Cost-effectiveness of strategies to reduce mother-to-child HIV transmission in Mexico, a low-prevalence setting

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Objective: To estimate and compare the cost-effectiveness of selected interventions to reduce mother-to-child transmission (MTCT) of HIV in Mexico.

Methods: A spreadsheet-based model was used to examine five scenarios, each estimated using both zidovudine (ZDV) and nevirapine (NVP). Scenarios differ according to coverage, type of voluntary counselling and testing (VCT), restriction to women at higher risk, and whether rapid testing is offered at delivery. Averted adult infections due to VCT are also estimated, as are savings due to averted treatment costs. Results are reported as cost per child infection prevented, net of averted treatment costs (C/CIP).

Results: Among 958 294 women attending public antenatal clinics, increasing VCT coverage from 4% to 85% is estimated to prevent 102 paediatric and 8 adult infections at a C/CIP of US$42 517 using ZDV. In the most restrictive scenario (III), 46 paediatric infections are prevented with a C/CIP of $39 220. Use of NVP increases C/CIP because the reduced drug cost is more than offset by its reduced assumed effectiveness. The cost of detecting infected women (approximately 90% of total) far exceeds treatment costs in such a low-prevalence setting.

Conclusion: Minimization of MTCT costs in low-prevalence settings should focus on VCT costs rather than drug costs. Even the most cost-effective scenario modelled compares unfavourably with other, highly cost-effective maternal/child interventions that still do not reach many Mexicans. However, it compares favourably against several therapeutic maternal/child interventions available in the public sector’s tertiary care hospitals.

Key words: disease transmission, vertical, prevention and control, economics, anti-HIV agents, cost-benefit analysis, HIV/AIDS, Mexico

Introduction

According to UNAIDS, globally more than 90% of the 800 000 HIV infections occurring in 2002 in children under age 15 are attributed to mother-to-child transmission (MTCT) (UNAIDS 1999a). The National AIDS Prevention and Control Council in Mexico (CONASIDA) estimates that the HIV prevalence among pregnant women in 1997 was 0.09% (CONASIDA 1998). Using these figures and the 2 200 000 births registered in Mexico, we calculate that approximately 1980 HIV-positive pregnant women delivered in 1997. Furthermore, we estimate that during 1997, 495 children in Mexico acquired HIV from their mothers. Of these, 330 could have been avoided had the mothers received antiviral therapy and a breast-milk substitute. These calculations are based on an assumed transmission rate of 37% without intervention and the efficacy reported by the ACTG 076 trial (66% reduction in transmission) (Connor et al. 1994).

In this study, we describe the use of a cost-effectiveness model for the comparative analysis of five alternative strategies to reduce MTCT. The model estimates both the costs and the effectiveness of each strategy to prevent MTCT. It also estimates the number of adult infections averted due to voluntary counselling and testing (VCT) as well as the cost saving associated with medical care averted for children and adults who would have become infected in the absence of any intervention.

When a pregnant woman does not receive any intervention, the probability of her infant becoming HIV-positive is equal to the probability that she is HIV-positive multiplied by the probability of vertical transmission. A woman can be offered a treatment to prevent transmission only if she: attends a prenatal clinic, is offered an HIV test, decides to take the test, receives the results and is identified as HIV-positive. We have not considered the possibility of universal nevirapine (NVP) (without HIV testing) as it is not appropriate in low-prevalence settings such as Mexico. For the women who receive an intervention, the probability of MTCT is reduced in accordance with the effectiveness of the intervention.

In the original evaluation, two different zidovudine (ZDV) short courses were considered, but since they are more expensive and appear to be no more effective than NVP, they
have been excluded here. The interventions analyzed individually or in combination are: (a) three stages of HIV testing (pre-test individual or group counselling, HIV test, and post-test counselling); (b) long-course antiviral treatment (ZDV) in accordance with the ACTG 076 protocol (Connor et al. 1994); (c) NVP to the mother once during labour and once to the child 72 hours after delivery; (d) elective caesarean section; and (e) breast-feeding substitution.

**Methods**

**Model description**

This study further develops and applies a model developed by John Stover of The Futures Group International (Bollinger and Stover 1999). The cost-effectiveness results are reported as cost per child infection prevented (C/CIP). This analysis considers only costs borne by the government health sector – the Mexican Secretary of Health (SSA, Secretaria de Salud) – and does not consider costs borne by patients and families. It also only considers the additional costs of adding the MTCT intervention to existing health care services and thus does not include any capital expenses. The additional space needed for storage of drug and other supplies is minimal and occupancy rates in Mexico (unlike highly affected parts of Eastern and Southern Africa) are typically well below 100%. Therefore we assume that no additional physical space is needed to implement the intervention and limit the incremental costs to personnel and supplies, including drugs.

**Structure of the model**

The model is a spreadsheet-based model, which simultaneously estimates and compares two different strategies, but enables the user to enter data for up to five different strategies. It estimates the cost of each component (VCT, ARV, caesarean, formula) per child infection and child death averted; as well as the cost of treatment averted per infection.

**Data sources**

The following estimates for the model’s parameters were obtained from Mexican-specific sources when available; when such data were not available, published data from the international literature were used. Sensitivity analyses were performed to estimate the model’s sensitivity to all of its parameters.

**Cost of voluntary counselling and testing of HIV (VCT)**

The approximate cost of each ELISA HIV test is about US$3 (Marseille et al. 1998). The total cost of VCT was estimated at $8 per woman tested, including $3 for the test and $5 for counselling. The latter was obtained by dividing a counsellor’s monthly salary by the number of clients they can reasonably schedule in a month. As it does not account for inefficiencies and ‘dead time’, it represents a lower bound estimate of the cost per woman. The results are consistent with lower costs estimates ($4) reported by Marseille et al. (1998) for East and Southern Africa, where labour costs are lower.

**Treatment regimens**

The following calculations are based on published recommended doses (Centers for Disease Control, Atlanta, USA, 1994) and the prices paid for drugs by the Mexican Secretary of Health (Hernandez, personal communication). The cost of health provider time for drug administration is not estimated (unlike that for counselling) because the additional time is small and the system is assumed to have sufficient excess capacity so that the incremental cost is minimal. Counselling time is included because we are assuming counselling with dedicated counsellors rather than just with existing prenatal care personnel. All values are expressed in 2001 US dollars. The transmission probabilities associated with each regimen are presented in Table 1.

The model utilizes two treatment regimens: (1) long-course ZDV treatment and (2) NVP treatment.

**Long course ZDV treatment**

Used in AIDS Clinical Trial Group Protocol 076 (ACTG 076) and recommended by the US Centers for Disease Control (Connor et al. 1994), this treatment regimen consists of three phases of therapy: (1) oral ZDV, 100mg five times a day starting between the 14th and 34th week of gestation and continued until labour begins; (2) intravenous administration of ZDV, 2mg/kg of body weight during labour as a loading

### Table 1. Vertical transmission probabilities by type of delivery and feeding

<table>
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<tr>
<th>Type of treatment</th>
<th>Probability by type of delivery and feeding</th>
<th>Caesarean delivery</th>
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<tr>
<td>Nevirapine (HIVNET 012)</td>
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<tr>
<td></td>
<td>Bottle</td>
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<tr>
<td>Nevirapine (HIVNET 012)</td>
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<tr>
<td>None</td>
<td>0.158</td>
<td>0.158</td>
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</tbody>
</table>

Sources: Connor et al. (1994), Bollinger and Stover (1999) and Guay et al. (1999).
dose, followed by a continuous infusion of 1mg/kg of body weight per hour until delivery; and (3) infants are treated orally with ZDV syrup at 2mg/kg of body weight every 6 hours, starting 8 to 12 hours after birth and continuing for 6 weeks. The average cost of the long ZDV therapy is calculated at $526. This cost includes the cost of administering ZDV to the mother for a period of 11 weeks during gestation (the average period of antenatal treatment during ACTG 076), during labour, and to the newborn during the first 6 weeks postpartum.

**NVP treatment**

A new regimen treatment with NVP is incorporated in the model. Researchers from the United States and Uganda found that administration of just two doses (one 200mg dose of oral NVP to mother at the onset of labour, followed by a 2mg/kg oral dose given to their babies within 3 days of birth) reduced MTCT by 50% (Guay et al. 1999). The cost of NVP is calculated at $8 (for the two doses).

**Eligibility for treatment**

It is estimated that 44% of women giving birth in Mexico’s public health care system (SSA) receive prenatal care (Secretaria de Salud 1996). The SSA estimates that of the women receiving prenatal care from public health services, 27% begin attendance in the first trimester of gestation, 34% in the second trimester and 39% in the third (Secretaria de Salud 1996). By the end of the second trimester, therefore, an estimated 61% of pregnant women who will ever receive prenatal care will have had their first visit. Our baseline assumption is therefore that 61% of HIV-positive women who receive prenatal care are eligible for the long course ZDV treatment (i.e. present, are tested and received their results before the 34th week). One hundred percent of HIV-positive women with an attended delivery in a health facility are assumed to be eligible for NVP because such treatment is administered at the time of delivery.

**Number of women who are offered treatment**

Many factors can affect the decision to offer treatment. These include such things as financial constraints, available facilities and logistical difficulties. It is assumed that only 75% of those eligible for long course are offered this treatment. Ninety percent of those eligible for the long course, but who do not receive it, are assumed to be offered NVP. The high percentage of women offered NVP is explained by the short duration and the relative ease of oral drug administration in this regimen in comparison with the long course, which requires intravenous administration. The proportion of the population that is assumed to be eligible for the different regimens was varied in sensitivity analyses; they are not reported here because the model as estimated for Mexico was not sensitive to variation of these parameters across a reasonable range.

**Number of women accepting each treatment**

Women sometimes do not accept treatment when offered, citing reasons such as: (a) belief that the treatment will not work; (b) belief that the treatment is not safe; (c) fear of side effects; and (d) fear of stigmatization (Rothenberg and Paskey 1995; Ladner et al. 1996).

Acceptance rates for the long-course ZDV prophylactic treatment reported from the UNAIDS trial in Africa were 75% (Marseille et al. 1998). The baseline assumptions in this study assume that 75% of those offered the long course accept it and 90% are assumed to accept NVP treatment.

**Number of women complying fully with each treatment**

The effectiveness of a treatment depends, among other things, on the level of compliance. The Centers for Disease Control (CDC) trial conducted in Thailand showed that more than 90% of participants followed the prescribed ZDV treatment at appropriate dosages from the 34th week of pregnancy to delivery (Thaineua et al. 1998). In our study, the baseline parameter values used for full compliance among seropositive mothers are: 70% for the long-course and 95% for women receiving NVP.

**Formal specification of the treatment selection**

**Proportion of pregnant women who receive full long-course ZDV**

The proportion of women who receive the long-course ZDV is the product of the proportion of women eligible for the long-course \( (E_L) \), the proportion offered the treatment \( (O_L) \), the proportion who accept \( (A_L) \) and the proportion who comply with the treatment \( (C_L) \).

\[
\text{Long-course ZDV} = E_L \cdot O_L \cdot A_L \cdot C_L = \Theta_L
\]

**Proportion of pregnant women who receive NVP**

The proportion of women who receive NVP is the product of the proportion of women eligible for NVP \( (E_N) \) minus those who receive the long-course \( (\Theta_L) \), the proportion offered treatment \( (O_N) \), the proportion who accept \( (A_N) \) and the proportion who comply \( (C_N) \).

\[
\text{NVP} = (E_N - \Theta_L) \cdot O_N \cdot A_N \cdot C_N = \Theta_N
\]

**Elective caesarean**

We calculate that the cost of elective caesarean section is the additional cost of elective caesarean sections performed on women who would not have otherwise received an emergency caesarean section. We have no reason to believe that emergency caesareans are more or less common in Mexico than in the USA, or more or less common among HIV-positive or negative women; what is likely to be different is the number of elective caesareans. Our baseline estimate for emergency caesareans is 7%, consistent with the study by Okonofua and colleagues (Regional Reproductive Project 1996; Okonofua et al. 1998). The average additional cost of a caesarean section is calculated at US$322 (Avila, personal communication). In each scenario, we assume that the proportion of HIV-positive women who undergo caesarean
section rises to 50% for women who have been tested (or 43% elective, given 7% emergency). We estimate that 50% is a reasonable coverage target for an elective caesarean section programme, given the disparate conditions in which births take place in Mexico.

**Breastfeeding and formula cost**

MTCT linked to breastfeeding is avoidable through formula feeding (UNAIDS/UNICEF/WHO 1998). The cost of formula per child per month is $31 and is paid for entirely by the SSA (Avila, personal communication). In this study we assume that less than 2% of HIV-positive pregnant women who receive prenatal care and ARV treatment then go on to breastfeed their infants (Avila, personal communication).

**Lifetime paediatric and adult HIV/AIDS treatment costs**

Mexican literature on treatment costs and lifetime treatment costs for either children or adults with HIV/AIDS is limited. Saavedra et al. (1998) estimated an annual average cost of $2550 for children infected with HIV/AIDS and $5504 for adults infected with AIDS in Mexico. No published estimates of paediatric lifetime costs are available. Using Saavedra’s annual estimates and assuming average post-infection survival of 7 years for children, 10 years for adults and a discount rate of 5%, we calculated the average net present values of lifetime treatment costs for Mexican children and adults to be $11 040 and $31 848, respectively.

Some critics of programmes to prevent MTCT have argued that the costs of caring for orphans should be added to the cost of preventing transmission, because a large proportion of the children who are born ‘uninfected’ as a result of the programme will lose one or both parents before the age of 15. Such costs have not been included here for several reasons. First, it is not customary in cost analyses of health interventions to include the non-medical costs of supporting survivors – if that were customary then almost any life-saving intervention for persons close to retirement would be prohibitively expensive. Second, we have assumed the perspective of the government health sector which would not bear the costs of orphanhood. However, even if we adopted a social perspective, only the incremental costs of orphanhood would be included – and in the absence of studies, it is not at all certain that more is spent on average to maintain an orphan than is spent on a child with living parents.

**Behaviour change among HIV-negative pregnant women**

No Mexican studies are available that assess the proportion of pregnant women who change their risk behaviour as a result of HIV testing and counselling. Studies in other countries suggest that this figure ranges between 0 and 80% in settings where the HIV prevalence is high. It is difficult to extrapolate these estimates to a low-prevalence setting such as Mexico (Higgins et al. 1991; Asiimwe-Okiror et al. 1997). A meta-analysis by Weinhardt and colleagues in 1999 did not show any consistent impact of HIV testing on the behaviour of HIV-negative participants (Public Health Service Task Force 2002). In Scenario 1 for this study, we assume that 0% of HIV-negative pregnant women in Mexico change their behaviour (eliminating their risk of sexually acquired infection) as a result of counselling or testing. In the sensitivity analysis we increase behaviour change 30%.

**Treatment efficacy**

Treatment efficacy varies from 67% in the ACTG 076 trial to 50% in a NVP trial sponsored by the National Institute of Allergy and Infectious Diseases (Connor et al. 1994; Bollinger and Stover 1999; Guay et al. 1999). Table 1 shows these results as summarized by the Futures Group (Bollinger and Stover 1999).

**HIV prevalence**

Data from sentinel sites in Mexico, as reported by CONASIDA, indicate a prevalence rate among pregnant women of 0.04% in 1991 and 0.09% in 1997 using ELISA and Western Blot testing. For the baseline analysis and for cost calculations in this study, we use the 0.09% prevalence as the proportion of pregnant women who test positive and are thus eligible for treatment. For effectiveness calculations, however, we estimate the proportion of women testing positive who are truly infected (0.0816%) using a specificity and sensitivity for the ELISA/WB combination of 0.9999 and 0.98, respectively.

**Economic analysis and outcome measures**

The perspective used in this study for cost analysis is that of the Mexican Secretariat of Health (SSA, Secretaría de Salud) and includes only additional direct costs borne by the SSA.

**Outcome measures**

The total cost of each strategy is the sum of its component interventions. The cost-effectiveness of each scenario is evaluated in terms of the cost per child-infection averted:

\[
(C_{\text{MTCT}} - P_P C_{\text{Tx}})/ P_P e
\]

where \(C_{\text{MTCT}}\) is the cost of identifying a positive woman and providing treatment to her, \(P_P\) is the probability that she would have transmitted HIV to her child, \(P_e\) is the probability that the MTCT prevention is effective at preventing that transmission, and \(C_{\text{Tx}}\) is the lifetime cost of treating a child with HIV infection. The model also calculates child deaths averted and adult infections averted. Child deaths averted are calculated by subtracting the number of children who would have died before age 5 from the number of child HIV infections averted. Adult infections averted are calculated by adjusting the probability of infection according to the percentage of HIV negative women who change risk behaviours after VCT.

**Scenarios**

Scenarios were chosen to reflect the range of options under consideration by the Mexican government for MTCT prevention of HIV/AIDS. Each scenario described below is
estimated using both ZDV and NVP. We assume that all women who test positive are advised not to breastfeed and are provided with formula free of charge. In Scenario III a questionnaire was designed to identify pregnant women at higher risk for HIV infection. The HIV prevalence among the women at higher risk is estimated to be 0.15%, assuming questionnaire sensitivity of 0.50 and specificity of 0.70. These figures are varied in the sensitivity analysis.

I. Status quo: assumed that 4% of pregnant women who receive prenatal care are counselled individually and tested for HIV, and that the 076 treatment protocol, the short-course and intrapartum and neonatal treatment (in descending order) are offered to those who are eligible. Treatment with NVP is also estimated.

II. Same as status quo with increase in VCT from 4% to 85%.

III. Administering a questionnaire to 85% of pregnant women and offering VCT to those 30% identified at highest risk; treatment as in Scenarios I and II.

IV. Same as Scenario II, except that women receive group pre-test counselling and only HIV-positive pregnant women receive individual post-test counselling.

V. Same as Scenario IV, with an additional 15% of women who arrive for delivery without VCT and who are offered HIV rapid testing and, if HIV-positive, treatment. These figures vary in sensitivity analysis.

Results

In the ZDV programme, child deaths averted ranged from 4 with the status quo, Scenario I, to 89 with Scenario V. Child infections averted ranged from 4 with the status quo to 102 with Scenario V. Adult infections averted due to VCT range from almost 0 in the status quo to 8 with Scenario V if 30% of HIV-negative women eliminate their risk behaviour.

The expected total cost of the intervention with ZDV ranges from $268 359 with Scenario I to $5 723 943 with Scenario II. Offering pre- and post-test counselling to all women who agree to be tested makes Scenario II the most costly, followed by Scenario V. The cost results are presented in Table 2.

Scenario V would be the most effective intervention since it prevents 102 child infections at a cost of $25 300 per infection averted. Scenario III is the least effective (excluding the base case); it prevents only 46 child infections.

In the NVP programme, child infections averted ranged from three with status quo to 72 with Scenario V. Adult infections averted do not differ from the ZDV results above. The expected total cost of the intervention with NVP ranges from $259 262 with the status quo to $5 524 724 with Scenario II. Scenario V would be the most effective of the five, since it

<table>
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<tr>
<th>Outcome categories</th>
<th>Scenario 1 (Base case)</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
<th>Scenario 5</th>
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<td>40</td>
<td>79</td>
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prevents 72 child infections at a cost of $57 132 per infection averted. Scenario III is slightly more cost-effective, at $53 267 per child infection averted, but it prevents only 32 child infections. Table 2 shows the results of the NVP programme. Under any of the scenarios NVP is less cost-effective than ZDV.3

Using the baseline assumptions, the cost per child death or infection averted rises modestly from Scenario III to IV and V, but the total number of infections averted more than doubles. Any of the three are more cost-effective than Scenarios I and II. Scenario II is also more costly and is thus dominated – under no circumstances would it make sense to simply increase coverage of the existing programme to 85%. Scenario I might appear the logical choice if the maximum available budget were less than $1 million. However, in reality it is just a scaled-down version of Scenario II; any of the other scenarios could similarly be scaled down to stay within a budget constraint and thus Scenario I is also dominated. An incremental analysis was done of the additional cost and effectiveness changing from Scenario IV to Scenario V, with the result that the incremental cost per child infection averted is significantly higher than Scenario V, but still much lower than Scenario I or II.

**Sensitivity analyses**

All baseline inputs were varied to assess the robustness of the results of the decision model. Univariate sensitivity analyses are presented here for seven of the most important parameters: maternal HIV prevalence; VCT costs; additional costs of caesarean-section birth; formula costs; lifetime discounted paediatric AIDS treatment costs; lifetime discounted adult AIDS treatment costs; and percentage of women whose behaviour changes.

**HIV prevalence**

The estimate for maternal HIV prevalence was varied between 0.03% and 0.15%. At the lower extreme (0.03%), one paediatric infection would be prevented under Scenario I and 26 would be prevented under Scenario V. At the upper extreme (0.15%), eight paediatric infections would be averted under Scenario I and 181 under Scenario V. Maternal HIV prevalence also has an important effect on the net cost per child infection averted. At an HIV prevalence of 0.03% the net cost per child infection averted is estimated at $220 790 under Scenario I and $120 942 under Scenario III. At a prevalence of 0.15%, the net cost per child infection averted is estimated at $23 104 under Scenario I and $8908 under Scenario III (Figure 1).

**Voluntary counselling and testing**

VCT cost is varied from $4 to $12. The cost per child infection averted varies widely with changes in the cost of VCT. At a cost of $4 the total cost is estimated at $150 708 under Scenario I and $3 287 185 under Scenario V. At a cost of $12, the total is estimated at $411 364 under Scenario I and $8 763 812 under Scenario V. At a cost of $4 the net cost per child infection averted is estimated at $7466 under Scenario III and $20 964 under Scenario I. At a cost of $12, the net cost per child infection averted is estimated at $49 291 under Scenario III and $93 257 under Scenario I (see Figure 2).

**Lifetime discounted paediatric HIV/AIDS treatment costs**

Lifetime treatment costs are varied from $5000 to $25 000 per infected child. The net cost per child infection averted decreases linearly. At $5000 per infected child, the net cost per child infection averted ranges from $35 356 in Scenario III to $59 333 in Scenario I. At $25 000, the net cost per child infection averted ranges from $14 445 in Scenario III to $39 333 in Scenario I (Figure 3).

**Questionnaire sensitivity**

Questionnaire sensitivity (Scenario III) was varied from 30% to 70%. At 30%, 27 paediatric infections would be averted and at 70%, 64 paediatric infections would be averted. Using the same range, the net cost per child infection averted is
estimated at $47 661 and $14 845, respectively. Below 30% sensitivity, Scenario III is less cost-effective than Scenario I (Figure 4).

Why the scenarios may be less cost-effective than reported

The Mexican the population is served by multiple, parallel health care systems with very low and high levels of quality and coverage of care for the very poor and the very rich, respectively. The decision to assume that the existing infrastructure and referral network in the SSA health system is adequate for implementation of the proposed scenarios certainly is not an accurate reflection of the reality of this system and would tend to underestimate the true cost per death averted. In other health care systems however, such as the Social Security system (IMSS), it would be easier to implement an MTCT programme as the IMSS already has a functioning referral system and most beneficiaries deliver in a clinic or hospital.

As a result, an MTCT prevention programme might not be sufficiently cost-effective to be adopted by the SSA system which serves the poor, but in the government-run, very well funded health system for PEMEX, it could be considered highly cost-effective. Not only is the implicit cost-effectiveness threshold different in the different systems, but the cost of care averted by preventing HIV infections is also very different. Thus, MTCT prevention in the PEMEX system would likely be more cost-effective in both absolute and relative terms.

In addition, the baseline parameters in the model reflect the patient compliance figures that were observed in clinical trials. The compliance that would be attainable in an operational setting is almost certainly lower, though this would be expected to affect the cost-effectiveness of ZDV far more then NVP.

Why the scenarios may be more cost-effective than reported

While data from clinical trials may overestimate compliance with ARV therapy, the model assumes that therapy is completely ineffective in women who are not fully compliant. Use effectiveness is almost certainly greater than zero among women who are partially compliant, thus this would tend to underestimate cost-effectiveness.

The estimates used for the potentially averted cost of care for HIV-infected children are taken from a 1997 study conducted by CONASIDA. Since that time, the SSA has established a fund for purchasing antiretroviral drugs and gives priority to infected pregnant women and their children. As a result, the cost of care for HIV-infected infants is likely to already be higher than that previously reported, and every $1000 increase in cost of care approximately translates into a $1000 reduction in cost per infection or death averted.

In calculating the cost per child death averted, we have included the cost savings associated with adult infections averted among HIV-negative women because of behaviour change induced by the VCT. However, in an attempt to be consistent with other models in the literature we have reported the results as cost per child death averted, rather than cost per death averted. It would be logical to allocate...
some of the costs to prevention of adult infections/deaths and this would lower the cost per child death averted.

We only considered infections averted among HIV-negative women. To assume that there is no onward transmission from perinatally infected infants is an appropriate approximation, as most of them will unfortunately die before they begin sexual activity. Among adults, ignoring future secondary infections will significantly underestimate both infections averted and savings in averted treatment costs due to the prevention programme, making the programme appear less cost-effective than it actually is.

If a policymaker makes the decision to implement MTCT prevention programmes, then s/he is next confronted with the question of which to implement. The scenarios were constructed after preliminary work with the model, using Mexican data, revealed that due to the low HIV prevalence among pregnant women, the model was driven by the cost of VCT. Thus the scenarios reflect different possible approaches to reducing the cost of VCT from that associated with the ‘standard’ VCT approach advocated by, among others, the CDC, UNAIDS and WHO (UNAIDS 1999b).

The results presented here suggest that it is possible to reduce by approximately half the cost-per-child-death-averred by either eliminating post-test counselling for HIV-negative women or by applying pre-test questionnaires about risk behaviours and only offering VCT to the 30% at highest risk. These results are based on hypothetical scenarios and use cost parameters extrapolated from a pilot project that offered conventional VCT. Before making large-scale policy decisions based on these results, the scenarios would need to be validated and costed in pilot settings.

The decision to analyze both ZDV and NVP reflected the desire to see if the dramatic reductions in cost of a MTCT programme due to NVP reported from Africa would also be seen in Mexico (Marseille et al. 1999). Data from prior trials suggest that NVP is less effective than ZDV and this is assumed to also be true in a Mexican population. However, even if ZDV is used it still represents only approximately 2% of total costs. Thus, the cost of VCT that is ‘wasted’ due to the lower effectiveness of NVP is estimated to be far greater than the saving in drug costs associated with switching from ZDV to NVP. The difference in compliance between the two is likely to be greater than that observed in the clinical trials and this would reduce the true effectiveness of ZDV relative to NVP, reducing the difference in cost-effectiveness. Furthermore, the difference in effectiveness only applies to those women who are able to take ZDV prenatally; for those receiving treatment only during labour and to the infant post-delivery, NVP is assumed to be equally effective and thus far more cost-effective.

Current SSA policy is in favour of implementing MTCT prevention using an approach resembling Scenarios I/II. These results suggest that if such a programme is continued, it should explore less costly ways to implement VCT. However, even the most cost-effective Scenario (III) is at best only marginally cost-effective compared to other interventions to reduce infant/child mortality, suggesting that the SSA should question whether to implement a detection programme at all. To resolve this question additional work in several areas would be useful. First, more precise and representative estimates of maternal HIV prevalence are needed given the exponential relationship between prevalence and cost-effectiveness of MTCT prevention. Secondly, estimates of the cost of different VCT options need to be based on costing of actual interventions rather than desk-based estimates. Thirdly, additional approaches to reducing the cost of VCT need to be considered. Finally, to inform any policy regarding MTCT prevention, an estimate is needed of the cost of caring for infected children based on the current standard of care in the SSA, rather than one which predates widespread use of antiretrovirals in this population.

Endnotes
1 Dollars are US dollars throughout.
2 More children get infected than die from their infection because some of the ones infected would have died anyway from other causes.
3 We have no information from any study using both ZDV and NVP. Our conclusion is dependent on the cost of ZDV, but more importantly, it depends upon the ZDV regimen being more effective than the NVP and the very high cost of identifying a positive pregnant woman when prevalence is very low.
4 The design of the hypothetical questionnaire is different from that of a typical lab test with a threshold value that distinguishes a positive from a negative test. In such a case, as the sensitivity increases, the specificity usually decreases. In this case we assume that a questionnaire is applied and the 30% that score the highest on the questionnaire then go on for HIV testing. Assuming a sensitivity of 30% is the same as a questionnaire that does nothing (as 30% of the women are tested, if the questionnaire is useless, 30% of the positive women would be identified). As expected, in that case the specificity is 70%. As the sensitivity is increased to 70% (concentrating more of the very small number of positive women into the 30% that score higher), the specificity actually increases, but only to 70.036% because the vast majority of the women among the 30% that are tested are still HIV negative when the HIV prevalence is only 0.09%.

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