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Universal HIV screening of pregnant women in England: cost effectiveness analysis

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Abstract

Objective To estimate the cost effectiveness of universal, voluntary HIV screening of pregnant women in England.

Design Cost effectiveness analysis. Cost estimates of caring for HIV positive children were based on the stage of HIV infection and calculated using data obtained from a London hospital between 1986 and 1996. These were combined with estimates of the health benefits and costs of antenatal screening so that the cost effectiveness of universal, voluntary antenatal screening for HIV infection in England could be estimated.

Main outcome measures Lifetime, direct costs of medical care of childhood HIV infection; life years gained as a result of the screening programme; net cost per life year gained for different pretest counselling costs; and different prevalence rates of pregnant women who were unaware that they were HIV positive.

Results Estimated direct lifetime medical and social care costs of childhood HIV infection were £178 300 using a 5% discount rate for time preference (1995-6 prices). In high prevalence areas screening pregnant women for HIV is estimated to be a cost effective intervention with a net cost of less than £4000 for each life year gained. For areas with comparatively low prevalence rates, cost effectiveness could be less than £20 000 per life year gained, depending on the number of pregnant women who are unaware that they are infected and local screening costs.

Conclusions Our results confirm recent recommendations that universal, voluntary antenatal HIV screening should be implemented in the London area. Serious consideration of the policy should be given for other areas in England depending on local prevalence and screening costs.

Introduction

In England the uptake of antenatal HIV screening is comparatively low despite the existence of guidelines on antenatal screening for pregnant women.[1] Detection of HIV infection in pregnant women allows the risk of mother to child transmission to be reduced.[2–4] This study analyses the cost effectiveness of an antenatal HIV screening programme.

Methods

We assessed the cost effectiveness of universal, voluntary HIV screening of pregnant women in England in terms of healthcare costs to the NHS. A staged, progression of disease model was developed

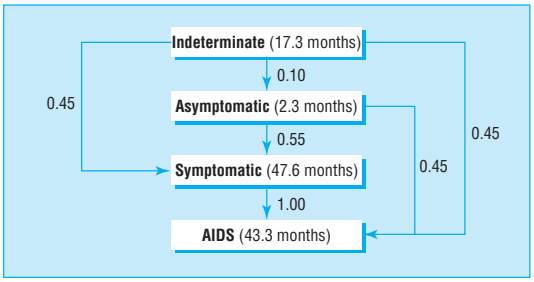

Fig 1 Model shows the progression of disease in HIV positive children. The mean duration of stay in each of the stages of the disease and the probability distribution for progression from one stage to another are also shown

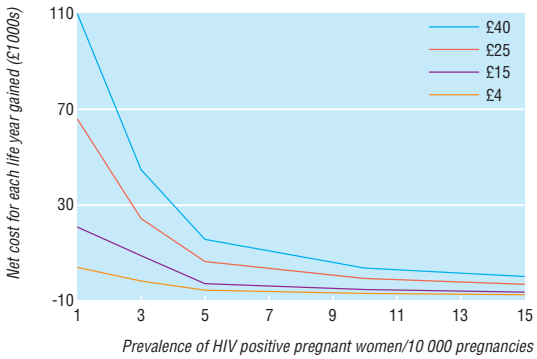

Fig 2 Cost for each life year gained with universal antenatal screening for different prevalences of women who do not know that they are HIV positive at different screening costs

using clinical and epidemiological data and estimates of the cost of caring for children with HIV calculated between 1986 and 1996.[5–6] The analysis is based on the effects of testing one pregnant woman who is unaware that she is infected with HIV, and we excluded from the analysis women who request an HIV test during pregnancy. Effectiveness was measured in terms of life years gained among children in whom infection with HIV was averted and in life years gained because of earlier antiretroviral treatment of the mothers. Costs considered included those of serological screening for HIV antibodies, pretest and post-test discussions and counselling, antiretroviral treatment, elective caesarean section, and the additional cost of formula feeding compared with breast feeding.

The probabilities for mother to child transmission used within the model were 14% for breast feeding,[2] 18% during pregnancy and vaginal delivery in the absence of zidovudine treatment,[3] 10% during pregnancy and caesarean delivery without zidovudine,[3] 8% with zidovudine treatment for the mother during pregnancy and for the child with a vaginal delivery,[4] and a 6% transmission rate was assumed for zidovudine treatment and a caesarean delivery. Independent probabilities were assumed for breast feeding and delivery. The zidovudine regimen used in the model was similar to AIDS clinical trials group protocol 076.[4] In the absence of preventive measures the probability of mother to child transmission was calculated to be 29%, which decreased to 23% if a caesarean section was performed, and to 6% if all preventive measures were implemented.[2–4] Four clinical stages of HIV infection were considered: indeterminate, asymptomatic, symptomatic non-AIDS, and AIDS.[7] The duration of stay within each clinical stage was assumed to be exponentially distributed (fig 1). Transition rates between the stages are described in figure 1.

The lifetime costs of hospital and community care for a child infected with HIV were estimated at £178 300 for the 1993-4 financial year indexed to 1995-6 prices[8] and were discounted at 5% (3% and 7% in the sensitivity analyses).[9] Lifetime costs of caring for a child infected with HIV were varied in the sensitivity analysis.

We assumed that the uptake of zidovudine among HIV positive pregnant women was 75% and that elective caesarean sections occurred in 40% of deliveries in HIV positive women.[10–11] The rate of emergency caesarean sections among HIV positive women was assumed to be similar to that of the general population, namely 15% of deliveries. Among women known to be HIV positive, we assumed that 95% would refrain from breast feeding compared with 23% in the general population.[10–11] In the sensitivity analysis lower and higher uptakes of these interventions were considered.

The cost of 20 weeks' treatment with zidovudine (14 weeks for the mother and 6 for the child) is £600 ($960), 91% of which is for zidovudine taken during pregnancy, 8% for zidovudine during delivery, and 1% for zidovudine given to the newborn. The cost of a vaginal delivery is £400; an elective caesarean costs £1100, and an emergency caesarean costs £1300.[12] In this model the first test was an enzyme linked immunosorbent assay with 100% sensitivity and 99.9% specificity; it was followed by a set of confirmatory enzyme linked immunosorbent assays. The costs for these tests were estimated at £4 per woman (T Oliver, personal communication). False positive results from the first round were considered in the costing; false positive results after all tests were completed were not considered. The current costs of screening and pretest counselling were estimated at £40.[13] Costs below £40 reflect a situation in which universal screening for HIV is integrated into routine antenatal care. For illustrative purposes an evaluation at marginal costs—that is, test costs only—was included. The cost of counselling women who tested positive for HIV infection was set at £50. The additional cost of formula feeding over breast feeding was estimated to be £800 (table 1).[14]

Cost effectiveness was expressed as net cost per life year gained. The net cost comprised the total costs of antenatal screening minus the screening benefits of averted health care for children infected with HIV. Life years gained were calculated by comparing life years lost due to HIV infection with and without antenatal

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Table 1 1995-6 prices (£) used in the cost effectiveness analysis of universal, voluntary antenatal HIV screening

Lifetime cost of care for child infected with HIV	**178 300**
Zidovudine treatment of mother and newborn	600
Vaginal delivery	400
Elective caesarean delivery	1100
Emergency caesarean delivery	1300
Screening costs (test plus pretest counselling)	40
Post-test counselling (only if HIV positive)	50
Formula feeding	800
Postpartum triple therapy for the mother per asymptomatic patient year gained	12 300

Table 2 Net cost (£) per life year gained with the introduction of universal, voluntary antenatal screening for different prevalences of women who are unaware that they are HIV positive per 10 000 pregnancies

	Model			
Prevalence	**1/10 000**	**1/10 000**	**15/10 000**	**15/10 000**
Screening costs	£40	£4	£40	£4
Scenario				
Reference case*	114 400	7 300	3 300	Cost saving
Discount rate 3%†	76 600	4 400	1 800	Cost saving
Discount rate 7%†	151 600	10 400	5 200	Cost saving
Life years gained, not discounted	30 900	2 000	900	Cost saving
No life years gained for the mother‡	157 700	5 200	Cost saving	Cost saving
Two life years gained for the mother‡	90 800	8 300	5 200	Cost saving
Low uptake of interventions§	138 100	10 800	6 100	Cost saving
High uptake of interventions¶	103 800	5 700	2 100	Cost saving
Low lifetime cost of caring for child infected with HIV††	116 600	9 400	5 500	Cost saving
High lifetime cost of caring for child infected with HIV‡‡	112 200	5 100	1 100	Cost saving

*Discounted at 5%. Uptake of interventions in the reference case is 75% for treatment with zidovudine, 40% for elective caesarean section, and 95% for formula feeding. Lifetime cost of care for child infected with HIV in the reference case is £178 300. †Compared with 5% in the reference case. ‡Compared with one year in the reference case. §Low uptake scenario corresponds to 60% for treatment with zidovudine, 20% for elective caesarean section, and 80% for formula feeding. ¶High uptake scenario corresponds to 90% for treatment with zidovudine, 60% for elective caesarean section, and 100% for formula feeding. ††75% of costs of reference case. ‡‡125% of costs of reference case.

screening. Seventy life years lost is equal to the remaining life expectancy at age 7; this is the estimated average age of death for a child infected with HIV. Life years gained were discounted but as discounting health benefits is controversial,[15] non-discounted life years gained are also presented. A gain of one year was assumed to reflect the health benefit for HIV positive mothers of starting antiretroviral treatment earlier. As most mothers would be asymptomatic, the costs of triple therapy for the mother with a protease inhibitor were included at £12 300 per patient year[16]; this combination therapy was used in the model as it has the highest cost.[16] However, as the intermediate and long term benefits of triple therapy are unknown, cost estimates for long term treatment with triple therapy were not included. The assumptions of the impact of screening on the mother were investigated in the sensitivity analysis.

Results

Reference case

For the reference case the cost per life year gained varied from a situation of cost savings to a cost of £114 000 (fig 2, table 2). If more than one woman in every 10 000 pregnancies is unaware that she is HIV positive and the costs of screening are below £40, better cost effectiveness ratios are achieved. For example, if the prevalence of HIV among pregnant women is 10/10 000 pregnancies, the net cost for each life year gained is £7300 when screening costs £40; the net cost for each life year gained is £10 200 when there is a prevalence of 5/10 000 pregnancies and screening costs £25. If screening costs fall further then situations of cost savings become possible. For example, if the screening costs are below £8 per woman at a prevalence of 5/10 000 pregnancies then screening becomes cost saving. If the prevalence is 15/10 000 pregnancies then universal antenatal screening costs £3300 per life year gained when screening costs £40.

In the reference case the lifetime cost of care for children infected with HIV for each mother detected is £29 100 less than the costs accumulated in the absence of screening. Furthermore, the costs of treatment with zidovudine, counselling after testing, extra caesarean sections, and extra formula for feeding amount to £1300. At a prevalence of 15 women unaware that they are HIV positive per 10 000 pregnancies, screening costs are £26 700 (£40 per case of screening) for detecting HIV infection in this one woman. Differences in the costs of the reference case were compared with a situation of no screening.

Sensitivity analysis

Relevant parameters were varied between low (1/10 000) and high prevalences (15/10 000) of women unaware that they were HIV positive and low and high screening costs (£4 and £40 respectively). Major improvements in cost effectiveness are found when the discount rate is lowered to 3%, when life years gained are not discounted, and when there is a high lifetime cost of paediatric HIV care (table 2). Assuming that two life years are gained instead of one for the mother results in an improvement in cost effectiveness only for the situation of low prevalence and high screening costs. In the other situations the costs of

Table 3 Break even costs of universal, voluntary antenatal HIV screening in 1995-6 prices at a prevalence of 14 women unaware that they are HIV positive per 10 000 pregnancies under different scenarios

Scenario	**Cost (£)**
Reference case*	22
Discount rate 3%†	25
Discount rate 7%†	19
Life years gained, not discounted	22
No life years gained for the mother‡	39
Two life years gained for the mother‡	5
Low uptake of interventions§	13
High uptake of interventions¶	27
Low lifetime cost of caring for child infected with HIV††	12
High lifetime cost of caring for child infected with HIV‡‡	32

*Discounted at 5%. Uptake of interventions in the reference case is 75% for treatment with zidovudine, 40% for elective caesarean section, and 95% for formula feeding. Lifetime cost of care for child infected with HIV in the reference case is £178 300. †Compared with 5% in the reference case. ‡Compared with one year in reference case. §Low uptake scenario corresponds to 60% for treatment with zidovudine, 20% for elective caesarean section, and 80% for formula feeding. ¶High uptake scenario corresponds to 90% for treatment with zidovudine, 60% for elective caesarean section, and 100% for formula feeding. ††75% of costs of reference case. ‡‡125% of costs of reference case.

treatment during the life years gained caused a lessening in cost effectiveness. If there are no life years gained for the mother whose infection is detected by the programme, then screening becomes cost saving at current screening costs and a prevalence of 15/10 000. This reflects the cost effectiveness of that part of the screening programme that focuses on reducing the transmission of infection from mother to child. The high prevalence combinations that were cost saving in the reference case remain cost saving. The sensitivity analysis shows that adequate uptake of interventions is crucial in achieving good cost effectiveness and that cost effectiveness is sensitive for the lifetime costs of caring for a child infected with HIV if the prevalence is high or test costs are low.

Finally, to illustrate how the cost per screening visit can be varied to break even, the sensitivity analysis was performed assuming a prevalence of 14 women unaware that they were infected with HIV per 10 000 pregnancies, a prevalence recently reported for London.[17] The break even point is the situation that occurs when screening costs equal the averted costs of caring for a child infected with HIV. In most situations, screening costs below £25 result in cost savings when the costs of averted health care outweigh the costs of screening and intervention (table 3). If universal HIV screening is integrated in to routine antenatal care then screening costs might drop well below the current £40.

Discussion

In situations in which the prevalence of pregnant women who are unaware that they are HIV positive is greater than 5/10 000 pregnancies and screening costs are £40 per test, screening for HIV infection might be a cost effective intervention with a net cost per life year gained of less than £20 000. With a prevalence of 14/10 000 pregnancies universal antenatal screening would cost £3900 per discounted life year gained, £1000 per non-discounted life year gained, and would be cost saving at screening costs below £22. This compares to costs of about £2500 per non-discounted life year gained for both antenatal screening for hepatitis B and the NHS breast screening programme.[18–19] Universal, voluntary antenatal HIV screening would be a cost effective intervention in London.

In areas of low prevalence where 1 pregnant woman per 10 000 pregnancies is unaware of being infected with HIV and when screening costs are less than £15 the cost per life year gained is less than £40 000. For regions with a prevalence of 3/10 000 pregnancies, screening costs of less than £25 bring the cost per life year gained to below £20 000. Universal antenatal HIV screening seems to be cost effective for some regions outside London.

The cut off point at which the cost for each life year gained becomes acceptable differs over time and between societies. One Canadian article placed this point at $C20 000 per life year gained,[20] whereas the point in the United States currently is around $US50 000 per life year gained.[21] No cut off point has yet been defined for England, although one has recently been defined in terms of seroprevalence.[22]

Limitations of the model

The costs of terminating a pregnancy for reasons related to HIV were not incorporated into the model. Since the costs of terminating a pregnancy are below £500, their inclusion would make the cost effectiveness ratios more favourable.

It was assumed that all pregnant women offered the test would agree to be tested. If women who decline testing are at a higher risk of HIV infection than those who agree to be tested, cost effectiveness ratios may become less favourable. An increased uptake of screening would improve the cost effectiveness of such programmes and vice versa; however, early access to services, and barriers of language and literacy are all factors which may influence uptake.

Many important psychological factors cannot easily be costed and therefore were not incorporated in to the model. The cost of training additional healthcare professionals was also not included in the model. Additional training might be required especially if antenatal HIV screening with pretest discussions and counselling were offered outside of sexually transmitted disease clinics by comparatively inexperienced staff. These factors would not, however, dramatically change the study's general conclusions.

This model assumed that all women whose HIV infection was detected would be offered treatment with zidovudine and not combination therapy. Guidelines continue to recommend the use of zidovudine,[23] although the minimum duration of treatment required to prevent transmission to the child is being investigated.[24–25] However, if combination therapy were adopted during pregnancy (R Smith, personal communication, 1998), the impact on the model would be limited. Assuming costs of an additional £2000 for the use of a triple combination therapy regimen during pregnancy, the estimates of the cost effectiveness increase by less than £1000.

Neither the possible reduction in HIV transmission, due to behavioural change once a woman learns that she is infected, nor indirect costs were included in the model. A transmission rate of 6% was assumed if all interventions were implemented. This may be an overestimate; a recent study reported a transmission rate of only 1% if all interventions discussed were used.[26] All of these factors would produce more favourable cost effectiveness ratios if they had been incorporated. For example, if the 1% transmission probability were applicable to the London area, the cost per discounted life year gained would be reduced to £2700.

Conclusion

Since the incidence of mother to child transmission of HIV can successfully be reduced, the introduction of universal, voluntary antenatal screening needs to be considered. The availability of reliable cost estimates of treatment for HIV positive children enabled the first cost effectiveness assessment of antenatal screening for HIV in England to be performed.[5–6] Although uncertainties remain and more detailed information is needed to further develop assessments of cost effectiveness, the results presented to date indicate that in areas of high prevalence, such as London, universal, voluntary antenatal screening of pregnant women is cost effective. For areas of lower prevalence the cost effectiveness of such screening programmes could be well below £20 000 per life year gained; antenatal screening for HIV should be considered depending on possible reductions in screening costs and local preva-

Key Messages

- The lifetime costs of care for a child infected with HIV have been estimated at £178 300
- Screening pregnant women for HIV can avert this cost and lead to gains in life years for both mothers and children
- Universal, voluntary antenatal HIV screening is estimated to be a cost effective intervention with cost saving potential in areas in which there is a high prevalence of HIV infection among pregnant women
- In areas with lower prevalence rates, cost effectiveness could be well below £20 000 per life year gained, and universal, voluntary antenatal screening could be considered

lence rates. These conclusions confirm the recent recommendations of the Intercollegiate Working Party for Enhancing Voluntary Confidential HIV Screening in Pregnancy.[27]

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Contributors: MJP and EJB conceived the idea for the project. MJP developed the cost effectiveness model in conjunction with EJB, SM, LS, MDSW, HH, and JCJ. EJB and SM provided the cost data that were used in the model. LS provided particular input on the social context. MDSW provided specific input on the clinical context relevant to the analyses as well as providing clinical care to many of the children who participated in the original study. MJP and EJB were primarily responsible for writing the paper; the paper was written in conjunction with SM, LS, MDSW, HH, and JCJ. MJP and EJB are guarantors of the study.

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Antenatal HIV testing: assessment of a routine voluntary approach

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The benefits of testing pregnant women for HIV are increasingly assured, particularly with regard to reducing vertical transmission.[1] Yet uptake of antenatal HIV testing in Britain remains low.[2] Our previous study examined an opt-in approach (women had to make an active choice to be tested).[3] Some women were uncomfortable with this, feeling that it indicated high risk behaviour. We therefore assessed an approach based on similar requirements for information and consent but with a change in emphasis, in that testing was routine unless the woman declined.

Subjects, methods, and results

The testing programme was conducted during February to April 1998. Before their booking appointment, all women were sent a leaflet about blood tests to be conducted, including HIV testing. At the antenatal