Comparing the cost-effectiveness of HIV prevention interventions

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The study examined 26 interventions for the prevention of human immunodeficiency virus (HIV). The interventions were grouped into four broad categories:

- individual interventions that included counselling and testing, counselling without testing, discordant couple counselling, videos in sexually-transmitted disease (STD) clinics, group counselling, partner notification, and school-based education;
- community and social network interventions that included opinion leader programmes, street outreach, and community mobilisation;
- biomedical interventions that included drug treatment programmes, STD screening and treatment, HIV antiviral treatment, and male circumcision; and
- structural interventions that included condom availability, needle exchange, needle deregulation, alcohol tax increases, youth supervision programmes, and mass media campaigns.

Type of intervention
Primary and secondary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The population and, hence, HIV prevalence rates used in the studies to derive model parameters for each intervention varied significantly.

Setting
The setting was the community. The economic study was carried out in the USA.

Dates to which data relate
The effectiveness data were derived from studies published between 1989 and 2003. In terms of resource use, data for some interventions were from studies published between 1993 and 2001; the authors did report the dates for the others. The price year was not reported.

Source of effectiveness data
The effectiveness data were derived from a review of the literature.
Modelling
To estimate the number of HIV infections prevented, the authors used a Bernoulli process model for assessing the interventions that prevent HIV transmission through sexual acts. They also used a similar Bernoulli process formula for assessing the interventions that prevent HIV transmission through needle exchange. For other interventions, the authors assumed that the reductions in HIV incidence were proportional to the reductions in incidence of gonorrhoea. Details of the modelling for each intervention were described in the article. The time horizon for the study was one year. The models initially produced outcomes for different time periods. However, these were then standardised to one year on the assumption that effects less than a year would continue for a year; effects found for durations longer than a year were interpolated linearly.

Outcomes assessed in the review
The major outcomes estimated were:

the pre-act HIV transmission probabilities of male-to-female vaginal sex, female-to-male vaginal sex, male-to-male anal sex, injection with an infected needle, injection of a needle used by an HIV-infected person, and proportionate reduction in sexual transmission as a result of condom use;

the number of sexual partners of high-risk heterosexuals within 3, 6 and 12 months;

the number of sexual partners of men who have sex with men (MSM) within 3, 6 and 12 months;

the number of sexual acts per year between high-risk heterosexuals;

the number of sexual acts per year between MSM;

the rates of condom use before and after the intervention;

the number of sexual partners before and after the intervention;

the number of sexual encounters before and after the intervention;

the rates of needle exchange;

the rates of STD reduction; and

HIV prevalence of men and men's partners, women and women's partners, and MSM.

Study designs and other criteria for inclusion in the review
Some of the primary studies were based on a rigorous, randomised, controlled design, whereas others were natural experiments or were not randomised. The inclusion or exclusion criteria used to identify the studies were not reported.

Sources searched to identify primary studies
Not reported.

Criteria used to ensure the validity of primary studies
Not reported.

Methods used to judge relevance and validity, and for extracting data
Not reported.
Number of primary studies included
The effectiveness evidence used in the model was derived from 42 primary studies.

Methods of combining primary studies
Not reported.

Investigation of differences between primary studies
Not reported.

Results of the review
The pre-act HIV transmission probability of male-to-female vaginal sex was 0.001, of female-to-male vaginal sex 0.0006, of male-to-male anal sex 0.01, of injection with an infected needle 0.0067, of injection of a needle used by an HIV-infected person 0.9, and of proportionate reduction in sexual transmission as a result of condom use 0.9.

The number of sexual partners of high-risk heterosexuals was 2.3 within 3 months, 2.6 within 6 months, and 3.0 within 12 months.

The number of sexual partners of MSM was 2.5 within 3 months, 2.7 within 6 months, and 3.1 within 12 months.

The number of sexual acts per year between high-risk heterosexuals was 81.

The number of sexual acts per year between MSM was 54.

The authors also reported in detail the effectiveness results reviewed for each prevention intervention.

Measure of benefits used in the economic analysis
The summary measure of benefit was the number of HIV infections prevented. This was obtained from the models for each intervention. Discounting was not relevant as the time horizon was one year.

Direct costs
The cost/resource boundary adopted was that of the public health system. The costs included the total cost to the public health system of implementing the intervention. The lifetime costs of treating HIV were not included in the total costs. These were left to form a threshold for the cost-effectiveness ratio of an intervention. The costs for some interventions were derived from the review of published studies, while those for other interventions were taken from figures at the Louisiana Office of Public Health and/or the Los Angeles County Department of Health. For each intervention, the costs per person reached and the number of people reached were reported. These were then multiplied to derive the total costs of the programme. Discounting was not relevant as the time horizon was only one year. The price year was not reported.

Statistical analysis of costs
The costs were treated deterministically.

Indirect Costs
The indirect costs were not included in the analysis.

Currency
US dollars ($).
Sensitivity analysis
To evaluate the robustness of the estimates used in the decision model, the authors conducted 1-way and 2-way sensitivity analyses. Model parameters such as HIV prevalence, cost per person, rate of condom use, number of sexual partners, the rate of sex and needle sharing, and STD incidence were systematically varied. The method used to select the ranges was not reported.

Estimated benefits used in the economic analysis
The reported numbers of HIV infections prevented (duration) for each intervention were for different time periods. They were only adjusted to 12 months for each intervention when calculating the cost-effectiveness ratio.

For individual interventions:
counselling and testing, combined HIV+ and HIV-, resulted in 1.56 HIV cases prevented (6 months);
counselling and testing, client centred, 1.01 (12 months);
counselling without testing, single session, 0.06 (6 months);
discordant couple counselling, 4.66 (6 months);
videos in STD clinics, 2.52 (7 months);
group counselling, multiple sessions, 0.02 (3 months);
group counselling, multiple sessions, 0.29 (2 months);
partner notification for HIV+ partner, not reported;
partner notification for HIV- partner, 11.56 (6 months);
school-based education, multiple sessions, 0.0027 (7 months); and
group counselling for youth, multiple sessions, 0.0044 (2 months).

Community and social network interventions:
opinion leader programmes resulted in 0.38 HIV cases prevented (2 months);
street outreach, 0.13 (12 months);
street outreach 41.9 (24 months);
community mobilisation, 2.13 (24 months); and
community mobilisation (Mpowerment), 7.43 (12 months).

Biomedical interventions:
drug treatment programmes resulted in 0.4 HIV cases prevented (12 months);
STD screening and treatment in HIV clinics, 9.04 (12 months);
STD screening and treatment in the general population, 0.51 (12 months);
HIV antiviral treatment, 26.16 (12 months); and
male circumcision, 4.39 (12 months).

Structural interventions:

condom availability resulted in 136.48 HIV cases prevented (36 months);

needle exchange, 1.89 (3 months);

needle deregulation, 13.98 (9 months);

alcohol tax increases, 67.83 (12 months);

youth supervision programmes, 0.0023 (6 months); and

mass media campaigns, 2,296.47 (84 months).

Cost results
The total costs for the interventions were not reported. Only the costs per person reached were reported.

Synthesis of costs and benefits
Incremental cost-effectiveness ratios of each intervention, compared with the absence of the intervention, were calculated. The measure of benefit used was the one adjusted to 12 months. No incremental analysis was performed to compare the different interventions.

The interventions with a cost-effectiveness ratio below $60,000 were as follows:

individual interventions, discordant couple counselling ($16 000) and videos in STD clinics ($1,300);

community and social network interventions, opinion leader programmes ($8,100), street outreach ($52,000) and community mobilisation (Mpowerment; $12,000);

biomedical interventions, STD screening and treatment in HIV clinics ($12,000); and

structural interventions, condom availability ($22,000), needle exchange ($13,000), needle deregulation ($2,700),
alcohol tax increases ($1,500) and mass media campaigns ($18,000).

The sensitivity analyses showed that the study results were quite sensitive to variations in prevalence of HIV infection and the cost per person reached by the intervention. The results of the sensitivity analysis were reported extensively.

Authors’ conclusions
The methods developed in the study provided a means to understand the general patterns of relative cost-effectiveness of different interventions. The authors found that this cost-effectiveness varied between interventions by several orders of magnitude.

CRD COMMENTARY - Selection of comparators
The rationale for the choice of the comparators was clear. The authors tried to include as many varied strategies as possible, which is a good approach for a cost-effectiveness analyses.

Validity of estimate of measure of effectiveness
The analysis of effectiveness was based on data derived from a review of the literature, although the authors did not explicitly state that this review was systematic. The sources searched and other details of the methodology and conduct
of the review were not given. The studies that provided the model parameters were based on different populations with differing HIV prevalence rates, which is a perfectly acceptable approach for the study question, but the reader must be aware of these specific populations when assessing the generalisability of the study results to their own settings. The validity of the results was enhanced by sensitivity analyses, which considered variability in the estimates over plausible ranges.

**Validity of estimate of measure of benefit**
The numbers of HIV infections prevented were selected as benefit measures in the economic analysis. They were derived from the models produced for each intervention. The time horizon was short, which biased against educational programmes for children with low HIV prevalence rates.

**Validity of estimate of costs**
The cost analysis was conducted from the perspective of the public health system. As such, it appears that all the relevant categories of costs have been included in the study. However, only the intervention costs were included in the analysis. The averted lifetime costs of treatment were used as a threshold in the analysis for determining whether or not an intervention is cost-effective. Sources of the cost data were provided. The costs were treated deterministically in the base-case, but sensitivity analyses were conducted. Appropriately, no discounting was carried out as the costs were incurred during less than two years. Given the great amount of data required for the study, the authors did well to report a cost per person reached and the numbers of people reached per strategy. However, a price year was not reported and neither were details of a price adjustment to a price year.

**Other issues**
Owing to the scope of the analysis, the authors made broad brush comparisons with other economic evaluations. The issue of the generalisability of the cost and effectiveness results to other settings was addressed by the sensitivity analyses. The authors noted some limitations of their analysis. First, comparisons across interventions using different models could be inaccurate. Second, the duration of intervention effectiveness was adjusted to 12 months, and it was unclear whether this adjustment was appropriate. Third, the authors were concerned about the strength of the effectiveness evidence because some primary studies were natural experiments or were not randomised, although others were based on a randomised controlled design. Finally, the effectiveness in terms of changing behaviour varied substantially under different research conditions, which appears to limit the generalisability of the study.

**Implications of the study**
The authors' findings suggested that a comparison of the estimates of the cost-effectiveness of HIV interventions provides insight that could help local communities maximise the impact of their HIV prevention resources.

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