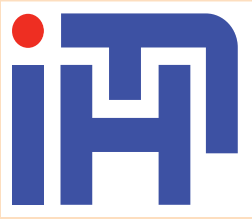

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A comparison of the potential impact of microbicides in two contrasting African settings, Johannesburg, South Africa and Cotonou, Benin.

Background

There were five million HIV infections in 2002, three and a half million of which were in sub-Saharan Africa and 58% amongst women. Many women have no access to or control over using current prevention options. If vaginal microbicides are shown to be effective against HIV, they would offer women a significant new prevention option.

Until specific products have completed phase III clinical trials and start to be distributed, it is hard to know what impact an efficacious microbicide will have on the HIV epidemic in different settings. In practice, the impact of a microbicide will depend upon factors specific to the setting and microbicide, including the level of HIV infection, underlying patterns of sexual behaviour and condom use, the microbicide's efficacy against HIV and STI transmission, the extent to which people are able to access microbicides, and their patterns of microbicide use in different partnerships.

In this briefing note, mathematical modelling, in combination with site-specific data, is used to compare the extent to which a microbicide reduces HIV transmission in two contrasting African settings; Hillbrow, an inner city area of Johannesburg and Cotonou, an urban area in Benin. These settings have widely different prevalences of HIV and STIs amongst sex workers and the general population, and different underlying patterns of sexual behaviour and condom use. In each setting, a mathematical model is used to project the 4 year impact of a 40% HIV and STI efficiacious microbicide used widely in each setting. Comparisons between the projections from each setting are used to explore similarities and differences.

Setting the scene: Hillbrow, Johannesburg

The community of Hillbrow has an adult population of approximately 50,000. Approximately a fifth of the sexually active population report having a current casual partner, and sex work is common, with an estimated 12% of women selling sex and 26% of men buying sex. Sex

Box: Key findings

- A low efficacy microbicide can have an important impact on HIV incidence in both settings.
- In Hillbrow – a setting with a generalised HIV epidemic, high HIV incidence and high condom use between sex workers and their clients – the widespread distribution of a 40% HIV and STI efficacious microbicide results in:
  - 1,568 HIV infections averted per 100,000 population (adults) over 4 years
  - 9% decrease in the district's HIV incidence
  - 87% of the impact is in main and casual partnerships
- In Cotonou – a setting with a less generalised HIV epidemic, lower HIV incidence and lower condom use in long term partnerships – the microbicide results in:
  - 436 HIV infections averted per 100,000 population (adults) over 4 years
  - 39% decrease in the district's HIV incidence
  - 20% of impact is in main and casual partnerships
- In Hillbrow, microbicide use results in 3-fold more HIV infections averted per 100,000 population than in Cotonou, but a 4-fold smaller reduction in HIV incidence.
- In both settings, the impact of the microbicide arises both from its HIV efficacy, and also from the indirect benefits associated with the microbicide reducing levels of STI transmission.
- A microbicide with moderately high STI efficacy alone can significantly impact on HIV. Indeed, in Cotonou, the STI efficacy of a microbicide may be more important in determining impact than HIV efficacy. In Hillbrow, the opposite is likely to be true.

worker clients come both from inside and outside Hillbrow. There is a strong sex worker HIV prevention intervention, and although sex workers report on average 32 clients per month, condom use is high with paying clients (83-88% of last sex acts), but much lower with their non-commercial sexual partners (41% report not using condoms in last month). Likewise, reported condom use amongst the general population is quite low (>37% report not using a condom in last month). The prevalence of HIV is high in Hillbrow, in 2001 approximately 30% of antenatal clinic clients [1] and 60% of sex workers were infected [2]. Other STIs are also common: in 1998, 24% of female family planning clients and 39% of sex workers were infected with chlamydia and/or gonorrhoea [3].

Cotonou, Benin

The city of Cotonou has an adult population of approximately 310,000. In contrast to Hillbrow, nearly all men are circumcised. The general population report less sexual partners than in Hillbrow, and sex work is less common, with an estimated 1% of women selling sex and 30% of men buying sex. There is also a strong HIV prevention intervention focusing on sex workers and their clients. However, compared to Hillbrow, sex workers report more clients per month (52 on average) and condom use is slightly lower with paying clients (80% of last sex acts), but much lower amongst other sexual partners (82% report not using condoms) [4]. Reported condom use amongst the general population is low (<21% report frequent condom use) [5]. In contrast to Hillbrow, the prevalence of HIV is much lower in Cotonou, in 1998 approximately 3.3% of the general population and 41% of sex workers were infected [4, 6]. Other STIs are also less common, in 1998 less than 3.5% of the general population and 25% of sex workers were infected with chlamydia and/or gonorrhoea [4, 6].

Methods and aims of analysis

In both settings we consider the impact of introducing a 40% HIV and STI efficacious microbicide that is used in 50% of non-condom protected sex acts, and assume that microbicide use results in a 5% reduction in condom use (condom migration). The 4 year impact of microbicide use is simulated using a dynamic mathematical model with site specific data, fitted to local epidemiological data. The model is used to explore how the impact estimates vary between the two settings, for different assumptions about the efficacy of the microbicide, and the types of sexual partnership in which microbicides are used.

Projections of microbicide impact in both settings

Although HIV infection is widespread and continues to spread rapidly in Hillbrow, the model projects the microbicide will result in a 9% decrease in the district's HIV incidence, with 784 HIV infections averted in the district per 100,000 population (only include adult population) over 4 years. In contrast, a 39% decrease in the district's HIV incidence is predicted for Cotonou, with 436 HIV infections being averted per 100,000 population over 4 years. Thus, in Hillbrow microbicide use results in a much greater number of HIV infections averted per 100,000 than in Cotonou, but a much smaller reduction in HIV incidence.

Impact of microbicide use in different types of partnership

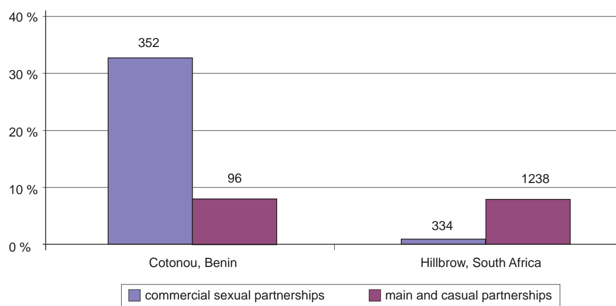
The impact projections above assumed that the microbicide was used in 50% of non-condom protected sex acts in all sexual partnerships, and was shown to impact on HIV transmission in both settings. Figure 1 shows the projected impact of the microbicide being used in specific types of partnership in each setting.

The figure shows that in Cotonou the greatest decrease in incidence is achieved when microbicides are used in commercial sex partnerships, whereas in Hillbrow the greatest decrease occurs when they are used in main and casual partnerships. This also holds for the HIV infections averted. This disparity is mainly due to differences in the HIV epidemic in each setting. In Cotonou, most HIV transmission occurs amongst sex workers and their sexual partners, and so microbicide use in commercial sex partnerships has a large impact. In contrast, the HIV epidemic in Hillbrow is more generalised, with more HIV transmission occurring in non-commercial sex partnerships in the general population. This results in greater impact being attained from microbicide use in non-commercial partnerships.

Impact of microbicide for different HIV and STI efficacies

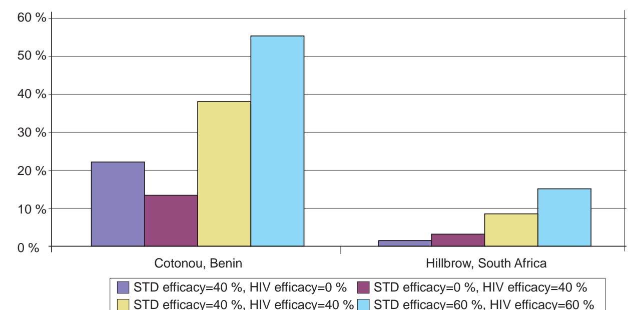
The baseline impact projections assumed that microbicides are efficacious against HIV and STI transmission. However, although there is data that current microbicide candidates are active against HIV and STIs [7], at present there is no data on their likely HIV and STI efficacy. Indeed, it is possible that some microbicide products will only be efficacious against HIV or other STIs. Figure 2 shows the projected impact of the microbicide for different assumptions about its HIV and STI efficacy.

Figure 1: The impact of using a microbicide (40% HIV and STI efficacy) in specific types of partnership.
The numbers above each column are the HIV infections averted per 100,000 population in 4 years*



* As before, this analysis assumes 75% of the population has access to microbicides, microbicides are used in 50% of non-condom protected sex acts and microbicide use results in a 5% relative reduction in condom use.

Figure 2: Projected 4-year impact of the microbicide for different HIV and STI efficacies*



* As before, this analysis assumes 75% of the population has access to microbicides, microbicides are used in 50% of non-condom protected sex acts and microbicide use results in a 5% relative reduction in condom use.

The findings suggest that a microbicide could impact on HIV transmission even if it is solely efficacious against the common STIs in each setting. Indeed, in Cotonou the STI efficacy of the microbicide has a greater contribution to the overall impact of the microbicide than its HIV efficacy. The degree to which this is the case is related to the extent to which HIV transmission is driven by STIs in each setting, and the extent to which microbicide use reduces STI transmission. In Hillbrow, as there is a very high risk of STIs, microbicides have less impact on STI transmission because individuals are frequently exposed to infection [8]. Figure 2 also illustrates the gains in impact achieved with increases in microbicide HIV and STI efficacy. An increase in efficacy from 40% to 60% HIV and STI efficacy results in a 43% and 72% increase in impact in Cotonou and Hillbrow, respectively.

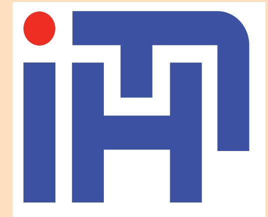
Conclusions

Impact on HIV transmission – Main trends

This analysis shows that microbicide use could significantly reduce HIV transmission in two distinct African settings – one with high HIV prevalence and incidence, and another where the epidemic is less generalised. However, the impact of the microbicide in decreasing HIV incidence and averting HIV infections varied widely in the two settings, with a 4-fold greater relative decrease in HIV incidence in Cotonou but 3-fold more HIV infections averted (per 100,000 population) in Hillbrow. This shows how a microbicide's impact will depend on many factors, including the stage or type of HIV epidemic, and the degree to which HIV transmission is driven by STI cofactors. Specifically, the results suggest that microbicide use may have a greater impact on HIV incidence in less generalised HIV epidemics, such as in Cotonou, but may avert a greater number of infections (per 100,000) in more generalised epidemics. The findings illustrate the potential importance of microbicides, but highlight the care that should be taken in selecting suitable populations for microbicide trials or microbicide distribution, so that the decrease in HIV incidence can be maximised. Conversely, it also illustrates the problems in generalising the results of microbicide trials to other settings.

Importance of STI efficacy for microbicide impact

Our analysis also shows that a solely STI efficacious microbicide can result in a significant decrease in HIV transmission. Indeed, in Cotonou the STI efficacy of the microbicide is more important in determining impact than its HIV efficacy. However, the degree to which STI efficacy contributes to the impact of a microbicide is very variable and does not solely depend on the STI prevalence in the setting, but also on how generalised the HIV epidemic is in that setting and the percentage of HIV infections attributable to STI cofactors. This is illustrated in our analysis because the STI efficacy of the microbicide contributed more towards impact in Cotonou, the setting with the lower STI prevalence, because in that setting a greater proportion of HIV infections were due to STI coinfection (59% versus 32% in Hillbrow).



Microbicide impact in different sexual partnerships

The relative impact of microbicide use in different types of partnership was found to differ between the two settings, with most of the impact being due to microbicide use in commercial sex in Cotonou, and microbicide use in main and casual partnerships in Hillbrow. This is partly due to higher levels of condom use in commercial sex partnerships in Hillbrow and lower levels of condom use by sex workers with their non-paying partners in Cotonou. Nevertheless, the findings also suggest that as HIV infection becomes more generalised, a greater proportion of a microbicide's impact is likely to arise from microbicide use in primary and casual partnerships.

Recommendations

1. Many people are not using condoms consistently. Alternatives are urgently needed.
2. Microbicides could significantly reduce HIV transmission if inconsistent and non-condom users find them easy to use. In product development it is important to identify what programmatic and product related characteristics may affect whether they will eventually be widely available and used.
3. No one method of HIV protection provides the solution to the HIV epidemic. Many complementary methods of protection are needed particularly where HIV infection is widespread. In advocacy and education activities care must be taken to present microbicides as a method to complement and enhance other prevention activities.
4. There has been limited research focus on the potential importance of the STI efficacy of a microbicide. Given their potential importance on HIV transmission these properties of microbicides should be further investigated.
5. Microbicides should be promoted for use in casual and long-term stable partnerships, where condom use is generally low. Methods of doing this need to be identified.
6. Microbicides could also potentially reduce HIV transmission when used as a fall back to condoms in commercial sex, especially in low transmission settings. However, care needs to be taken to avoid condom migration.

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