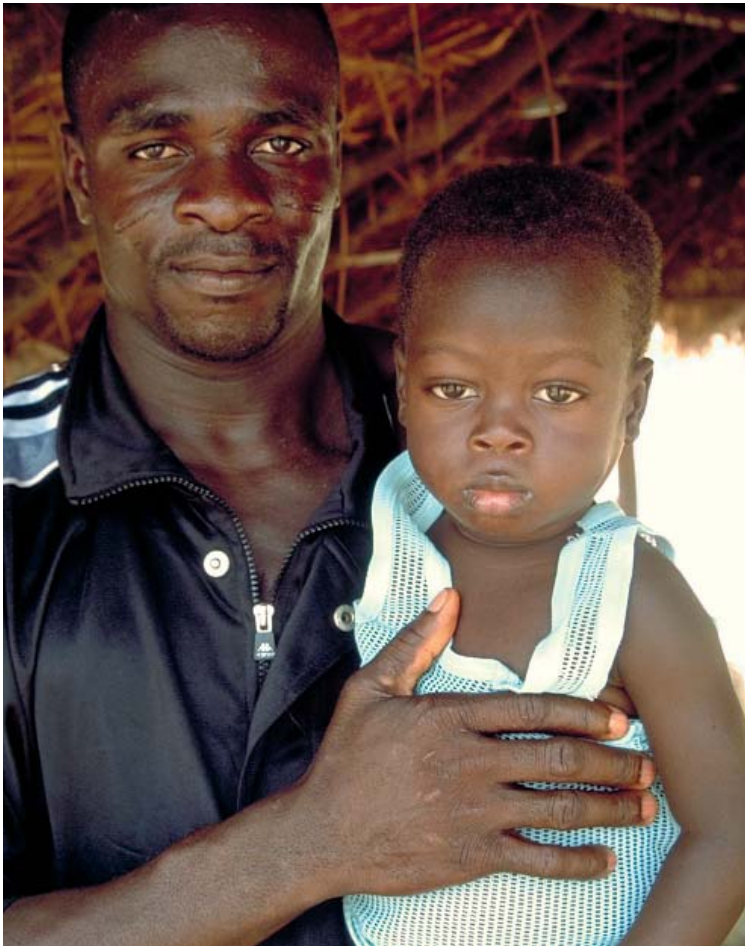
Making decisions on male circumcision for HIV risk reduction: modelling the impact and costs

Report from a UNAIDS/WHO/SACEMA consultation, Stellenbosch, South Africa, November 15-16, 2007



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Executive Summary

This report summarizes the discussions and recommendations from a consultation held in Stellenbosch, South Africa (15-16 November 2007), convened by the Joint United Nations Programme on HIV/AIDS, the World Health Organization, and the South African Centre of Excellence in Epidemiological Modelling and Analysis. Mathematical modellers, researchers, and representatives from governmental and non-governmental research funders compared modelling approaches to determine the potential epidemic impact and costs of diverse male circumcision service scale-up strategies and assessed the development of a programme planning spreadsheet tool for decision-makers. Although different in methodology, baseline assumptions, and input and output variables, the models had similar essential components and outcomes. The models estimated that under a probable scenario, the effects of male circumcision programmes over 10 years would be a reduction in HIV acquisition incidence by up to 30% in the male population (direct effect) and up to 15% in the female population (indirect effect). HIV prevalence would decrease by 20-30% over 20 years; and it would take 2-67 circumcisions to avert one HIV infection, depending on baseline HIV prevalence and incidence. The average cost of performing a male circumcision, including costs for communication, testing, counselling, and treatment of surgical complications, varied from USD 35-69 in six countries, leading to an estimated cost per HIV infection averted of USD 150-313 in five countries with high prevalence and incidence. Further refinement of model assumptions and outcomes is expected to underpin the programme planning tool to assist decision makers in assessing potential costs and impact of different programmatic choices.

Objectives of the meeting

Three randomized controlled trials (RCT) have shown almost identical results in favour of male circumcision as an efficacious intervention in preventing female-to-male HIV transmission. Following these compelling results a number of countries, in particular those with a high prevalence of HIV infection and a low prevalence of circumcised males, have expressed interest in introducing or expanding male circumcision services as part of comprehensive HIV prevention programming.

A two-day meeting convened by the Joint United Nations Programme on HIV/AIDS (UNAIDS), the World Health Organisation (WHO), and the South African Centre of Excellence for Epidemiological Modelling and Analysis (SACEMA) in Stellenbosch, South Africa, compared modelling approaches to determine the potential epidemic impact and costs of expanding male circumcision services and assessed the development of a programme planning spreadsheet tool. This tool is intended to assist policy makers and programme managers in choosing target groups, implementation rates, providers, and facilities, and make other programming decisions.

Background

An inverse correlation between the prevalence of circumcised males and the prevalence of HIV has been recognised for a long time, with several observational studies having identified lack of circumcision in men as a risk factor for HIV acquisition, yielding a combined risk reduction estimate for male circumcision of 58%[1]. These results have been difficult to interpret due to the presence of potential confounding factors such as religion, ethnicity, and cultural tradition, which are determinants of male circumcision but are also potentially related to sexual and other behaviours linked to altered risk of HIV acquisition.

Three randomized controlled trials carried out in sub-Saharan Africa to assess the impact of male circumcision on HIV acquisition among men recently reported a strong protective effect of male circumcision with risk reductions of 51-60%[2-4]. Mathematical models have subsequently predicted that male circumcision could avert 2.0 million new HIV infections and 0.3 million deaths over a ten year period in sub-Saharan Africa[5], that HIV prevalence could be halved[6], and that the reduction in HIV incidence that could be obtained in some populations at higher risk of HIV exposure could reduce the basic reproductive rate to less than one, thus potentially halting the sustainable transmission of HIV in such populations under some scenarios [7].

WHO/UNAIDS recommendations made in Montreux, March 2007

An international consultation convened by WHO and UNAIDS in March 2007, discussed the policy and programme implications of the findings from the randomised controlled trials and made recommendations that male circumcision be recognized as an important intervention and an integral component of a comprehensive HIV prevention package to reduce the risk of heterosexually acquired HIV infection in men. The meeting recommended that health services be strengthened to increase access to safe male circumcision services, that countries with high prevalence heterosexual HIV epidemics and low levels of male circumcision consider urgently scaling up access to male circumcision services, and that additional resources be mobilized to support this[8].

Current needs and implementation activity in Southern Africa

Several concerned countries have already begun the preparation process for scaling up, including Botswana, Kenya, Lesotho, Malawi,

Mozambique, Namibia, Rwanda, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe. Situational analyses are either underway or completed, and some countries have prepared draft or finalized national policies. South Africa is awaiting the results of phase IV studies currently in progress in Orange Farm, the setting of the South African randomised controlled trial. There is now an urgent need to provide operational guidance and technical support to those countries wishing to strengthen and rapidly scale up safe, voluntary male circumcision services.

To maximize effectiveness, it must be known: what will be the best strategic approaches to service delivery, including prioritization of services, timing, and target groups; how can safety be ensured through prevention and management of clinical complications, supervision of health workers performing male circumcision, as well as quality assurance through monitoring of safety standards; and what will be the most effective communication strategies to guard against risk compensation following male circumcision, at the individual and population level.

First UNAIDS/WHO/SACEMA consultation

In November 2005, when only the results of the first trial were known[2], UNAIDS, WHO, and SACEMA convened a meeting in Geneva, Switzerland to discuss aspects of applying mathematical modelling to predict the impact of rolling out male circumcision, in order to be prepared if the two still ongoing trials produced equally convincing evidence of the efficacy of male circumcision. The meeting specifically aimed to discuss what questions mathematical models would be able to answer; how modelling could influence policy making and programme planning for comprehensive HIV prevention services; what data were currently available and what further data would be needed; and what kind of models should be used to answer what kind of questions.

The meeting participants concluded that with application of a combination of different types of models, it would be possible to identify geographic areas and priority populations in which male circumcision might have the greatest impact on HIV transmission. This work would need to take into account heterogeneity of sexual activity, the structure of sexual networks, and individual sexual interactions; identify costs to individuals, families, communities, and governments, differentiating between total resources required, cost effectiveness analysis, cost utility analysis, and cost-benefit analysis; and assess marginal costs with increasing coverage.

Models should incorporate different rates of scaling up and different modes of service delivery by provider (doctors, nurses, clinical officers, counsellors), training costs, supervision and monitoring costs, circumcision procedures, and number of follow up visits. They should model potential synergies with other services, such as treatment of sexually transmitted infections, HIV testing and counselling, sensitisation and socialisation programmes for young men concerning violence against women and gender relations, behavioural counselling, and peer support. It was agreed to carry forward this work by formulating modelling questions that could be answered using available data, developing more specific models, ensuring rapid access to new data as they emerge, and continuing to share approaches and ideas.

Second UNAIDS/WHO/SACEMA consultation

When the next two randomized trials were stopped prematurely in December 2006 and published in 2007[3, 4], a number of mathematical modelling groups were already working on the subject [5-7, 9, 10]. UNAIDS, WHO, and SACEMA held a second consultation with the following objectives: 1) to review the progress in modelling the potential impact of male circumcision on HIV prevention since November 2005; 2) to review approaches to costing and cost-effectiveness of male circumcision for HIV risk reduction; 3) to assess a

programme planning spreadsheet tool for decision-makers designed to calculate the costs of various programming choices for male circumcision, provide budgeting information in appropriate formats for funding proposals, calculate cost per HIV infection averted by programming option (age at circumcision, provider, coverage, speed of scale up) and show the time frame for impact on a country's epidemic; and 4) to discuss the implications of the revised UNAIDS/WHO HIV survival estimate parameters for male circumcision modelling and costing.

The meeting was attended by researchers, mathematical modellers, and representatives from governmental and non-governmental research funders. Following a summary of current knowledge, presentations were made of models estimating the impact of rolling out male circumcision on HIV incidence and prevalence, and the number of circumcisions needed to avert one HIV infection. Models estimating the cost of implementation of male circumcision programmes of varying intensity were presented along with the current resource estimates for male circumcision. The revised UNAIDS/WHO disease progression projections were discussed. Finally, the decision-makers' programme planning tool was presented.

Model introductions and descriptions

Although different in methodology, baseline assumptions, and input and output variables, the models had similar essential components. Components that can be measured and are often assumed to be already known in the area where the models are to be applied included: baseline incidence and prevalence of HIV, baseline male circumcision prevalence, sexual practice patterns, use of male and female condoms, and reduction in female-to-male transmission risk following male circumcision. Components for which magnitude is more difficult to determine or which can be influenced, were divided into programmatic, biological, and behavioural variables. Programmatic variables

included age group targets, risk group targets, speed of intervention scale-up, and final level of MC coverage reached. Biological variables included risk of male-to-female HIV transmission and both HIV transmission risk and HIV acquisition risk during wound healing post surgery. Behavioural variables included potential risk compensation post male circumcision in the form of less frequent condom use and increased numbers of sex partners. The modelled outcomes were the impact on HIV incidence and HIV prevalence, and the number of male circumcisions required to avert one HIV infection.

Variable level ranges in the different models were: baseline HIV incidence (1.3-3.8 new infections per 100 persons per year), baseline HIV prevalence (11-20%), baseline male circumcision prevalence (10-16%), risk reduction in female-to-male transmission if circumcised (40-75%), target age groups (10-year age intervals), target risk groups (high versus low risk behaviour males), time to intended coverage reached (0-20 years), maximum level of circumcision prevalence reached (25-100%), reduction of male-to-female transmission risk (0-50%), transmission risk during wound healing (80-120%), increase in the number of sexual partners post circumcision (0-100%), and reduction in condom use (0-100%).

Modelled impact of male circumcision on the HIV epidemic

The models estimated that under a probable scenario, the direct effect of male circumcision programs would be a reduction in HIV acquisition by up to 30% in the male population over 10 years. Over the same time span, the indirect effect would be an incidence reduction of up to 15% in the female population. HIV prevalence would decrease by 20-30% over 20 years; and it would take 2-67 circumcisions to avert one HIV infection - fewest in high-prevalence/high-incidence settings.

A variety of sensitivity analyses had been performed to assess the robustness of the primary findings and to reveal which components would have the greatest potential to alter the estimates. Two models were concordant, showing that targeting the very sexually active age group of 20-34 year-olds would have the greatest impact on the epidemic in the first 20 years, whereas targeting the younger group of 15-24 year-olds would result in a slower start, but a more lasting effect. A strategy circumcising only newborn boys would take more than 20 years to have an impact on the epidemic, whereas circumcising men at all ages would have both the quickest and most durable effect.

Focusing service offers predominantly on males with high-risk behaviour would have little impact on overall male HIV incidence because their numbers are relatively small, but could double the indirect effects as measured by a reduction in female incidence. This is because this group of men, if HIV-infected, would be responsible for a disproportionately large share of onward transmission. Offering them circumcision would therefore have a disproportionately large impact on the epidemic, with the benefit accruing not only to women but also to men at relatively low risk. Making quantitative estimates of this impact is difficult because it depends on the nature of sexual networks. One approach is to estimate impact assuming scale-free networks and focusing the offer of services to men attending STI clinics, clients of sex workers, men in sero-discordant relationships, or other men at higher risk of HIV exposure.

An indirect effect of even greater magnitude would be obtained if male circumcision were found to reduce the risk of male-to-female transmission by 30%. Further, a doubling of the incidence reduction after 10 years could occur if the programme were rolled out over 3 years as compared to 10 years, or if the coverage level reached 75% as compared to 50%. Expanding the circumcision procedure to HIV-infected males, thereby reducing the proportion of available surgical capacity spent on uninfected males, would have a negative impact on

the reduction in HIV incidence of approximately the magnitude of the HIV prevalence among men showing up for circumcision.

Most models agreed that although risk reduction obtained by circumcision could potentially be nullified by changed sexual behaviour, it would require a substantial increase in the number of sex partners. Altered condom use practices alone would be unlikely to cause such an effect. If males who are already circumcised were to increase their risk behaviour as a result of it becoming widely known that circumcision protects against HIV acquisition that could potentially impair the positive effect.

Modelled costs, cost-effectiveness, and savings

The average cost of performing a male circumcision, including costs for communication, testing, counselling, and treatment of surgical complications, varied from USD 35-69 in six countries. This lead to an estimated cost per HIV infection averted of USD 150-313 in five (South Africa, Kenya, Swaziland, Lesotho, and Zambia) of the six countries. The model from Uganda differed in that the estimated cost per HIV infection averted was around USD 2000, which may be a consequence of the low incidence and prevalence in this country compared to the other five.

A further analysis based on the Swaziland data showed that if scale-up was speeded up to avert 31% more infections in 8 years, even though the total costs would increase, it would result in improved cost-effectiveness with a decrease of 16% in the cost per HIV infection averted. An interesting analysis from South Africa incorporated the money saved in antiretroviral drugs and other health care costs and came to the conclusion that the net *savings* per HIV infection averted would be USD 2,411. Sensitivity analyses showed that the savings would be higher in areas with HIV prevalence higher than the 25.6% level in the model.

Decision makers' programme planning tool

A decision makers' programme planning tool was developed in order to help governments make decisions on whether and how to introduce or expand male circumcision services in their country, in order to have maximum impact with limited resources. The tool consists of a questionnaire, a costing template, and a policy screen. Default values include country-specific HIV prevalence and AIDS mortality information from UNAIDS and demographic information from the UN Population Division. The tool allows each country to enter more detailed data on its own epidemic, service delivery mode and costs, intended target groups, scale-up rate, and coverage goals. The tool projects 25 years' HIV incidence, HIV prevalence, number of new HIV infections, number of AIDS deaths, number of male circumcisions performed, changes in male circumcision prevalence, net costs per HIV infection averted, and net cost of the intervention.

New estimates: disease progression, survival, and resources needed for HIV prevention-related activities

The revised UNAIDS and WHO projections for disease progression, used in the recently published 2007 AIDS Epidemic Update[11], were presented. For untreated persons there has been an increase in the estimated median time from HIV acquisition to AIDS death from 9 to 11 years, and an increase in the estimated median time from need for treatment to AIDS death from two to three years. Given current HIV prevalence estimates, the new projections will result in a decrease in the estimated HIV incidence, but possible increases in the estimated number of people in need of antiretroviral treatment. They should be taken into account in future modelling of the epidemic, including the modelling of the impact of male circumcision.

Further, UNAIDS has estimated the resources needed to implement male circumcision in all countries with generalized epidemics and a prevalence of circumcised males of less than 80%. With a target group

of males aged 15-24 years, and a coverage level goal set to reduce the difference between the current proportions of males circumcised and 80% by half by the end of year 2010, the number of circumcisions needed to be performed would cost an estimated USD 457 million over a three-year period. This is dwarfed by the total estimated resources of USD 34.3 billion needed to scale up all HIV prevention activities at similar rates during the same three-year period.

Suggested improvements to refine models and tools

The presentations stimulated enthusiastic and fruitful discussions at a high scientific level. Working group and plenary discussions saw participants reaching agreement on a number of steps to carry the modelling and implementation process forward.

First, the models should be extended to incorporate detailed risk compensation behaviour among previously circumcised men, newly circumcised men and their respective female partners, the interaction between antiretroviral treatment and HIV transmission probability, sexual mixing patterns, changes over time in age and sex distribution in HIV-infected populations, and the latest disease progression projections. They should also take into account that risk behaviour in those who are reluctant to be circumcised at first may be profoundly different than in those receiving the procedure at the beginning of scale-up. Further, they should model the scenario of concurrent introduction of other prevention programmes with potential diminishing marginal returns from male circumcision, as well as the potential cost-savings and impact on female partners of encouraging HIV testing before male circumcision.

Options should include offering circumcision to the potentially seronegative partners of women receiving antiretroviral treatment to prevent mother-to-child transmission, men who present for treatment of sexually transmitted infections, and men who present for voluntary

counselling and testing. Alternative service delivery modes, e.g. similar to the way high-volume cataract surgery is delivered in low- and middle-income countries [12] and different levels of male circumcision demand should be accommodated. The refined models should be compared at future meetings aiming to identify common results and reach consensus.

Second, the meeting recommended that the decision makers' programme planning tool include declining prevalence over time and risk compensation; take into account that a population may be divided into men with high-risk and men with low-risk behaviour; include differential costing for neonatal circumcision; make sure that the effects in women are adequately modelled; and build sensitivity analysis into the model. The tool should be designed to assist decision-makers in assessing which implementation strategy to choose for their context. Therefore, it should include a number of pre-specified scenarios and provide an easy way to choose the most cost-effective approach according to a limited budget. The tool outcome should be compared with that from more advanced models with which it should be in line.

Finally, it was discussed that as male circumcision provision increases there will be a need for both demand creation and demand forecasting in order to anticipate need for supplies and training requirements. A better understanding of positive and negative drivers of demand in specific populations and their dynamics over time is needed and will require coordination between policy makers, implementers, and communication specialists.

The way ahead

The consultation participants came up with the following action points: 1) the decision makers' programme planning tool to be tested in 1-2 countries during the first quarter of 2008, 2) UNAIDS, WHO, and SACEMA to convene a meeting for a smaller group of modellers to refine assumptions and modelling for improvement of the decision makers' programme planning tool and arrive at a consensus on modelling, and 3) a regional training workshop to be held for potential users of the decision makers' programme planning tool in 'leading countries' in the region, following its revision after pilot tests.

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The Joint United Nations Programme on HIV/AIDS (UNAIDS) brings together ten UN agencies in a common effort to fight the epidemic: the Office of the United Nations High Commissioner for Refugees (UNHCR), the United Nations Children's Fund (UNICEF), the World Food Programme (WFP), the United Nations Development Programme (UNDP), the United Nations Population Fund (UNFPA), the United Nations Office on Drugs and Crime (UNODC), the International Labour Organization (ILO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO), and the World Bank.

UNAIDS, as a cosponsored programme, unites the responses to the epidemic of its ten cosponsoring organizations and supplements these efforts with special initiatives. Its purpose is to lead and assist an expansion of the international response to AIDS on all fronts. UNAIDS works with a broad range of partners – governmental and nongovernmental, business, scientific and lay – to share knowledge, skills and best practices across boundaries.

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