Commentary

Can we obtain realistic HIV/AIDS estimates for India?

Recent reports have indicated that China, India and Russia are headed for a major public health calamity with regard to AIDS if indeed the calamity is not already upon these countries. It is therefore of some concern that there is uncertainty associated with existing estimates of the number of HIV infected individuals in India. According to a report, the US Central Intelligence Agency has predicted that India will have 25 million AIDS cases by 2010 (National Intelligence Council, USA 2002). The Government of India was quick to point out that these estimates are exaggerated. The World Bank has projected 10·9 million AIDS cases by 2024 (*The Hindu*, 17 November 2002), on the assumption that adequate intervention measures are implemented (table 1). The National AIDS Control Organisation (NACO) (2002), the nodal agency for HIV surveillance in India has estimated 3·97 million HIV cases by the end of year 2001. In this article, I try to highlight the importance of accuracy of HIV estimates. I assume that infection by HIV in an individual is a strong indicator of the future development of AIDS.

Estimates of the magnitude of the HIV epidemic in India are required for the design and calculation of costs of control programmes (involving both treatment and preventative measures). These programmes are necessary to reduce mortality of infected individuals, and to prevent new infections.

The process of measuring and quantifying HIV transmission and spread is complex. This is because both the diverse modes of transmission and unpredictability of individual's behaviour and prevention practices must be taken into account. The spread of HIV may be modelled by considering behavioural changes among the population at risk. However, in the absence of well-quantified behavioural parameters from various parts of India, these models will not account for HIV spread adequately. The modes of transmission and major subtypes of the virus in the country are known. But cultural diversity and geographical variations introduce uncertainty into the estimations, making predictions a challenging task.

NACO computes HIV estimates for various subgroups. These add up to a national estimate (H), given by

$$H = \sum_{i=1}^{k} S_i = \sum_{i=1}^{k} r_i n_i , \tag{1}$$

where S_i is the HIV estimate for the ith subgroup, r_i is the proportion of HIV positive cases out of the sample tested in ith subgroup and n_i is the estimated population size of the ith subgroup. National HIV estimates obtained in this manner have been more reliable in the recent past than those made a decade earlier. When HIV surveillance was initiated in India, the calculations using eqn. (1) may not have been truly representative because few surveillance sites were used. However, the present number of 320 sites (in 2001) may be more representative of the total population. The distribution of these sites

Table 1. HIV/AIDS estimates.

Agency	Year	No. (millions)	HIV/AIDS	Remarks
NACO	2001	3·97	HIV	Commonly accepted
NIC USA	2010	25	AIDS	Not reasonable
The World Bank	2024	10·9	AIDS	Cannot say

NACO, National AIDS Control Organization; NIC USA, National Intelligence Council USA.

according to risk group was: 135 sites in sexually transmitted diseases (STD) clinics, 170 sites in antenatal clinics, 13 sites among intravenous drug users (IDUs) and 2 sites for men sex with men (MSM). (See detailed description of geographical distribution of these sites in NACO's web page, NACO 2002). The number of sentinel sites required to represent the current Indian population is not clear. If the samples tested within each site are truly representative of the population and epidemic is uniformly spread then increasing the number of sentinel sites should not change the estimates significantly.

The size of risk groups is another important determinant of the HIV estimate. It is difficult to estimate the active homosexual population ('men who have sex with men', MSM) of India, for example. Therefore, when we multiply this subgroup size by the proportion of those infected, the resultant HIV estimate for the MSM group may not be truly representative. An attempt has been made in the past to project HIV cases for India by multiplying the proportion of the HIV infected subgroup at high-risk by the absolute size of that population at risk (Rao and Srivenkataramana). Such techniques are useful and results need to be interpreted cautiously. Such techniques if they also incorporate the proportion of infected individuals among the low-risk population then the error due to overestimation can be reduced.

NACO has arrived at the estimate of 3·97 million HIV cases based on their sentinel surveillance data. This estimate was derived from consultation with epidemiologists and bio-statisticians in the country (NACO 2002). According to NACO, the number of new HIV infections, estimated at 0·11 million in 2001, was lower than the previous year's figure of 0·16 million. This is a considerable decrease and has been attributed to preventative steps taken to control the HIV epidemic. NACO is optimistic about controlling the epidemic by means of preventative measures. Assuming the worst-case scenario (that there is no improvement in the existing preventative measures), the current trend still does not indicate that 25 million HIV cases will occur in the next 10 years (as predicted by the US National Intelligence Council). If we assume an exponential rate of growth in the number of HIV-positive cases from 3·5 million in 1998 to 4 million in 2001, and assume the same growth rate (r = 0·045) up to 2010, the estimated figure for 2010 would be 6 million. If we assume that the previous growth rate doubled after 2001, the estimated figure would be 9 million. This is a crude way of handling figures since no note has been taken of future preventative policies. However, this illustrates the point that the many-fold increase in HIV infections reported is difficult to derive. To develop more complex models that predict future HIV cases, we need to incorporate assumptions regarding behavioural parameters. Unless certain behavioural parameters (such as the rate of response to control programmes and the rate of reduction in risk behaviour) are measured, it will be difficult to estimate the size of the HIV epidemic with any degree of accuracy. The information available from behavioural surveys is limited (Grassly *et al* 2003).

AIDS prevention campaigns have increased in momentum since the mid-90s. There are now more than 100 Non-Governmental Organisations working on Information Education and Counseling programmes for high and low risk groups across the country. However, if the control programs are concentrated in high-prevalence geographical regions, it is possible that the incidence of new infections will increase in currently low-prevalence regions. This would neutralize any benefit achieved. It is only after cautiously overcoming the above limitations that, eqn. (1) can be used as a reliable means of getting HIV estimates.

The basic reproductive rate of an epidemic, R_0, (the number of secondary infections produced by one primary infection in a wholly susceptible population) is an important parameter in understanding the initial course of an epidemic. However, cultural constraints particularly the stigma associated with AIDS, make it difficult to estimate the doubling time of the HIV epidemic. Assuming the population mixes homogeneously, the basic reproductive rate R_0 and doubling time T_d are related to $1/D$, the incubation period between infection and development of AIDS as follows:

$$R_0 = 1 + \frac{1}{DT_d} \ln (2) . \tag{2}$$

The incubation period is a variable, but a working estimate of the mean incubation period for adults in developing countries can be taken as 9 years (The UNAIDS Reference Group on Estimates, Modelling and Projections 2002). This enables us to estimate the basic reproductive rate at the beginning stage of the epidemic for varying doubling times (table 2).

Table 2. Basic reproductive rates for varying doubling times.

Sl. No.	T_d	R_0
1.	1·5	1·051
2.	2	1·039
3.	2·5	1·030
4.	3	1·026
5.	3·5	1·022

Note: Incubation period is taken as 9 years.

The estimate of HIV prevalence given by NACO for each year is widely referred to as a national HIV estimate, but the calculation procedure requires national surveillance data for that particular year. Projecting future HIV cases based on these annual HIV estimates is not reliable, because such projections are based on no more than a simple trend analysis. This does not consider biological or epidemiological information. Back calculation can give reliable HIV estimates for the near future but only if diagnosis and reporting of AIDS cases are complete. However, this is not the case in India. Hence, back calculation methods must be adjusted for underdiagnosis and underreporting.

In summary, data currently available are inadequate for accurately estimating the number of HIV-infected people. However, the slow growth of HIV new infections observed in the recent past (NACO 2002) can be further investigated. The recently released Behavioural Surveillance Surveys (BSS) by NACO (2002) report reductions in risk-behaviour of high risk groups including commercial sex workers in some parts of the country. Decreases in risk behaviour among members of other high risk groups would further invalidate current projections of particularly high numbers of HIV cases in the next 10 years. The problem of estimating the sizes of risk groups remains. We need to come up with reliable subgroup population estimates before the question of accuracy of HIV infection estimates can be answered.

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References

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