

Predicting HIV trends to strengthen strategic planning in India: Modeling and analysis

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(Extended Abstract)

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Running head: Indian NACP III predictions

Abbreviations: AIDS: Acquired Immunodeficiency Syndrome, ART: Anti-retroviral therapy, HIV: Human Immunodeficiency Virus, IDU: Intravenous Drug User, MSM: Men Who have sex with Men, NACP: National AIDS Control Policy, PLHA: People living with HIV/AIDS.

Abstract: Recent annual estimates of HIV prevalence in India indicate that the growth rate of the epidemic has slowed compared to that of the previous decade. The country is moving towards implementing the third phase of the National AIDS Control Program (NACP III) for controlling the spread of HIV. The targets established by the GOI for behavioural and therapeutic interventions under NACP III were inserted into a mathematical model developed to predict the HIV incidence. We report that if the targets are reached within by the prevention programs for susceptible and infected, then the number of people living with HIV in India will stabilize during 2007 – 2012. These findings support the strategy that is being proposed by NACP and will be useful to public health planners.

After successful completion of the second phase of the NACP to control the spread of HIV in India, the third phase of the five year NACP III is scheduled to be launched in late-2007. Assuming that the program targets suggested by the NACP III implementation plan will be met, a mathematical modelling exercise has been performed by our group to predict the number of people living with HIV up to 2012. While expanding the prevention programs of the second phase, a new framework has been introduced in NACP III to address the issue of positive prevention², along with the rapid scale-up of care support and treatment services for people living with HIV/AIDS (PLHA). Special importance is given to identifying infected people through an expanded network of integrated counselling and testing centres, strengthening condom promotion activities among people living with HIV/AIDS (PLHA) and ensuring the access to anti-retroviral therapy (ART) for all eligible PLHA. By considering mixing patterns between male-female, male-male (MSM) and injecting drug users (IDU), a compartmental model was developed to estimate the infection curve. The infected population is divided into six risk-groups (marriage partners, commercial sex workers, MSM, IDU, casual sex partners and those infected through blood). The model allows transmissions from a proportion of the infected individuals in various subgroups to individuals of the opposite gender except for MSM groups. Based on the observations from various studies and estimates on high risk groups prepared for NACP III, subpopulation infection levels and their sizes are included. The model description, related mathematical content, analysis and data limitations can be seen elsewhere³. Major data sources are NACO¹, Indian Census⁴, Sample Registration System⁵ and NACP III framework². India has a concentrated epidemic and that the major emphasis of Phase III will be to strengthen prevention programs for those at highest risk of HIV.

As stated in the recent release by the National AIDS Control Organisation (NACO)¹, the HIV estimate for 2005 is 5.2 million in India. This number is almost 66,000 more in comparison to the previous year's estimate (HIV estimate for 2004 was 5.134 million). Taking into account the large adult population in the country, (there are 521.3 million people in the 15-49 age-group in India according to the 2001 Indian Census⁴), the proportion of this difference of HIV estimates between the last two years to the total number of adults is very low, and this could be easily attributed to the success of the ongoing NACP II. If NACP III is successfully implemented over the next five years, then we predict that the total number of people living with HIV will come down to 4.96

million by 2012. A similar trend is also observed by spectrum analysis⁶. Moreover, our modelling predictions indicate that the introduction of NACP III in 2007 is expected to bring HIV estimates down to between 3.82 million (with 100 per cent targeted interventions) and 4.17 million (with 50 per cent targeted interventions) by the end of 2012.

NACP III planning team prepared a policy framework for a possible expansion of prevention programs which is expected to be launched in later part of 2007, and the country is now preparing to implement policies to further strengthen its ongoing prevention programs. It is proposed in the framework that anti-retroviral therapy will reach 0.38 million infected people by the end of the third phase, which will be almost 90 per cent of the eligible infected people. It is likely that the preventive measures practiced by the general population, as well as some risk-groups, will result in a decline in the prevalence levels or at least in the number of new infections – with ART would expect PLHA to survive longer so mortality should decrease. A study of couples in which one couple has HIV⁷ indicated that incidence rates among them remained very low, and regional trend analysis⁸ indicates that the prevalence levels in some states of India have declined. The reductions in incidence and prevalence in the respective populations were attributed to an increase in condom usage and other preventive actions. Given the current estimate of 5.2 million PLHA, India faces a serious public health concern, which requires careful planning if prevention and control programs are to be successful.

Our results suggest that properly guided anti-retroviral therapies will lower the number of new infections in the next five years due to decline of viral load and subsequent reduction of HIV transmission, in addition to decreasing the progression of the disease and deaths of infected people. In the absence of an effective monitoring system and positive prevention program, with similar ART scale-up the model predicts that there could be as many as 6 million PLHA in India by the end of the program period.

There are an estimated 2.3 million MSM in India, and best available data suggest that 7.7 per cent of them are infected^{2,3}. If we achieve 100 per cent of the targets proposed to be implemented gradually over the next five years (for example in this case annual targets are: 2007 - 56%, 2008 – 62%, 2009 – 68%, 2010 – 74%, 2012 – 80%), then the number of MSM with HIV will decline to 60000 by 2012 (with 50 per cent targets, this number is 35000). The number of IDU varies substantially between regions in India, with the highest concentrations in the north-eastern states bordering Myanmar. Assessments carried out for NACP² on high risk groups suggests that, of the nearly 150,000 intravenous drug users in the country, there are approximately 24,000 who are infected with HIV. Through increased coverage of IDU population with planned interventions, we predict this number can be reduced to 12,000 by the end of 2012 (with 50 per cent targets this number is 3,000). There is a need to model an IDU driven epidemic for the north eastern region, and some other focused regions of the country, to better understand HIV spread. Perinatal transmission data analysis suggests that 58,000 vertical transmissions to new born children could be avoided by NACP III interventions. The importance of designing appropriate surveys for estimating sub-population infection levels in India, and its impact on obtaining national prevalence were discussed⁹. The reductions in HIV

estimates for general male and female populations (including sex-worker populations), with a gradual increase in 100 per cent targeted prevention interventions of NACP III, could be 0.70 million and 0.46 million respectively. With 50 per cent targets, these numbers are 0.51 million and 0.33 million, respectively.

Overall, the results support the accomplishments of ongoing programs and give new hope for further success in reducing the HIV number in the country. Prevalence could be brought to a stable, or rather stationary, level by successful implementation of the NACP III. We see these predictions as consequences of targeted condom promotion activities among general and infected populations, and also providing anti-retroviral therapy with support. We assume in our model, that the infection spreads through six population sub-groups mentioned, so estimation of sizes of the subpopulations and their infection levels are important inputs to the model. Any inaccuracies in the estimation of sub-population sizes and their infection levels could limit our predictions. Present modelling attempt is for the total PLHA in the country. As the state level data on various parameters becomes available, a model for understanding HIV spread in each state level could be more appropriate. We might revisit our model framework if necessary as the more information becomes available and also might consider different models at state level in the future. Understanding the mechanisms of the disease spread and HIV epidemiology within the country for the last two decades has helped in framing prevention programs, and might be responsible for the launch of several new surveys of HIV prevalence in the country. India has a decentralized administrative system. We hope that additional data banks at the state level becomes available on sub-group sizes and infection levels in the course of time, and that these will improve modelling frameworks and increase productivity in preventive actions among sub-groups in the future.

References:

1. NACO. www.naco.nic.in (browsed on 2 May 2007)
2. Frame work NACP III, National AIDS Control Organisation.
3. Rao, Arni S.R. Srinivasa, Kurien, T, Sudhakar K and Maini PK. HIV Epidemic in India and predicting the impact of public policy: Modelling and analysis (revised Submitted)
4. Census of India. Also available at (<http://www.censusindia.net>)
5. SRS India. Available at (<http://www.censusindia.net/srs21.html>)
6. Reddy D.C.S. Projections on HIV Epidemic in India. Prepared for NACP III projection implementation plan 2006.
7. Mehendale SM, Ghate MV, Kumar BK, et al. Low HIV-1 incidence among married serodiscordant couples in Pune, India. *J Acquir Immune Defic Syndr.* 2006;41(3):371-3.
8. Kumar R, Jha P, Arora P et al. Trends in HIV-1 in young adults in south India from 2000 to 2004: a prevalence study. *Lancet.* 2006; 367(9517):1164-72.
9. Rao, Arni S.R. Srinivasa (2003). Can we obtain realistic HIV/AIDS estimates for India? *J. Biosci.* 28 (4), 367-369.