

LMKWOTLg (cow fa.

Controlling HIV in Africa: effectiveness and cost of an intervention in a high-frequency STD transmitter core group

Stephen Mosestfi, Francis A. PlummerTi, Elizabeth N. Ngugit, Nico LD. Nagelkerket, Aggrey O. AnzalaT and Jacksoniah O. Ndinya-AcholaT

Since 1985, a population of over 1000 predominantly HIV-positive female prostitutes residing in a low-income area of Nairobi, has been enrolled in a sexually transmitted disease (STD/HIV) control programme. The major elements of the programme include the diagnosis and treatment of conventional STD, and the promotion of condom use to prevent the transmission of HIV and other sexually transmitted infections. Using estimates of numbers of HIV-seropositive prostitutes, numbers of sexual contacts, susceptibility of clients to HIV, HIV transmission efficiency, rates of condom use and the basic reproductive rate of HIV infection in Kenya, we estimate that the programme is responsible for preventing between 6000 and 10000 new cases of HIV infection per year among clients and contacts of clients. The total annual operating cost of the programme is approximately US\$77000 or between US\$8.00 and US\$12.00 for each case of HIV infection prevented. Programmes to reduce the transmission of HIV and other sexually transmitted infections which are targeted at high-frequency STD transmitters, such as prostitutes, can be effective and relatively inexpensive to undertake. More such programmes should be developed and evaluated in different settings.

AIDS 1991, 5:407-411

Keywords: AIDS, HIV, sexually transmitted disease, prevention, programme evaluation, cost-effectiveness, prostitutes, condoms, Kenya.

Introduction Few HIV infection control programmes which focus on the role of what have been termed high-frequency STD

Efforts to control the sexual transmission of HIV in Africa have consisted largely of information and education programmes directed at the general public. These programmes usually operate separately from programmes to control transmission of the conventional sexually transmitted diseases (STD). The impact of this approach is difficult to assess, and few evaluations of the effectiveness or cost-effectiveness of health-education programmes aimed in reducing HIV transmission have been undertaken

1,21. transmitter core groups B1 have been reported from Africa (4,5). It is this subset of the population with its rapid rate of change in sexual partners that helps to sustain epidemics of STD. Because of their central role in STD transmission, intensive efforts to reduce transmission of HIV infection within such groups of individuals could, at last in theory, have a considerable effect in slowing the spread of the HIV epidemic.

In this paper we attempt to derive conservative estimates of the number of new cases of HIV infection which are

From the 'Departments of Community Health and Medical Microbiology, University of Nairobi, Nairobi, Kenya. the 3Departments of Community Health Sciences. Medical Microbiology and Medicine, University of Manitoba, Winnipeg Canada, and the 9Kenya Medical Research Institute, Nairobi, Kenya.

4

Requests for reprints to: Dr Stephen Moses, Department of Community Health. University of Nairobi, PO Box 19676, Nairobi, Kenya.

Date of receipt: 24 October 1990, revised: 23 January 1991.

©) Comm Science Ltd ISSN 0269-9370

prevented over a period of time by a programme which focuses on one such group of high-frequency transmitters, and to assess the costs associated with operating the programme.

Methods

The programme

Since January 1985, a cohort of over 1000 female prostitutes residing in the low-income Pumwani area of Nairobi has been enrolled in an STD/HIV control programme operated by the University of Nairobi and the Kenya Medical Research Institute in collaboration with the Nairobi City Commission's public health department. Approximately 8096 of these prostitutes are HIV-seropositive. The programme utilizes a primary health care approach and has been described elsewhere (6,7). Health education has been a major component of the programme, and is undertaken both in public meetings (barazas) and individually. A major aspect of the health education programme is counselling the women to encourage their clients to use condoms to prevent the transmission of HIV infection and other STD. Condoms have been supplied to the women free of charge since June 1986.

A health clinic has also been established to serve the women, and it has been operating continuously since 1985. At this clinic general health services, with particular emphasis on the prevention and treatment of STD, are provided free of charge. Health education and counselling services related to STD and HIV infection are offered as required. At approximately 5-month intervals, all women who are resident in the area are requested to attend the clinic for a health assessment, including diagnosis and management of STD. They are also asked to complete a questionnaire covering sociodemographic information, and medical, social and sexual histories, including numbers of sexual partners and condom usage. In addition, all women are encouraged to attend the clinic whenever they have an STD or other health problem.

Model assumptions

To arrive at an estimate of the number of new cases of HIV infection prevented annually by the programme, a simple model was constructed, and a number of estimates and assumptions were made.

(1) Although the total population of prostitutes numbered over 1000, approximately 500 are resident in the area at any given time. This number is determined by the semiannual censuses and has not changed significantly since 1986.

(2) Approximately 80% (400) of the women in this population are HIV-seropositive at any given time. This figure is also determined through the semiannual censuses, and has been at this level since 1988.

(3) The women in the cohort have an average of approximately four clients per day. The average has ranged between three and five clients per day over the past 3 years.

(4) About 90% of clients are HIV-seronegative, and are believed therefore to be susceptible to HIV infection. This figure is based upon studies conducted at the Nairobi Special Treatment Clinic (STC), the major referral centre for STD in Nairobi, among men with STD who report the likely source as a Pumwani prostitute. Their prevalence of HIV infection is approximately 10%, and has not changed greatly over the past several years.

8 . 1

(5) The risk of a susceptible client acquiring HIV infection from a single sexual contact with an infected woman is 1%. Estimates of the risk of a susceptible male acquiring HIV infection after one

' sexual contact with an infected woman vary considerably. The World Health Organization (WHO) estimates the average range to be between 0.1 and 1%. However, previous studies in Nairobi have found the risk to be up to 13% among high-risk populations, probably because of the presence of important cofactors such as other STDs. Our estimate of 1% therefore seems reasonable, but results are presented for a range of HIV transmission efficiencies from 0.2 to 2%.

(6) Condoms. when used, are 90% efficacious in preventing HIV transmission. Condom efficacy is difficult to ascertain precisely (91). but it has been estimated that their use reduces the risk of HIV transmission 10-fold (101).

(7) To allow for the possibility that some clients among whom HIV infection is prevented may subsequently become infected from other sources, a reduction of 10% in the number of new infections prevented has been built into the calculations. A number of susceptible clients may be 'regulars' and therefore counted several times. If this is true for a large proportion of clients, then the predicted number of clients who will become infected over a period of time must be adjusted. We can distinguish several cases:

(1) The probability of acquiring infection (p) per sexual contact is small, and is approximately the same for all individuals, i.e. the risks of acquiring infection during successive contacts are independent. If the average number of contacts per client (n) is such that $np \ll 1$, the probability of a client becoming infected, $1 - (1 - p)^n$, is approximately equal to np . and our estimates should be accurate. With a transmission efficiency of 196, this corresponds to an average number of contacts per client of ≈ 100 . Our calculations are based on this scenario.

(2) The probability of acquiring infection per contact is small. but the number of contacts per client is large. i.e. a small number of regular customers are responsible for the majority of all client-prostitute contacts. In this situation, fewer clients, but a

laige proportion of them, will become infected over a period of time (the same individuals ml! be re-exposed and re-infected several times). The prostitutes in Pumwani tend to report a small number of regular clients, but we have no data on the proportion of men who frequent many _ diEerent prosumtes in the same area. However, if this proportion were high, one would expect the overall setoprevalence of HIV infection among thementobemuchhigherthantheobserved 10%, ultimately approaching that observed among the prostitutes themselves We therefore do not believe this to be the case.

(3) There is significant variation in the risk of a client acquiring infection when exposed. i.e. the as-sumptionofindependencedoesnotholdms wouldldadtoaneffectsimilartodtatofalaige number of contacts per client, Le the expected number of infected clients would be reduced, but the proportion infected increased However, if, on average. up is (1, as it would seem to be, this eifect should not have major impact on our os-timates.

We have termed each newly infected client a 'pn'mary tme', and each individual subsequently infected by a client a 'secondary mse'. Using the current doubling time of the AIDS epidemic in Kenya of approximately 2 years, and current estimates of the mean duration of infectivity of apptoximately 4 years (111. each HIV-infected individ-ual is responsible for transmitting approximately two sec-ondary cases on average. We assume that this also applies to clients of prostitutes. In fact, the figure is likely to be even higher among such sexually active individuals. Of coutse, the cases of secondary transmission would not necessanlyoccurmthesamey wastheprimarycase

As the future course of the HIV epidemic is uncertain, infections which may subsequently be transmitted by the secondary cases have not been comidered In this sense. our estimates of cases of infection prevented may be con-semptive.

Results

The estimated number of new cases of HIV infection pre-ventedannuallybytheprogtammeinpumwaniisgivenin Table 1. We have presented two scenarios for condom use: one in which condoms are used in 8096 of sexual contacts, which is the current self-reponed Egre for the Pumwani prostitutes. and a more consetvative estimate of 50% condom use. With 80% condom use and a trans-mission efficiency of 196, it appears that approximately 10200 new cases of HIV infection should be prevented annually by the programme. The more conservative esti-mate of 50% condom use would result in approximately 6450 uses prevented annually. A transmission edicienq of 0.2% would reduce these estimates by a factor of 5, and a uansmission efficiency of 296 would double the es-timata.

a ffectivene-ss of AIDS control in Africa Moses 9! alt .k- the major uncertainty about the impact of the pro-gr:::me in reducing HIV transmission relates to the va. 11-lin of the self-reported data on condom use. it is im-portant to try to verify this information.

Verification of condom use data

First. we can examine condom distribution We dis-tribute approximately 150000 condoms per year to the women in Pumwani. and another group working in the area distnbuta an additional 200000 (L Lux, AIDSTECH, Nairobi, personal communication, 1990). With 500 pros-titutes and an avenge of four clients per day, and as-sumingthataallcondomswwhicharesuppliedareused, this works out to approximately 50% condom use, which issomewhatlessthantheaverageofefoxwhichiscur-

rently repented by the women. However, over 30% of the women report that condoms are supplied by their clients at least some of the time, and this could account for part of the gap between numbers of condoms supplied and numbers reported used. In any case, a lower figure of 50% condom use has been included in our calculation. Second, we have examined prospectively the risk of HIV seroconversion among the women, and have been able to demonstrate a reduced risk of seroconversion among women who report increased condom use. Women who report any condom use have been shown to have a three-fold reduction in their risk of seroconversion, and there is a dose-response relationship between reported condom use and decreased risk of seroconversion (61). There has also been a significant reduction in the annual incidence of culture-positive gonorrhea and of other conventional STD among the women in Pumwani since the condom promotion programme began. The annual gonorrhea incidence rate has fallen from 2.85 cases per woman (sd 3.82) in 1986 to 0.66 cases per woman (sd 1.12) in 1989. The difference between these rates is statistically significant ($P < 0.001$).

Table 1. Estimated new primary and secondary cases of HIV infection prevented annually among clients of prostitutes by the sexually transmitted disease (STD) control programme in Pumwani.

Cases

New cases prevented
HIV with no intervention
transmission intervention
efficiency Cases in) use in) use (n)

	1986	1989	Primary	Secondary	Total
1986	150	250	5	3	4
1989	150	250	5	3	4
Primary	150	250	5	3	4
Secondary	150	250	5	3	4
Total	150	250	5	3	4
0.2% Primary	150	250	5	3	4
Secondary	150	250	5	3	4
Total	150	250	5	3	4
29. Primary	150	250	5	3	4
Secondary	150	250	5	3	4
Total	150	250	5	3	4

The third way that we have tried to verify self-reported condom use is by indirectly examining the trend in STD incidence among the clients of Pumwani prosti-

tutu. These data are presented in Fig. 1. We compared the trend in numbers of men from Pumwani with an STD attending the Nairobi STC with those from the Kariobangi/Dandora area of Nairobi, an area similar to Pumwani in terms of location and socioeconomic status, but with no large-scale condom distribution programme. The expectation here is that clients preferentially frequent prostitutes from their own area. We looked at clinic attendances in four sample months (January, April, July and October) in the years 1981, 1983, 1985, 1987 and 1988. There was a marked decrease in men from Pumwani presenting to the STC after 1985, while attendance by men from Kariobangi/Dandora (as well as, for that matter, overall attendance at the STC) remained relatively constant. The drop-off in attendance from Pumwani relative to Kariobangi after 1985 also represents a significant departure from the trends prior to 1985. (This was tested by means of logistic regression, with location as the response variable and both time and intervention as covariables. The intervention was highly significant - $P (0.001)$). There may of course be factors other than the intervention which could explain the decrease in attendance by men from Pumwani, such as changes in demographics, client preferences and healthcare-seeking behaviour (such as a shift from the public to the private sector). However, the observed trend is consistent with what would be expected if the reported use of condoms by the women in Pumwani is reasonably accurate. We are currently planning studies to investigate the sexual behaviour patterns and reported condom usage among the clients of the Pumwani prostitutes and other groups of high-risk men.

700

000

500

400

300

200

111: 10 02M-:CI

100

0

19M 19!! '3 19.. 088 1900' 0907 '90!

YEAR

Fig. 1. Numbers of men with sexually transmitted disease attending the Nairobi Special Treatment Clinic in the same four sample months for the years indicated; D, from Pumwani; X, from Kariobangi.

Costs and cost-effectiveness

Cost data are presented in Table 2, and relate primarily to the cost of operating the clinic. All figures represent current costs. Personnel includes one physician, two nurses and a clinic assistant. The training item represents the value of the time contributed by senior University of Nairobi faculty towards the operation of the programme. Premises for the clinic are provided by the Nairobi City Commission, so we have included the approximate cost of renting similar premises in Nairobi. Laboratory investigations consist primarily of cultures for *Neisseria gonorrhoeae* and serology for syphilis and HIV. Other STD are diagnosed clinically and treated empirically. The drugs which are supplied are primarily for the treatment of STI. Condoms are currently provided free of charge through the Kenyan Ministry of Health, so an in-kind cost of 1.00 Kenya shilling per condom has been included (D. Oct. US Agency for International Development, Nairobi, personal communications, 1990).

Table 1. Qualitative costs of the sexually transmitted disease control programme in Pumwani.

US dollars.

Kenya rounded

shillings (RES) (1 00055 - 2M5)
 Salaries 394 000 17 100
 Training 230 000 10 (IX)
 Rental of premises (in kind) 168W 7 mo
 Laboratory tests 230 can 10 000
 Clinic supplies and dings 400000 17400
 Condoms (in kind) 300000 13 000
 Transportation and
 miseeihnm ' 50000 2 200
 Total 1 772 000 77 (IX)

With an HIV transmission eEcieng of 1% and 80% con-
 dom use. the cost per case of HIV infection prevented
 works out to approximately \$8.00. With 50% condom
 me. the cost per case of HIV infection prevented comes
 to approximately \$12.00. With a transmission emdency
 of 0.2%, the cost per use prevented increases fivefold,
 and with a transmission eiliciency of 2% it is reduced by
 half.

Discussion

In this paper we have demonstrated that a large reduction
 in HIV transmission can be achieved through an inex.
 pensive intervention programme among a group of pros-
 titutes. In addition, the Pumwani programme probably
 reduces HIV transmission in more ways than have been
 considered here. First, as indicated above. condom use
 prevents or at lest delays HIV infection in initialh' unin-
 fected women, and thus keeps them out of the pool of
 HIV transmitters. Another way in which the programme
 probably reduces HIV transmission is through the pre-
 vention of other STD. There is aidence that concomitant
 STD. especially those causing genital ulceration, substan-
 tialiy increase the probability of HIV trammission 112.151.
 L'sing condoms reduces genital dlcer transmission. and
 eariy treatment of ulcers shortens their duration. so that
 the infectivity of the women should be reduced even at
 times when condoms are not used. As indicated previ-

ously, our estimates of the impact of the programme on HIV transmission are therefore likely to be conservative. The major cost of the programme in Pumwani is the provision of services to diagnose and treat the conventional STD. Although such activities may not play the major role in preventing HIV transmission (except insofar as conventional STDs are cofactors for transmission), ready access to effective health services, particularly for the treatment of STDs, the major health problem encountered by the women in Pumwani, is felt to be a critical element of the programme. Ineffective and accessible health services were not available. It is unlikely that the women would be as receptive to the health educational and promotional efforts of the programme.

The estimated cost of between \$8.00 and \$12.00 to prevent a case of HIV infection may be compared with the cost of medical care for an individual with AIDS. This has been estimated in Tanzania and Zaire to range between \$100 and \$1600 per year. The indirect costs attributable to a case of AIDS are of course much higher.

It is also interesting to compare the estimated cost-effectiveness of a programme such as this one with that of other HIV infection control measures, such as blood-bank screening. In Kenya approximately 250 000 units of blood are provided by donors each year, and as of 1989 approximately 296 of units were HIV positive (P. Sieben, National AIDS Control Programme, personal communication, 1989). Assuming that all units are screened, that the screening test has a positive predictive value of 95%, that the risk of HIV infection through a blood transfusion is 100%, and that 95% of the blood recipient population is susceptible, then approximately 4 500 new cases of HIV infection should be prevented annually by such screening. Not all such transfusions would be given to sexually active adults (certainly not to adults as sexually active as clients of prostitutes), but let us still assume a further 9000 secondary cases of infection prevented. The annual operating budget of the Kenyan National AIDS Control Programme for laboratory support, which consists primarily of support for blood-bank screening, is approximately \$1.8 million. The cost of preventing one new case of HIV infection through blood-bank screening is therefore well over \$100. Of course, nobody would argue that screening blood for HIV is not important or cost-effective.

Clearly, strategies to interrupt the epidemic of HIV must comprise many different elements. There is increasing evidence, however, that control programmes targeted at STD transmitter core groups can be highly effective in reducing HIV transmission (15,16). Such core groups include not only prostitutes but other high-risk groups such as regular clients of prostitutes and long-distance truck drivers (17). We have demonstrated in this study that such programmes can also be cost-effective, a major concern in most African countries where health-sector funding is scarce. Emphasis should be placed, therefore, upon developing STD/HIV control programmes targeted at core groups in different settings.

References

1. VAN DAM C): AIDS: is health education the answer? Health Policy and Planning 1990; 46:141-167.
2. Sroun EJ, Runaway CW: Evaluation of AIDS prevention and control program AIDS 1989; 3 (suppl 5):5289-5296.
3. You AY, HETHCO LT HV, Now A: Dynamic: and control of HIV transmission in the community. S Afr Med J 1990; 75:51-56.
4. Nours EN, Puma FA: Health outreach and control of HIV infection in Kenya. J Acquir Immune Defic Syndr 1988; 1:570.

5. Wnson D, 5mm 3, Maori L Nsnwm 5, Dust G: Health education among commercial sex workers in Zimbabwe. Africa V International Conkrence on AIDS Manual. June 1989 (abstract W.G.O.19I.
6. NGL'GI EN. Pwum FA. Swansea 1N, HAL: Prevention of mmission of human immunodelicienq virus in Africa: cEectjvcnm of condom promotion and health education among prostitutes. lance! 19\$. itsa7-89o.
7. SlMONSEN JN. PLCMMER FA. Nomi EN. ET AL; HIV infection among lower socioeconomic strata prostitutes in Nairobi. AIDS 1990. 4:139-141
8. 5lmm 1N, Cmnos W. GAXTNYA M. ETAL: Human im-munodelicicncy tin: infectim among men with sexually mmited disencs. Experience from a center in Africa. N Engl J Med 1988. 319:279-278.
9. CmmotsmCoemtouCondomsforpreventbnofV sexually transmitted discs: MM"? 1988. 37:135-137.
10. Hm N, Hum? 58; Preventing the heterosexual spread olAle Arewegh-ingmrpatiemsthebestamice?m 1988. 259:24'28-2432.
11. Nmmmm NJD, PLL'MMER FA. Horton D. ETAL: Tramitlon dynamicsol'HlVd'tseaseinacohor-tofmcanprostjtmea: a Markov model approach AIDS 1990. 4:545-747. -
12. CAMERON DW. SIMONSEN JN D'CouTA Ll. HAL: Femak-to-male mission of human immunodehcicncy virus type 1: risk factors for seroconvetsion in men. lance! 1989. mow.
13. Pom J, Plum FA Batman RC. tr AL; me interaction offlvllVinfectionandothersea-uallymmittedd'ueaes an opportunity for intervention AIDS 1989. 3:3-6.
14. Ova M. Burrow S. CHIN J. Natty B, Mmm'z K '11: direct and indirect cost 0! HIV Infections in devel-oping countries- thecasesolbireandTanzaniaIn The Global Impact quIDS edited by Flemming AF. Fitzsimons DW, MamJ. CarballoM. BaileyMR. NewYork; AlanRUs, 1988. pp 123-135.
15. AL'VErtB. MooasM, BmTE, eTAL: Dynamiaofmv infection and AIDS in central African cities In!) Epidemiol 1990. 194:17428.
16. Ram A PAPOUSAKB G. mos G. Nwotunou 1L Pummoatou G: Prevention of HIV infection in Greek reg-istered Mute: A Eve-year study. W International Con-hence on AIDS. San Fmtcisco. June 1990 Iabstnct scmo).
17. Mowwm Au 0. Brno D; Mum AN. JAOKO w, Puma: FA Kmss JK; Sexual bchznour of longdistance truck drivers and their contribution to the spread of sexually transmit-ted diseases and HIV infection in East Africa. 11 Inlemo-tional Conference on AIDS. San-Ftancisco. June 1990 Iabstran E07291.