National and provincial estimated costs and cost effectiveness of a programme to reduce mother-to-child HIV transmission in South Africa

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Objective. To estimate the cost and cost effectiveness nationally and for each province of a programme to reduce mother-to-child transmission (MTCT) of HIV in South Africa.

Methods. A model developed to estimate cost and cost effectiveness of interventions in Hlabisa, KwaZulu-Natal, was modified and applied to each province. This model predicts a 37% reduction in paediatric HIV infections if short-course oral zidovudine (ZDV) plus infant formula feed for 4 months is provided within a strengthened health system. Estimates of the number of pregnancies and HIV prevalence among pregnant women per province in 1997 were combined with an estimated 30% MTCT rate. Costs were calculated from a health system perspective, and effectiveness was estimated as cost per infection averted and cost per disability-adjusted life year (DALY) gained.

Results. In 1997, 63,397 paediatric HIV infections were estimated to have occurred in South Africa, mainly in KwaZulu-Natal (18,513, 29%) and Gauteng (10,417, 16%). The cost of a national programme is estimated at R155.9 million (1997 rand costs, 0.94% of the national health budget). Major cost items are drugs (R46.4m, 30%), staff salaries (R45.8m, 29%), and formula feed (R37.1m, 24%). Most money would need to be spent in KwaZulu-Natal (R37.6m, 24% of national cost), Gauteng (R25.2m, 16%) and the Eastern Cape (R24m, 15%). National cost per infection averted is R6,724, and R213 per DALY gained. Provincial DALY costs range from R176 to R369.

Conclusions. A national programme preventing 37% of expected paediatric HIV infections would cost a small fraction of the national health budget, at a cost equivalent to R3.89 per capita total population. The cost per DALY gained compares well with established public health and clinical interventions in middle-income countries, even without factoring in the care costs that would be saved through a successful programme. Cost effectiveness is greatest where HIV prevalence is highest.

South Africa is suffering from an explosive HIV epidemic, among the worst in the world, with HIV prevalence among pregnant women close to 30% in some areas. The number of children infected with HIV, and the incidence of illness in these children, are rising rapidly. In Hlabisa Hospital, KwaZulu-Natal, 26% of children admitted to the paediatric medical wards in 1997 were HIV-infected.

Most HIV-infected children are infected by their mothers during pregnancy, birth or through breast-feeding. A costly, complex regimen of zidovudine (ZDV) that excludes breast-feeding (ACTG076) was found to reduce mother-to-child HIV transmission (MTCT) by 67%. Adoption of this regimen, plus safe obstetric practice, has virtually eliminated MTCT in some developed countries. A short, oral course of ZDV combined with infant formula feeding in Thailand reduced MTCT by 51%, and UNAIDS has recommended that developing countries plan the implementation of programmes to reduce MTCT.

Before effective implementation is possible, and if maximum public health benefit is to be achieved, careful planning is required.

We have presented data suggesting that only 11% of expected paediatric HIV infections might be prevented if antiretroviral drugs are made available in the public sector within current resource constraints in the Hlabisa district. However, with appropriate health system strengthening we estimated a possible 37% reduction in HIV infections. In the present paper we apply our model to South Africa as a whole and to the nine provinces, and use it to appraise the cost and cost effectiveness of a ZDV intervention programme at these levels.

Methods

Model

We first developed a detailed model for the Hlabisa health district in KwaZulu-Natal (population approximately 250,000, antenatal HIV prevalence 26% in 1997) that used data from several studies done in the district to estimate the possible effect of interventions to reduce MTCT under different scenarios. We then applied this model to the whole of South Africa. The annual number of pregnant women per province and HIV prevalence in pregnant women per province were...
taken from reports published by the national Department of Health. Applying an estimated MTCT rate of 30%, the expected number of paediatric infections was estimated for each province and the country as a whole for 1997, assuming that there was no intervention to reduce MTCT in place at the time.

**Steps required to reduce vertical transmission**

If a programme to reduce MTCT is to have maximal public health impact, then several distinct steps are required: (i) as many pregnant women as possible must attend antenatal care as early as possible; (ii) as many women as possible must be counselled about the potential intervention, tested for HIV infection, receive test results and be counselled accordingly; (iii) as many women as possible must receive the intervention and be adherent to it; (iv) as many women as possible must deliver either in hospital or clinic so that intra-partum anti-retroviral drugs can be administered; (v) risk from breast-feeding should be minimised as breast-feeding contributes approximately 30% of the risk of vertical transmission; and (vi) paediatric follow-up — in order to provide support and to assess the impact of the intervention, the mother-child pair requires regular assessment; it may be important to determine early in the postnatal period whether the intervention has been successful so as to guide further feeding practice decisions and because the parents are likely to want to know.

As previously described for Hlabisa, it seems likely that these steps cannot be achieved within current resource and infrastructure constraints in much of South Africa. We therefore modelled one possible national programme to reduce MTCT.

In this model ZDV is provided as in the Thai protocol. We assumed that substantial efforts are being made to enhance service infrastructure, with the goal of improving programme delivery. Enhancements include: widespread health promotion to encourage early attendance for antenatal care and to inform the community about the intervention available, on-site (rapid test) HIV testing, extra staff to increase counselling capacity, an assured drug supply, extra staff to provide a 24-hour maternity service in all clinics, and avoidance of breast-feeding when safe and feasible. Infant milk formula is provided for 4 months.

To estimate effectiveness we assumed that health promotion is successful and that only 2.5% of pregnant women do not attend antenatal care. Due to on-site HIV testing and increased counselling capacity we assumed that 75% of women accept testing, receive the result and receive the intervention. The MTCT rate among these women is assumed to be 15% (50% reduction). The remaining 25% do not receive ZDV and experience a 30% MTCT rate.

**Intervention costs**

The cost analysis was undertaken from the perspective of the health system. Each intervention component was costed individually. Drug costs were based on those recently announced for developing countries by Glaxo-Wellcome (P Moore, Glaxo-Wellcome — personal communication), and formula feed costs were estimated using government tender prices (Dr G Gray, Perinatal HIV Research Unit — personal communication). HIV test costs were based on existing market quotes.

The cost of extra staff, training and health education were estimated on a per pregnant woman screened basis, using the model developed for Hlabisa. For example, the total cost of extra counselling capacity required in Hlabisa was divided by the number of women receiving counselling, and the cost of extra midwives was divided by the numbers of women receiving the ZDV intervention. Staff costs were based on gross salary figures. The largest cost was for counselling. In the Hlabisa model, it was assumed that professional nurses would do the counselling. Since this seemed unrealistic for South Africa as a whole (not enough extra nurses could be recruited), in the national model we assumed that trained lay counsellors would be used and that they would receive a salary 50% of that paid to a nurse.

**Calculation of cost effectiveness**

Cost data were combined with our estimate of effectiveness to calculate the cost per infection prevented. The number of disability-adjusted life years (DALYs) gained per infection prevented was calculated using a life expectancy of 69 years, the average for South Africa in 1997. The DALY is a composite measure that allows valid comparisons of the effectiveness of different interventions. The cost per DALY was calculated by dividing the cost per infection prevented by the number of DALYs gained per infection prevented.

**Sensitivity analysis**

A sensitivity analysis was undertaken to determine the impact that reduced programme effectiveness (25% reduction in the number of paediatric HIV infections versus 37% reduction) and life expectancy (49 years average life expectancy among HIV uninfected children versus 69 years) would have on our estimates.

**RESULTS**

**Estimated number of paediatric HIV infections in 1997**

As reflected in Table 1, the estimated number of paediatric HIV infections by province for 1997, based on the estimated prevalence of HIV infection among pregnant women and the number of pregnancies, is highly variable. Most infections occurred in KwaZulu-Natal (18 513, 29%), Gauteng (10 417, 16%) and the Eastern Cape (8 672, 14%), with few in the Western Cape (1 751, 3%) and Northern Cape (558, 1%).
### Table II. Unit costs of programme components

<table>
<thead>
<tr>
<th>Programme component</th>
<th>Cost (rands)</th>
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</thead>
<tbody>
<tr>
<td>ZDV per woman</td>
<td>300</td>
</tr>
<tr>
<td>Infant milk formula (4 months)</td>
<td>240</td>
</tr>
<tr>
<td>Single rapid HIV test</td>
<td>13</td>
</tr>
<tr>
<td>Double ELISA HIV test</td>
<td>13</td>
</tr>
<tr>
<td>Single ELISA HIV test</td>
<td>7</td>
</tr>
<tr>
<td>Health promotion (per woman screened)</td>
<td>2.4</td>
</tr>
<tr>
<td>Training existing staff (per woman screened)</td>
<td>4.3</td>
</tr>
<tr>
<td>Extra counsellors, midwives and laboratory technicians (per woman screened)</td>
<td>35.8</td>
</tr>
</tbody>
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ZDV = zidovudine; ELISA = enzyme-linked immunosorbent assay.

### Total costs

As reflected in Tables I and III, the major programme costs are salaries for counsellors (R45.8 million, 29%), antiretroviral drugs (R46.4 million, 30%) and infant milk formula (R37.1 million, 24%). These costs vary substantially by province. For example, staff costs and HIV test kit costs both depend primarily on the number of pregnant women in a province, and on the number who are screened. Drug costs and infant formula costs primarily depend on prevalence of HIV infection among pregnant women.

### Table III. Total and component costs of a national programme to reduce mother-to-child HIV transmission in South Africa

<table>
<thead>
<tr>
<th>Programme component</th>
<th>Cost (rands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counsellor salaries</td>
<td>45 794 703 (29)</td>
</tr>
<tr>
<td>Antiretroviral drugs (zidovudine)</td>
<td>46 599 093 (30)</td>
</tr>
<tr>
<td>Infant milk formula</td>
<td>37 087 274 (24)</td>
</tr>
<tr>
<td>HIV tests</td>
<td>16 861 974 (11)</td>
</tr>
<tr>
<td>Training</td>
<td>6 234 880 (4)</td>
</tr>
<tr>
<td>Health promotion</td>
<td>3 530 084 (2)</td>
</tr>
<tr>
<td>Total</td>
<td>155 872 008 (100)</td>
</tr>
<tr>
<td>Total as % national health budget</td>
<td>0.94</td>
</tr>
<tr>
<td>Total as cost/capita (total population)</td>
<td>3.89</td>
</tr>
</tbody>
</table>

We estimate the total cost of a national programme at R155 872 008, equivalent to approximately 0.94% of the national health budget. Provincial programme costs vary from 0.61% to 1.88% of provincial health budgets (Table I).
Cost effectiveness

Nationally, the cost per paediatric HIV infection prevented is estimated at R6 724. This figure varies from R4 232 in KwaZulu-Natal to R11 656 in the Western Cape, reflecting the efficiency of providing interventions in high-prevalence settings. The cost per DALY gained is R213 nationally, varying from R134 in KwaZulu-Natal to R369 in the Western Cape.

In our sensitivity analysis, assuming 25% reduction in the number of infections rather than 37%, and assuming life expectancy of 49 years rather than 69 years, the cost per infection prevented is R9 830, and the cost per DALY gained is R311, nationally.

We estimate that the cost of such a national programme is equivalent to 0.94% of the national health budget and is equivalent to an expenditure of R3.89 per person living in South Africa.

DISCUSSION

This model suggests that a national programme to reduce mother-to-child HIV transmission in South Africa is potentially affordable and cost effective. It would cost less than 1% of the national health budget and the cost/DALY compares favourably with figures for clinical and public health interventions already in place. For example, when costed in 1990, the Expanded Program on Immunisation Plus programme was estimated to cost US $25 - 30 per DALY gained, and family planning was estimated to cost US $100 - 150 per DALY gained. However, there is substantial variation in HIV prevalence across South Africa. The most efficient approach might be to phase the implementation of any programme, starting in high-prevalence settings such as KwaZulu-Natal, Mpumalanga and Gauteng, since it is notable that the intervention would be most cost effective in these areas.

Limitations of the model

Modelling exercises of this nature are inherently limited. They are dependent on available data from other studies and on assumptions made about the applicability of these data to other settings. We aimed to use the best available published data in our model. We used a published model developed for Hlabisa and extrapolated it to the rest of South Africa. Clearly, several of the conditions that hold in Hlabisa will not hold precisely elsewhere in the country. For example, the proportion of women that attend for antenatal care may vary, the acceptance of HIV counselling and testing and access to test results will differ and the ease of ensuring a secure drug supply is also likely to differ by site. As data on such variables are not available for other sites in the country, the best we can do is to state our assumptions explicitly, to modify them as new data become available, and to make the model available to others who wish to modify it.

We relied on population and fertility estimates based on the 1991 census, and while these may be too high, no revised data were available from the 1996 census at the time of this study. There is also no consideration given to activity in the private sector. We found no published data on utilisation rates of private sector obstetricians, HIV prevalence, or current practice around MTCT interventions in the private sector. Costs in the private sector are higher than in the public sector and hence the total cost of a national programme is likely to be higher than the cost we estimated here. However, private sector utilisation will not affect the cost to the government of a national public sector programme.

We may have overestimated the total cost of the programme. In some urban and well-developed areas there may be little need to strengthen health services with extra staff, extra clinics and on-site HIV testing. In other, very remote and underdeveloped areas, substantial extra effort and expenditure may be needed to provide a reasonable service. Some of the extra costs we considered, e.g. laboratory services and staff time, might be shared across other activities and programmes within the health service. Should the public sector pay for and provide infant formula? While leaving the cost of formula to mothers would substantially reduce programme costs from a health service perspective, there would be a danger that programme effectiveness might fall, as avoidance of breastfeeding is a key component of the intervention.

It is also important to note that this modelling exercise has not incorporated the savings to health service costs that a MTCT programme would inevitably generate.

By averting HIV infection among a large number of children, costs associated with medical care for HIV-related problems among HIV-infected children would fall. There are few data to guide the size of these cost savings, but if the cost of medical care per HIV-infected child exceeds R6 724 (the cost of averting an infection), then the intervention would actually be cost saving. Data from elsewhere concerning the cost of care for adults with AIDS suggest that it is conceivable that care costs could be this high. One major problem in this modelling exercise is that we have little idea about what these care costs are likely to be in practice. It is therefore a priority to assess them more thoroughly as they could make the case for a national MTCT intervention both more convincing and more accurate.

It is also important to raise the issue of the potentially negative impact of bottle-feeding on the community, its health, and the costs of health care. Most HIV-infected pregnant women have HIV-uninfected children, and although we cannot identify who they will be, breast-feeding would remain their preferred feeding choice. Similarly, there must be concern about bottle-feeding, with its negative health consequences, gaining favour among HIV-uninfected women.

It seems possible that provinces would develop programmes...
tailored towards their own needs. Some provinces with a very low burden of HIV infection might not consider an MTCT programme a priority. Some might not need to provide extra staff or staff time for their programmes; others may choose to provide infant milk formula for 6 months rather than 4 months. Our model is simple and easy to use and interested parties are encouraged to modify it and so estimate the costs and cost effectiveness of programmes under different scenarios. As new data become available they can also be used to modify the model. This process is now underway.

References

FROM POLICY TO PRAxis – A FRAMEWORK FOR THE DELIVERY OF DISTRICT MENTAL HEALTH CARE IN KWAZULU-NATAL

I Petersen, A Bhagwanjee, A Parekh

This article provides a schema for the provision of mental health care at district level. A framework for service delivery was derived from research conducted by the Community Mental Health Programme (CMHP) into the development of aspects of a district mental health care system in a semi-rural community area in KwaZulu-Natal. Furthermore, information was drawn from interviews with key stakeholders, national and provincial policy documents as well as international experience in the implementation of community-based systems of mental health care.

The implementation of a national health care system in South Africa based on the principles of universal primary health care necessitates an urgent restructuring of mental health care services. Historically, the latter has existed as a vertical service within the health care system, providing largely institutional and curative care for the seriously mentally ill. Current policy imperatives, as contained within the White Paper on the Transformation of the Health System in South Africa, emphasise the need for a shift towards a comprehensive and community-based mental health care system that is integrated with other primary care services and provided by appropriately trained multidisciplinary health care teams. Within this approach mental health care is conceptualised broadly to include the promotion of the psychosocial well-being of the population as a whole.

In line with these policy imperatives, this article provides a schema for the delivery of district-based mental health care in KwaZulu-Natal. A framework has been developed that has been informed, in the first instance, by the work of the Community Mental Health Programme (CMHP), which has been involved in developing aspects of a district mental health care system in the KwaDedangendale community area in the