Modelling the Dynamics of the AIDS Epidemic in Southeast Asia

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Introduction

Today's present knowledge on the sexual behaviour and practices of people, and probability of HIV transmission through various forms of sexual intercourse is very limited. Moreover, statistical data on demographic information of the developing countries are both limited and unreliable. These drastically harden the modelling studies, especially for the developing world. Still, the authors believe that, experimenting with the simulation models of the AIDS epidemic under the light of systems thinking, can help extend our knowledge about this most recent plague.

The global pandemic of HIV infection is influenced by many factors - eg. time of introduction, population density, cultural and social issues. Incidence rates have been the highest in developing countries where heterosexual transmission is most common. Because of the late introduction of the epidemic, low social status of women, inadequate health infrastructure, poor economic conditions, cultural misconceptions and social inhibitions, and the density of the population, there may be more HIV infected individuals in Asia by the year 2000 than in any other region of the world. Therefore, the application area of the study was chosen to be Southeast Asia, a region which accommodates approximately 25% of the world's population and is still in the early phases of an explosive HIV/AIDS epidemic. Although HIV was introduced much later in Asia than the rest of the world, over 4 million people are now thought to be infected. WHO estimates that, with continued escalation of HIV transmission, nearly 9 million HIV-infected people will reside in South-East Asia by the turn of the century.

Major aim of this modeling study of the AIDS epidemic is to propose certain policies and recommendations regarding the future course of actions that will be followed by policy makers. These policies aim to reduce the peak value of infection rate.

The Model

Sexually active population is partitioned into groups according to their sexual preferences relying on the fact that, the infection risk posed on the individuals is determined by the sexual activity they are engaged in. These groups consist of heterosexual females, commercial sex workers (CSW), male heterosexuals, male homosexuals, and male bisexuals . The importance of distinguishing CSW stems from the fact that commercial sex is very wide spread in Asia.

For each of these groups the infection rate equation is tailored to reflect the coupling patterns based on the sexual practices (Pala, Güneralp & Mergen 1997). For example, the infection rate equation for female heterosexuals describes contacts with both male bisexuals and male heterosexuals. This rate defines the number of HIV-negative people that become infected in a month as a result of sexual intercourse. To calculate the total number of people (of a specific group) that become infected in a month, an infection probability per individual per month is computed and then multiplied with the susceptible population of the relevant group (Pala, Güneralp & Mergen 1997).

Public awareness is also incorporated into the model as a negative feedback loop. The level of the surveillance of the epidemic in the society affects the people, in terms of getting aware of the current status of the epidemic. The increased public awareness causes an increase in condom usage, a decrease in the number of casual partners and a decrease in the percentage of males visiting CSW. The changes in these factors affect the level of surveillance of the epidemic via the infection rate, completing the loop. In this manner, the analysis of how the awareness of the people and the control they exert on their sexual practices affect the spread of the epidemic is utilised (Pala, Güneralp & Mergen 1997).

However there is a discrepancy between the "implied" and the "actual" public awareness. The authors believe that of this discrepancy is due to the following reasons. First of all, people do not directly perceive the state of the epidemic. The situation is realised by various organizations, first. Then actions to be taken are determined and information is conveyed to the public via various educational and communication means. Thus, there is a certain time delay before the public gets to know the real situation, before people process what they learn and start taking some precautions. The clinical evolution of the disease includes certain distinct stages: HIV-negative, HIV-positive seronegative, HIV-positive seropositive unidentified, HIV-positive seropositive identified asymptomatic, Symptomatic - ie. developed AIDS, Dead. These stages are shown for each group defined above (Figure 1). HIV-negative state accumulates people that have the risk of becoming infected, namely the susceptible in the classical epidemic terminology. The newly infected people pass onto the next stage that represents the HIV-positive, seronegative individuals. The duration of this stage is three months, during which time the antigens reach a threshold level that permits the identification of the virus in the blood. This leads to the group of people who are HIV-positive seropositive, thus can be identified, but not tested yet. A third order material delay of 7.5 years, which represents the mean incubation period of the disease, is used. This is the time period between the infection and the

appearance of the symptoms. Individuals that become identified at each stage of the incubation period are represented as HIV-positive seropositive identified asymptomatic. The reason for the distinction of the unidentified and identified infected people is that a percentage of the HIV-positive tested individuals no longer take part in sexual activities. Thus, they are "isolated" in the sense that they do not have effect in the spread of the virus. People that become clinically symptomatic, or in other words that develop AIDS are accumulated in the next stage. The mean life expectancy from the time of the development of AIDS is taken to be 2 years. This evolution ultimately leads to death (Pala, Güneralp & Mergen 1997).
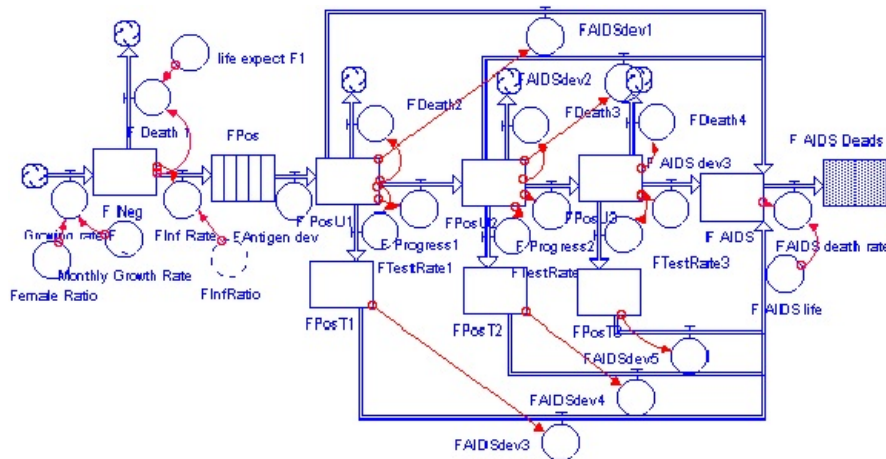

Figure 1

Conclusion

A total of 35 runs were performed. It can be concluded from the results of these runs that there is no threat of extinction for the human beings even without exerting significant control on their sexual practices. However, it should be noted that the significant difference in the number of infected people within the next 20 years makes it worthwhile to try to increase the public awareness. One of the major consequences of the epidemic is the reduction in the useful lifetime of the individuals. From an economical perspective, HIV affects people during their most productive stages of life. This definitely can become a dominant factor that adversely affects the GNP and life expectancy of the nation, both of which are critical factors of economic development for the developing countries.

The results obtained from the sensitivity analysis suggest that, the spread of the AIDS epidemic in South-East Asia is highly sensitive to the identification of the infected CSW and the prevention of their sexual practices. Identification and removal of the infected CSW greatly reduces the infection rate resulting from commercial sex, a widespread practice in the region of study. In turn, the reduced infection rate of heterosexual, and bisexual men results in lower HIV prevalence among these groups. The lower HIV- positive ratio among these groups serves as a means of survival for the heterosexual women who engage heavily in sexual practice with individuals from these two groups. For example, an increase in the testing of CSW from 30% to 90%, decreases the number of total infections by 35%. Thus, as a result of this study, we recommend that the policy makers concentrate on the CSW; their identification and the isolation of the identified CSW from further practice of commercial sex.

The runs also revealed the importance of condom usage in terms of reducing virus transmission. Condom usage should be promoted in the society in all sexual practices, but especially in commercial sex.

Finally, we would like to conclude with stating that the availability of reliable and usable data constitutes the major constraint in building and validating such models. The main line of future research on this model should be data collection and extensive validity testing.

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