new infections over a year in previously uninfected people.

² Syndromic management is based on the identification of groups of symptoms and easily recognised signs (syndromes), and the provision of treatment that is known to be effective against the most important (curable) infections that cause a syndrome. It is the recommended approach in resource-poor settings where laboratory capabilities required for aetiological diagnosis of STDs are often unavailable.

trial data. During the trials, reported sexual behaviour was riskier and prevalence of curable STDs was higher in Mwanza than in both Rakai and Masaka (Table 1).

	Rakai		Masaka		Mwanza	
	M	F	M	F	M	F
HIV (%)	13.9	19.0	10.7	13.2	3.4	4.2
No. recent partners (%)						
- 0-1	72.6	95.9	79.6	96.4	46.8	88.5
- 2-4	25.8	4.0	18.2	3.7	43.5	10.6
- 5+	1.4	0.1	2.1	0	9.6	1.0
Condom Use (%)	20.3	5.9	27.7	14.9	2.1	0.1
Gonorrhoea (%)	1.1	1.9	0.9	1.8	2.8	2.3
Chlamydia (%)	2.7	3.2	2.2	1.6	2.3	13.0
Trichomoniasis (%)		30.8		n.a.		41.9
Syphilis – All (%)	7.7	7.2	4.5	3.9	7.3	8.9
Syphilis – Recent (%)	2.3	1.4	1.2	0.7	5.6	6.3
HSV-2 (%)	21.0	42.8	16.8	44.2	13.3	47.4

Table 1: Behavioural indicators and HIV/STD prevalences for the populations at the time of the trials

Simulations of the relative effectiveness of each intervention in all three study populations showed that, at the time of the trials, any of the intervention strategies would have had greater impact on HIV incidence in Mwanza than in either Ugandan site. In Mwanza, HIV was still clustered among individuals with higher risk behaviour, who were more likely to be infected with an STD. In contrast, in the Ugandan sites, curable STDs played a relatively minor role in HIV transmission due to lower STD rates and a more generalised HIV epidemic, in which HIV transmission occurs predominantly between regular partners.

CONCLUSIONS

The difference in HIV impact between the trials was due predominantly to differences between the study populations in sexual risk behaviour, STD rates and maturity of the HIV epidemic. STD treatment in Rakai and Masaka had little impact on HIV incidence because in those study populations curable STDs accounted for only a small proportion of HIV infections. This was due to a previous reduction in sexual risk behaviour leading to low rates of curable STDs, and a mature HIV epidemic so that most transmission was occurring between stable rather than casual partners (Figure 1).

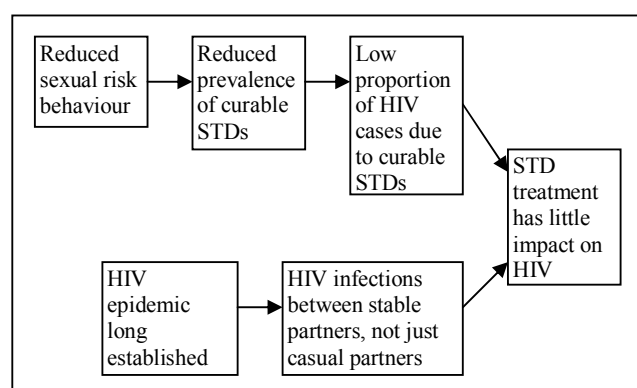


Figure 1: Probable reasons for lower impact of STD control on HIV in Uganda compared to Mwanza

The study has shown that the effectiveness of intervention strategies may vary depending on the characteristics of populations and the stage of the HIV epidemic. These factors should be considered when planning prevention programmes for specific populations.

Public health implications in Tanzania and Uganda

In both countries, STDs are important causes of morbidity. Thus, effective STD treatment services must be maintained and strengthened to reduce STD rates in both countries, and to prevent STD resurgence in Uganda.

In Tanzania, STDs also play an important role in HIV transmission, so improved STD treatment is a valuable HIV control strategy. Promotion of safer sexual behaviour and interventions targeting high-risk groups need further strengthening.

In Uganda, despite recent reductions in HIV prevalence, HIV incidence remains unacceptably high. Promotion of safer sexual behaviour must be strengthened, and interventions to prevent transmission between stable partners are a particular priority.

Public health implications in other populations

The study results indicate that improved STD treatment may have greatest impact in populations with high STD rates and an early HIV epidemic, as in parts of India, China and Eastern Europe. Simulations also show substantial effects of STD treatment on HIV incidence in more mature epidemics where risky sexual behaviour and STDs remain highly prevalent, as in many parts of Southern Africa.

In all these settings, primary prevention through behavioural interventions remains a priority, but improved STD treatment could make an important contribution to reducing HIV spread. Improving, through community-based health education, the proportion of STD patients who recognise symptoms and promptly seek treatment would further enhance the impact of treatment services.

In advanced HIV epidemics where behaviour change has already occurred, interventions to prevent HIV transmission in stable relationships, e.g. vaginal microbicides, measures to control genital herpes, voluntary counselling and testing, and vaccines, deserve urgent attention.

Bibliography

For a list of published papers on STDSIM, see the Programme's website: <http://www.lshtm.ac.uk/dfid/aids>

Collaborators and Acknowledgements

This was a large collaborative project which would not have been possible without the involvement and contributions from many groups including Erasmus University, Rotterdam (JDF Habbema, EL Korenromp, R Bakker), the Mwanza HIV/STD programme, Tanzania (A Gavyole, J Chagalucha, W Mwita, J Todd), the MRC Programme on AIDS, Uganda (A Kamali, J Whitworth, L Muhangi) the Rakai Project Study Team, Uganda (D Serwadda, N Sewankambo), Johns Hopkins University, USA (RH Gray), Columbia University, USA (MJ Wawer), and the London School of Hygiene and Tropical Medicine, UK (RJ Hayes, H Grosskurth, KK Orroth, RG White). We thank the Department for International Development, UK for financial support.

The **DFID Knowledge Programme on HIV/AIDS and STIs** is funded by the Department for International Development, UK, and based at the London School of Hygiene and Tropical Medicine (LSHTM) and the Medical Research Council (MRC), Social and Public Health Sciences Unit, University of Glasgow.

For further information, please see the Programme's website, <http://www.lshtm.ac.uk/dfid/aids/>, or contact the Programme Coordinator, Onno Dekker at Onno.Dekker@lshtm.ac.uk

Disclaimer: The UK Department for International Development (DFID) supports policies, programmes and projects to promote international development. DFID provided funds for the Programme as part of that objective, but the views and opinions expressed are those of the author(s) alone.