MODELLING APPROACHES AND THE EPIDEMIOLOGY OF HIV/AIDS :

A Review

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CERTIFICATE

Certified that the dissertation entitled "MODELLING APPROACHES AND THE EPIDEMIOLOGY OF HIV/AIDS: A Review:" submitted by ANIL GUPTA is in a partial fulfilment for the award of the degree MASTER OF PHILOSOPHY of this University.

This dissertation has not been submitted for any other degree of this University or any other University and is his own work.

We recommend that this dissertation may be placed before the examiners for evaluation.

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GLOSSARY AND ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
CDC	The Centres for Disease Control
DGHS	Director General of Health Services
ELISA	Enzyme – Linked Immuno–Sorbent Assay
GPA	Global Programme on AIDS
HIV	Human Immuno – deficiency Virus
ICMR	Indian Council of Medical Research
IVDU	Intro-venous durg User
INCIDENCE	The number of new cases in a survey population reported over a specified period
NACO	National AIDS Control Organisation
RETROVIRUS	Retrovirus are a class of viruses characterised by their ability to convert RNA to DNA during replication in the host cell (instead of the reverse as in most other viruses)
SPR	Seropositivity rate
STD	Sexually Transmitted Disease
T-HELPER CELLS	Also called T4 cells. These are one type of white blood cell or lymphocyte that helps people in defending aganist disease by initiating antibody production.

CHAPTER-I

INTRODUCTION

INTRODUCTION

Acquired Immune Deficiency Syndrome, a clinically complex disease against which presently there is no proper way of prevention in terms of vaccine or cure evokes complex responses from people, world-wide (Ankrah 1989: 274). Unknown prior to 1981, AIDS now seem to dominate public health programmes and health services in a significant number of countries across the world. This is evident from the fact that, in 1987 AIDS became the first disease ever discussed on the floor of the United Nations General Assembly. The World Health Organization's insistence that AIDS is a global health problem with enormously important social, cultural, economic and political dimensions and impact led to the formal resolution by the General Assembly to mobilize the entire United Nations system in the world wide struggle against AIDS. Another significant event highlighting the extraordinary importance of AIDS occurred in January 1988. A world-Summit of Ministers of Health, organized jointly by the WHO and the government of United Kingdom, brought together more Ministers of Health than have ever come together, for any purpose, at any time. Their common statement---the London Declaration on AIDS---calls for the full opening of channels of communication in each society; the forging of a spirit of social tolerance through information, education and social leadership, and the protection of human rights and dignity in AIDS prevention programmes. The year 1988 was declared a year of global communication about AIDS-----to culminate in World AIDS Day on 1st December 1988. Since then, on 1st December every year, World AIDS Day is being observed across the nations. In short, there is no precedent in the history of global health for the speed,

intensity or scope of this global mobilization against any disease (Mann et al.1988: 89). AIDS is now seen as a global health problem of paramount international importance.

The description of AIDS as a new communicable disease, the characterization of its modes of transmission, the identification of the HIV as the causative agent, the depiction of the groups at major risk and development of possible control strategies are events that have occurred with unprecedented speed. AIDS became the first disease for which the development of mathematical models to project the future course of epidemic and to understand the dynamics of HIV spread have evolved simultaneously. The idea behind this approach was to help planners in making appropriate strategies (in light of the estimate projected) to adequately tackle the problem. The main tool for spread of concern about AIDS and for promotion of action for its control has been the projection of number of persons going to be affected by the disease in different regions and countries of the world. Due to estimates, governments in many Third World nations have started shifting their attention from other basic health problems to AIDS. In the case of India, stimulated with huge international funding and Western dominated concepts, a National AIDS Control Programme has become operational. NACP has become another fully centrally financed and controlled vertical programme India.

The World Health Organisation estimates that there are more than 4.5 million AIDS cases which have occurred world-wide since the emergence of the epidemic. Till the mid of 1995, it is estimated that around 18.5 million adults, and more than 1.5 million children have been infected with HIV (NACO 1995). The WHO further estimates that AIDS virus has transmitted among 3.5

million people in Asia, with India and Thailand among the worst affected countries (in the region). The WHO predicts that by the turn of the century, Asia will have more new people infected with HIV than the rest of the World combined. According to Hira there will be 8-12 million HIV infected people and 1.2 million AIDS cases by the end of the century. As per his estimates 1,70,000 AIDS cases should have occurred by now in the country. (Hindustan Times July 1, 1996).

Scientifically projected HIV/AIDS cases can be of great use in the development of priorities for disease management. Estimating the current prevalence of HIV and projecting the future incidence of AIDS is of use to predict the load of the disease on the available health infrastructure. On the basis of various projections of the future course of the epidemic by a number of agencies of international repute, a number of AIDS controlling strategies are being devised. But it is pertinent to note here that these projections have never come close to the reality even in the highly developed countries of the world (like some Western Countries where AIDS case reporting is also sound). More reliable and valid HIV prevalence data at different levels is urgently needed. These authentic national estimates are necessary to provide a scientific basis for predicting the number of HIV/AIDS cases that can be expected during the next several years, for determining whether, where, and to what extent HIV infection is increasing in the population and for targeting country as well as region- specific preventive programmes.

Since the recognition of AIDS in the early eighties, it is one of the defining events of the twentieth century, and the volume of material it generates---good, bad and indifferent---is

sufficient to dismay the most alarmed inquirer. Morever, AIDS is a sensational event and gets a sensationalist response from the press. News about AIDS is given wide coverage in the mass media. The mass media is naturally eager to publish newsworthy items, and the more sensational a forecast of the AIDS epidemic, the wider the coverage given to it in the media, and the bolder the headlines. The media cannot be blamed alone for their deeds in this regard. Quite often the sensational forecast is not directly from a journalist, but comes from the so called highly respected scientific community. So, it is not always the media that exploit science and the scientists, but the 'scientists' who also exploits the media and their eagerness for newsworthy items. Due to this problem in the mass of information, it is often difficult to sort out the wheat from the chaff, the information from the misinformation that bombards everyone (Schall and Padayachee 1990:503).

Over the last four decades we have launched a number of vertical programmes but were not successful in properly controling any of the diseases (except smallpox). Again, instead of properly understanding the root cause of the problem, the acute urgency to 'do something about AIDS' has been used to justify the adoption of plenty of inadequate and unscientific approaches. There are a number of powerful factors which have come in the way of adopting a public health approach to the problem of AIDS. Analysing the popularly known National AIDS Control Programme in India, Banerji (1992) says:

"One of the most unfortunate factor amongst the factors which became instrumental in adopting a public health approach to AIDS is the tendency among international health organisations to

impose certain pre-determined, pre-packaged, techno — centric programmes on the countries of the south. These programmes are not only gravely suspect from the scientific point of view, but they are also the very antithesis of the approach developed at Alma Ata in 1978, which gave key importance to community self-reliance andsocial control over the technology. This is a total surrender to the ill-conceived and poorly elaborated concept of selective primary health care."

Apart from the fact that the industrialized countries of the West are so concerned about AIDS in the world because it by posed a major public health threat in their societies, large scale funding and technical assistance for AIDS control programmes in the third world countries is the pressure to create market for their products (Pharmaceutical and for different testing kits). They may also get an experimental field to perform different clinical trials necessary for development of AIDS vaccines. Hira (also a member of International Vaccine Committee) is optimistic about the development of vaccines in the fight against AIDS, but remains silent on the secret and controversial AIDS vaccine trial that shook Bombay recently in which his name also figured. (Hindustan Times, July 1, 1996).

Considering the significance of future AIDS projections it is necessary to study the various aspects directly or indirectly involved in the process of modelling the techniques of HIV/AIDS projection. Special attention needs to be given to their applicability in different contexts. The concept of high risk group has been another significant aspect of the epidemiology of AIDS. However its implications both for understanding the course of the epidemic and for AIDS control remains debatable. This aspect too, therefore, needs to be studied.

Thus the objective of the proposed study is to analyse the mathematical/statistical methodologies that have been developed for mapping the course of the AIDS epidemic in the light of existing knowledge about its epidemiology, to examine applicablity in the Indian context and to examine their implications for AIDS control activity.

OBJECTIVE AND AIMS OF THE STUDY

1. To outline the existing knowledge about the epidemiology of AIDS globally and in India.

2. To outline the AIDS control activities in relation to its epidemiology and to the estimates and projections of HIV infected persons and AIDS cases globally and in India.

3. To review some of the existing statistical AIDS projection models including those of the WHO.

4. To analyse the validity of the WHO technique and its assumptions in light of Indian data.

5. The possible impact of the projection on NACP; and,

6. The issues related to High Risk Groups and its implication on various AIDS prevention strategies.

MATERIAL AND METHODS

The study is primarily a review of secondary material developed with special emphasis on the analysis of different

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types of available models for projection of the AIDS/HIV epidemics. The study attempts to analyse both types of models, namely the explanatory as well as the empirical model. In the category of the explanatory model, the model developed by Isham and Anderson will be taken into consideration. The Back calculation method proposed by Brookmeyer and Gail and others will be analysed under the empirical model category.

Almost all the developing countries of the world are using the WHO model of AIDS/HIV projection. An attempt is being made to clearly understand the model and to see its applicability in the Indian context. While analysing the said WHO model of projection an attempt will be made to fit it in the Indian situation.

Macro data available at the agencies of high repute in India like the Indian Council of Medical Research and the National AIDS Control Organisation will be used for the purpose. Recognising the limitations of this data (namely, under-reporting of a high order and the biased nature of the sampling) an attempt has been made to use largely the fairly reliable data series showing trends in specific regions or groups.

In addition, the present work will try to incorporate major issues relating to the evolution of National AIDS Control Programme in India. NACO's yearly and monthly updates have been used to throw some light on the issue. Frequent changes in the surveillance technique have also been given due consideration in the study.

The study falls naturally under six chapters. The second chapter deals with an overview of the AIDS epidemic explaining the origin of the desease and its causative agent HIV, the modes of transmission, the incubation period, variations in infectivity over time and the clinical manifestation of the disease. This chapter also discusses the global spread of HIV/AIDS epidemic including the detection strategies. The third chapter discusses the HIV/AIDS in the global region and diverse social contexts. In this context Africa, America, Europe, The Westren Pacific region and the South-east Asia have been discussed. Among these Thailand and India have also been separately discussed. The fourth chapter discusses the evolution of the National AIDS Control Programme in India. This also incorporates periodic changes which has taken place in India with respect to AIDS control strategies.In the fifth chapter several mathematical models for the spread of HIV infection have been examined. The models are classified under two sections namely the explanatory and the empirical. This section discusses several factors such as the incubation period, the rate of conversion from HIV to the development of clinical symptoms of AIDS, the level of infectivity, sexual and other transmission related issues and the model validation. The sixth chapter analyses the validity of the WHO technique and its assumptions in light of the Indian data. Some approaches employed by Indians have been used to predict/estimate the future course of the epidemic. The seventh and the final chapter comprises of the conclusions of the study.

CHAPTER-II

AN OVERVIEW OF THE EPIDEMIC

AN OVERVIEW OF THE EPIDEMIC

THE DISEASE

AIDS-acquired immunodeficiency syndrome - is a stage in which the inbuilt defence systems of the body break down completely. This phenomenon is gradual, but ultimately leads to total depletion of a very important cell component of the immune mechanism. Those affected are thus unable to combat commonly known diseases like pneumonias, diarrhoeas, tuberculosis and even problems like colds; ultimately, they die due to one or another of these infections. In a nutshell, AIDS is not one disease but a combination of diseases. Usually not all people who develop AIDS suffer from the same diseases, but there are certain type of illnesses that occur very frequently in AIDS. This is the reason why AIDS is called a syndrome. AIDS is a syndrome in which the body's immunity starts diminishing. Simple things like walking or digesting food become exhausting chores. Basic processes like maintenance of body temperature, chemical balances and blood cell production that healthy people take for granted, malfunction or cease to function as the natural defence system, which normally regulates these internal processes, is gradually weakened by AIDS.

Strictly speaking, the term AIDS is the last stage of the HIV disease spectrum. At this stage, the infected patients develop one or more disease(s), mostly due to opportunistic infections or cancers. Some infectious agents-parasitic, bacterial, viral and fungal-remain silent, unexpressed in the body. They grab the opportunity to manifest themselves and cause illness when the

body's resistance (immune system function) is depressed. They are also known as opportunistic diseases. This also applies to some malignant cells kept under control by a strict immune surveillance system. Once the system weakens or fails, the cells take the opportunity and grow as opportunistic cancers. Most of the opportunistic diseases can be overcome by persons with intact immune mechanism; however in patients with AIDS, they become life threatening because the body's defence has remarkably declined due to the depletion of a particular type of CD4 positive T-helper cell (a wbc of lympocyte) which plays a key role especially in cell-mediated immunity. (Parvi 1992).

CAUSATION

HIV, or Human Immuno-deficiency virus is supposed to be responsible for AIDS. "HIV positive" (expressed as HIV + or HIV ab +) is a term indicating that HIV is present in the blood as determined by a blood test. This test is based on estimating specific antibodies in the blood sample of the individual. Unlike most other viruses (causing diseases like poliomyelitis and mumps), in the case of HIV, presence of antibodies does not mean that the individual carrying HIV antibodies is immune from disease. Thus the persons with HIV antibodies are not considered immune, but in contrast, as carriers of HIV.

It is important to note that, although the majority of the researchers are of the view that HIV is the causative agent in AIDS, there exist a minority position too. Dr. Peter H. Duesberg, from the University of California at Berkeley, is a major protagonist of another view which denies that HIV is the causative agent. Duesberg contends that AIDS is caused by a combination of

(1) "chronic promiscuous male homosexual activity", (2) "parasitic infection," (3) malnutrition, and (4) narcotic toxins. Dr.Shyh-Ching Lo is another scientist who raises questions about the role of HIV. According his hypothesis there is also the possibility that a mycoplasma organism is involved in the development of the syndrome. Mycoplasmas are the smallest known organisms which, unlike viruses, have the ability to reproduce themselves. They occupy a biological niche some place between bacteria and viruses.

Luc Montagnier, whose team discovered HIV, gave partial support to the view that mycoplasmas may be co-factors, in statements at the Sixth International Conference on AIDS, San Franscisco, July, 1990.

The virus responsible for AIDS is transmitted when an infected individual's blood, semen or vaginal fluid enters another individual's body. The most common way of spreading the virus is during unprotected penetrative sex (i.e. penetrative sex without a condom) or when people are unknowingly given infected blood, or share used needles to inject certain drugs. There are evidences which support transmission of HIV from an infected mother to her foetus during pregnancy.

When HIV enters the body, the body produces antibodies in the blood in response to the virus. The most commonly used HIV test simply looks at a small sample of the individual's blood to see whether these antibodies are present in the sample. It is pertinent to mention here that the HIV test should not be called the AIDS test because it does not confirm whether a person has AIDS....... it can only tell whether the person who has given that sample of blood has produced antibodies in response to the virus that is supposed to cause AIDS.

Two serotypes of HIV are currently recognised, namely HIV-1 and HIV-2; but Worldwide, the predominant virus is HIV-1. However, HIV-2 appears to have spread extensively during the 1980s, principally in West Africa, although sporadic infection with this serotype have now been reported from East Africa, Europe, Asia and Latin America. The modes of transmission of HIV-2 are similar to those for HIV-1, and the two viruses appear to cause clinically indistinguishable AIDS. However, HIV-2 may be less easily transmitted, and the period between initial infection and illness may be longer in the case of HIV-2. (NACO 1994: 7).

ORIGIN OF THE DISEASE

AIDS was first identified in American homosexuals in 1981. If we consider the estimated mean incubation period of eight years for AIDS then it implies that the early American cases were initially infected in the 1970s. Prior to the isolation of HIV in 1983-84, speculation about a 1970s geographical source for a viral agent for AIDS was imposed upon Haiti, with the probability that the virus had mutated from the causative agent of African Swine fever. In the USA about 5% of the 700 AIDS cases up to June 1981, had been reported in Haitian immigrants which hypothesized the possibility of a viral agent imported into the USA from Haiti by North American homosexuals. (M.R.Smallman: 1990) During the 1970s Haiti had become a popular holiday resort for Californian homosexuals; this was linked with a rise in male prostitution, although the correlation has been challenged by some researchers. In addition, reports of AIDS symptoms in Haitians came from elsewhere in North America and Europe and Haitians themselves became officially categoried as a risk group, which stood until 1985. Some U.S.

researchers proposed that AIDS began with an outbreak of African Swine fever in Haitian pigs, and that the swine virus had been passed to human beings. Others suggested that a Haitian homosexual may have contracted the swine virus from eating undercooked pork, and then passed it on to the homosexual partners.... Others proposed that Haitians may have contracted the virus from monkeys as part of bizarre sexual practices in Haitian brothels. (Singer, 1322). After that it was realised that it was social behaviour rather than groups which placed people at risk of the HIV infection, simultaneously evidence also started emerging that HIV may have orginated elsewhere than Haiti.

These issues had a significant impact on the economic situation of Haiti thereby reducing its main source of earning in tourism sector. The perception of the spread of HIV by Haitians was so strong that in 1990 the US Food and Drug Administration officially banned Haitians from donating blood.

It was evident from the research undertaken by some of the Haitian physicians who found that most early emergence of HIV could be traced to Carrefour, a red-light prostituion centre at the southern end of the capital. These data were consistent with the hypothesis that HIV was introduced into Haiti by either tourists or returning Haitians coming from the United States or Europe. (Singer : 1323). Considering these vital facts in mind African leaders and Haitian activists have resisted the Africanization of AIDS.

When knowledge of the structure of HIV became relatively more clear, similarities between HIV and certain viruses found in African green monkeys were soon recognised. As a consequence, Africa emerged (replacing Haiti) as the main area for the hearth of the disease. Due to this 'change of hearth', now retrospective serological analysis has concentrated on the testing of African serum samples for antibodies to HIV. By 1983, European clinicians were diagnosing AIDS like disorders in African patients. A couple of studies done by Pivot (et al., 1984, Zaire) and Vande Perre (et al., 1984, Rwanda) confirmed the endemic nature of both HIV infection and AIDS in Central Africa. (M.R.Smallman, pp.169)

There is also strong evidence (Ancelle et al. 1987) for the early circulation of HIV in West Africa in the form of infection with the second HIV strain (HIV-2). HIV-2 is known to be endemic only in West Africa and it is hypothesized as being a key link in the evolution of HIV-1.

Some countries like Cuba, officially claims that HIV was introduced by American tourists although strong links with Africa may have been an alternative source of infection.

It has been a common practice to blame other countries for its spread. In the United States, Africa is referred to in racist ways as the point origin, the Cuban blame it on the US, the Soviet Union (before formation of Russia) called it a capitalist aberration, even in India some people usually talk of imperialist disease and American germ warfare research of the cause (Merrill 1994; pp.1332).

GLOBAL SPREAD OF HIV/AIDS

Now after observing the brief history of global AIDS, we can distinguish three periods : of silence, of discovery and of mobilisation . The first period, starting in the mid-1970s, was the time of the 'silent pandemic", during which HIV spread -- unnoticed to five continents. There were no conscious defences during this period, for the virus was silent in its passage and remain unrecognised. It is interesting to note that the emergence of global HIV epidemic started just as the techniques became available to detect human pathogens of this variety. Was this a highly fortuitous coincidence, or might be in the past have failed to see that which existed? (Mann, AIDS, 1988)

The recognition of AIDS in 1981 ended the silence and initiated the second period in the history of global AIDS - a period of discovery which culminated symbolically at the first International AIDS Conference in 1985. During this period, the modes of transmission were identified, the virus was discovered, and the test to detect anti-viral antibodies became instrumental to the detection of the infected persons and to awareness of the long latency between infection and disease manifestation. (Opcit)

AIDS and human immunodeficiency virus infections are not distributed randomly, for HIV has affected different groups or sub-groups around the world at different rates and at different points of time. With available information, three broad but distinct patterns of infection have been distinguished globally. Everywhere, the modes of HIV transmission are fundamentally the same - sexual, blood contact, and perinatal. A significant

difference in magnitude of variation amongst the countries reporting have been noticed. In some country some particular mode is dominant and in other countries another modes. Details of personal and social risk behaviours in different areas are said to influence the relative frequency and expression of these three modes of spread.

In pattern I areas, HIV probably began to spread during the mid-to-late 1970s. In these areas, sexual transmission of HIV occurs predominately among homosexual and bisexual men. Heterosexual transmission is also occuring in these areas, and is reported to be increasing. Transmission through blood contact in pattern I areas of the world now mainly involves persons with drug injecting behaviour, as blood for transfusion and blood products have been considered relatively safe. Areas where this pattern is presently found include : North America, Western Europe, Australia, New Zealand, and many urban areas in Latin America.

In pattern II areas, HIV also likely began to spread extensively during mid-to-late 1970s. Here heterosexual transmission has and continues to predominant. Transmission through HIV-contaminated blood transfusion continues where HIV screening of blood is not yet routine. Perinatal transmission is also reported to be a major problem in those areas where 5 to 15% or more pregnant women are HIV infected. Areas where this pattern is presently found include: sub Saharan Africa and increasing in Latin America especially in Caribbean.

In pattern III areas, introduction and/or extensive spread of HIV did not occur until mid-to-late 1980s. Significant spread

of HIV is now being documented in several countries in South-East Asia, but the prevalence of HIV, in most countries classified within this pattern, remains relatively low. Early AIDS cases were generally associated with contact with pattern I & II areas or imported blood or blood products. It is believed that HIV infection has insignificantly penetrated into the general population here. But HIV infection are being increasingly recognised among persons with so called risk behaviours, such as prostitute and persons with drug-injecting behaviour. Eastern Europe, the Middle East, North Africa, and most countries in Asia and Pacific are included in Pattern III. India has also been included in this group.

Of course, these three patterns oversimplify, for different patterns may co-exist within a single country, or even within a large geographical area. Also, the patterns are not immutable.

COST OF THE EPIDEMIC

It is not yet possible to assess the overall cost of AIDS. No attempt has been made to detail the cost of AIDS to the community, which grow from year to years. Although the UNDP report says that the global cost - direct and indirect -- of HIV and AIDS by 2000 AD could be as high as $500 billion a year __ equivalent to more than two percent of global GDP (UNDP, Human Development, Report, 1994, pp.28). The impact of HIV/AIDS on the western industrailized countries and the estimated cost of the epidemic worldwide stimulated intense global action to control it.

To provide technical capabilities to assess the scope of HIV infection in most of the AIDS affected countries a Global AIDS Strategy was formulated by the World Health Organization. This strategy is supposed to bear the responsibility to direct and coordinate the global fight against AIDS by providing multifacet assistance especially in terms of technological and financial support to the developing countries.

GLOBAL AIDS CONTROL ACTIVITY

Initiated by American and European scientists through the WHO with the setting up of the Global Programme on AIDS in 1986. Soon supported by other international funding and development agencies including the World Bank and UNDP.

Recently a new UN agency UNAIDS supported through six co-sponsors has emerged. It is based in Geneva at WHO, the organisation which is to provide administrative support. This newly launched UNAIDS is being headed by Dr.Peter Piot, a Microbiologist over a decade. This high powered agency is meant to serve as the primary source of policy and technical guidance on AIDS, including the polices, strategies and approaches that together constitute "international best practice". In addition, to1 serve as a neutral forum for achieving censensus on sensitive, technical and policy issues and to play a major role in setting and promoting the worlds research agenda on AIDS (UNAIDS update 1995).

The Global AIDS strategy has three objectives: to prevent HIV infection; to provide support and care to those already HIV-infected; and to link national and international efforts against

AIDS. In 1988 a new element - preventing discrimination against HIV-infected people and people with AIDS was added in this said strategy.

The first objective, preventing HIV transmission, is achievable precisely because HIV is transmitted through specific individual behaviours and through readily identifiable practices in the health system. For this reason, the proper focus of prevention is behaviour, not infection status.

The first two elements of prevention programmes - information/education and health and social services to support and sustain behaviour change ..... were essentially derived from traditional public health practices.

In this way to influence individuals behaviour information and education programmes have been advised to operate in all countries. Besides information and education, health and social services are also thought to support and strengthen behavioural change.

The third essential component in prevention is advised as supportive social environment. Each element of the information/ education programmes, health and social services, and supportive social environment ... is given extraordinary emphasis in national AIDS prevention programmes.

The second objective of the Global AIDS strategy is to reduce the personal and social impact of HIV infection. This implies ensuring humane care, of a quality atleast similar to that provided in that society for other diseases, to those who

are ill, and to provide counselling, social support and services to all who are infected.

The third objective to unify national and international effort against AIDS, has been urgently realised. The WHO has done this by predicting high levels of infection in all regions and countries so as to shake the policy makers and planners into action on the problem. Secondly, various international agencies stepped in, providing financial resources and by mobilizing people to help countries around the world to develop their own strong and comprehensive national AIDS programmes. Through a number of expert missions, technical evaluation and assessment visits regularly being made to the different countries develop appropriate strategies to curb the problem.

The objective of preventing discrimination against HIV people and people with AIDS was entirely innovative. Based on practical experience with the deleterious impact of discrimination on HIV prevention programme the WHO included non-discrimination towards infected people as an integral part of the prevention model.

Some of the internationally renowned experts like Jonathan Mann of Harvard School of Public Health says that on several levels, this programme based approach was successful. First, worldwide experience has shown that - atleast at the pilot project or community level - HIV prevention efforts can succeed, when all three element of the socalled prevention tried were ensured. Further, with time and experience, each of these elements was refined and improved upon.

National AIDS committees are now developing medium term, 3-5 year, comprehensive national AIDS plans. These national plans are the key to organizing, mobilizing and coordinating national and international resources for AIDS prevention and control. These plans are specific for different countries covering specific national requirements. It is remarkable to note that there is no precedent in the history of global health for the speed, intensity and scope of this global mobilization against AIDS. It is nothing but AIDS which became the first disease ever discussed on the floor of the United Nation General Assembly.

After the emergence of comparatively improved knowledge of HIV infection, its epidemiology, and measures for control, the global AIDS strategy has been revised and new problems, new challenges, and a greatly heightened sense of urgency have emerged. Changes in the strategy respond to the rapid emergence of heterosexual intercourse as the dominant mode of transmission, the increasing number of AIDS orphans, the increased risk of infection seen in specific groups, and the added burden of the parallel tuberculosis epidemic. The strategy also responds to the need to treat other sexually transmitted diseases, which greatly increases the risk of transmission to upgrade the social and legal status of women, and to plan immediately for the predemic devastating impact on social and economic development. (WHO AIDS Series 11, 1992)

AIDS DETECTION STRATEGIES $TH-6136$

It is now well established that the disease is caused by a viral infection although it is not possible to rule out that other co-factors may be necessary for the full expression of the

disease. Human Immunodeficiency Virus (HIV) is now the standard name for the virus associated with AIDS. The disease is transmitted through close contact with the infected individual in the form of sexual activity, needle sharing, direct blood contact such as transfusion, or perinatal contact. There is no proper evidence of transmission through casual contacts, airborne or waterborne spread or through insects. Shortly after infection, (in Window period, quite often detection is not easily possible) HIV antibodies can usually be detected in blood, where upon an individual has seroconverted and is therefore referred to as seropositive. The time from first infection to seroconversion is not known precisely, but it is thought to be less than six months. HIV infection develops through a series of stages affecting the immune system of the infected individual and finally leads to a number of other clinical infections. Emergence of a set or cluster of specific clinical conditions (which are extremely unlikely to occur in those uninfected with HIV) is what is commonly known as AIDS. It is important to note that the strict definition of what constitutes a dignosis of AIDS often evolved during the course of epidemic. Symptoms prior to the diagnosis of AIDS often include lymphadenopathy, night sweats, weightloss and various opportunistic infections. The period from infection to diagnosis of AIDS is known as incubation period. At some point, after infection, the individual enters an infectious period during which the infected individual is termed as infective and can pass on the disease to susceptibles. The potential to transmit the virus to susceptible during a contact is known as the infectivity.

DEFINITIONS

Prior to 1981 it was just a suspicion, an apprehension that there was "something other"; physicians and epidemiologists in Africa, Europe and America were noticing a mysterious new collection of ailments that defined classification and resisted all medical interventions. In 1981 five case Penumocystis Carrnii pneumonia (PCP) and twenty-six cases of Kaposi's sarcoma (KS) were reported to the CDC; both afflictions were medically known, but rare. All cases were traced in homosexual men from New York and California; unnoticed in the early years of the epidemic. There were also many cases of HIV infection among East coast IV drug users. In 1982 the CDC officially classified a new collection of clinical conditions, as a syndrome, and began monitoring a new officially recognised illness. After sometime a separate classification was established for children. The first cases of hemophiliac and transfusion infections were also recorded in 1982. Still no one knew what was causing the newly observed health problems and deaths. Then in 1983 LUC Montagnier from Franc's Pasteur Institute, isolated a virus believed to be the Human Immuno Deficiency Virus (HIV). The French hypothesis was also endorsed by findings from America's National Cancer Institute.

AIDS was first defined in 1982 by the CDC of the Department of Health and Human Service in the USA. The CDC has the primary responsibility for defining, tracing and containing epidemic diseases in the United States. The original and all subsequent definitions have been based on previous clinical and/or laboratory observations as to characteristics of HIV infection at various stages and in various population studies, as well as the

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CDC's epidemiologic need to define it in such a way as to gather and collect needed data. At any point then, AIDS equals a medical and scientific consensus as to the characteristics of a disease to be diagnosed, traced, and recorded in accordance with an official government definition. The use of the word 'consensus" a very political work - should sound waring that there can well be political as well as scientific/medical aspects to disease definition.

CRITERIA FOR DIAGNOSIS OF AIDS CASES

1. WHO clinical case definition (1986)
2. Revised, Caracas Clinical AIDS definition (1992)
3. CDC AIDS definition (1993)
4. European case definition (1993)
5. Abidjan WHO case definition and
    Expanded WHO case definition for AIDS (1994)

Pre-1987 Definition

Presence of opportunistic infections and tumors including a pathological or histological laboratory confirmation was required before labelling of any screened blood sample.

The most common opportunistic infectious, or illness, observed in pattern I regions were:

-   a type of pneumonia called pneumocystis carini pneumonia

- a variety of gastor-intestinal infections resulting in diarrhoea and weightloss, causing AIDS to be known as "slim" disease in some areas.

- a skin cancer called Kaposi's sarcoma

- disorders of nervous system, sometimes resulting in dementia (deterioration in intellectual capacity), caused by other infection or HIV itself.

HIV may also trigger the activity of other infectious diseases which may be carried by individuals, such as tuberclosis, or aggravate the damage caused by others.

The presence of Kaposi's sarcoma or cryptococcus meningitis are often strong indicators for the diagnosis of AIDS, but these illnesses require diagnosis by specially trained clinicians.

Case Definition (implemented from 1st September 1987)

The following additional conditions are diagnostic for AIDS if an HIV laboratory test is positive.

1. Presumptive diagnosis (without pathological or histological laboratory confirmation) for certain diseases in the pre 1987 definition, such a pneumorgistic carinii pneumonia, esophageal candiasis, and Kaposi's sarcoma.

2. Additional opportunistic infections including cytomegalovis retinities and mycobacterium tuberculosis : presumptive diagnosis allowed for some of these diseases.

3. HIV encephalopathy (dementia) and wasting syndrome.

Because laboratory facilities in many countries are insufficient to allow reliable diagnosis of the opportunistic infections and malignant disorders required to define AIDS, and testing for the presence of antibodies to HIV may not be feasible, attempts have been made to provide a clinical based case definition. This is most useful in the areas where there is a high prevalence of AIDS, but is obviously less useful where AIDS is rare, since so many other diseases (notably tuberculosis) can sometime present the same symptoms.

The case definition currently used (in those instances where proper diagnosis of disease is impossible, and no antibody test is available) consists of the existence of two major signs in association with atleast one minor sign, in the absence of other known causes of suppression of the immune system - such as cancer or malnutrition). The signs used in the definition are given as:

Major Signs:

-   weightloss greater than 10% of body weight
-   fever for longer than one month
-   chronic diarrhoea for longer than one month (intermittent or constant)
-   persistent severe fatigue

- persistent cough for longer than one month
- general itchy dermatitis (skill irritation)
- recurrent Herpes Zoster (Shingles)
- oropharygeal candidiasis (fungus infections in the mouth/throat)
- chronic progressive and disseminated Herpes simplex infection.
- general lymphadenopathy (Swelling of Lymph glands)

The CDC 1982 definition has been changed twice in 1987 and 1993, and on both occasions was expanded to include new conditions or characteristics. It is probable that it will be altered again in response to changing information, changes patterns of infection, and changing domestic and international politics. However, whether now or in future, and in the CDC's words, "AIDS is the group of clinical conditions or laboratory measures that are indicative of severe immunosupression due to HIV infection.

The most recent definition is found in the CDC MMWR, "1993 Revised classification system for HIV infection and Expanded Surveillance Case Definition for AIDS among adolescent and Adults", December 18, 1992. It consists of two basic parts, first, is a list of twenty-five indicator diseases or symptomatic conditions (some of which have several parts); second, specifications of laboratory counts of CD4+,T lymphocyte cells that are considered markers or indicators of an underlying pathological condition. Given an HIV infected person (not

necessarily an HIV tested person), the cell counts and diagnosis of indicator conditions may be combined in various ways to meet the guidelines for a diagnosis of AIDS.

Thus combinations of clinical criteria and laboratory testing for workers of HIV infection are being used for deagnosis of AIDS.

Clinical manifestations of AIDS are many and vary in different parts of the world. In America and Europe, Kaposi's sarcoma has been a common feature of AIDS whereas in Asian Region it is not as prominent. Mycobacterium tuberculosis, has been found the most prevalent opportunistic infection in developing countries. The Indian National AIDS Control Organisation has evolved certain criteria on the basis of the main clinical manifestation of late HIV disease which have been detected commonly in AIDS patients in India. There is a marginal difference in the WHO and in Indian diagnostic criteria. This is evident from the NACO data which reveals that till September 15, 1995, out of 2009 reported cases of AIDS to the NACO, 1661 cases follow the WHO diagnostic criteria presenting the opportunistic infection and/or malignaneic, confirmed by laboratory investigations and the rest were diagnosed on the basis of AIDS diagnostic criteria adopted for India. This implies that country specific criteria of detecting HIV seropositives can provide better picture of the spread of the epidemic (NACO, Newsletter, December, 1995)

AIDS DEFINITION (WHO)

Major Signs

Weightloss > 10% of bodyweight

Chronic diarrhoea > 1 months

Prolonged fever > 1 months

(remittent or intermittent)

Minor Signs

Persistent cough for one month

Generalized pruritic dermatitis

Recurrent Herps Zoster

Chronic progressive and disseminated Herps and Simplex

Generalized lymphadenopathy

Presence of any two of the Major signs and one of the minor signs signifies that individual is suffering from AIDS.

AIDS Diagnosis Criteria Approved for India

A.   Positive test for HIV infection by two tests based on preferably two different antigens.

B.   Anyone of the following :

1(a) weight loss > 10% of body weight or cachexia

(not known to be due to a condition unrelated to HIV infection), and

(b) Intermittent or constant chronic diarihoea for more than one month.

2.   Disseminated or miliary or extra-pulmonary tuberculosis

3.   Kaposi's sarcoma

4.   Neurological impairment preventing daily activities, not known to be due to a condition unrelated to HIV (e.g. trauma)

5.   Candidiasis of the Oesophagus (Diagnosable with a dysphasia, odynophazia and oral candiasis).

HIV TESTING

The HIV testing is most vital component of the overall strategies of AIDS control. There are a number of tests to detect the HIV. Blood tests are done to look for specific antibodies produced by the HIV.

There are two types of tests used to detect infection. First type is antibody test which detect the presence of antibody to

the virus. If the antibody is present, it is reasonable to infer that the virus is also.

Two are widely used - the ELISA and the WESTERN BLOT blood tests. Neither tests directly for the virus but rather for antibodies (the immune mechanism has created, after infection, to fight the virus). The ELISA is considered as the main screening test, while the WESTERN BLOT is being used for confirming an HIV seropositive result by ELISA. Thus the ELISA is the preliminary screening test, and if sample is found ELISA positive, then the WESTERN BLOT test is applied to confirm the results.

The other type is used in cases where there are serious doubts as to the accuracy of positive results from the above tests. The suspicious sample can be confirmed by a test which reacts to the presence of the virus directly. These are the polymerase chain reaction assay, the p24 assay, and the HIV culture/co-culture tests. Now the obvious question arises why not use these tests to begin with? These tests are too expensive (Rs.6000-7000 per sample) and require very sophisticated equipment, trained personnel and sufficient time to be used as a broad screening test.

(a) Screening Tests :

    1. ELISA   : Enzyme Linked Immunosorbent Assay - the most commonly followed procedure through-out the world (presently cost between Rs.30 to Rs.50 per sample).

    2. PAT   : Particular Agglutination Test

(b)   Spot Test :

1.   Immunocomb Test : these test may give false positive
         results and hence are being rarely used.

2.   Confirmatory Test : WESTERN BLOT the most commonly
         followed procedure to confirm the entry
         of HIV in the body (costs around Rs.700 -
         900 per sample tested).

Inspite of the availability of these testing facilities a clinical suspicion has been felt throughout the globe due to the accuracy of these widely used tests and with the WHO definitions which are too general and are mainly based on the African experience.

ACCURACY OF THE TESTS

Uncertainty always prevails about the predictions made through these tests (ELISA & WB). Like all other prediction, it also carries same degree of errors. Error can creep into biological testing due to inadequately sensitive or selective testing. Errors can also result from unsystematic and casual laboratory work, but while this happen, it does not happen enough to affect national figures. However, there are several sources of significant error:

(i) A persons's immune system must have had sufficient time to generate antibodies against HIV before an antibody test can be effective. Generally the body requires from six weeks to 12 weeks (generally referred as window or latency period) after infection, although, in rare cases, the period can be much longer. In this case, if there are no antibodies then a test will read negative even though the individual is, in fact, positive. At the outset

of infection person may well test negative even though he or she may have a large quantity of virus in the blood and be very infectious. This latency period or window period makes it possible for infected blood to get into the blood banks inspite of screening and for people unwittingly to transmit the infection in sexual relations. During these terminal stages of AIDS, an infected individual may also test negative at the very end of his life. By that time, the immune system has collapsed and can no longer generate antibodies against anything.

Another important source of error, one with larger socio-political implications, begins from the fact that the predictive accuracy of the test is contingent not only upon their sensitivity and specificity but also upon the proportion of the population being tested that has, in fact, has been infected and developed the antibody. As a general rule, "the smaller" the proposition of those in the screened population who are infected, the higher a tests positive error rate will be : conversely, the higher the proportion of those in the screened population who are HIV positive, the more reliable a positive prediction will be. In other words a prediction by ELISA that individual is positive is very reliable if the individual is a member of group in which there is comparatively high HIV prevalence rate, the so called high risk groups (which is already a controversial issue). On the other hand it is being accepted that if the tested individual is not a member of such group, then the result is less reliable, more prone to error (individual belonging to general population may be wrongly labelled as HIV seropositive).

The overwhelming majority of the Indian population is not in a socalled high risk group and is not infected; the overall

seroprevalence is about 22,389 among the 2798521 screened individual (i.e. 8.00 per thousand). If the nation were to be tested with the ELISA alone, the number of false positives would be staggering, in fact they would greatly outnumber the true positives. The consequences of such a result may be incomprehensible - everything would be shaven as if by a giant hand. If these ELISA seropositive were checked by the WESTERN BLOT then the number of false positive would be greatly curtailed. But the costs would be extremely high.

Thus the Enzyme Linked Immunosorbent Assay (ELISA) may be false negative under following conditions:

(I) Biological Conditions

1. The test may be false negative during early stages of HIV infection. This period generally varies from 2-24 weeks but may be as long as 2 months. The false negative rate varies from 16% to 50% during this period.

2. In some patients there is an early production of antibodies followed by a cessation of antibody production and disappearance of antibodies from blood. This may be due to sequestration of the virus.

II Faculty testing. The ELISA may be false positive in case of:

    I.   Biological cross - reacting infections and antibodies.

    II. Epidemidogical in low prevalence populations.

    III. Faculty testing

Imagine testing 100,000 people in whom of prevalence is 0.01%. Of the 100,000, 10 are infected and 99,990 are not. If we allowed the false positive rate to be the best so far attained (0.02%), the tests will yield false positive results in 20 of 99,990 people who are not infected. Thus, of the 30 positive results, 10 will come from people who are infected, and 20 from people who are not infected.

PROBLEM RELATED TO LABELLING OF RISK GROUPS

Volinn (1989) stated that whenever it is practiced, the epidemiology of AIDS is never neutral. The means of investigation used to select among the available information in the collection of relevant data, give meaning to some aspect and neglect others.

Epidemiological studies to learn the why and how of the AIDS pandemic are important. A proper understanding of the evolution of an epidemic situation in a particular region is generally expected to help in formulating strategies for prevention. Epidemiology has contributed significantly in tackling some of the vital health problems. On the basis of some epidemiological studies carried out by western scientists several terms have been forwarded to scientific communities across the countries. Those at high risk of AIDS, called risk groups, were identified, routes of the disease spread were identified and even certain recommendations were made to reduce risks by behaviour change.

If one analyse the term highrisk groups then it can be easily visualized that the frequently used term high risk group (HRG) has an epidemiological concept which has a function to give special care to the members. However, it has become a negative

concept, helping to isolate and condemn individuals, rather than to educate, protect and treat them. There are a number of biomedical and physiological factors which make some groups compared to others more prone to the HIV infection. The modes of transmission of HIV puts many more people at risk than the label HRG implies. It is not what we are, but what we do, and what health institution (providing various services) do that constitute the primary risk factor. It therefore becomes crucial to understand the spread of HIV in terms of activities and not groups which are at high risk.

The concept of 'high risk' group atleast in AIDS seem to be socially rather than medically defined. In parts it reflect social norms of who are outcast, stigmatised, or simply "not like us".

Nodoubt it was public health experts who developed these HRG concept, while there may be some substance in the concept, how far it holds in the Indian context needs to be thoroughly analysed especially because of the negative impact that it creates. The basis on which these groups have been identified elsewhere and it was wrongly assumed that the same exactly hold true for India.

It is universally believed that specific categories of people (usually termed as high risk group) are spreading this disease. The state considers this commonly acceptable fact because it preassumes that it can limit the spread of the disease by eliminating those who are socially and economically vulnerable, to assert themselves.

When the state follows this stigmatization and in the process makes irrelevant ideas of scientific knowledge (intellect) on the subject, it is doing so as a custodian of bourgeois consciousness. The elite, which usually exercises control on the state policies, finds it quite convenient to assume that certain strata of the society (who are not like us/disreputable) of HRGs are responsible for this spread of the disease, and that this problem would be best kept in check if these specific strata of the society are isolated from the rest of the people. It has been continuously observed that scientists, who are also very much a part of the ruling elite, use their scientific skill to justify their burgeoi's prejudices, and have legitimised the attack on "high risk groups". Now another set of untouchables in the society has been visualised. The so called untouchable of the society, and women in prostitution, professional blood donors, IV drug users, homosexuals, long route truck drivers, migrants as well as patients attending STD clinics.

People from high risk groups are mandatorily tested, quarantined and subjected to all sorts of humiliation. However, it is high risk behaviour and not high risk groups which spreads AIDS. It is not just a poor sex worker who may indulge in "unsafe sex" (or sex with some infected partner without a condom); clients of sex workers, heads of various public and private enterprises and the business executives frequently visiting from one place to another are equally liked to do the same, but enjoys greater immunity with respect to state repression.

The state has deliberately stepped up the phobia on the AIDS issue so that right wing tendencies in the ruling class enjoys an

upper hand in the management of society. The United States of America has naturally shown the way in this regard. It reserves the right to deny a tourist or immigration visa to an HIV positive person. How an HIV positive person will spread the disease by simply going about in that country is perplexing beyond imagination.

Even without going into the medical aspect of AIDS, it deserves emphasis that group targeting will not minimise the transmission of HIV. Forcible testing of individuals are likely to drive the disease underground and further worsen the problem.

The state not only discriminates against visitors and travellers as a whole, but also show its preassumed class bias against the less privileged sections of society by harassing these categories of travellers more than the others. Several countries require visa applicants only from Africa to undergo HIV testing. In others, people from certain occupational groups i.e. performing artists, mine workers, and seamen are required to be screened or visa applicants (particularly from depressed sections of the society) intending to stay longer than a certain period are mandatorily tested, whereas those visiting for just few days, say as short term tourists or participants in elite conferences might be left. In Cuba, all travelling residents are obliged to take a test but tourists are not subjected to the same.

The state comes down sharply on those who want to establish temporary or permanent residence, in accordance with their social and economic status in society. The WHO concedes this discriminatory attitude in its standard on the long term travellers (who stays over 90 days).

Thus there are major sources of uncertainity in determing the epidemology of HIV/AIDS. Many aspects still remain unresolved. The focus remains on high risk groups while the larger section of general population is ignored. Detection techniques have a significant degree of unreliability. Yet, inspite of these shortcomings there is a need to use available techniquess and understanding in the best possible manner. The uncertainity of data an of the epidemic in different population groups must be recognized.

CHAPTER-III

HIV/AIDS IN THE GLOBAL REGIONS AND DIVERSE SOCIAL CONTEXTS

HIV/AIDS IN THE GLOBAL REGIONS AND DIVERSE SOCIAL CONTEXTS

As discussed earlier, AIDS and human immuno-deficiency virus infection are not distributed randomly, HIV has affected different groups or sub-groups and regions around the world at different rates at different times. With available authentic data, we can distinguish three broad but distinct patterns of infection. Everywhere, the modes of HIV transmission are fundamentally the same - sexual, blood contact, and peri-natal but details of personal and social risk behaviors in different areas influence the relative frequency and expression of these three modes of transmission.

Till June 30th 1995, a cumulative total of 1169811 individuals with AIDS were reported officially to the WHO from more than 200 countries/regions across the five continents. Of the reported cases, more than two thirds of the cases are from Africa and America. There are 62 countries who have reported more than a 1000 cumulative AIDS cases to the WHO.

The available and authentic global AIDS surveillance data indicate that AIDS cases are occurring worldwide, and the numbers are increasing in all the continents. The disease was first recognized in the US, and after that it was quickly detected in Europe and in Africa. Since that early recognition, now it is occurring everywhere in Australia, Asia and even in several Islamic nations. Although the United States has by far the largest number of reported cumulative AIDS cases, several developing countries in the American continent and in central and eastern Africa have a higher incidence of infection. In the American continent countries like Bahamas (131.4), Bermuda (77.2)

and Barbados (44.7) have quite high case rate per hundred thousand population. Their impact on the total AIDS cases in the continent remains insignificant due to their small population sizes. Almost everywhere a sharp marginal increase in the case rate per hundred thousand population or has been noticed in America except in Canada a country which showed a declining trend.

Many social factors like poverty have been found responsible for the heterosexual spread of the disease in certain countries across the continents. Recent developments on the economic front in the world has also become instrumental in increasing the number of infective individuals. Due to market - oriented strategies, state's inclination towards privatization in certain areas, tremendous amount of multifaced infrastructural developments are taking place like increase in transportation sector, tourism industry (in few countries), budget cuts in certain areas like health and social sectors (in some developing countries), urban migration due to shift from agricultural occupations and increase in prostitution. The effect due to these factors is that HIV is likely to get a more porous environment to circulate among different sections of populations. It is not only the case of developing countries but it has been observed in almost every country of the globe that the poor and marginalised have been more affected. The socio-cultural changes occurring across the globe also lead to the break up of marriages, increased urbanization creating a pool of people changing partners.

Table 3.1

Cumulative AIDS Cases in Africa
(as on June 30, 1995)

Country/ Region	No. of cases	Case rate per 100000 Population
Kenya	56573 (9139)	24.8 (19.2)
Uganda	46120 (21719)	23.2 (32.7)
United Republic of Tanzania	45968 (21208)	0.7 (17.6)
Zimbabwe	38552 (7411)	96.7 (13.2)
Malawi	37673 (12074)	49.2 (45.2)
Zambia	29734 (4690)	– (13.2)
Ethiopia	18042 (1218)	10.7 (0.6)
Cote d'Iovire	25236 (6836)	44.6 (15.3)

Figure in parentheses indicate reported data as on Sept.30, 1991.

The continent hardest hit by the AIDS pandemic is Africa, where all three infection patterns can be found. Pattern I and II are seen in South Africa, pattern III prevails in North Africa. In sub-Saharan Africa, pattern II prevails in the large urban areas of central, eastern and southern Africa. In West African Countries, where pattern II is also found HIV-2 infections are much more common than HIV-1 infection. Although, the cumulative total AIDS cases reported to the WHO by Africa are 415595, (till June 30th 1995) the possibility of under reporting cannot be overruled. Due to economic vulnerability and late delivery of adequate testing kits in African countries a number of undiagnosed cases remain.

Till June 30th 1991, Uganda dominated the number of reported AIDS cases with a total of 21,719 (now 46,120 on 30th June, 1995) but during the last four year Kenya has reported the maximum

number of AIDS cases (56,573) with more than 25 case rate per 100,000 population. Zimbabwe and Malawi have also reported a tremendous increase in the reported number of AIDS cases during last 4 years. Zimbabwe is the country in Africa which has the maximum case rate (about 100) per 100,000 population.

AIDS has become one of the major health problems that confront the countries of central and eastern Africa. In many of the urban centres of the Congo, Rwanda, Tanzania, Uganda, Zaire and Zambia 5 to 20 percent of the sexually active age-group have already been infected with HIV, rates of infection among some screened prostitute groups range from 27% in Kinshasa, Zaire, to 66% in Nairobi, Kenya and more in Rwanda & Butare. Peri-natal transmission of HIV is also reported by increasing in some countries of the African continent.

HIV infection and AIDS are already widespread in central and east Africa. The epidemic in West Africa started later and GPA (WHO) supported prevention programmes have attempted to curb HIV transmission by improved technology and education about the routes of infection.

The major route of spread of HIV is as a STD in countries like Ghana, where HIV is spreading heterosexually. Many poverty related factors are responsible for heterosexual spread, including the impact of structural adjustment programmes which is found significantly instrumental in increasing the risk of HIV infection in a significant number of developing countries (Robinson et al 1995; 1263-1270). The transmission of infection is therefore closely linked with socio-economic problems under development and changing socio-cultural patterns. Poverty is

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increasing in many African countries. The transportation network that developed in the 1980s tended to support the export led economies promoted by SAP rather the commercial or personal needs of subsistence farmers. This resulted in permanent as well as seasonal migration to large cities by rural dwellers searching for wage employment. Thus, networks connecting outlying areas to export centres developed, connecting rural areas to urban centres with high HIV sero-prevalence (Jurie et al 1995). This results in increasing the probability of acquiring HIV infection.

In this manner transportation routes may also facilitate the spread of HIV, as truck drivers and other workers carry the virus from the cities to the casual partners along the roadways. More unstable marital relationships and increasing use of prostitutes and other pre or extra-marital sexual partners have developed (Jurie et al 1995).

In the absence of an effective drug and vaccine, the WHO has called for vigorous efforts to prevent transmission of HIV infection. The three main intervention strategies currently employed by national AIDS control programmes in countries of Africa are promotion of condom use, promotion of a reduction in sexual partners and treatment programmes for other STDs. In many of these countries where prevalence levels of STDs are high, their control is now considered an important intervention approach, supplementing increase and use of condom and casual partner reduction.

Table 3.2

Cumulative AIDS Cases in America Reported to WHO
(as on 30th June 1995)

Country/Region	No. of cases	Current case rate per 100,000
U.S.A.	441528 (191601)	16.0 (15.1)
Brazil	62314 (14361)	4.7 (3.0)
Mexico	22055 (7170)	4.2 (1.0)
Canada	11192 (5228)	3.8 (4.3)
Argentina	6187 (920)	5.4 (0.7)
Colombia	5577 (1285)	3.3 (1.0)
Haiti	4967 (3086)	- (7.0)
Venezuela	4475 (1061)	2.2 (1.7)
Honduras	4283 (1133)	13.6 (4.5)

Figures in parentheses indicate data as on 30th Sept., 1991.

The above table reveals the number of cumulative AIDS cases reported to the World Health Organization till June 30th, 1995. Americans dominate the number of reported cases in part no doubt due to the comparatively high reporting efficiency in the USA, which perhaps approaches 80 to 90 percent. During the last 4 years, a more than two fold increase in the number of AIDS cases has been observed in the American continent. There are presently 16 countries in America who have reported more than 1000 AIDS cases. The United States of America stands out as the country with maximum number of cases and a case rate much higher than other countries of the region. Brazil, Canada and Mexico are other countries with large numbers of reported AIDS cases in this continent. In many of the countries in America, HIV probably began to spread extensively in the late 1970s. Most cases occur among homosexual or bisexual males and urban intravenous (IV) drug users. Heterosexual transmission is responsible for a

comparatively small percentage of cases but is reported as marginally increasing now. There was transmission due to the transfusion of some blood and blood products between the late 1970s and 1985, but that route has now been practically reduced by convincing people in the so called high-risk groups not to donate blood and by routine, effective testing of blood donors for antibodies against HIV. Unsterile needles, except some of those used by IV drug users, are not a significant factor in HIV transmission in these countries.

Current data suggests that AIDS incidence may continue to increase during the next several years unless any dramatic progress is made both in the development of therapeutic interventions and in the improvement of access to medical care and therapy for HIV infected persons. Data shows an increased burden of disease due to HIV infection among women and children, social/ethnic minorities, and persons living in remote areas (Mann 1991).

Pediatric AIDS cases constitute approximately about 2 percent of total AIDS cases in the United States, but HIV infection and AIDS among children pose a growing concern.

In Brazil (which has reported 62314 AIDS cases till 25 Feb.1995) as in most other countries, HIV transmission has taken place primarily through sexual contacts, increased rapidly over the course of the last decade. Yet same sex relations between men have continued to play a central role in the epidemiology of HIV/AIDS, and continue to account for almost half of the cases of AIDS reported in the country as a whole.

In Mexico, (which accounts for a total of 22055 AIDS cases), infected blood or blood products are reported to be responsible for 13% of all cases of AIDS and for the majority of cases among women. Remunerated donors have been noted to be a group with high rates of HIV infection and are now classified as a separate transmission category. It is important to mention here that officially blood donation is voluntary and unremunerated by law in Mexico.

EUROPE

Table 3.3

Cumulative AIDS Cases Reported To WHO In Europe
(as on 30th June, 1995)

Country	No. of cases	Current case rate per 100,000
France	35773 (15534)	8.5 (6.0)
Spain	31221 (9112)	14.2 (6.0)
Italy	27511 (9792)	8.9 (4.2)
Germany	12808 (6708)	2.2 (2.5)
U.K.	10693 (4758)	2.4 (1.6)
Switzerland	4465 (1891)	6.5 (6.8)
Netherlands	3488 (1799)	2.7 (2.6)
Rumania	3119 (1466)	1.7 (0.9)
Portugal	2413 (676)	4.4 (1.5)

Figures in bracket represent AIDS cases till 30th Sept., 1991.

In Europe which has reported 141768 cumulative AIDS cases to the WHO (till June 30th 1995), the epidemiology of AIDS shows a sharp contrast from East to West and from North to South. In Western Europe the pattern is strikingly similar to that in the US. France (35,773), Spain (31,221), Italy (27,511), Germany (12,808) and U.K. (10,693) are the countries which have maximum number of AIDS cases in Europe.

In several European countries, the first AIDS cases were diagnosed, as in the United States, well before the syndrome had a definite name, just after the first descriptions in the CDC Morbidity and Mortality Weekly Report (1981). As in the US, most cases diagnosed in the very first years were men in their thirties who had a history of sex with men. Despite the lessons from the US, where a rapid increase of cases pointed to the epidemic nature of the phenomenon, the recognition of AIDS as a public health problem often took many years in Europe. For a long time AIDS has been perceived as a problem of foreign labour of the Africans coming for treatment to Belgium. Only after 1985 did the government become concerned with prevention.

In a number of countries in Europe governments intervened after non governmental mobilization had already initiated their work of AIDS prevention activities. A significant difference in geographical distribution of AIDS cases with respect to mode of transmission has been observed in Europe. In Northern Europe, the Netherlands, Germany and the United Kingdom, more than 70 percent of cases are male homosexuals and bisexuals, whereas intravenous drug users predominate in the Mediterranean South (Italy and Spain). France, Ireland and countries like Australia in Europe have a balanced epidemiological situation, with 50 percent of the cases among male homosexuals and bisexuals. The control of blood products became a high priority in Europe once the HIV antibody test was available in 1984. Systematic screening of blood and blood products were introduced between early 1985 and 1987 in Western Europe. Poor hospital hygiene (viz. the reuse of syringes and the lack of effective cleaning materials) were found responsible in spreading the infection in

the Eastern Europe. Peri-natal transmission has also been noticed in Rumania.

There is a strong network of non-government organizations in some countries of Europe working closely with public authorities against AIDS. Besides differences in the social context, this is probably one of the reasons why rate of transmission differs significantly between the United States and industrially developed countries like France, Germany.

THE WESTERN PACIFIC REGION

Table 3.4

Reported Cumulative AIDS Cases To WHO
(as on June 30, 1995)

Region/Country	No. of Cases	Current case rate per 100,000
Western Pacific		
Australia	5737 (2678)	4.5 (3.4)
Japan	924 (405)	0.2 (0.1)
New Zealand	473 (274)	1.2 (2.0)
Vietnam	228 (0)	0.2 (0.0)
Malaysia	200 (28)	0.4 (0.0)
Philippines	198 (51)	0.1 (0.0)

In the Western Pacific region, as of June 30, 1995, 26 countries have reported a total of 8390 cases of AIDS. In this region Australia is the country which accounts for maximum number of AIDS cases and has the highest case rate. The identification of HIV in 1983 in Australia and the subsequent development of tests to detect HIV antibody permitted the diagnosis of HIV infection in asymptomatic people. National surveillance for

newly diagnosed HIV infection began in Australia in 1989 building on a notification system established by state and territory health authorities and HIV diagnostic laboratories.

Of the HIV diagnosed among males, for which information on exposure was available 86% were attributed to homosexual contact. This percentage changed little during 1985-90, but decreased marginally to 82% in 1991-92. The proportion of HIV diagnosed among males attributed to injecting drug users remained relatively constant during 1985-92 where the proportion among females decreased from more than 40% during 1985-86 to less than 20% during 1991-92. Although the proportion of HIV diagnosed due to heterosexual contact is gradually increasing in Australia. The proportion of HIV diagnosis attributed to medical procedures (receipt of blood, blood products or treatment of hemophilia) declined very significantly to about 1% presently. Peri-natal transmission is rarely reported there.

Although countries like USA and Australia are well developed countries in the world belonging to the pattern I infection, a significant difference in the current case rate of AIDS per hundred thousand population has been noticed. Now the obvious that question arises is why comparatively slow spread of disease has been documented in Australia than in the USA. In this regard it is important to note that majority of diagnosed HIV infection has been found due to sexual contact between men in Australia, unlike in the USA relatively small number of cases has been found attributed to injecting drug use, or to heterosexual contact in Australia. These findings clearly state that HIV transmission through sharing injecting equipment or heterosexual contact has been limited in Australia, a conclusion well supported by the low

prevalence of HIV infection detected in female and heterosexual male injecting drug users, pregnant women, patients requiring surgery and blood donors.

SOUTH EAST ASIA

Table 3.5

Cumulative AIDS Cases Reported To WHO In South East Asia
(as on 30 June, 1995)

Country	No. of cases	Current case rate Per 100,000
Thailand	19095 (119)	17.5
India	2528* (72)	
Myanmar(Burma)	475 (0)	
Indonesia	67 (10)	
Sri lanka	47 (10)	
Nepal	35 (4)	
Maldives	2 (0)	
Bangladesh	1 (1)	
Bhutan	Nil (till, 17.4.95)	
Korea	Nil (till, 17.4.95)	

Figure in parentheses indicate data as on September 30th, 1991.
* Till March 31, 1996.

Introduction and/or extensive spread of HIV did not occur until mid-to-late 1980s in South-East Asia. Extensive spread of HIV is now being reported in a few countries in South-East Asia, but the reported prevalence of HIV in most of these countries, remains relatively low. Probability of under reporting of cases in this part of the globe seems to be quite high. It is significant to note that countries like Bhutan and Korea have still not reported any AIDS case to the WHO except Bangladesh (who has not reported any new AIDS case since last four years).

Thailand and India are the most affected countries in South-East Asia due to AIDS pandemic. A highly significant difference in AIDS case rate per hundred thousand population has been documented between these countries. Probably due to different socio-cultural and traditional bonds India and Thailand have different AIDS case rate per hundred thousand of population. In South East Asia Thailand has the maximum (17.5) AIDS case rate per hundred thousand population, where as India still has an insignificant case rate.

THAILAND

In June 1995 there were 19095 AIDS cases in Thailand; a significant number of these individuals were from the seven upper north provinces, which comprises 12% of the country's population. The spread of HIV-1 in Thailand was first detected among homosexual men, followed by intravenous drug users, prostitutes and their clients.

Since 1987, (sex) tourism has become the country's number one foreign exchange earner, surpassing rice and textiles. This has become one of the significantly important factors responsible for tremendous increase of HIV sero-positivity in Thailand. But it is pertinent to note that the sex industry is not only used by foreign clients but that it increasingly serves Thai men, both single and married as well. It has become a social norm for many men in all economic groups to frequently visit the entertainment establishments.

Intravenous drug use is another of the vital factors due to which HIV/AIDS has taken significant hold in the Thai population.

Being a heroin-exporting country with ready access to the drug, Thailand has a huge user community, mostly concentrated in the capital. The said IV drug users usually share their needles resulting in a high degree of HIV transmission. Unfortunately, drug use appears to be spreading very rapidly among young men in some rural areas of Thailand.

Prevalence of a homosexual community in the Thai society is also instrumental in increasing the number of infected individuals there. Now even the gay western men swear that outside of San Fransisco, Thailand is the one place in the world where homosexuals are, if not fully accepted, then generously tolerated. But there is no doubt that due to the work of gay activities, Thai homosexuals may be among the most well informed about AIDS. Among the IV drug users high infection rate has been recorded in some jails. Thai data also reveal that about 40-60% of the prostitutes who entertain more than 8 clients per day have a comparatively higher prevalence of HIV infection. High rate of peri-natal transmission has also been observed in Thailand (Danaiya 1993).

Some traditional myths among Thai Women have become important like preferring that before marriage her male partner sleep with a prostitute to protect her own virginity, upholding a one sided monogamy, while her husband has relations with prostitutes; and reinforcing the curious idea that a man's sexual needs are stronger and more important than hers.

Due to the world wide liberalization drive Thailand has received five IMF or World Bank structural adjustment loans between 1980 and 1991 which ultimately resulted in a high degree

of urbanization, development of transportation infrastructure, road construction, reforestation projects and logging encroachment on the land of the rural poor forcing them to join the so called main-stream. Migration of Thai population to urban centres such as Chiang Mai, where HIV epidemic has been particularly severe are significantly increasing the degree of vulnerability of the urban poor to HIV infection.

INDIA

Table 3.6

Probable Sources of Infection in India.
(Till March 31, 1996)

Source	No. of AIDS cases
Heterosexual promiscuous	2048
Blood transfusion	206
Blood Product Inf.	22
Homosexual contact	22
Spouse of AIDS Patients	32
IV Drug addicts	117
Others	81
Total	2528

Source: NACO, 1996.

By the end of March 31st 1996, a total of 28,16,304 samples were screened for detection of antibodies against HIV in India. Out of screened individuals 22,529 were found HIV sero-positive including 2528 AIDS cases throughout India. Out of the total reported AIDS cases there are 1894 male and 634 female who have been detected as AIDS cases (NACO, 1996). A significant state wise variations has been observed in India. These regional variation may be only partly correct due to unavailability and

completeness of authentic data. The states of Maharashtra and Tamilnadu are leading in the number of cases, having reported 1242 and 492 AIDS cases respectively. They are followed by Punjab (100), Manipur (104), Pondicherry (100), Delhi (99) and Kerala (96). Till 31st March, 1996, no AIDS case has been reported from the states of Arunachal Pradesh, Andaman & Nicobar Islands, Daman & Diu, Lakshadweep, Mizoram, Meghalaya, Sikkim and Tripura.

A significant geographical variation with respect to modes of HIV transmission of infection has been noticed in India. The comparatively high infected states like Maharashtra and Tamilnadu have traced multi-sexuality among heterosexual partners as a major mode of transmission. The north-eastern states have witnessed the use of IV drugs as major route of infection. Imphal in Manipur is said to be responsible for spreading infection through contaminated needles and syringes which are supposed to be shared by other drug users (IV). The easy availability of heroin from the golden triangle through Burma (now Myanmar) border is supposed to be responsible for the transmission of HIV.

Infected blood is also reported to be a significant mode of transmission of HIV. NACO data reveal that more than 15% of all HIV infection in the country is acquired through blood transfusion.

Blood collection and supply is presently regulated by the Drugs and Cosmetics Act which specifies equipment, trained manpower and procedural requirement for licensing blood banks. The Act requires that all blood to be used for transfusion be

tested for HIV, HBV, Malaria & syphilis before being released for transfusion. If we consider the WHO norms of 7 units per bed per annum blood then we require more than 4 million units of blood but only 2 million units of blood are being collected annually. The government has established 154 zonal blood testing centres nationwide for testing of samples for HIV using equipment supplied mainly through WHO & USAID. Here it is remarkable to note that a majority of commercial blood banks which rely mainly on professional blood donors for 94% of their stocks do not have adequate testing kits to detect the antibodies against HIV virus. In 1990, a study done by A.F.Ferguson, found that out of 1018 blood banks in India 616 were unlicensed. The study also revealed that 85% of the collected blood is not screened for AIDS (NACO December 1995).

The annual estimated requirement of 40 lacs unit of blood is based on the WHO standard (7 unit per hospital bed) which does not seem appropriate in the Indian context. In addition, according to a renowned pathologist of Bombay if we properly utilize blood then even 1 unit of blood can fulfill the requirements of 3-4 patients because only 2 percent of people requires whole blood (Sunday, 1996:39). Keeping this vital factor into consideration by proper management and optimum utilization of blood we can reduce the probability of transmission via this route.

Peri-natal transmission is reported to be marginally increasing in some parts of the country. Of the pregnant women tested at ante - natal clinics, it was found that 2.5 percent of them were infected in Maharashtra, 1.1 percent in Salem, Tamilnadu, and 1 percent in Manipur. It will be pertinent to

mention that these findings are mainly based on the specified tested groups of the population.

The Government of India has launched a comprehensive National AIDS Control Organization under the Ministry of Health. Its importance can be well understood from the fact that it is being headed by an IAS Officer of the rank of Additional Secretary in the Government whereas the Registrar General of India (no doubt under Ministry of Home) responsible for vital records census like has been given the rank of Joint Secretary. With the abundance of national and international support NACO has started a number of programmes along the lines of the global programme like I.E.C., developing sentinel centres for surveillance and developing market strategies for easy availability of good quality condoms including monitoring of blood and blood products in some of the countries. However, one wonders whether these interventions can have much impact without the proper support of effective basic health services.

Table3.7

India' Plan Outlay of Different Diseases

| Disease | Plan Outlay in crores | | | | | |
	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96
Malaria	82.00	83.00	77.00	90.00	90.00	119.00
T.B.	15.00	16.00	29.00	35.00	46.00	50.00
Leprosy	24.00	24.00	35.00	35.00	94.00	80.00
Trachoma & Blindness	6.20	12.80	20.00	25.00	40.00	72.00
AIDS	–	–	63.99	66.24	72.35	79.80

The annual budget-plan outlay of health revealed that in the period of 1992-93 and 1993-94 inspite of having no technological means to tackle the problems AIDS was given the higher propotion in the budget than what was allocated to TB and Leprosy together, the diseases for which technological support is available. Is it rational to be spending so much on interventions like IEC when its effectiveness is of little value in the absence of a health service trusted by the people? (Table3.7)

Now AIDS is strongly realized as a global problem requiring a global response that has no regional or political boundaries but does have a high degree of difference in magnitude and nature of the epidemic in different regions, countries and social groups. Available literature reveals a significant variation regarding mode of transmission among a number of countries in the world. Till June 30th 1995, the WHO reported that 11,68,911 individuals had developed AIDS across the five continents of the globe. Of individuals infected with AIDS as of 30 June 1995, two-thirds were from America and Africa. There is a significant difference in the rates of cumulative reported AIDS cases per hundred thousand of population among the countries reporting AIDS. While America has the highest case rate ever now, does the extent of the problem of AIDS or the possible interventions justify this large proportion of the health budget going to AIDS? It has been common to blame AIDS on developing countries of Africa and South-East Asia by the Western dominated international agencies of high repute. For the year 2000 AD, the current projection is that there will be a cumulative total of 30 - 40 million HIV infections in all the five continents, of which more than 90% will be in the developing countries. Similarly the projected cumulative total of adult AIDS cases is close to 10 million in 2000 AD.

It is remarkable to note that in the mid 1980s, the epidemic was well established in North-America and Africa, but by 2000, it is being propagated that most of the new infections will be in Asia.

The validity and reliability of projections can be easily analyzed from the WHO technique used for Indian estimates. It is important to note that while doing projections for India the WHO has taken into consideration 'the number of estimated prostitutes (female) and of sexually active persons supposed to be practicing high risk behaviour in the country. There is rarely any reliable data on the sexual behaviour of Indians as a whole, or more pertinently of different sections of Indian Society including commercial sex workers. Till June 31, 1995 inspite of having maximum number of cumulative AIDS cases in America, some what in sensational manner negative reporting is being done for Africa and for South East Asia. For the year 2000 AD the current WHO projection is that there will be a cumulative total of 10 million HIV cases in Asia. Majority of these cases will be in Thailand and India.

The recent available data shows a high AIDS case rate (17.5) per hundred thousand population in Thailand. Infact it is unjustified on the part of the WHO to put India along with Thailand which has many differences in social and cultural patterns that make it much more conducive for the spread of HIV than is 'prima facie' the situation in India. This is not to say that AIDS is not a growing public health problem in India but that the predictions of its size may be exaggerated.

Thus there is a marked diversity between regions and between countries within regions. The reasons for difference in AIDS case rates between apparently socio-economically and regionally similar countries (e.g. USA and Canada or Australia) need to be examined for greater understanding of the epidemic. That social contexts are of importance in nature and degree of spread of HIV/AIDS is evident. Thailand and India provide another example of this diversity. Yet, the two are being bracketed together and estimates and projections of HIV infection/AIDS cases being made accordingly. The implications of this are significant for health planning and AIDS control programming in each country. Therefore, both processes, of making projections and of planning will be studied in following chapters with special reference to India.

CHAPTER-IV

EVOLUTION OF AIDS CONTROL PROGRAMME IN INDIA

EVOLUTION OF AIDS CONTROL IN INDIA

The first evidence of HIV-1 infection in India was detected in 1986 amongst the prostitutes of Madras city in Tamilnadu by the AIDS Task Force of the Indian Council of Medical Research, and within a couple of month HIV was also reported among prostitutes in nearby cities. The first patient in the final stage of the disease was detected in May 1986 in Bombay. The source of infection was traced to blood transfusion during a coronary bypass surgery in the USA. Shortly thereafter, the Indian Council of Medical Research (ICMR) opened 30 Centres around the country to collect seroprevalence data. HIV was soon reported among prostitutes in Bombay and Pune in Maharashtra state. In July 1987 the first transfusion transmitted HIV infection in India was diagnosed. The donor reported that his last contact with a prostitute had been in 1984 suggesting that HIV was present in India atleast by that time. By October 1987, the ICMR surveillance identified 145 HIV infected individuals of whom 35 were foreigners. Among the Indians, 62 were prostitutes, 33 reported multiple sexual partners, and one was homosexual. (ICMR Bulletin 1988). Perinatal transmission of HIV was found at about the same period in October 1987. In 1989 HIV infected intravenous drug users (IVDUs) were found in Manipur state. In 1990 HIV-2 infection was identified in Bombay, Madras and Vishakapatnam.

After detecting full blown AIDS in May 1986 in a patient in Bombay who was a recipient of blood transfusion in the United States, the first indigenous case of full-blown HIV disease was detected in April 1988.

Shortly thereafter, AIDS was diagnosed in two Indians without a history of foreign travel. But, the focus of transmission remained on foreign contacts. This was also supported through a risk factor study among prostitutes which emphasized that contact with non-Indian clients was the only significantly different variable between HIV positive and seronegative women (4 of 14 or 36% versus 18 of 398 or 4.5%). HIV in the North-East belt was also attributed to contacts with infected intravenous drug users from neighbouring countries like Thailand and Myanmar.

As introduction and/or extensive spread of HIV did not occur until mid-to-late 1980s in India. India has been clubbed in the pattern III distribution of HIV among the three global pattern of HIV infection. As the number of infected persons has increased, the pattern has become complex, transmission is clearly accelerating, and geographic variations have emerged.

AIDS was first described in 1981 as an obscure disease among homosexual men in the USA. The next few years were devoted to defining the epidemiology, etiology and pathogenesis of AIDS. Most of the data came from the USA where the HIV epidemic affected mainly homosexuals and I/V drug users. By the mid-eighties, it was recognised that HIV also spreads through heterosexual promiscuity and it can be passed from mother to the foetus. Since then special efforts have been made to obtain global information about the magnitude of HIV infection in the world. Because sound epidemiological data on prevalence of infection and modes of transmission are essential pre-requisites for evolving logical intervention strategies for disease control,

the Centre for Disease Control, Atlanta, USA was the first organisation that initiated the systematic epidemiological data collection of HIV cases. Subsequently, several national reporting systems for AIDS patients were started, and by 1986 the WHO organised a global reporting system for AIDS patients.

Realising the potential threat posed by HIV infection and the urgent need for finding out the magnitude of the problem in India, the AIDS Task Force of the ICMR, New Delhi, recommended initiation of serosurveillance for HIV infection among asymptomatic persons belonging to so-called high risk groups. The National Institute of Virology (NIV), Pune and the Christian Medical College (CMC), Vellore began the screening in October 1985. By April 1986, a total of 3027 persons from HRGs were screened and 10 prostitutes were detected to be seropositive.

The AIDS Task Force of ICMR considered these findings and recommended that a national serosurveillance and clinical surveillance of HIV infection should be immediately started. The objective of this epidemiological exercise was to obtain information on the prevalence and major mode of transmission of HIV infection. It was decided that the national surveillance would be established as a collaborative effort of ICMR, Director General of Health Services, New Delhi and State Health Authorities.

A network of five reference centres and 43 surveillance centres were established in six months with the existing health infrastructure employing minimum essential additional inputs. The second phase of surveillance began in May 1986. Initially the emphasis was on the screening of prostitutes. The screening of

a relatively small number of these women revealed that HIV infection existed in different parts of India. Subsequently, a wide coverage of the known risk groups was attempted.

By the end of 1986, it became obvious that heterosexual promiscuity played a major role in the transmission of HIV infection in India. During the second phase (which completed in October 1987) 53,907 persons were screened, 135 individuals were found to be seropositive and 14 patients of AIDS were detected. It was obvious that seropositivity rate even among HRGs was quite low. Consequent to finding seropositives among pregnant women, infants, blood donors and blood recipients during this phase, the ICMR Task Force recommended that in the third phase of seroserveillance, blood donors, and mother-infant dyads should be included in addition to the high risk groups.

The first part of the third phase of serosurveillance began in November 1987 and lasted till October 31, 1988. During the period 1,09,632 persons from high risk groups were screened and 387 seropositive individuals including 11 AIDS cases were detected. There was a significant increase in screening activities during this period not only among high risk groups but so among blood donors and pregnant women. The overall seropositivity rate remained less than 4 per thousand screened cases, but it was obvious that there were an increase in seropositivity rate among blood donors and promiscuous men.

The second part of the third phase of serosurveillance started in November 1988. During the period from November 1988 to October 1990 the major attention of the surveillance/reference centres was on providing assistance to the service programmes for

screening of blood donors, blood products, blood product recipients, and diagnostic screening and training of personnel from newer centres.

During 1990 the National Institute of Cholera and Enteric Diseases (NICED), Calcutta, in collaboration with the Regional Medical College, Imphal and State Health Authorities in Manipur carried out a screening of intravenous (IV) drug users in the state. In the same year, during January and February, a cluster of seropositives were detected among a group of IV drug users in the same North-East belt of India. Preliminary results from the survey indicate that over half the drug addicts screened were seropositive. Considering these findings efforts were made to strengthen and expand facilities for screening for HIV, and providing counselling and care of seropositive individuals in this region.

Studies undertaken in Vellore and Bombay have demonstrated a rather steep increase in the HIV seropositivity rate among prostitutes and promiscuous men. About one fourth of the all prostitutes screened by these centres in 1990 were seropositive. A similar steep increase in seropositivity rate has been found among men attending STD clinics in Vellore and Bombay in 1990. Nearly 10 percent of men attending these clinics were seropositive. Seropositivity rate among low risk groups such as pregnant women, men and women attending hospitals for medical or surgical ailments in Vellore and Bombay ranged between 1 to 5 per thousand of cases.

Longitudinal seroprevalence studies have been carried out among STD clinic patients and prostitutes in southern India. In

Madras, the incidence of HIV antibodies among STD patients increased from 0.6-1.4% in 1986-89 to 8.5% in 1991-92.(Jain 1994: 1186), whereas in Vellore the rate among prostitutes screened increased from 1.8% in 1986 to 28.6% in 1990. Limited data from STD patients from other urban centres in southern India varied from well below 1% in Bangalore in 1991 (and 1992) to 6.5% in Madurai in 1991. Seropositivity rate increased marginally among blood donors in Madras (from 0.06% in 1986 to 0.35% in 1991-92) and Vellore (from 0.11% in 1988-90 to 0.31% in 1992), but over the same period the rate among antenatal mothers in Vellore remained with mean of 0.05% from 1987 to 1992 (Jain 1994: 1186).

Serial independent serosurveys show an increase in HIV positivity among posititutes screened from 1% in 1987 to less than 40% by 1992 (Bhave 1990) and from 0.83% to 26% in STD clinic attending patients over the same period (Jain 1994: 1198), with a significant increase lin the last three years. In contrast, only 16 out of 849 screened (i.e.0.7%) were seropositives.

Available data from the Northern belt of the country suggest that the AIDS epidemic has not yet taken off here. In 1987, for example, only eight of 2046 high-risk persons screened were HIV seropositives(0.4%), and all infected were foreign nationals or had a history of foreign travel (Malaviya 1987: 407-9). Keeping these factors under consideration it was concluded that there was little indigenous HIV transmission in northern India. In 1988 only one of 701 prostitutes screened and none of 4,572 STD patients was HIV-1 positive. Till 1992 no significant variation of seropositivity had been found among prostitutes and STD patients. But VDRL positivity among prostitutes screened in New Delhi was 48% which was similar to the rate of southern India.

Since VDRL can be considered to be a marker for the transmission of STD. This supports the proposed fact that HIV is likely to rapidly spread in New Delhi as in Bombay (Chattopadhya 1991: 320-22 and Singh 1991: 1008-9). Other evidence suggests that this may have already happened.

In the year 1991-92, a medium term plan was evolved and implemented with the assistance of WHO in five comparatively high affected states and Union Territories. The existing programme was reviewed through a high powered meeting under the Chairmanship of Prime Minister of the country. Thereafter steps for setting up the priorities and further strengthening of the programme were initiated. As a result, a comprehensive strategic Action Plan for prevention and control of HIV and AIDS in India has been drawn up by the Health Ministry in collaboration with WHO. The NACP, operational since 1987, has been further strengthened and consolidated in 1992 at an estimated cost of Rs.222.60 crores for the period of 1992-97. This project is being funded through assistance from the World Bank by a loan of US $ 84 million and other multifactorial assistance from the WHO. As a consequence of these efforts, an extensive network of 62 surveillance centres has been established in different parts of the country to monitor the trends and extent of spread of HIV infection in the country. In order to ensure the supply of safe blood , 154 Zonal Blood Testing centres with stringent regulatory mechanis, have been established (NACO December 1995:64).

Considering the presence of STD as catalyst in the transmission of HIV, the Government has embarked upon a multifaceted approach to deal with the problem of STDs. On the one hand, the existing 372 STD clinics are being strengthened in

terms of providing good quality specialised services, while on the other hand a sincere effort is being made to provide non-stigmatizing services at the first level of contact [i.e. Primary Health Centres (PHC)] by training the health functionaries in STD syndromic management (NACO December 1995: 43-45). An extraordinary effort is being made towards behavioural change through the IEC for controlling STDs.

The latest surveillance report reveals that the major concentration of infection remains in Bombay, Imphal and Madras. The surveys conducted among the commercial sex workers in Bombay have indicated an increase in the rate of HIV prevalence. In spite of having a number of methodological weaknesses some studies have reported that prevalence of HIV infection is as high as 52% among CSW's in Bombay. Another finding of the report said that prevalence of HIV among STD clinic attendees are around 36%. Antenatal clinic attendees who belong to the low-risk groups have 2.5% prevalence rate. A similar type of sentinel survey carried out among the injecting drug users (IDUs) found that the prevalence of HIV among the high risk group is as high as 55%. Here, too, about 0.8-1% prevalence has been noticed among low risk groups like pregnant women. In Madras, the HIV prevalence among pregnant women has been reported to be about 1.5%.

According to Hira of the AIDS Research and Control Centre, Bombay, by the end of 1995, two million Indian had been infected by HIV-1 and HIV-2 and by the end of the century an estimated 8-12 million will have been infected. He is of the view that there are presently 1,70,000 AIDS in India. His further assessment is that by 2000 AD 1.2 million AIDS cases will occur in India. Bombay, which has crossed the 2.5% infection rate limit and 2.5%

infection rate among pregnant women, reflect the extent of problem in the community. He further said: "14% of those infected in Bombay, both sub-types of HIV-1 and HIV-2 are found mixed. Nowhere in the world this type of mixed infection have been noticed in the significant proportion. It is also intriguing because the presence of one sub-type hinders the acquisition of the other because of the presence of antibodies. It means that epidemiological progression is very fast and people are getting exposed to both strains of HIV in a very short period before antibodies are formed. Commenting on the rate of progression of the viruses he reveals that the rate of progression of HIV-1 is higher than that of HIV-2. That means people with HIV-1 die faster" (The Hindustan Times, July 1, 1996).

From the above discussion, it is not clear whether these findings are based on any systematic study. At present HIV-1 dominance has been recorded in almost every corner of the world and in some countries HIV-2 strains have also been noticed occasionally. If the rate of progression of HIV-1 is greater than HIV-2 then both will have different incubation periods. Moreover clearly HIV-1 will have a shorter incubation period. Still it is merely a hypothesis which should be tested in light of the sound data incorporating other transmission dynamics of the virus.

SURVEILLANCE METHODOLOGY

The availability of HIV tests to detect the presence of antibodies against the virus has made it possible to know the prevalence of infection, and to monitor trends of the infection

in populations (This does not provide any idea about the possibility/extent of infection in the general population, because these tests are being conducted on specific individuals belonging to particular strata of the society). This surveillance information can be of great value in designing AIDS control strategies if representativeness and unbiasedness criteria are adequately given importance. However, testing/screening of any population for HIV infection requires careful consideration of a variety of issues such as logistic, laboratory, operational legal and ethical ones. The design of the selected surveillance methodology should maximize the likelihood of gathering relevant, valid and reliable epidemiological information about the distribution of HIV infection in the community. At the same time, the methodology should minimize the possibility of adverse individual and community consequences.

All the surveillance techniques have certain limitation. Keeping all factors under control, optimization of the techniques is to be given emphasis while conducting any surveillance on any specific region. In some situations some methods may be of great use than others. It is important to note here that the data emanating from the surveillance centres is now considered inadequate owing to changing priorities. Therefore, with a view to revamping and strengthening HIV surveillance activities, it has been decided to adopt a sentinel surveillance methodology wherein a few selected sentinel sites and population would be screened for HIV prevalence and trends over a period of time.

HIV surveillance activity may consist of sero-surveys in which individuals are selected on a random or voluntary basis, reports of identified HIV-positive individuals, and sentinel

surveillance systems to monitor HIV trends in selected population groups.

Realising the importance of a need-based surveillance system which provides essential information on the dynamics of the HIV epidemic, the prime aim behind the surveillance is not only to monitor trends, but also to provide inputs with which to further strenghen the programme's control activities and evaluate the implementation of the AIDS programme in near future. In the context, the national HIV/AIDS surveillance system has undergone modifications in response to changing needs and scenarios. In 1985, the Indian Council of Medical Research (ICMR) started screening blood from some so called 'high risk behaviour groups' to determine the existence of HIV in India (ICMR Bulletin 1989).

HIV surveillance entered its second phase in May 1986 when its objective was re-defined as indentifying the geographical spread of HIV infection and determining the major modes of transmission. HIV testing facility were extended to cover other parts of the country. The second phase revealed that HIV infections had reached almost all over the country with different intensities. It was further revealed that heterosexual transmission is the major mode of HIV transmission in the country. During the third phase (November 1987) screening was further extended to cover special groups such as blood donors. It was in October, 1990 that when overall responsibility of surveillance was handed over to the Directorate General of Health Services replacing the ICMR.

Until 1994, surveillance was based on data collected from 62 surveillance centres established in different parts of the

country. The collected data pooled from different target groups, cumulative in nature, did not serve the purpose of monitoring HIV trends in India. To get an idea about the trend of infection in specific high risk groups and in sentinel risk groups (e.g. antenatal clinic attenders) some changes have been made in the ongoing surveillance strategies (NACO December 1995: 36).

For methodological and ethical considerations, the WHO recommends that sentinel populations be selected where blood is already being drawn for other reasons, and that an unlinked anonymous testing method be used over a period of two to three months. Common sentinel populations are STD clinic attenders and women approaching antenatal clinics.

To make the approach representative a sentinel surveillance system has been followed, which is supposed to satisfy some scientific criteria. This is meant to incorporate strict sampling procedures in limited sites with specific population groups. On the basis of existing as well as auxilliary information of HIV prevalence among different groups, existence of high risk behaviour and socio-economic factors, samples of population and sites are chosen. At most sites the following identified groups are included:

*   STD clinic attenders have been considered as initial sentinel group.
*   IVDUs in Manipur, Maharashtra, Delhi and Nagaland
*   Pregnant mothers in selected states like Maharashtra and Manipur, where the epidemic is comparatively well recorded.

A sample size of 400 STD clinic attenders and 800 pregnant women has been set up by the NACO (not clearly stated by which sampling method), which is supposed to provide result with sufficient accuracy at the present HIV prevalence levels. In order to avoid repeated testing of the same individual, the sampling period has been fixed as 6 to 8 weeks (NACO December 1995:37).

For this surveillance purposes, serial testing with two ERS (ELISA, Rapid & Simple) tests have been recommended without reference to Western Blot. This is in contrast to transfusion testing, the aim of which is to ensure transfusion of HIV free blood, and for which every unit of blood is screened with an initial test. If found HIV positive, it is discarded with no further testing.

The National AIDS Control Programme is another fully Centre sponsored health programme with abundance of international funding, like the other prevailing vertical health programmes in the country. If the history of vertical programmes in India is studied, it is to be noticed that these programmes were among the first efforts in India to deal with some of the problems of public health importance. The term "vertical programme in the context of the Indian health services refer to the unipurpose health care programmes with a centralized approach, with unified single line of command from the top to the bottom.

It is important to note here that, disease control has not always been the criterion of launching vertical programmes. The Family Planning Programme, inspite of its haphazard and half hearted unity with the MCH services, has preferred to follow a

vertical path-way and it was started not to control any communicable disease. These programmes generally followed pilot projects. There is sound logic behind the launch of these vertical programmes in India. In fact, it is the result of interests of different national and international agencies too. These international institutions wanted to create a market for their pharmaceutical and pathological products. By allowing plenty of financial assistance they were preparing grounds for a number of clinical trials necessary for manufacturing vaccines and drugs.

The hope behind these programmes were that the disease will be rooted out once for all after an initial heavy investment and there would be no further need of investment in future. These programmes were implemented with an extraordinary zeal for a long time, but till date it has not been possible to eradicate or adequately control any of the communicable disease (except small-pox which had an epidemiological and clinical picture very conducive to control activity and therefore is not a replicable precedent). Thus it seems baseless to think that after massive investment in a vertical programme alone it shall be possible to control the AIDS problem.

NACP, another vertical programme with a one-cause perspective is likely to play role against the concept of multiple causal relationship between the disease and the environment. The concept of NACP seem to have contradicted the integrated approach as recommended by the high powered Bhore Committee during 1940s.

No other disease has generated so much fear and so much funding as AIDS. The AIDS control programme is heavily supported by World Bank loans which will be recycled back to donor countries through multinational companies manufacturing HIV testing kits and other pharmaceutical products. Even though more people in India die due to prevalence of easily curable diseases like malaria, tuberculosis and diarrhoeal diseases, AIDS seem to have caught the fancy of all fund givers which gets almost ten times the funds that a number of these disease control programmes receive.

In 1991 the Ministry of Health and Family Welfare, decided to use for reporting purposes the WHO clinical case definition supported by HIV serological test results. According to NACO guidelines, a passive institution based surveillance is to be conducted by all health institutions operating in the country, government, private and charitable. Here the target population represent all persons who go to medical institutions for help in various capacities. There are two types of institutions, namely "non referral institutions" (which identify suspect AIDS cases and diagnose it provisionally) and "referral institutions" (hospitals confirming AIDS cases). Specially trained physician in each of those hospitals, called "AIDS case Surveillance Co-ordinators" (ASCs) are supposed to confirm suspect cases. The ASCs are involved in a variety of activities related to the surveillance. The state and district ASCs are supposed to monitor the activities in their areas and report AIDS cases.

For the purpose of recording and reporting of AIDS cases, details on the life and medical history of a suspect AIDS case will be documented in a routine hospital individual case record

format. A specially designed record called "individual case record" (ICR) will be used for both suspect and confirmed cases. The confirmed case record will be sent to the state ASCs, and compiled by them for the report to NACO. The reports of the district/urban ASCs will be sent to NACO. Four times a year the ASCs will also report on the statistics of AIDS morbidity, including number of cases, number of deaths and the case fatality rate (Shivlal 1994: 30).

The figures on AIDS morbidity and mortality will also be included in the monthly report submitted routinely to the hospital administrator. Following 3 to 4 years of training and practice in AIDS cases diagnosis and reporting, the ASCs referral system will be dismantled and the reporting on AIDS integrated into the routine disease reporting system (NACO 1993).

AIDS cases are finally reported to the WHO in Geneva, Switzerland from member states via WHO regional offices.

An adequate and systematic reporting of AIDS cases can be of great use in the development of a AIDS prevention and control strategy. This is possible only through an effectively functioning basic health service system . Non-discriminatory handling of HIV positive persons by medical institutions will further help in their detection. The experience of many countries which have well established epidemics indicate that the politicians, health administration and communites do not react to the epidemic before they see people dying due to the same epidemic.

The incidence of AIDS provides indirect description of the underlying and preceding HIV epidemic, and its proper recording provides understanding of the present and future course of the epidemic important for the development of preventive strategies, health care planning and intervention evaluation.

Delays between AIDS diagnosis and case reporting have been observed, although they are inevitable even in the countries with relatively sound reporting infrastructure. Even in the countries like the US which has one of the advance surveillance system, is not able to manage cent percent completness in reporting.

As per the projections based on HIV prevalence circulated by the Ministry of Health and WHO, by the end of 1991 there may have already occurred 2700 to 9000 cases (NACO, 1991). If the doubling time is taken as 12 months the number of cumulative AIDS cases is approaching 20,000 by now. A relatively small number of the officially reported cases and their geographical distributions i.e. concentation around selected institutions like the CMC Vellore, the Madras Medical College, Madras, and the JJ Group of Hospitals, Bombay indicate that the reporting system is not efficient. The lack of timely recording and reporting methodology and clinical knowledge among physicians are probably the main underlying factors (Shivlal 1994:29). The need for establishing an interim surveillance through identified hospitals and clinicians is felt desirable in the country.

The WHO had projected that by the end of 1991, there may be 0.25 - 1.00 million HIV carriers in the country. It was further stated that there were 2700 - 9000 AIDS cases in the country

during the same period. The report says that for these projecctions of estimates, the WHO has taken into consideration the number of estimated female prositutes and sexually active persons practicing high risk behaviour in the country (NACO, 1991). However, data related to female prostitute and sexually active persons engaged in high risk behaviour is lacking in India (Priya Ritu, 1994:236). Even the terms like high risk behaviours have not been clearly defined. In the light of these problems, how such are estimate was arrived at is questionable.

CHAPTER-V

ISSUES RELATED IN MATHEMATICAL MODELLING OF THE HIV/AIDS EPIDEMIC

ISSUES IN MATHEMATICAL MODELLING OF THE HIV/AIDS EPIDEMIC

After the emergence of AIDS in the early eighties, a number of mathematical models have been developed by researchers for estimation and prediction of the course of the epidemic. In this chapter a brief review of the available mathematical models of transmission of infection in the context of AIDS epidemic has been presented. There are wide ranging uncertainties in the past and current infection rates due to the lack of adequate epidemiological data for monitoring the spread of HIV infection, therefore the necessity of using statistical models for the HIV/AIDS epidemic. On the correctness of assumptions underlying the mathematical and statistical models will depend the degree of accuracy of predictions.

Predicting the future course of the AIDS epidemic has been done at two levels:

1.   Data for the immediate past can be extrapolated in the short term by in effect plotting them against time and fitting some kind of smooth curve to the points. Such empirical predictions are useful upto 2-3 years into the future, after which they become too imprecise due to variation in biological and socio-demographic factors.

2.   Mathematical models for the spread of infection have been developed to provide predictions for upto several decades ahead. These forecasts depend upon various assumptions made about basic characteristics of the epidemic. Differences between alternative forecasts not only throw light on the trustworthiness of the predictions but also indicate areas in which new information needs to be collected.

These models can be categorized into two type of models, namely the explanatory and the empirical.

Explanatory models attempt to describe the growth of the AIDS epidemic by trying to reproduce (in mathematical form) the actual properties of the universe. Empirical models, rely on collected information and assumptions of smoothness to extrapolate counts of cases and related quantities into the future. Some aspects of the Empirical and Explanatory models overlap, but for the purposes of clarity they are treated in separate sections.

The natural history of an infectious disease is concerned with how an organism survives in the infected host, produces the clinical symptomatology and the final outcome. Infection with HIV produces a varied and wide ranging clinical picture, having at one end a mild 'flu like illness' and, on the other, full blown AIDS. Following the exposure to the virus , events that occur in infected hosts are mild , mostly silent (Parvi, 1992), Stages of progression of HIV infection to the full blown AIDS are given below :

Approximately three to six weeks after exposure to HIV, some individuals develop an acute 'flu like illness. This acute phase may be accompanied by fever, some throat, joint and muscle pains, and other non-specific symptoms. This illness on the whole is so mild that it passes off as unremarkable at that time , and certainly not remembered later (Parvi, 1992). At the end of this phase the majority of the infected persons develop HIV antibodies which are detectable in the blood. Therefore this acute phase coincides with seroconversion.

The interval between the exposure to the HIV infection and the manifestation of the disease syndrome, i.e. AIDS, is called the incubation period. Quite often we do not have a fair idea about the time of exposure to the virus except for those infected through blood transfusion and in case of paediatric AIDS cases. The issue of incubation period has been widely debated in modelling the AIDS/HIV projections.

There are certain vital factors which determine the extent of HIV/AIDS transmission. Issues like probability of contact with an infected partner , average number of partner change per unit of time, chances of receiving infected blood , increased probability of infection in the presence of some STDs, and the variation with respect to sex. Most of these factors are being used to predict the future course of the epidemic.

EXPLANATORY MODELS:

In order to provide projections of HIV infected/AIDS case counts or description of epidemic curve, these models attempt to reconstruct the course of the epidemic. They take certain assumptions (Jewell,1989) under consideration which are directly or indirectly related to the following aspects of HIV/AIDS transmission dynamics, viz.:

- the incubation period
- variation in infectivity
- the role of cofactors in HIV transmission
- heterogeneity of levels of sexual activity and other high risk activity,
- various mixing groups (the pattern by which individuals choose contacts from a given population)
- for projection purposes it is necessary to accommodate any changes of these quantities in time in response to the

growth of the epidemic, intervention activities and temporal phenomena, and ,

- immigration and emigration from so called "high risk groups" including elimination (death),

It is important to note that AIDS epidemic is a combination of sub-epidemics amongst qualitatively different so-called risk groups, so the interaction between these groups must also be viewed in order to project total HIV/AIDS counts.

Owing to the complexity of such models most of the work in this area is deterministic in nature. Isham (1988) in her extensive review of mathematical models for AIDS, describes many models which have features in common: they are all deterministic, or large sample equivalents of stochastic models; they are all described in terms of differential equations (Jewell 1989); they all rely on parameters whose numerical significance we do not yet know with any certainty.

Principles of epidemic theory have been used to develop mathematical models to describe the spread of HIV infection. This approach requires assumptions about the mixing within and between individuals at risk of HIV infection, estimates of the probabilities of HIV infectivity per contact with an infected individual or blood product, estimates of the number of high-risk behaviours of an individual (for example the number and duration of sexual partnership or needle-sharing behaviours among intravenous drug users) and their changes through time, the incubation period, distribution and estimate of initial HIV prevalence. Because very little is known about HIV related parameters, this approach has not been found useful for obtaining quantitative estimates, but does provide qualitative insights about the shape of the infection curve.

1. Isham has extensively used this modelling technique to study some of the vital issues relating to HIV/AIDS. While evolving a mathematical model for the sexual transmission of HIV infection and AIDS, she started with a simple homogeneous mixing model involving just five parameters: the probability of transmission of infection from infectives to susceptibles per partnership, the rate of partner change, the probability that an infective will develop AIDS, and the parameters of the exponentially distributed incubation period for AIDS patients and of the infectious period for non - AIDS seropositives respectively. In situations where both the parameters of exponentially distributed incubation period become identical so that the infectious period is the same for both classes or becomes zero, the non-AIDS seropositives remain infectious indefinitely, leaving the model with only four parameters. Here the concentration has mainly been on the "highly active homosexual community". The said community has been assumed to be closed. It is significant to note here that while discussing the model relating to the heterosexual epidemic (as in May and Anderson, 1987) immigrants were considered to be susceptible while emigration represented death, either AIDS related or due to natural mortality.

The basic model has been extended to incorporate variations in the rate of partner change, thus assuming proportionate rather than homogeneous mixing. Moreover, the unrealistic but frequently used assumption of an exponentially distributed incubation period has been avoided. This model suggests that using an exponential distribution for the incubation period may be inappropriate and a long-tailed distribution like a gamma or weibull distribution seems preferable. The effect on the spread of infection in the

early stages of the epidemic of the non-exponential incubation period and of a reduced population at risk have been considered. In this model the sexual transmission of HIV infection has been considered a dominant means of infection. Isham admits that it is simple enough if required, to incorporate those infected by other routes (e.g. transfusion-recipients, haemophiliacs, and drug addicts) as immigrants into the class(es) of infectives.

The model is generalized to apply to broad communities. It is straight-forward and mathematically satisfying, to include more and more sources of variation between individuals. It has also been advised to separate out the so-called highly promiscuous individuals from the rest, thus dividing them into "high" and "low" activity. Furthermore, Isham considers that infectives are most infectious soon after infection and around the time they develop AIDS. But if this were to be the case then at peak infectiousness the chance of transmission of infection would be much greater than the current level assumed.

Isham has highlighted another aspect of modelling: the incorporation of spatial features. For the most part the models have envisaged a fairly small closed community, but it is also of great relevance to see how epidemics in different locations are linked together. The idea of an epidemic in one community feeding the infective into another community in which a self-sustaining epidemic may or may not be generated has already been mentioned in the context of homosexual and heterosexual populations, but the idea applies equally to communities distinguished by spatial location. According to Hayes, "HIV prevalence is thought to be lower in most rural areas than in large cities. To understand the spread of infection from the city to the village, we shall have

to consider movements of population and the role of migrant labour, including the widespread tendency for young rural dwellers to spend some years working in the city before (rarely) returning to their villages to raise a family. She further explores that "heterogeneity of sexual activity and inter strata movement of individuals must be considered properly while modelling".

May and Anderson (1987) similarly proposed a mathematical model of the transmission dynamics of HIV which will help to identify some of the essential relations between epidemiological factors, such as distribution of incubation periods and heterogeneity in sexual activity, and the overall pattern of the AIDS epidemic. In the absence of correct information about the duration and intensity of infectiousness, or about the fraction of those infected who will go on to develop AIDS, mathematical models of the transmission dynamics of HIV cannot be used to make accurate predictions of future trends in the incidence of AIDS, but they can facilitate the indirect assessment of certain epidemiological parameters. Their approach is mainly based on the spread of HIV among homosexual males, supposed to be responsible for 70-80% of the bulk of AIDS cases in the United States and in European countries.

In contrast to standard epidemiological models in homogeneous populations (where the exponential phase of rising incidence lasts until something like half the pool of susceptibles have been infected), the early exponential phase, of a relatively short duration, has been considered in this model, giving chance to a nearly linear rise in the fraction infected. This is because most susceptibles in the sexually

active categories are infected in the early stages of the epidemic, producing saturation effects in these categories which decrease the exponential rise in incidence within them. Although the incidence of infection continues to rise among individuals in less sexually active categories, the overall rate of increase is now slower than exponential.

May and Anderson emphasized that what is epidemiologically important is the average rate of acquiring new sexual partners, not necessarily the same as the average number of partners per unit time. For developing countries their assertion is that at present and into the near future, it is probable that sexually transmitted HIV infections among females are likely to come mainly from bisexual males. Whether subsequent spread of infection from such females to heterosexual male partners is likely to reach significant levels, and more importantly, whether purely heterosexual transmission of HIV infection may be selfsustaining, depends on estimates of the different transmission parameters (Anderson and May, 1988b).

2. A simpler explanatory model was developed by Wilkie (1987). Through his proposed model he considers prediction for the UK population from an actuarial view point. Thus the basic grouping of the population is by age ,with no additional variable for sexual activity, and it is assumed that each infection occurs from a contact between two individuals within a single age group. One of the other significant features of the said model are that there is a "clean group" and an "at risk" group with individuals able to transfer from the latter to the former (but not vice-versa)and that some parameters of the model are assumed to be time-dependent. Moreover, the infection is taken to be confined

to the homosexual community and all those infected ultimately (in the absence of natural mortality) develop AIDS. The effect on total UK mortality of deaths from AIDS is predicted using varying values for parameters.

In the above model age cohorts have been treated separately. This model assumes that infection can only be transmitted within age cohorts and not between them. Without having any numerical evidence, the model gives projections from the age of 15 years and assumes in some of them an infectivity which starts at zero at that age, rises linearly to 0.7 by 25 years, remains at a constant 0.7 to 50 years and then reduces to zero again at ages 70 and over. The model also assumes that infectiousness may vary according to the duration of infection of the infected partner. However, as it is based on assumptions which do not match the reality, it has not been put to much use.

3. The IWG AIDS model is another complex deterministic model of the spread of HIV infection and the development of AIDS in a population of Pattern II and III countries in the Third World. It was developed under the sponsorship of the Interagency Working Group (IWG) on AIDS Models and Methods of the US. Department of State (Stanly et. al. 1991). Given a set of user inputs, the model can project the future path of an AIDS epidemic in both urban and rural sectors. Among the many potential outputs from the model are age and sex-specific seroprevalence levels, AIDS cases, AIDS deaths, and AIDS-related mortality rates.

This model has been used by the Center for International Research to examine the potential demographic and macro-economic impact of an AIDS epidemic in a "typical" African country (Way

and Stancki, 1991; Way and Over, 1992). In these applications, demographic parameters characteristic of all of Sub-Saharan Africa were used, together with selected behavioral data based on regional studies. It has also been used in Thailand, in collaboration with the Thai AIDS Working Group, to project the spread of AIDS in that country during the decade of the 1990's.

To project the impact in the 14 selected countries, three alternative scenarios were developed, corresponding to low, medium, and high AIDS epidemics. For all of these epidemics, the demographic parameters corresponding to Sub-Saharan Africa were used, while the behavioural parameters were varied. Slightly different initial HIV seroprevalence levels were also used in the three scenarios.

The purpose of the three scenarios was to represent alternative long-term trends in the spread of HIV in human populations for use in projecting country-specific epidemics. The alternative scenarios also reflect an appropriate lag between HIV infection and AIDS mortality under circumstances of varying rates of epidemic growth. In a rapidly growing epidemic AIDS mortality at a given HIV infection level tends to lag behind the mortality associated with the same HIV infection level in a slowly growing epidemic.

In developing the methodology for these projections, the Center for International Research has attempted to maximize the use of both the empirical data and the modeling tools available. However, there is much that is unknown about the dynamics of AIDS epidemics in countries around the world, and the methodology is necessarily imprecise. The actual path of AIDS epidemics in the

the countries that were selected will undoubtedly differ from the course projected. As epidemics grow, future behaviour changes and interventions being implemented in countries around the world may also alter that course.

In addition, recent simulations by the US Centers for Disease Control and Prevention suggest that even should such a vaccine become available, its impact on the epidemic would not be felt for a number of years (Dowdle, 1993). A variety of therapeutic drugs have also shown some promise, but none has yet demonstrated the ability to do more than extend the survival of those infected by perhaps a year or two.

The use of a typical model based on the African experience for understanding AIDS in Thailand and other developing countries represents an advance over the earlier practice of deriving lessons from America, because, in the main, transmission in the developing nations occurs through heterosexual contact as is the case in Africa. Moreover, the IWG model incorporates more socio-demographic variables than the American one.

Anderson et al.(1987b) proposed a mathematical model of the dynamics of transmission of HIV within the male homosexual population in the United Kingdom . For modelling purposes, the incubation period of the disease is described by a Weibull distribution as indicated by several transfusion associated cases of AIDS. The distribution of the rate of acquisition of new sexual partners per unit time is assumed to follow a Gamma distribution (a flexible, non-negative distribution) with variance greatly in excess of the mean (due to a higher degree of heterogeneity in sexual activity). It was also assumed that

infected people in whom AIDS develop are infectious throughout the incubation period and that the proportion who are infected but in whom AIDS does not develop are infections on an average for as long as those in whom it does. This assumption is made in the absence of detailed quantitative data on infectiousness of those in whom AIDS does or does not develop. It was also assumed that an individual who develops AIDS will not contribute to transmission and live for an average of 1.5 years.

Using an exponentially increasing rate function and Weibull incubation period, the fitted means are 8.8 years for females and 5.6 years for males (all ages). There is no obvious explanation for this difference since the mode of infection (blood transfusion) is the same in each case. One possibility is that there is an immunological difference between men and women, but alternatively perhaps for one reason or another men tend to receive more blood during a transfusion or perhaps there are biases in diagnosis which result in men being diagnosed earlier in the course of the disease (Isham,1988).

They assume that the mean infectious period for those who do not develop AIDS is the same as the incubation period of those who do. They also assume that the epidemic started in 1978-79 from a single infected individual , having a very high rate of partner change, in an otherwise wholly susceptible community. Two values (4.3 and 8 years) are taken for the mean incubation infectious period together with four possible values of the proportion of those infected who ultimately develop AIDS. The transmission coefficient is estimated by trial and error, comparing the predicted and the observed incidence of AIDS. Projections were made of the total epidemic size on the assumption that all transmis-

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sion of infection ceased at the end of 1986 and illustrate the dramatic increase which results when the mean incubation period takes the higher value rather than the lower one, the variation due to changing the value of proportion of those infected who develop AIDS is much less marked.

Explanatory models, by their dependence on various mathematical forms based on different variables (which are still not clearly understood), tend to be extremely complex. The unavailability of accurate empirical evidence regarding these above stated assumptions and parameters, limits the ability of an explanatory model to provide precise projections.

EMPIRICAL MODELS

These models use some form of curve fitting (for example, weighted non-linear regression techniques) to statistically modelled AIDS incidence data with subsequent extrapolation to obtain projections of future AIDS incidence.

These models are based on the following approaches:

1. The first approach, simple extrapolation of the AIDS incidence curve, has a couple of serious limitations. Firstly, the estimate depends completely on the mathematical function, used as the basis of the extrapolation. Secondly, extrapolation produces projections only of AIDS cases and not HIV prevalence or incidence. Furthermore, although AIDS incidence is one of the most reliable data sources for monitoring the epidemic, it too is subject to a number of uncertainties, including delay in reporting cases, under-reporting and changes in the surveillance

definition. Brookmeyer and Gail have applied the same technique for the short-term projections.

Anderson et al. (1987b) disagree strongly with Brookmeyer and Gail's (1986) assertion that a method can predict the minimum size of the epidemic without taking account of the number of seropositive individuals. Here the basic aim of model development is to help in the identification of the types of quantitative data that are required to make reliable predictions. This model suggests that there is a need to trace and monitor the sexual partners of HIV infected patients, as well as to acquire quantitative data on viral abundance in the blood , secretion and excretion of HIV infected people throughout the duration of infection.

Applying various assumptions, Tillet and Healy (1988) proposed a technique to extrapolate the number of AIDS cases forward for 2 years from the monthly figure. The rate of increase is approximately exponential the doubling time having various constants since mid - 1985 at around 14 months. There are two ways of forecasting which are frequently used. On the one hand a mathematical model of the disease can be made and used to provide forecasts for as far ahead as is desired, on the other hand, the number of recorded cases can be plotted against time and the resulting curve extrapolated forwards. The said extrapolation forecasts technique have been used by Tillet and Healy owing a model-fee criterion. They have considered the period of diagnosis as an independent variable and adjusted the data for reporting delays. It is significant to note how quite minor changes in the model's (exponential growth model) assumptions can lead to very large differences in forecasts, even over a short

period of time by exponential terms in the model. Through this model they suggest that the doubling time will increase. The significance of the use of a quadratic term into the exponential model, and the possibility of a change in slope (equal to the doubling time) in the exponential model has been positively viewed.

Through their modelling approach Tillet and Healy used reported AIDS case data for short term (2-3 years) projection of AIDS cases using statistical extrapolation technique to the observed temporal curve of reported AIDS cases. They assume that after adjustment for inherent reporting delays, past trends in reported cases will continue for the next few years in a pattern quite similar to that already noticed. Their method is relatively easy to apply but they unfortunately do not accommodate any biological or epidemiological data other than reported AIDS cases. Thus, the present modelling can be used for projections of AIDS cases only in areas where AIDS cases are said to be relatively reliable and complete.

2. The second approach projects forward from estimates of the number of HIV infected.After the development of the HIV antibody screening test, a number of HIV prevalence surveys have been conducted in some special segments of the population. Due to the lack of representativeness and unknown sizes of transmission (risk) groups as basis of these surveys, they carry plenty of uncertainties. Even some attempts to develop representative surveys have been made by CDC, but due to high non-response rate they were never very fruitful.Surveys and cohort studies in the San Francisco homosexual population provide direct estimate of infection rates. These surveys suggest that the infection rate

grew rapidly between 1978 and 1981, slowed between 1981 and 1982 and subsequently declined dramatically. AIDS incidence and the incubation period distribution are used to reconstruct the historical infection rates that may have occurred in order to give rise to the observed patterns of individuals diagnosed with AIDS. Uncertainties about this approach arise because of the limited information about the incubation period distribution and errors in AIDS incidence data. Furthermore estimates of the recent infection rates are imprecise because recent infections are not yet reflected in the AIDS incidence owing to the long incubation period. This method of back calculation have been used by Brookmeyer and Gail (1986) in order to estimate the minimum size of epidemic. Therefore 'back-calculation' methods for estimating HIV infection rates from number of AIDS cases have been developed.

Brookmeyer and Gail (1988) developed a technique for obtaining short term projections of the AIDS epidemic. This is a method for estimating the minimum size of the epidemic by projecting AIDS cases from among those already infected. The method depends only on counts of AIDS cases in previous years and an estimate of the incubation distribution. Here the parametric back calculation approach assumes a parametric model for the epidemic density and combines assumed distribution of the incubation period between the time from infection to the onset of clinically acquired immunodeficiency syndrome with AIDS incidence data to reconstruct a HIV infection curve. With the help of this technique one can make a projection of future AIDS incidence by convolving incubation period distribution with the estimated HIV infection curve, and estimate future infection by extrapolating the infection curve.

The back calculation method developed by Brookmeyer and Gail involves parameterizing the epidemic density and maximizing a multinomial likelihood function with unknown size. They used weibull incubation distribution:

$$F(t) = 1 - e^{-\lambda t^{\nu}}, \text{ with } \lambda = 0.0243 \text{ and } \nu = 2.286 \text{ and a median of } 4.3 \text{ years.}$$

This model uses data on estimated HIV infection in addition to progression rates from infection to AIDS in order to estimate the number of past AIDS cases and to provide short term (3-5 years) projection of AIDS cases. This approach uses annual reports of AIDS for cases to estimating yearly HIV infections through the use of a "back calculation" method based on annual progression rates. The derived estimates of annual HIV infection are then used to project AIDS cases over the next 2-3 years.

They also stressed the need of the incubation distribution and subsequently reported on the sensitivity of projections to variations in this distribution. The method essentially consists of estimating infection times by back-calculation for the observed AIDS incidence data via use of the incubation period distribution.

They claim that their methods are useful for obtaining short term projections, which are not nearly as sensitive to the assumed incubation period distribution as are long term projections. Although these short term projections do not account for new infections, they may be accurate because of the relatively long incubation period of HIV infection. They also support their estimate with numerical evidences, for example

"using only 1985 data, their projection of the number of AIDS cases diagnosed in the USA in 1986 was 15,100". The actual number diagnosed in 1986 after adjustment for reporting delays (as of May 18,1987) was 14,682. If this evidence is considered, then their projection was no doubt quite close to that of the USA. However, it may be due to a matter of chance, because some of the quite significant factors like dynamics of the seropositive individual have not been given due consideration in the method. So, it will not be fair to conclude that the said approach will also give close estimates for other countries of the world or for the USA at other time periods.

Brookmeyer (1991), through his technique, suggests that the overall HIV infection rate in the United States has declined dramatically since its peak in the 1980s. He further suggests that AIDS incidence in the US may plateau during 1991 to 1995 (after adjustment for 10% underreporting). This plateau is due not only to an earlier decline in the underlying infection rate, but also to therapies that delay AIDS diagnosis.

It is important to note that both these methods rely crucially on the accuracy of reports of incident AIDS cases, although projection can readily be modified to account for any postulated fixed rate of under counting.

In a third approach Macro-simulation models have been used to determine, over time, the rate of new infections (in the particular area). In these simulation processes, only heterosexual transmission and vertical transmission from HIV-infected mothers to their newborn infants have been considered. With heterosexual transmission the rate of new infections will,

among other things, depend on the sexual behaviour of members of the population. In order to obtain realistic results, it has been found good to divide the population further according to sexual behaviour patterns (for example rate of partner change) and to make assumptions about the patterns of partner choice between the age and sexual behaviour cohorts. Due to scarcity of data, very little is known about these factors in South Africa at present, and it has been found even more difficult to forecast how they may change in future.

Schall (1990) has tried to estimate the maximum size of the AIDS epidemic among the heterosexual black population in South Africa. He has applied a macro-simulation model to estimate the future course of the AIDS epidemic. His approach is based on techniques applied by Anderson et al. for the study of the transmission dynamics of the HIV type I in the male homosexual community in UK.

Macro-simulation model consists of (i) a demographic cohort model and (ii) a model of HIV infection (onset of AIDS, and death from AIDS). In demographic cohort model the population is usually divided on the basis of age and sex cohorts and whenever needed further stratification with respect to geographical area can be considered. Data required for the model are the demographic structure of the population at the beginning of simulation, age and sex-specific (non-AIDS) mortality rates, and age-specific fertility rates.

For modelling the infection with HIV the onset of AIDS, and death from AIDS, each age and sex is further subdivided into three compartments:

*** Individuals susceptible to HIV (Compartment I)
*** Individuals infected with HIV (Compartment II)
*** Individuals with AIDS (Compartment III)

Here, every possibility exists that on the basis of the infection rate, some suceptible individual may become infected with HIV and on the basis of the incubation period a certain proportion of the HIV positives will become AIDS cases and following survival function, some AIDS cases, are likely to leave their compartment.

The simulation starts with very few HIV infected individuals, at the introduction of the epidemic into the said country. Over time, new infections, progression to AIDS, and deaths from AIDS occur, and are recorded along with the number of new births and non-AIDS mortality.

In this situation, in order to avoid the problem of unavailability of data on the key parameters (factors) of the epidemic, Schall has discussed simulation on the basis of scenarios. Her assumptions are made about unknown factors and the scenario is essentially the combination of all assumptions about the initial setting of model parameters and their changes over time. The greatest problem in a realistic simulation of the AIDS epidemic is the modelling of sexual behaviour of the population. The two key determinants of the spread of the epidemic are:

i.   the pattern of partner choice; and
ii. the distribution of the rate of partner change in the population.

Schall has made an attempt to simulate three scenarios to assess the maximum size of the AIDS epidemic among the

heterosexual black population of South Africa (Schall 1990:507-10).

1.   In the first scenario it is assumed that sexual partners are chosen at random. But in practice the probability that sexual partners are more likely to be chosen within their own sexual activity class is quite high rather than in classes of much higher and lower sexual activity. The assumption that sexual partners are chosen at random implies that the simulated epidemic spreads evenly among the whole population, within containment in high risk groups. Thus the simulated epidemic tends to be larger than the actual future epidemic.

A further assumption is that the rate of partner change is identical for all members of the population. This implies that for simulation purposes it has been assumed that all members of the population are at equal risk for HIV infection.   The assumption that a high infection rate for all members of the population makes the simulated epidemic larger than the actual one.   The first scenario seems unrealistic because the same HIV infection level have never been observed in large heterogeneous population, and are far higher than even those observed in high risk population of Central Africa.

2.   In the second scenario the assumption that sexual partners are chosen at random is still made, but the rate of partner change is assumed to follow a Weibull distribution.   This is likely to result in a smaller epidemic than that from the first scenario.

3. While considering the third scenario Schall assumed that two-thirds of sexual contacts take place within their own sexual activity class, while one third of the partners is chosen at random. The rate of partner change is again assumed to follow a Weibull distribution. This will be further a smaller epidemic than that resulting from the second scenario due to the fact that partner choice is no longer random. There is no doubt that third scenarios may give the smallest epidemic among all the three scenario but still it may be viewed as an upper boundary of the actual epidemic.

Besides assumptions about sexual behaviour, at least two other assumptions tend to make the simulated epidemic longer than the actual future epidemic. Firstly, the probability of infection per sexual contact with an infected partner, and the patterns of sexual partner choice do not change over time. But this assumption may be pessimistic because it is conceivable that, with increased awareness of AIDS and increased education and prevention measures, the infectivity per partnership and the rate of partner change may decrease. Secondly geographical, urban-rural as well as the cultural variations have not been modelled. This implies that considering the population as homogeneous with respect to age, factors expect sex and sexual activity class the resulting epidemic tends to be longer than the actual one.

In brief it can be concluded that according to Schall, the third scenario could be realistic if all pessimistic assumptions and model simplications implicit in that scenario turn out to be realistic. This very well disproves the popular doomsday forecast usually produced by the simplistic extrapolation of the

initial spread of the epidemic to the whole population (ten and more years ahead) without taking into account such factors as natural mortality, fertility, heterogeneity of the population and a decreasing pool of susceptible epidemic.

Bailey and Estreicher (1986) admit that the infectious period of AIDS follows a negative binomial distribution as used by Scherrer et al.(1985) to predict the spread of influenza to some areas of USSR (now Russia). Inspite of having inadequate data they suggested methods which could be used by administrators to act more effectively. For the said model, homosexual and bisexual men attending the San Francisco city clinic for treatment of venereal disease (along with hepatitis B) on specific study on prevalence of HIV antibody and incidence of AIDS were taken after getting written consent of the patients during 1978 to 1980. They assumed that a large number of variable factors would have an overall average effect on large populations that could be described by a simple model with only a "few" parameters. It had worked for influenza, but whether it also works for AIDS is a vital issue which they also raised (Baily 1988).

In short, from the review of literature it appears that the empirical methods are widely used for the purpose of short term projections. The techniques have been mainly apllied on the some American and European countries' data, as one of the major factors influencing HIV transmission in these areas is the significant reporting of spread due to homosexual and IVDUs transmission. However, in a significant number of the countries in the world, heterosexual mode of transmission is dominant, which is why their applicability in the Third World countries is suspect.

ISSUES RELATED TO THE RELEVANT PARAMETERS

INCUBATION PERIOD

One of the highly significant and distinctive factors of HIV infection, yet the least understood one, is the length of the incubation period, i.e.,the time elapsed from infection with HIV to onset of clinical AIDS. Understanding the nature of the incubation period and its relationship with other factors is important to our understanding of the natural history of HIV and the potential for delaying the onset of AIDS. It is one of the most vital biological factors which play a significant role in techniques to project the future course of the epidemic.The fact that on individual may be infected and infectious but asymptomatic for long periods has important consequences for the spread of the epidemic's rate of spread for the back-calculation of HIV infected from AIDS case rate and thus for estimation and prediction of the epidemic.

It is difficult to find the length of the incubation period for various reasons. First, except in the case of perinatal transmission or HIV infection acquired through blood transfusion, the date of infection cannot be established with certainty. Second, due to the long and variable incubation period, follow-up surveys of large numbers of exposed infected persons must be conducted for many years before the proportion of those infected who will ultimately develop AIDS can be established. Thirdly, incubation period may vary by route of transmission.

Quantitative and qualitative information about the distribution of the incubation period mainly derives from transfusion-associated AIDS cases and cohort studies of patients for whom the time point of seroconversion is known. On the basis of the data gathered by the U. S. Center for Disease Control of 494 transfusion associated cases of AIDS diagnosed before July 1987, it has been estimated that the mean incubation period ranges from 4.5 years (Lui et al, 1986) to 15 years (Rees, 1987). These methods for the estimation of the distribution may be parametric and non-parametric. Parametric methods are of most use in the context of the formulation of transmission models of HIV spread, because extrapolation beyond current observations requires an assumed distribution for the incubation period (Medley et al, 1987).

A significant magnitude of variation has been noticed with respect to use of incubation period in different models for predicting the future course of epidemic.

Malcom Rees (1987) suggested a model for the distribution in the time of occurrence of AIDS after infection which give some estimates of the number of new infections in the United States and the United Kingdom. His estimate of the prevalence of infection in the US is based on the use of the normal distribution embodied in the matrix (showing probabilities that people with HIV leading to AIDS will develop the disease in future years) and the published data for the incidence of new AIDS cases ,leads to the estimate that at the end of 1985 or thereabouts there were 2.5 millions infected that will result in AIDS over the next 30 years or so. His estimate was found higher than that of some others, who estimated that there were 1.75

million people in the US infected in mid-1985. For modelling purposes, here people infected in a particular year have been regarded as a cohort that will generate AIDS cases in subsequent years , so that the number of new infections arising in a future year from that cohort alone will be a product of the size of the cohort and the probability of developing AIDS, given by the probability distribution . Rees fits a normal distribution here using a trial and error method. The fitted distribution has a mean of 15 years and a standard deviation of 5 years so that the chance of negative incubation period is very small.

Malcom Rees' method is based on the suggestion of a 15 year mean incubation for the HIV transferred by blood transfusion and a consequently high estimate of future incidence. His mode of analysis seems to be indirect. At all events, the simple "actuarial", approach leads to a different conclusion. If P_s is the chance of AIDS diagnosis in the s-th year after. Then the ratio $R_x = P_{s+1}/P_s$ may be directly estimated from the diagonal total relating to the same set of annual cohorts of infected. From this the calculated estimates of the used data are not consonant with a gaussian distribution with a mean 15 and standard deviation 5 years.

The observed ratios suggest that the probabilities rise rapidly to a peak around five years. Rees' suggestion of a log-normal graduation could give rise to ratios with characteristic. So equally would graduation using other distributions like the gamma (which arises for example as a special case of the analogous distributions advocated by Julian Peto in carcinogenesis using staged models). Whatever form is used for graduation the salient feature is the same: a mean incubation of

about five years rather than fifteen. This leads to an order of magnitude reduction in the said projections (Barton,1987).

According to Dagpunar et al. (1987), in view of the paucity of the available data, the possible methodological difficulties of applying results from transfusion related cases to victims of AIDS in general and the problems of fitting suitable models, it is perhaps wisest to admit that in this matter, estimates are little more than guesses. Dagpunar et al refitted the said normal distribution, taking into account the censoring of the data and its coarseness (expressed in incidence during each year). The maximum likelihood estimates for the mean and the standard deviation were found to be 6 and 2 years respectively, in contrast to the 15 and 5 years as suggested by Rees.

Anderson et al. (1988) further refer their analysis of 512 cases in which dates of transfusion and diagnosis of AIDS are known suggests the mean and median incubation periods (based on Weibull distribution for the incubation interval) for both between 7 and 8 years in patients older than 12 years. Medley et al. (1987) refers to studies based on models with parametric assumptions, wherein the average incubation period has been disconcertingly close to the time span over which data are available, suggesting that the average could lengthen as more information accumulates. Another study, however, suggests that estimates of the average are setting to 7 to 8 years. Curran et al. (1988) found almost similar estimates for homosexual men in a cohort study in the U.S. Anderson et al.(1987) found that with respect to the transfusion-associated cases, the average incubation period is some what less in children (< 12 years) and elderly people (> 60 Years). A further study done by Rogers et

al. (1987) found that children infected either perinatal or via transfusion also reveal short-average incubation period of 17.4 months and 17.4 months and 24.4 months, respectively.

Bacchetti and Moss (1989) have made an attempt to develop an alternative approach to deal with the problem of incubation period of AIDS. In the proposed method, the time from seroconversion to AIDS diagnosis has been estimated from the data available for seroconversion rather than for infection. There is some probability that seroconversion may occur later than infection. In this approach population has been assumed as closed population which implies (no immigration or emigration) and the gay community of San Francisco has been used. The annual seroconversion rate of monthly AIDS diagnosis have been plotted which dramatically shows a sharp decline in 1984. This was almost the same as was in the case of rectal gonorrhoea rates among males during the same time. Presumably this was due to significant behaviour change in the said community. The effect of such on HIV infection have been enhanced by the saturation of high-risk sub-groups as well as due to behavioural changes. Jeffreys et al.(1985) have also stated an early sharp increase through their mathematical models of epidemic spread in a susceptible population.

For the estimation of the incubation period , Bacchetti and Moss proposed to estimate certain parameters like the hazard rates (h_k) for developing AIDS in 'K months' after seroconversion. With the available 10 years data, h_k can be estimated for all k=0 to 120.

If $D_{j,k}$ denote the number of persons who seroconverted in month j and were diagnosed in month k and all $D_{j,k}$ were known, then maximum liklihood of hk would be expressed as

$$\hat{h}_k = e_k / r_k \qquad \text{where} \quad e_k = \sum_{j=0}^{120-k} D_{j,j+k}$$

is the number of persons diagnosed exactly k months after seroconversion, and rk is the number of persons still free of AIDS (k-1) months after seroconversion.

If $D_{j,k}$ are unknown, then they suggested the use of the EM algorithms to estimate the hazard rate h_k. The said algorithms begins with some arbitrary value of the h_k and calculates the expected values of the conditional on the initial h_k and the known seroconversion diagnosis pattern.

The expected values are now used in place of the unknown $D_{j,k}$ in the main equation showing MLE of h_k to yield refined estimates of h_k. The refined h_k's lead to new expected values, which new estimated h_k's , and so on. The algorithms continues and the new estimates converges.

Because it is biologically reasonable that the hazard change smooth curve over time, he further modified his equation

$$\hat{h}_k = \sum_{i=k-6}^{k+6} e_i \; / \; \sum_{i=k-6}^{k+6} r_i$$

The estimated probabilities developing AIDS during the first to tenth years following seroconversion were 0.002, 0.007, 0.022, 0.043, 0.061, 0.073, 0.082, 0.081, 0.074 and 0.067 respectively. The estimated distribution is an average for all gay men in San Francisco. It is believed that it may well do for the sub-groups of this population, and it may change as prophylaxis of seropositives becomes more widespread before diagnosis.

There are four factors which may bias the estimate: the use of the more inclusive 1987 definition of AIDS, use of the seroconverted outside San Francisco in diagnosis totals but not in seroconversion totals, and possible downward bias in the magnitude of the seroconversion curve resulting from over representation of seropositives from the sampled area among diagnosed AIDS cases.

It has been seen that owing to the availability of information on seroconversion among gay men in San Francisco and because the drop in seroconversions makes the pattern of diagnoses quite informative about the incubation. Its dependences on an accurate estimate of seroconversions is a major drawback, but it does not rely on parametric assumptions, and show that the estimate is more precise than others, even allowing for uncertainity in estimating seroconversions.

Here the most reliable information on the incubation period distribution has been derived from cohort studies of HIV infected homosexuals. The approach suggests that the probability of progression to AIDS within 2 years of conversion of HIV positivity is less than 0.02, rises to between 0.25 and 0.35 within seven years and to about 0.50 within 10 years.

Bailey's (1987) approach of dealing with incubation period is split into two parts, the first of which is to be thought of as the period when immune defences are breaking down and is modelled by a gamma variable via a series of exponentially distributed stages. During the second part, the individual is at major risk of opportunistic infection and, after an exponentially distributed interval, develops AIDS. In general, this will not give a gamma distribution for the incubation period since the parameter for the later exponential distribution is not assumed to be the same as the parameter of the earlier stages. Through this model, which assumes that all those who are infected will ultimately develop AIDS, a much longer-tailed distribution for the incubation period is obtained. Commenting on Bailey's approach someone remarked that he has a fraction (to be estimated) of the population, which plays little or no part in the spread of HIV infection. This leads to a degree of heterogeneity in the simplest model, and to simple parameter estimates.

According Isham (1988), the corresponding assumption in a simple stochastic model is that the incubation period of each such infective has an exponential distribution with mean which is inversely proportional to the rate at which infectives who develop AIDS are withdrawn into the class of AIDS patients.

Isham further explores in her model that essentially the only available observations of IP are for transfusion associated cases of AIDS, so that model fitted to these data are not necessarily applicable to other categories of AIDS patients. For example, the suggestion is often made that the mean incubation

period for transfusion associated cases of AIDS will be less than
that for other methods of transmission since the transmission
recipient is likely to receive a much larger number of infected
cells.

Medley et al, 1987, gave an estimate that ranges from 5.1
years to 10.6 years for the total population. He further shows
that the mean incubation period varies by sex and by age. It is
shorter for males (compared with females) and shorter for persons
aged under 5 years and above 59 years. It is also believed that
when HIV infection is acquired through blood transfusion the
sheer quantity of the virus transmitted may result in a more
rapid progression towards disease manifestation. Brookmeyer and
Gail(1988) show that long term forecasts of epidemic size are
very sensitive to the shape of the incubation period function. In
fact, the fixing of the median incubation time but changing the
values of the parameter for the shape of the incubation function
leads to large changes in the expected minimum number of AIDS
cases. If one wishes to forecast to extrapolate AIDS cases by
fixing the incubation period function, the results are likely to
be sensitive to the functional representation for the HIV
epidemic.

The review of models reveals that the weibull distribution
for the incubation period is proving to be a good empirical model
of observed trends as more data accumulates. The high risk of
developing AIDS appears to rise faster than linearly as the time
from infection increases. The fraction of the infected who will
ultimately develop AIDS is likely to approach unity in value. It
also highlights the probable variation in incubation period with
age, sex and route of transmission.

LEVEL OF INFECTIVITY

The level of infectivity plays an important role in applying epidemic models to project the spread of the virus and in evaluating various intervention strategies. Thus estimation of the infectivity and the manners in which it depends on various factors is of crucial importance to our understanding of the growth of the AIDS epidemic, effective means of control, and the natural history of the disease.

The assumption that infected people are equally infectious throughout the long and variable incubation period appears less realistic as data accumulate on longitudinal fluctuations in infectiousness in infected patients. Some researchers point out to an association between HIV antigen levels in blood serum and the infectiousness of an infected person to a susceptible sexual partner. At present it appears as though there are two major peaks in infectiousness: one shortly after seroconversion and the second higher peak as the patients progress to AIDS related complex (ARC) and AIDS. In between these peaks, infected patients are probably with low infections.

If two major peaks in infectivity occur on average during the long incubation period of AIDS, the relative magnitude of the transmission probabilities and the relative durations of the two episodes will have a major influence on the shape of the epidemic curve. At present, it appears probable that the first episode is of short duration (perhaps 6 months or less) and of less intensity than the later episode (perhaps lasting for 1.5 to 2 years with infections twice as high as that in the first episode). This implies that after an initial exponential phase

of growth in the incidence of AIDS, the epidemic will enter a longer phase of linear growth before saturation effects (or changes in sexual habits) reduce the incidence.

Wilkie (1987) in his actuarial model assumes that infection can only be transmitted within age cohort and not between them. Without having any numerical evidence, this model gives projections from the age of 15 years and further assumes in some of them an infectivity which starts at zero age, rising linea.·ly to 0.7 by 25 years, remaining at a constant 0.7 to 50 years and then reducing to zero again at ages 70 and over.

May and Anderson (1987) also used a simple deterministic model to relate the probability (that an infected individual will infect a susceptible partner over the duration of the relationship) to the doubling time of the epidemic in its early stages amongst male homosexual and bisexual men. Their method required a knowledge of the effective rate of partner change C, and the average duration of infectiousness, D. On the basis of the observed doubling time of approximately one year, they conclude that the value of the parameter combination BC is approximately unity in value (defined per year).

Other research based on few longitudinal studies of the likelihood of seroconversion for susceptible sexual partners of HIV infected patients, such as monogamous partners of men and women infected either in the course of I.V drug use or by transfusion blood of its products, suggests average transmission probabilities in the range 0.1 - 0.2 (Anderson and May , 1988).

SEX DIFFERENCE IN INFECTIVITY: SEXUAL AND OTHER TRANSMISSION RELATED BEHAVIOUR

A simple model based on the assumption of proportionate mixing between groups with different rates of sexual partner change (where partners are chosen at random but the rate is weighted by the partner activity) suggests that the effective average should be expressed as:

$$C = m + \sigma^2 /m$$

Where m is the mean rate of partner change, and σ^2 is the variance.

The assumption of random choice of partners weighted by partner activity level is an extreme assumption and ignores the problem of how people in different sexual partner change groups choose their partners from their own and other change rate groups. An opposite extreme is to assume that partners are only chosen within the same activity group. The reality will lie some where in between these two extremes - perhaps more towards the proportionate mixing assumption. The advantage of the assumption presented in the above mathematical expression is that means and variances can be calculated from survey data on sexual behaviour. Network data on "who mixes with whom" is limited and, furthermore, difficult to acquire.

MODEL VALIDITY

Bailey (1994) has made an attempt to explore an important issue of HIV/AIDS, namely model validation. In this context the

prevalent trend is that for a majority of long term theoretical investigation people often adopt a specific model structure, assume certain values of interlinked parameters, and then study the behaviour of the system in depth using plenty of computational techniques. Unfortunately, they do not bother about the validity of their model.

Bailey has tried to explain this vital aspect of modelling validation in four sections along with the Geneve-Bern Model.

GENEVA-BERN MODEL OF HIV/AIDS

This is basically a compartmental model formulated in 1985 from a research project in the University of Geneva involving continuous- time modelling in biology. This has been used for various experimental investigations as well as to predict the spread of influenza to some areas of USSR (now Russia). On the same lines Scherre et al.(1988) evolved a population dynamics model of AIDS and HIV infection. Again in 1991, Bailey expanded this approach for the use of operational modelling of HIV/AIDS in a systems approach to public health decision making. Owing its extensive use among researchers dealing with AIDS/HIV, it was subsequently expanded to include the outbreak of AIDS in San Francisco using the available HIV prevalence information along with the AIDS incidence data (Bailey, 1994).

There are some hypothetical assumptions which have been made here: individuals spend only a limited time in a high activity core group (implies gay men, IVDUs and heterosexuals). Here it has been presumed that infectivity is uniformally spread over the incubation period, whereas it is believed that at the initial and

final stages of the incubation period the level of infectivity remains high from the average level. Due to scarcity of data no proper idea of incubation period has been made to model the disease properly. Keeping in view the wide applicability of incubation period of gay men , the San Francisco data has been modelled.

Along with this approach Bailey has suggested the following technique for the purpose of model validation:

a.   Model Fitting to Existing Data

Baroyan et.al's (1977) approach of modelling and prediction of influenza epidemics in the USSR (now Russia) has revealed that simplifying of clinical and epidemiological processes can lead to a comparatively simple model that gives good predictions of the spread of disease from one city focus to other centres. Further simplication, which endorsed the Soviet work, suggests that the average of many recognised micro-level heterogeneity could lead to valid results in a public health context.

Using maximum likelihood estimation of core-group size, infection transmission rate, average incubation period has given good fit for HIV prevalence of San Francisco data for gay men.

Analysis of Swiss data on AIDS incidence has given maximum likelihood estimate of core-groups allowing for proportion of cases picked up from death certificates. Estimates of transmission rates have been found satisfactory for IVDUs but not sound for gay members.

There is no doubt that considerable regional variations (between countries) in relative incidence have been found. Even where the substantial quantities of data are available the model fits well. There is evidence for a shorter incubation period in IVDUs.

b.   Cross-checking with other Research Results

It has always been advisable to cross check the findings of the study with other research results in the said area. This gives an idea about the extent of validity of the result. This approach also suggested that when no HIV prevalence data are available for example as was in Switzerland at that time, it would be sensible and useful to include core group as a main parameter to be estimated. Here another approach of cross-checking, viz by comparing HIV prevalence obtained through using dynamics models and with estimates derived from specially designed surveys, of the highly variable incubation period has been given due importance in model fitting of existing data as well as in estimating the relevant parameters along with other system parameter.

c.   Preliminary Prediction of Further Events

The proper prediction of the future outcome of an epidemic is an important part of the verification of scientific hypothesis and theories, but the ability to make adequate prediction is also an essential aspect of any attempt to assist decision making and planning. At the initial stages of the epidemic, there is no procedure to verify the predictions of future events. Only when

a short time has passed can one check whether short-term projections are adequately verified. Although this is quite close to using simple short-term extrapolations which prove very early when we look a bit further ahead.

For example, one can fit his dynamic model to Swiss AIDS incidence data on gay men upto the end of 1987, and then project ahead to the end of 1992 and see how well the predicted incidence over the five year period compares with what was actually reported. If the results were comfortably close then one can have more confidence in, say, using all the data upto the end of 1991 and making tentative predictions of 5 or 10 years to the end of 1996 to 2001 A.D.

Here the model was fitted for 216 AIDS cases in gay men over the period of 1983-87. The total number expected to be reported by the end of 1992 was calculated to be 1025 (excluding death certificate reports introduced from mid-1988). The total number actually reported by the end of 1992 was 1048. This was, of course, closer than they might expect.

The main problem here is that a considerable degree of heterogeneity is observed when the final structure is investigsted, especially in studies involving details of sexual behavior patterns, and it is unlikely that average indices would be even approximately valid at the macro-level, when considering, say, transmission rates or core group sizes.

In brief, it has been found that almost all the models reviewed have made certain assumptions in their modelling procedures. The majority of these models have been developed in

some American and European countries. In a fair proportion of the existing models data on homosexual and IDVUs have been extensively used. Almost all the projections have been found quite far from the actual reported cases even in the USA and Europe. Lack of data, its reliability and completeness in reporting have been viewed as a major problem in accurate modelling. In spite of these problems, few steps have been taken to strengthen the validity of the models. In course of time, even when comparatively more data became available, little attempt was made to check model validation in the light of the emerging data.

It has been possible to follow this epidemic for less than 20 years, and as Chin, Lwanga and Mann state in 1989, holds true to date, "there is virtually no similar retrovirus infection in humans which has been adequately studied to provide an analogy for predictions" (1989). They further raise the following specific problems:

[a] the pattern of behavior associated with HIV transmission has not been fully identified and is difficult to study.

[b] neither the proportion of HIV infected persons who will develop AIDS nor the progression rate over time from to AIDS is well-known.

[c] the role of co-factors in facilitating HIV transmission or progression of AIDS is not known with any degree of certainty; and

[d] the degree and the variability in individual infectiousness remains to be determined.

Such data as are available on these points come primarily from selected strata of the population in more developed countries, and their applicability to the other populations is not known.

Since the emergence of AIDS in early eighties, it has been observed that models incorporating only the explanatory variables or depending only on the empirical variables have not been able to properly solve the problem of modelling. Thus, some researchers are presently trying to incorporate both types of variables in order to overcome the problems.

Finally, the number and diversity of models of the AIDS epidemic have tried to predict the future course of epidemic with a high magnitude of variations. The diversity of models has inevitably led to diversity in outcomes. Answers to a single query are multiple, while the range of the prediction is broad and is usually unaccompanied by a measure of their uncertainty. In an actual sense, no criteria exists to facilitate a choice among the models. However, the WHO (GPA) has chosen empirical models for world-wide application. They are being extensively used in both international and national AIDS control programmes globally. These are discussed in the next chapter.

CHAPTER-VI

THE INTERNATIONAL PERSPECTIVE OF PROJECTING AIDS IN THE DEVELOPING COUNTRIES EPIDEMIC

THE INTERNATIONAL PERSPECTIVE OF PROJECTING AIDS
IN THE DEVELOPING COUNTRIES

In the last chapter we saw that a number of models have been developed to predict the course of the epidemic either in specific population groups or in the general population. Models to project the future course of the epidemic can be visualized under two categories, namely explanatory and empirical. The empirical projections or extrapolations are based on the availability of reliable data on reported cases of AIDS. Such data are supposed to be available for the United States and for a number of countries in Europe.

The WHO has also prepared a short-term empirical model to predict the future course of the epidemic similar to models developed by other researchers. This model depends on the technique of statistical extrapolation (or fitting) from the observed curve of reported AIDS cases. Such estimates assume that after adjustment for inherent reporting delays, the past trend of reported cases will continue, at least over the short-term, in a similar manner. This technique may provide estimates for the countries where reporting is said to be up to the mark (viz. USA and some countries of Europe, who claim 80-90% of case reporting).

In countries where reporting of AIDS cases is mostly incomplete, or where reporting of AIDS cases has been quite late (as is the case in a majority of the Third World countries), it becomes difficult to estimate the future magnitude of the disease from the reported AIDS cases. Considering this situation, the WHO

has developed a technique of short-term projection based on epidemiological data from serological surveys carried out in a few countries.

For making short-term projections the WHO has from time to time modified their technique by incorporating more and more estimate and assumptions. Chin and Mann (1988) outlined some estimates and assumptions for the WHO model during its initial phases.

These were :

- the year when HIV infection probably began to spread extensively in the population was assumed,

- the cumulative prevalence of HIV infection in the population which can be derived from serological survey data,

- the estimated number of persons infected with HIV in each year (i.e. annual infected cohort), and,

- the estimated annual progression rate for HIV to AIDS.

In a quite similar manner, in 1991, Chin and Lwanga suggested a few imsprovement in the WHO (Global Programme of AIDS:GPA) model. In this approach, the annual cohort of HIV-infected person is calculated by using HIV point prevalence estimate along with the HIV infection curve during the epidemic period. After getting this derived estimate of HIV infected persons, it is multiplied with the progression rate of HIV to AIDS to get the number of AIDS cases.

Here it has been presumed that with any population group, cumulative HIV infection follows a sigmoid curve. The model further assumes that the distribution of HIV infection over time

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GRAPH **6.1**

Gamma Distr.Showing Incidences

derived from expression
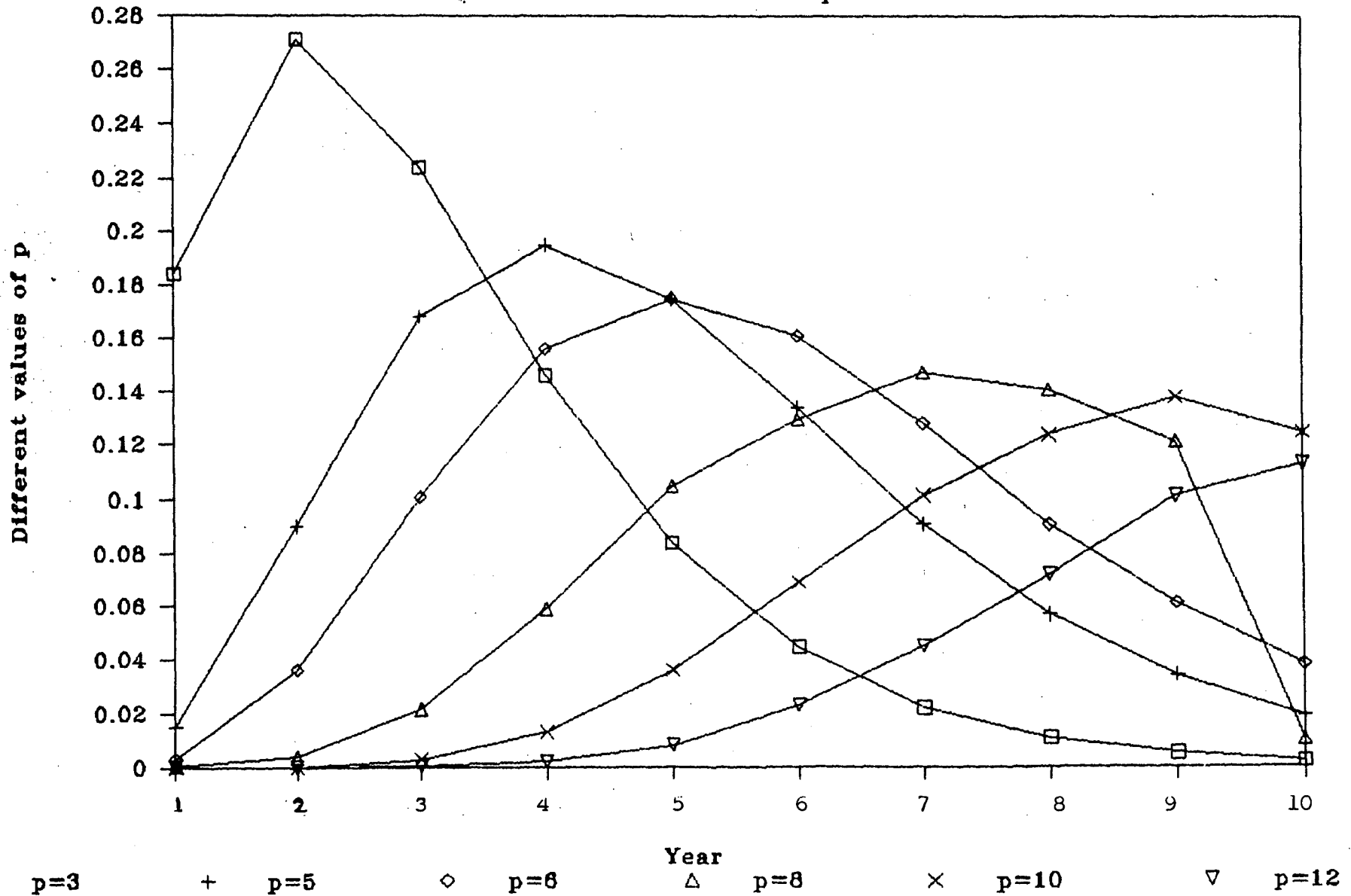
in any population will be skewed with a long tail. Thus, they chose a simple Gamma Distribution function:

$$t^{p-1} \, e^{-t} \, / \, (p-1)!$$

to describe the HIV incidence at time t, where p is the steepness of the HIV epidemic curve (Graph 5.1). A hypothetical value of $p=5$ has been used in order to get the best fit to reported AIDS case curves in countries with reliable case-reporting systems (viz. the USA and some European countries).

The present GPA WHO model uses the progression rate from HIV to AIDS, drawn on the basis of cohort studies. On the basis of the above discussed model, the WHO has developed a computer program (Epi model) to estimate and project AIDS cases. The Epi model enables the user to change any of the variables used such as HIV point prevalence, distribution of HIV infection, annual progression rates from HIV to AIDS and progression from AIDS to death. In paediatrics AIDS cases, it also incorporates the effect of different age specific fertility rates in women, and different transmission rates from an infected mother to her fetus. It has been thought that on the basis of the country specific HIV point-prevalence estimate can be derived to run Epi model.

In order to predict the future course of the epidemic in South and South East Asia the following specific assumptions or estimates were also used. Based on 350,000 HIV infected adults as of late 1990 and assuming no further increase in HIV infection, the WHO model projected a minimum of 60,000 AIDS cases for this region by 1994 (Chin and Lwanga 1991:403). Further, the WHO projection for 1995 is of the order of 250,000 adult AIDS cases

(Mann and Tarantola, 1992:24). Upto the June 30 1995, just a little over 20,000 AIDS cases had been reported in the region. As of mid-1995, a total of 1,169,811 adult AIDS cases have been reported to the GPA. But the GPA believes that the true number of cases may be four times this estimate, i.e. in the range of 4.5 million. The estimate takes into account under-diagnosis, under-reporting and delays in reporting. Based on an estimated prevalence in January 1992 of 11.8 million HIV infected adults worldwide, the WHO model estimated, by 1995, a cumulative total of 17.5 million HIV infected adult in the world (Mann and Tarantola,1992:24). The WHO estimate of 4,062,500 adult, AIDS cases in the world by 1995 is significantly higher than the reported 1,168,911 AIDS cases even till January 30, 1995. Reporting adult AIDS cases to the WHO (till mid-1995) by various regions/countries are substantially higher than the projections of the World Health Organization, during the same period. The discrepancy in the reported and the projected AIDS cases are of the order of more than twice the number for America (including North America which is known to have sound AIDS reporting mechanisms) six times for Africa and more than twelve times for South-east Asia (Table 6.1).

Table 6.1
Projected and Reported Cumulative AIDS Cases

Region/Country	1995 WHO* Projections	Reported@ AIDS Cases	Extent of Over Estimation	No. of Regions Reporting > 1000 cases
Africa	2,500,000	415,595	6 times	28
America	1,245,000	580,129	2 times	16
S.E. Asia	250,000	20,758	12 times	2
Others**	1,187,500	152,429	>7 times	16
TOTAL	4,062,500	1,168,911	3.5 times	62

Source: Figure in Column [@] represents the number of AIDS cases reported to the WHO as on June 30, 1995.

*   As appeared in Mann,J. and Tarantola,D.(eds.) *AIDS in the World*, Harvard University Press,(1992), pp.24.

**   Includes Europe, Oceania, Caribbean, South - east Mediterranean and North-east Asia.

By 1995 the developing world was projected to account for 84 percent of the cumulative global total of HIV infections (Mann, 1995). In the previous chapter we have discussed the issues that still remain to be resolved before accurate prediction/estimation is possible.

The sources of uncertainty in the WHO model can be stated as follows:

1.   The prevalence rates of HIV infection of large populations are only estimates and not actual figures for most of the Third World Countries. Thus, the method of estimating HIV prevalence needs to be examined (Priya Ritu, 1994).

2. The seroprevalence rates are drawn from convenience samples, and while providing early evidence of the importance of a problem, selection bias is present. Because there has been no large scale investigation of HIV/AIDS incidence and prevalence in the general population. (Brookmeyer and Gail, 1994).

3. Back projection for HIV is based on assumptions about incubation period and rate of conversion from HIV to AIDS. And we have seen in the previous chapter how these still remain unresolved issues. The currently used rates of progression from HIV to AIDS are based on some cohort studies (especially of homosexual and bisexual men) that followed HIV-infected persons from the time of initial HIV infection. They revealed that only 3% developed AIDS within the first three years. Thereafter, the annual progression rates used in the WHO model upto year 10 were extrapolated from some cohort studies. Even in the absence of any empirical evidence the WHO model further assumes that about 70% of the initial cohort will develop AIDS in 15 years and 90% within 20 years.

4. The sero-surveillance data is largely indicative of trends but cannot provide reliable estimates of rates because the denominator, i.e. the number of screened individual in each group, is not always known.

5. Significant variation have been noticed in the data available from different regions of the country, and without some clues to the degree and nature of variation, estimates are bound to be highly inaccurate.

6. It has not been properly stated whether short-term projection is independent of new HIV infection or will be in proportion of existing HIV infection.

If the applicability of the WHO projection technique to the Indian situation is studied, it will be found that Indian data does not fulfil a majority of the assumptions taken by Chin and Lwanga to make short-term projections of the future course of the epidemic. The WHO model use 1988 as a year of extensive spread (more than 1% HIV seroprevalence in the high risk groups) for India. But this seems to be a hypothetical period because the emergence of AIDS in India was spotted quite late in the mid-eighties. The magnitude of the problem remained insignificant till the late eighties, but for one on two cities of the country. A high magnitude of regional variation with respect to modes of transmission and level of seropositivity have been recorded by the NACO. Official data available for a period ranging from 1986 to 1990 remained always questionable as during the said period there were few centers for screening the blood for detecting antibodies against HIV even in big cities. After getting multifaceted assistance from a number of international agencies, the network of surveillance centers was increased to 154 Zonal blood testing centers. This may have led to some spurt in cases/infected persons detected without an actual increase. This must be kept in mind while analyzing the data.

Table 6.2

Annual HIV Scenario in India (October 1985 to December 1995)

Time period	No.tested	No.positive	SPR per 1000
Oct.85-Oct.87	56,934	145	2.55
Nov.87-Oct.89	307,343	1,505	4.90
Nov.89-Dec.91	864,110	4,764	5.50
Jan.92-Dec.92	437,563	4,916	11.20
Dec.92-Dec.93	308,339	2,908	9.43
Dec.93-Dec.94	456,356	2,886	6.32
Dec.94-Dec.95	337,351	4,440	13.16

Source: NACO Data as appeared in the Journal of Indian Medical
Association, Vol.92, No.1, 1994 ,pp.3.
Figures collected from NACO monthly updates.

On the basis of the data collected by the ICMR and the NACO, it reveals that the infection rates are rising progressively in various high risk behaviour groups over the years and also it appears entering in the general population as evidenced by HIV infection rates among voluntary blood donors and antenatal clinic attenders in different parts of the country. According to the available information and the latest surveillance reports, the major concentration of infections remains in cities like Bombay (now known as Mumbai), Manipur and Madras. This is amply reflected by the trends observed in the states of Maharashtra, Tamil Nadu and Manipur. In Bombay, the seropositivity rate among commercial sex workers rose from less than 1% in 1985 to 51% in 1993 (NACO December 1995:24). A parallel increase has been observed among the antenatal mothers from less 0.1% in mid

Graph   6.2

Seropositivity Rate (%) Among

CSWs in Bombay
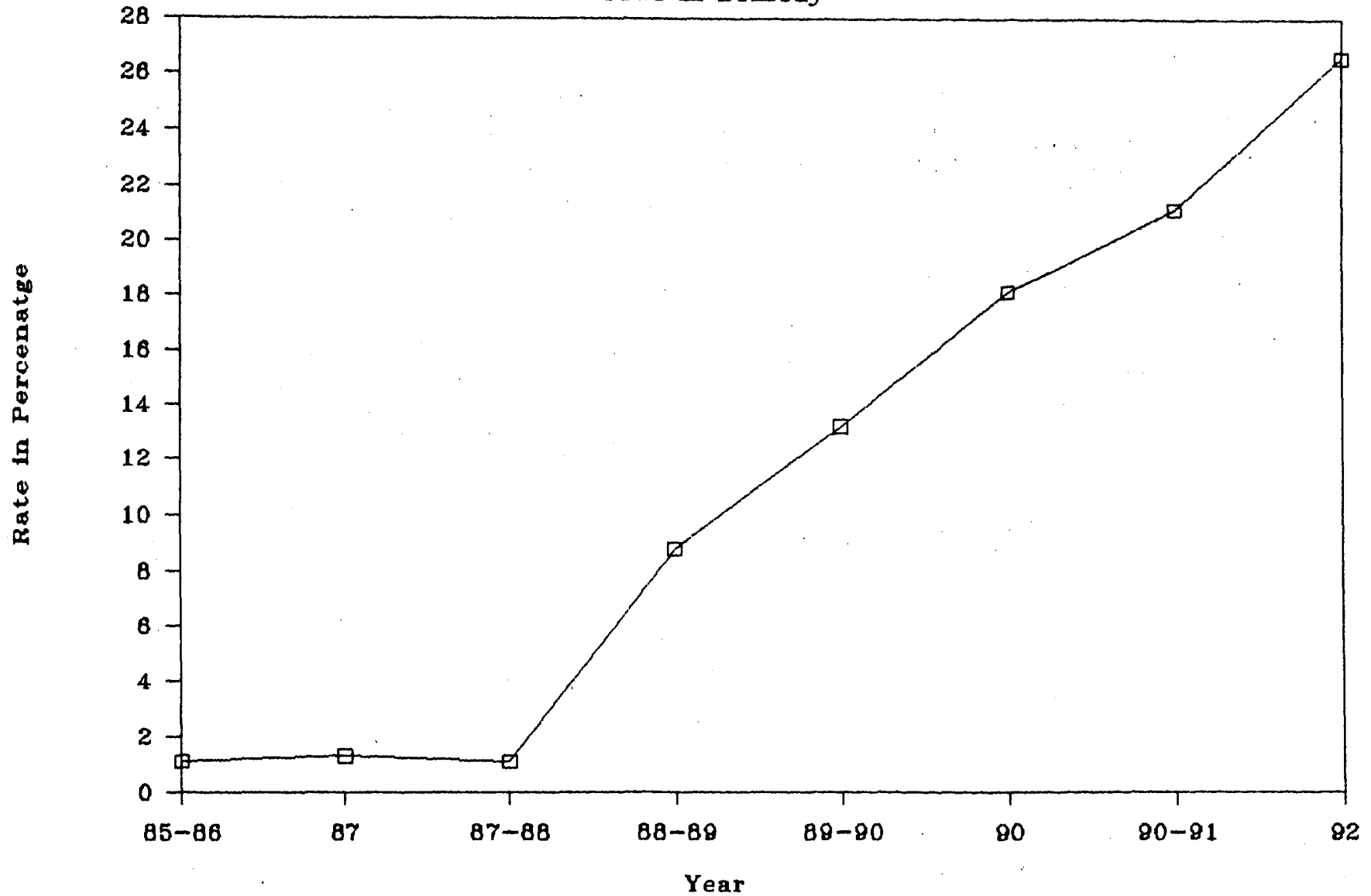
Graph   6.3

Seropositivity Rate(%) Among STD

Patients in Bombay

Rate in Percentage

Years
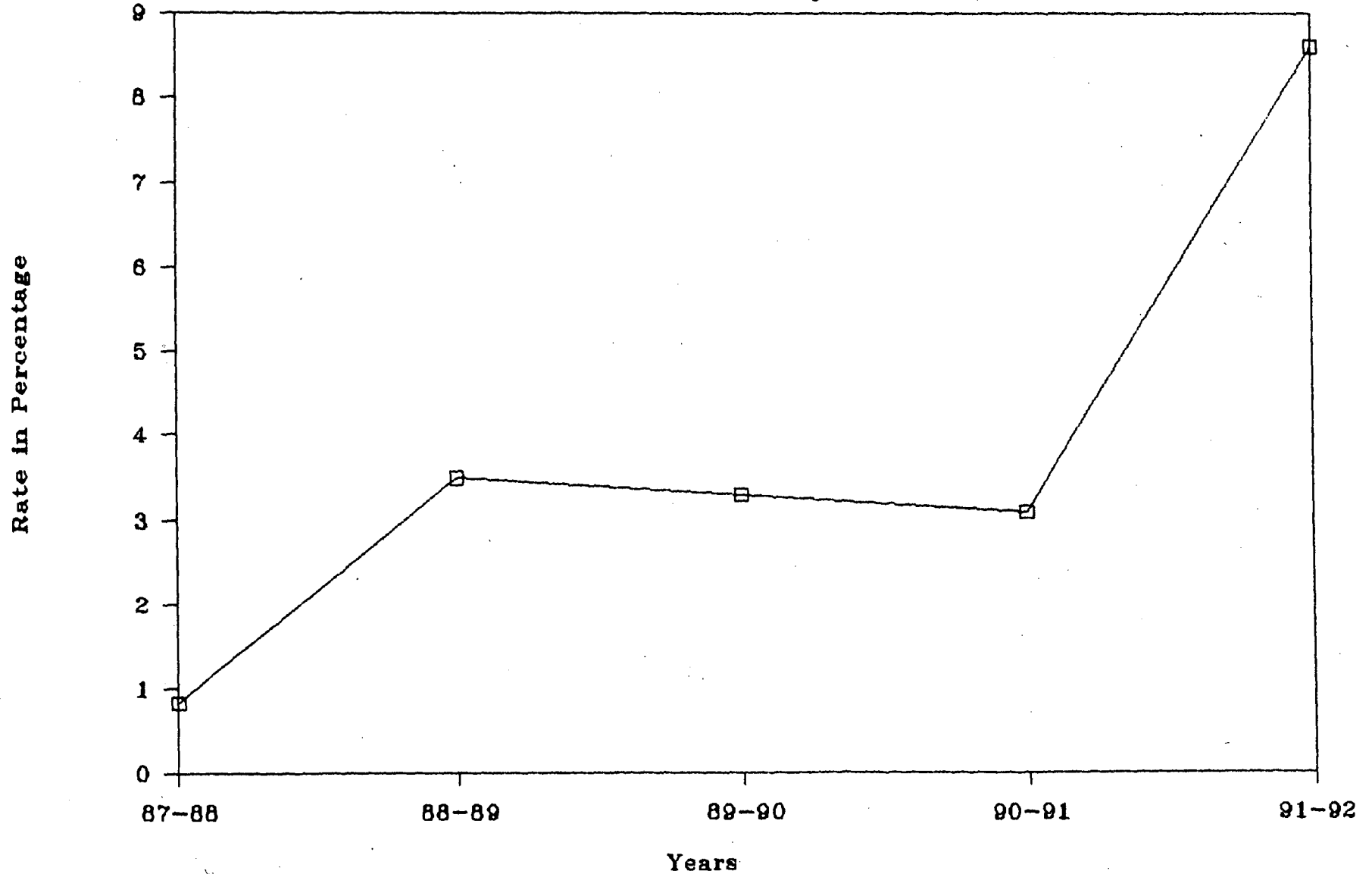
eighties to 2.5% by 1994. Sentinel data collected by the NACO through three round surveys revealed that prevalence of HIV in STD clinic attenders in Bombay is significantly increasing. Bhave (1992a, 1992b) through some of his studies also endorsed this finding proposed by the NACO (Graph 6.2 and 6.3).

The principal mode of HIV transmission in the North Eastern states including Manipur is through the use of infected injecting needles used by IVDUs. Some data available from few studies revealed that till late 1987 there were no reported HIV seropositive case in Manipur. But after 1988, seropositivity among IVDUs was found to be significantly increasing. There were swiftly escalating trends among IVDUs in Manipur, i.e. from merely 0.1% in 1988 to about 51% in 1994 (NACO December 1995:24). In Manipur two rounds of surveillance were carried out in February/March 1994 and February/March 1995. The results from these first two rounds are shown below:

Table 6.3
Results from Manipur Sentinel Surveillance, 1994-95

GROUP TESTED	1st Round(1994)		2nd Round(1995)	
	No.tested	% Positive	No.tested	% Positive
Blood Donors	737	2.1%(1.3-2.9)	740	1.4%(0.7-2.0)
STD clinic Attenders	312	4.8%(2.9-6.7)	256	3.9%(1.9-5.9)
IVDUs	373	55.7%(51.5-59.9)	190	61.1%(55.2-66.9)
Pregnant	615	0.8%(0.3-1.3)	437	0.45%(0.08-0.98).

* Figure in brackets are the 90% confidence intervals. This means that if we took 100 samples of the same size from the group being tested, and tested people in these samples, we could be sure that 90% of the samples would give a percentage positive figures lying with the range shown in brackets.

Graph   6.4

Seropositivity Rate(%) Among
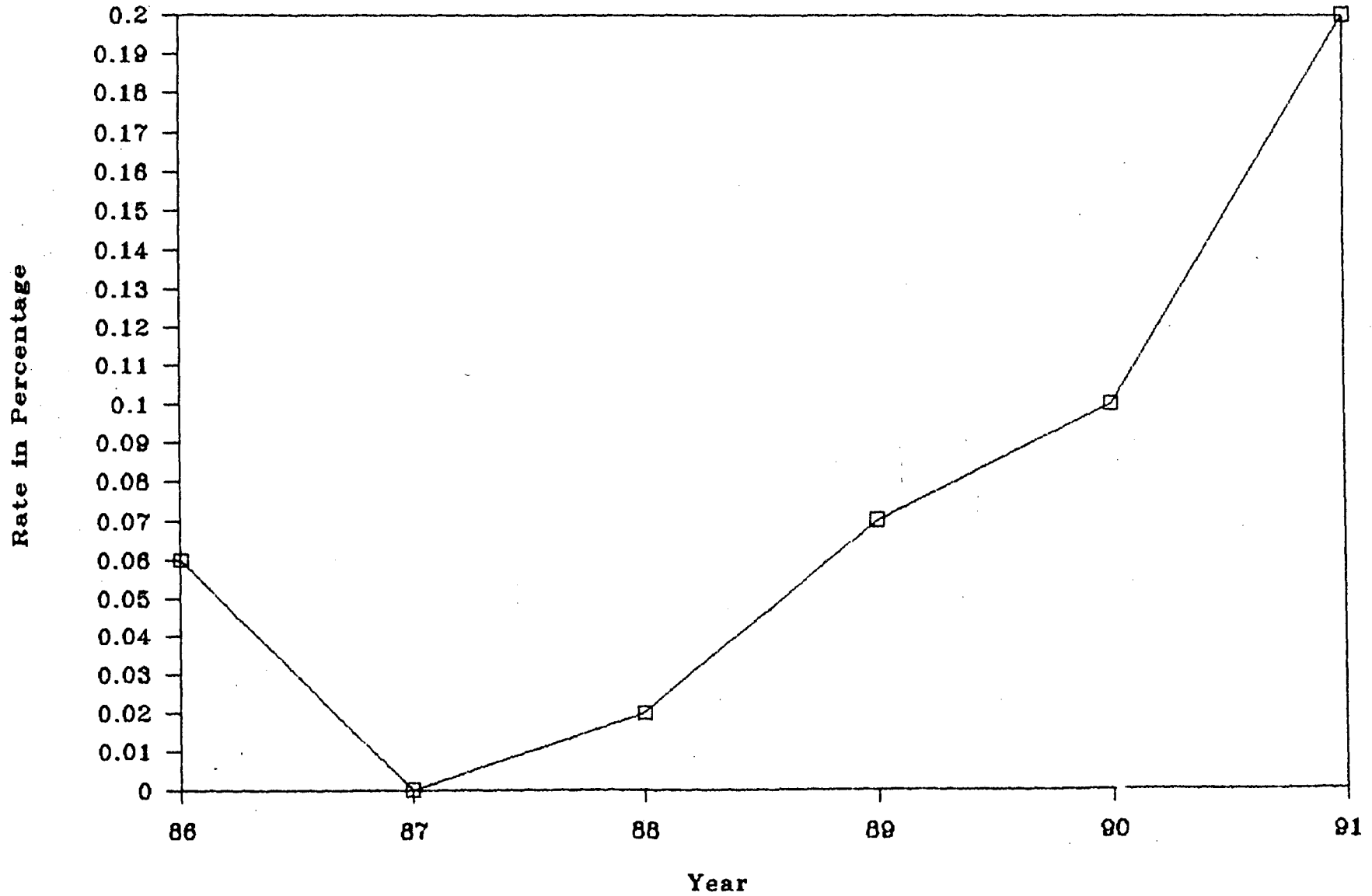
Blood Donors in Madras

Table 6.4

Annual HIV Scenario in Manipur (Jan 1993-Jan 1996)

Time Period	No. Screened	No. Positive	SPR/1000
Jan 93-Jan 94	1673	254	151.82
Jan 94-Jan 95	7367	801	108.73
Jan 95-Jan 96	17519	1200	68.50

Source: Figure derived from NACO monthly updates.

This table (6.3) shows that seropositivity rate among IVDUs is increasing whereas it is found marginally decreasing amongst blood donors, STD clinic attenders and pregnant mothers attending antenatal clinics (NACO Country Scenario 1995:39). One of the main reasons for the increase in the seropositivty rate only amongst IVDUs may be probably due to a comparatively less number of screened cases. This is also clear from the table (6.4) showing annual HIV scenario in Manipur. During the period January 1995 to January 1996, a sum of 17,519 samples were screened in Manipur which gave a seropositivity rate of 68.50 per thousand. Seropositivity rate were of the order of 151.82 when only 1673 sample were screened during January 1993 to January 1994. This data very well shows that as soon as we increase the number of screened samples, seropositivity decreases very significantly. This table 6.4 also suggests that IVDUs association with blood donors, STD clinic attenders and other groups are becoming weak. This probably means that infected IVDUs have already spread the virus to the other infection prone individuals. This may also be due to the fact that people have become aware about the role of infected IVDUs in transmitting the virus among the population. Finally, saturation of the available population of different

Graph 6.5

Seropositivity Rate (%) Among

Antenatal Mothers in Vellore
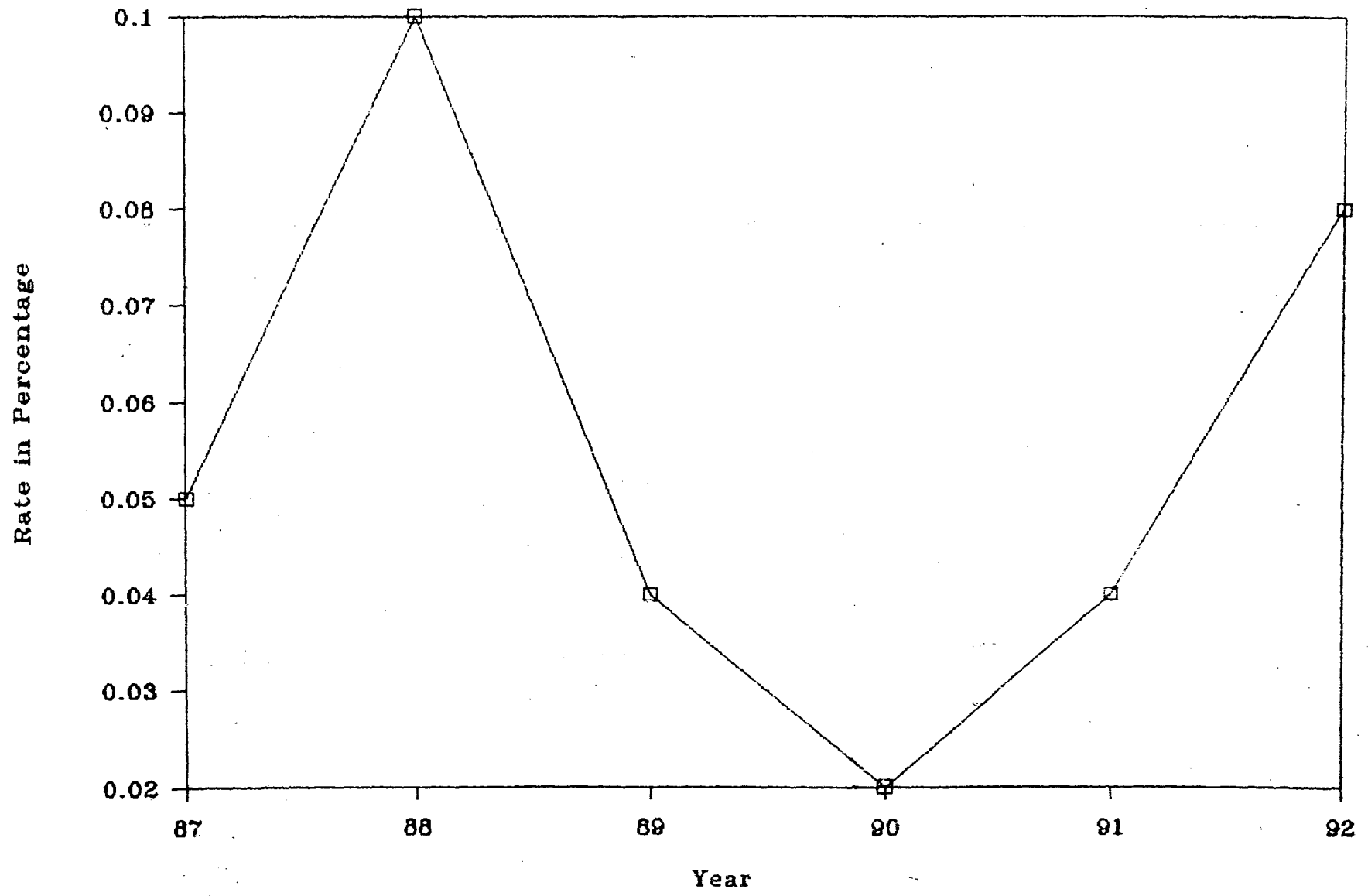
persons in high-risk groups may have contributed to the plateau. Similar evidences have also been noticed in the IVDUs in New York city (Thomas et al, 1993:1), Recently, it has been noticed that consumption of heroin, ganja and opium showed a declining trend in some of the states in the North East region like Mizoram. But it is frightening to note that the demand for some of the pain killers is reported to be increasing significantly in the area. Some of the IV drug users take out the powder from these capsules (like proxyvon), dissolve it in water, and inject into their arms. A high dose of proxyvon is said to have LSD like effect (Karmakar 1994:36). Now the overall seropositivity rate in Manipur is reported decreasing.

In Tamilnadu, overall seropositivity rate has been found marginally increasing in Madras. The rates among IVDUs rose from 0.48% in 1988 to 4.17% in 1995. In a quite similar manner seropositivity rate among blood donors is increasing in Madras (from 0.06% in 1986 to 0.20% in 1991) (NACO Country Scenario 1995:33) (Graph 6.4). The available data also shows that in Madras the incidence of HIV among STD patients increased from 0.6-1.4% in 1986-89 to 8.5% in 1991-92 while in Vellore the rate among CSWs increased from 1.8% in 1986 to 28.6% in 1990 (Jain 1994:1184). Seropositivity increased among blood donors in Madras from 0.06% in 1986 to 0.35% in 1991-92 (NACO 1991:18 and Ravinathan et al 1992), and in Vellore from 0.11% in 1988-90 to 0.31% in 1992 (Jain 1994:1186). But over the same period the rate among antenatal mothers in Vellore remained in the range of 0.05% to 0.1% (Graph 6.5) (John et al, 1994). It has been noted that the seropositivity rate amongst different high risk groups are progressively increasing over the years. This trend can also be clearly noticed in the STD clinic attenders and blood donors in

Graph   6.6.

YEARWISE SPR PER THOUSAND IN INDIA

(OCT.1985–DEC.1995)

Seropositivity rate /1000

oct85–oct87   nov87–oct89   nov89–dec91   jan92–dec93   dec93–de15

YEARS
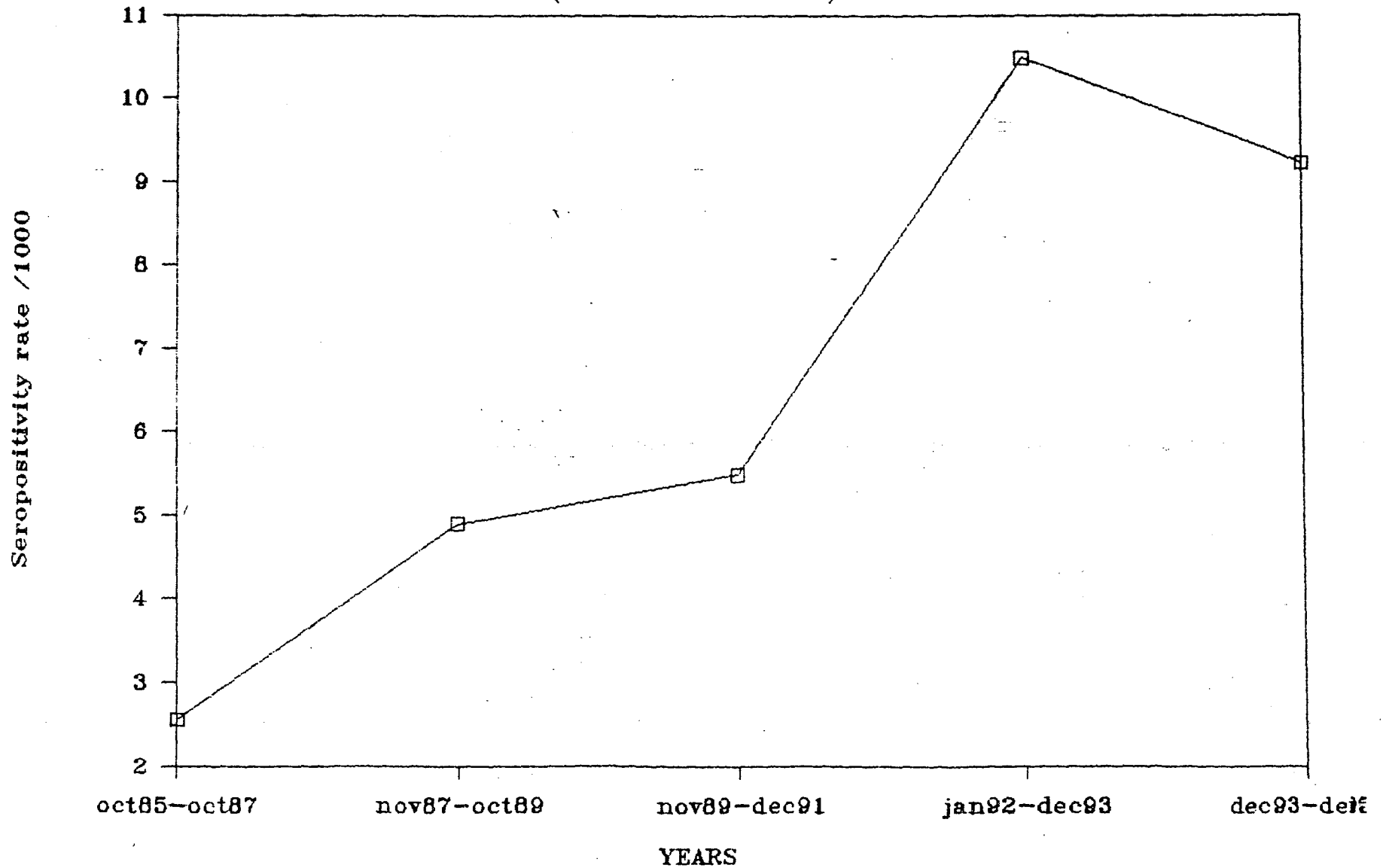
the city of Madras (NACO 1991:17). The three round data collected by the NACO also revealed that HIV seropositivity rate among STD clinic attenders in Madras is increasing (NACO 1995:38).

If the group wise (so called high risk group) period-specific HIV seropositivity in India is analyzed, it may be found that in almost every group a significant jump had been noticed in CSWs and blood donors of Bombay, blood donors in Madras, and antenatal mothers and STD Clinic attenders of Vellore during 1991-92 (Bhave 1992 a and b). The rationale behind this shift was probably due to identification of the back-log cases after the establishment of the vast infrastructure of 154 zonal blood testing centres and other related institutions in India. The all India annual seropositivity rate is still increasing (Graph 6.6). If this is compared with the WHO projection model then the value p=5 defining the steepness of the HIV curve does not suit the Indian situation. This difference is only with the overall Indian data. If the state-wise distribution of the figures is seen then it can be observed that there is an even greater discrepancy in the value of p for projecting the future course of epidemic. The state-wise cumulative HIV seropositivity rate now shows a decreasing trend in some of the states (previously having high seropositivity rate). In the state of Manipur where transmission through IVDUs is dominant, there is a downward trend after March 1994 (NACO monthly updates). Maharashtra is also showing a declining trend and almost the same is the condition for states like Tamilnadu and Delhi. In Goa, a marginal increase in the HIV seropositivity has been noticed. Sentinel surveillance data analysed on the basis of three round conducted by the NACO reveals that in Baroda and Ahmedabad seropostivity rate among STD clinic attenders is decreasing (NACO December 1995:38).

If these trends are critically seen, then a conclusion of taking p=5 at least in Indian situation may not be arrived at. As far as the use of the cumulative rate of progression from HIV to AIDS in the WHO model is concerned, its use in the similar magnitude creates confusion because these rates have been derived from the cohort studies conducted on homosexual men and males with hemophilia (Moss and Bacchetti, 1989: 55-61). This group constitute only a small proportion among all the reported HIV seropositive individuals in India.

Although Chin and Lwanga cautioned the used of projection beyond 4 years in their model, but it has been found that the WHO even in early nineties has projected a cumulative total of 30-40 million HIV infection worldwide in 2000 AD (NACO December 1995:7).

ALTERNATIVE METHODS OF PROJECTION/ESTIMATION IN INDIA

Using Indian data, Shivlal et al (1994) have tried to project adult HIV prevalence at the end of 1994. They have tried to incorporate various surveillance data to arrive at any conclusion. While reviewing findings from studies of HIV prevalence for estimation purposes, several considerations emerged and a number of additional alternatives were used to describe the prevalence level and its trend. The time interval for which blood samples were drawn is used to ascertain whether the HIV prevalence rate is a point estimate (i.e. over a few months) or a period estimate (i.e. over a period of 6 months). Attempts have been made to incorporate urban-rural disparity during estimation. They have tried to estimate the number of HIV infected individuals, while considering certain situations.

Unadjusted estimated number of HIV infected adults were calculated by overall seropositivity rate which existed during 1985 to February, 1995. In this period 2,460,075 blood samples were screened (confirmed with Western Blot) for antibodies against HIV. For getting the number of HIV infected adults seropositivity rate of 7.25 per thousand were multiplied by adult population. In this way Shivlal et al calculated 3,254,685 adults infected with HIV.

To get some more refined estimate Shivlal et al calculated 2,525,000 state-specific estimated number of HIV infected adults. Considering that the major concentration of the problem is in urban areas, in the early stages of the epidemic they multiplied the same seropositivity rate of 7.25/1000 with adult urban population and arrived at an estimate of 914,708 infected individuals. They further calculated state specific urban estimate number of HIV infected adults and found this figure to be around 840,000.

The above estimate assumes that seropositivity rates are unbiased and almost representative. This may be a misleading assumption because the HIV seropositivity rate have been derived from the data mainly on some specific segment of the population. The said estimate of seropositivity cannot be taken as representative for estimating the universe of infected individuals in the tested population. The reason behind this is that these screened samples have not been taken in any scientific manner. A number of unexplained criteria have been applied to detect the screened group. In order to get a representative estimate, group specific unbiased and representative estimate

will have to be found out this may give us a better idea about the level of HIV seropositivity in the general population. In addition, qualitatively and quantitatively sound case reporting system may prove as a catalyst in proper estimation.

If we compare these estimated figures with the actual number of reported figures then we find a significantly high degree of overestimation of expected number of HIV infected adults in India.

The high degree of variation in estimates with different surveillance data groups, and categorization highlights the high levesl of diversity in rates and the uncertainty of estimation/ projection.

Singh (1993) has developed an empirical model to estimate the number of individuals infected with HIV in India. His approach has some similarity with the method applied by Schall (1990), discussed in the previous chapter.

To get some sort of a representative estimates Singh has categorized the entire population in three groups on the basis of sero prevalence per thousand estimates of ICMR, namely high risk group, intermediate risk group and low risk group. The high risk group constitutes mainly the prostitutes, STD patients, homosexuals and IVDUs for which data have been drawn from sero-surveillance studies. The data available on STD patients through sentinel surveillance have been used for estimating the HIV seropositivity for the intermediate risk group. For getting an idea about the magnitude of problem in the general population, data collected through sentinel surveillance on pregnant women,

medical OPD and blood donors for females and medical OPD and blood donors for males have been considered.

There are no reliable estimates of sexes of different risk groups. For getting somewhat more refined estimates, he further calculated zone-wise HIV seropostivity rate among intermediate risk group population for the year 1991-92. As per the ICMR Technical Bulletin, the estimates of the size of population in high risk group and intermediate risk group were of size 0.5-1.0 million and 1.0-5.0 million respectively (ICMR Bulletin, December 1991).

Utilizing these tentative estimates the number of persons infected with HIV works out as 0.44 and 0.50 million respectively. However, Singh considers this estimate as a conservative one and concludes that the number of promiscuous persons could be much more than this. He further calculated 0.61 million of HIV carriers by assuming the size of intermediate risk group as 25 million.

For this purpose he has devised a trend growth model consisting few variables to get an estimate at regional level.

$$P_t = a\,e^{bt}$$

Where P_t is the HIV prevalence at time "t", a and b are regression coefficients and b is tested for significance.

Here it may be noted that 1991-92 data will be used only when significant increasing trend is existing, otherwise he has suggested to use pooled data.

Estimation of number of persons infected with HIV:

For this purpose he has given the expression :

$$M = \sum_{c=1}^{3} N_c P_c = N_1 P_1 + N_2 P_2 + N_3 P_3$$

Where C = 1,2 &3 for high intermediate and low risk groups.

   N_c = Number of susceptibles in risk group "C"

   P_c = HIV prevalence (seropsotivity) for risk group C

   M = Number infected with HIV

1991-92 data have been used for medium and high risk groups where an increasing trend can be observed. As no significant trend has been observed in HIV prevalence for low risk group, pooled data for 1989-1992 have been utilized. On the basis of these data, the estimates obtained are 66.5 per thousand for high risk group, 6.89 for intermediate and 1.00 for the low risk group. The total susceptible population has been estimated to be 400 millions. On on the basis of these two estimates he predicted that the number of persons with HIV is estimated to lie between 0.44 to 0.61 millions.

Due to the unavailability of data on the size of the different risk groups it seems difficult to have an appropriate idea about the magnitude of the problem in the near future. In spite of these limitations, the propagated technique gives some idea of estimating the future course of epidemic in India. Among all the available estimates propagated through various international agencies of high repute, Singh's estimate is lowest and appears comparatively closer to actual reality. His estimate can be further revised by incorporating the intergroup simulation.

A simulation process can take the following lines in its preliminary stages to predict the future course of epidemic.

For calculating the seropositivity rate, the following simulation method of calculation can be employed:

$$R_{s1} = 1/1000 \sum_{i=1}^{n} p_i r_i$$

p_1, p_2,---,p_n represent the estimated population of the individuals belonging to the high risk groups and r_1,r_2----,r_n being the corresponding seropositivity rates among these populations.

$$R_{s2} = 1/1000 \sum_{j=1}^{m} p_j r_j$$

p_1, p_2,-----,p_n represent the estimated population of the individuals belonging to the intermediate risk groups r_1,r_2----,r_n being the corresponding seropositivity rates among these population.

$$R_{s3} = 1/1000 \sum_{k=1}^{1} p_k r_k$$

p_1, p_2,.........,p_1, represent the estimated population of the individuals belonging to the low risk groups r_1, r_2,.......,r_1, being the corresponding seropositivity rates among these population.

The overall seropositvity rate will be expressed as

$$R_s = \sum_{a=1}^{3} R_{sa} = 1/1000 \left\{ \sum_{i=1}^{n} p_i r_i + \sum_{j=1}^{m} p_j r_j + \sum_{k=1}^{1} p_k r_k \right\}$$

To get a representative and an unbiased idea about the level of seropositivity in different groups, an adequate sample size will have to be taken. The size of the individual sample drawn from the particular risk group will depend on the current incidence rate or seroprevalence rate (on the basis of whatever government

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information we have). If the rate is high then the size can be restricted to 25% - 30%, and if the rate is low then the greater proportion of the population can be selected. Thus, the size of the population studied will depend upon the level of the seropositivity in that particular group.

Further, for the estimation of the sample size the following technique can be employed:

To calculate the adequate sample size required for accuracy in estimating proportions, we need at first to decide the following factors (Fisher A, 1991:44-45):

1. What is the prevalence of disease in the study area?

2. What degree of accuracy do we want to have in our study? How far can we allow the sample estimates to deviate from the true prevalence in the study area as a whole?

3. What confidence level do we want to use? How confident do we want to be that the sample estimate is as accurate as we wish? Customarily, the 95% confidence level is generally used.

4. What is the size of the population that sample is supposed to represent? If it is greater than 10,000 the precise magnitude is not likely to very important. But if it is less than 10,000, the required sample size may be smaller.

5. If we are seeking to measure the difference between two sub groups with regard to a proportion, what is the minimum difference we expect to find statistically significant? The smaller the difference we expect to be significant, the larger our sample size will have to be.

On the basis of these five arguments we can calculate the sample size needed to measure a given proposition with a given degree of accuracy at a given level of statistical significance by using a simple formula that the total population size is greater than 10,000:

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$$n = z^2 \, pq/d^2$$

Where:

n = the desired sample size (when population is greater than 10,000).

z = the standard normals deviate, usually set at 1.96 (or more simply at 2.0), which correspondence to the 95 percent confidence level.

p = the proportion in the target population estimated to have a particular characteristic. If there is no reasonable estimate, then use 50 percent (.50).

q = 1.0 - p.

d = degree of accuracy desired.

Let us assume that the prevalence of HIV seropositivity be 10% (say p) in a high risk behaviour population of a particular area. Then the required sample size to study the said area will be:

$(0.01)^2 \backsim 4 \quad \dfrac{0.1 \times 0.9}{n}$ assuming that 10% of errors can be tolerated.

$\Rightarrow \quad n = \dfrac{0.1 \times 0.9 \times 4}{0.01 \times 0.01}$

$n = 3600$

In this situation a sample size of 3600 persons will be adequate to study the said population. Thus, the error of tolerance (prevalence) of disease will be inversely proportional to the required sample size.

In cases where getting the sampling frame of individuals seem difficult as far the IVDUs and professional blood donors are concerned, the snowball sampling approach can be attempted to detect these individuals (Gupta 1996:63-65). If they are attending any health institutions then their records can be screened. For getting an idea of the extent of the problem in the general population, records of the patient chronically ill (with history of STDs or blood borne disease) should be taken into consideration.

It seems difficult to have any idea of the extent of problem

in the general population. For urban areas antental mothers attending clinics and blood donors (voluntary) could be studied. Already available infrastructure of health services could be employed to understand the situation in rural areas. The available list of eligible mothers at ICDS and sub-centres (health) can be utilised as sampling frame. From this available frame, randomly selected individuals should be traced (periodically) to know the situation. If lists are not available then ANMs and other staff available there could be asked to prepare it. After preparing a frame of individuals qualifying to different risk groups a random selection of 25% of the sample can be taken. Retrospective information regarding their health status should be screened. In this way, one can enquire about the factors contributing to the level of seropositivity in this particular group.

There is no doubt, that the technique suggested here is complicated and expensive. But with the available abundance of financial support of various international agencies this technique can be used to examine the real situation in an area, so that we shall be able to properly modify our future strategies.

CHAPTER-VII

CONCLUSION

CONCLUSION

AIDS has been considered a global problem which has similar mode of transmission in all societies but the the dominant modes of transmission vary from society to society. The available evidence today indicates that HIV and AIDS have crossed the traditional geographical boundaries. Now AIDS is strongly realized as a global problem requiring a global effort, that has no regional or political boundary but has a high degree of differences in magnitutude and nature of the epidemic in different regions, countries and social groups.

Till 30th June 1995, the WHO reported that 11,68,911 individuals, had developed AIDS across the five continents of the globe. Of individuals infected with AIDS as of 30th June 1995, two-third were from America and Africa. There is a significant variation in the rates of cumulative reported AIDS cases per hundred thousand of population among the countries reporting AIDS to the WHO. Even now, America has the highest reported case rate. Despite this it has been common practice to focus attention on AIDS in developing countries of Africa and South East Asia societies and to project higher and higher case rates for them in the future.

It is pertinent to note here that in the mid 1980s, the epidemic was well established in North-America and Africa, but by 2000 A.D. it is being propogated that most of the new cases will be in Asia. The West is still not faced with the prospect of a heterosexual AIDS epidemic: adult AIDS infection is mainly confined to homosexuals, bisexuals and intravenous drug users and their long-term partners. In Asia, as is evidenced by Thailand, India and Burma, most infected persons are probably males supposed to be

infected by sex workers, or the female partners of the males ,
IVDUs and due to medical negligence. Exploring the negative role of
extrapolated estimates Mann admits that discrimination is the
result of random statistics given out (without checking its
scientificity) at conferences and statistics that are pointed to
particular countries (ABVA , 1993:48).

Like most countries in Asia, India is included in the Pattern
III distribution of HIV disease. HIV entered India in the mid-
eighties, a relatively delayed entry when compared to other parts
of the world. However, it spread rapidly in some states, viz
Maharashtra, Tamilnadu and in some North-Eastern States, especially
Manipur. Since the detection of the first AIDS case in Bombay[1] in
1986, a comulative total of 2528 AIDS cases have been reported to
NACO from different parts of the country. Out of 2816304 samples
screened, 22529 have been found to be HIV antibodies postive (NACO
March 1996) i.e. a seropositivity rate of about 8 per thousand. As
the spread of the virus is determined by a magnitude of factors,
viz. extent of prevalence of risk behaviours, and socio economic
conditions, the HIV epidemic in India has taken a varied course in
different regions (NACO 1995:7). While in the main cities of some
states, the epidemic is already in its advanced phase, in other
states the problem is only in its early stage

The later sentinel surveillance conducted by NACO revealed
that the major concentrations of infection still remain in places
like Bombay, Imphal, Madras, Vellore, Madurai. Goa and Pune are
emerging as important concentrations of infection. It has been
observed that since August-November overall seropositivity rate of
among the state like Maharathtra, Tamilnadu, Manipur and National

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[1].   The source of infection was traced to blood transfusion
during a caronary bypass surgery in the USA, prior to the
introduction of HIV screening in that country. This was the fact
why initially AIDS was considered as a "foreign disease".

capital of Delhi (socalled high concentration zones of the infection) is reported decreasing. The above referred sentinel surveillance report reveals that overall infection rates in India is rising progressively in different high risk behaviour groups over the years and are also penetrating the general population marginally. This is on the basis of the noted evidence of HIV seropositivity among voluntary blood donors and ante-natal clinical attenders.

The implication of this is that if we have to respond to this situation among the "high risk group" by targeted interventions, we have to simultaneously prevent the entry of the infection to the general population (which has lower infection rate but much larger numbers) through proper means.

There are many epidemiological aspects of HIV infection which urgently require proper investigation. These include factors affecting the latent, infection and incubation periods, and especially those relating to the probability of transmission of the virus from an infected individual to a susceptible partner. Such investigations should be based on carefully devised epidemiologcal and statistical studies in diverse social and regional settings, including longitudinal studies of virus secretion and excretion in infected subjects. Properly evolved mathematical models of infection and disease serve as pillars, as foundations to build on, as analytic tools for the estimation of epidemiological parameters, and as guides to the information needed for improving epidemiological understanding and in planning programmes of control.

The lack of primary data (micro on the frequency and distribution of different diseases within developing countries makes it difficult to effect a rational allocation of the limited resources which are available for disease prevention and patient care. It has been seen that a qualitatively and quantitatively

appropriate data base is a pre-requisite of any disease control programme. This helps in formulating feasible strategies to effectively monitor the situation and the optimum utilisation of the government machinery. It also helps in assessing and monitoring the effects of measure taken to control the spread of infection. Unfortunately in almost all the developing countries in the world proper attention has not been given to this vital fact. As a results all these countries are lacking valid and reliable data.

Predicting the future course of the epidemic in a specific area helps the planners to optimise their priorities in formulating any disease control programmes. Realising the need for a sound statistical data base, Tripathy states that "with no visible prospect of a vaccine or a drug in the near future, India stands to qualify for a dubious distinction of possibly having a substantial proportion of the total infected population in the Asian Continent by the turn of the century. I hope our statisticians will accept the challenge facing us now, and set up a special group to design statistical methods by which we could determine with reasonable accuracy the prevalence of HIV infection in our country, predict its course and the impact of various intervention including health education and use of condom, and the application of vaccines and drugs as and when they become available" (ISMS 1992:9). Since the discovery of the aetiological agent of AIDS, some progress has been made in the fomulation of a wide variety of models and their use for many different purposes. Some of these models use reported AIDS case data for short term projection of AIDS cases by using statistical extrapolation techniques to the observed temporal curve. The Isham (1988) model fits a mathematical curve to the available data on reported AIDS cases from pattern I countries. While the above statistical models are useful to an extent, there is a strong tendency in the dominant stream of public health to

overestimate their importance.

With the emergence of AIDS in early eighties different statistical models have been simaltaneously developed to understand the transmission dynamics of the epidemic. These models use various types of parametric distribution to discuss different factors (such as incubation period) related to HIV. Malcom Rees gave his estimate of incubation period of 10 to 20 years (15 and a standard deviation of 5 years) based on transmission data which follows normal distribution. Commenting on this range of incubation period, Dagpunar stated that the Gaussian curve is not applicable in this case and found incubation period in the range of 5 years. Anderson used the Weibull distribution and found a marginal difference in the incubation period for both sexes. Based on Scherrews influenza model, Bailey et al also used negative binomial distribution to understand incubation period dynamics related to AIDS. Bailey used gamma variable in the initial phase and subsequently used exparential distribution for just before manifestation of AIDS. The Bachetti and Moss model is based on seroconversion rates to AIDS diagnosis in San-Francisco homosexuals, and it seems to be the most reliable method.

Considering the prevailing AIDS problems in developing countries, the WHO prepared a few models (which have been periodically modified) to project the future course of the epidemic. The WHO has developed a model for the areas where AIDS case reporting is known to be largely incomplete and unreliable. In this process the initial model was developed by Chin and Mann during 1986-87 to make short term (3-4 years) projection of AIDS Cases in the developing countries. The WHO further applied the Delphi method to check the validity of these estimates. This amounted merely to a compilation of the experts' opinion on the subject. Thereafter in 1989 Chin and Lwanga modified the WHO model for estimating the future course of the epidemic. In this

approach a number of assumptions were made. This approach uses annual reports of AIDS cases to estimate yearly HIV infections through use of a back calculation depending on annual progression rates. The derived estimates of annual HIV infections are then used to project AIDS cases over next 2-3 years. Brookmeyer and Gail (1988) use data on estimated HIV infections in addition to progression rates from infection to AIDS to calculate the number of past AIDS cases and to provide short-term projection of AIDS cases. If the applicability of the said model in Indian context is studied, then it will be easily observed that a majority of these assumptions do not suit Indian realities. The result is overestimated figures. On account of the direct influence of the international agencies, the NACO guidelines are being prepared in the light of these overstimated figures. As a result, an extraordinary emphasis is being given to the programme. As the verticality of the programme itself poses a problem, its consequences will be grave if accurate estimates are not formulated.

Many social factors such as poverty have been found responsible for the hetrosexual spread of the disease in some countries in the world. Recent developments in the economic front in the world have also become instrumental in increasing the number of infective individuals. Due to market - oriented strategies, the state's inclination towards privatisation in certain areas, a tremendous amount of multifaceted infrastructural developments are taking place, such as increase in the transportation sector, tourism industry (in few countries) budget cuts in areas such as health and social sectors (in some developing countries), urban migration due to shift from agricultural occupations and an increase in prostitution. The effect due to these factors is that HIV is likely to get a more porous environment to circulate among different sections of populations. It is not only the case of

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developing countries but it has been observed in almost every country of the globe that the poor and marginalised have been more affected. The socio-cultural changes that are occuring across the globe also lead to the break up of marriages, creating a pool of people changing partners.

India's health services are already over stretched on account of managerial and financial problems. There are several communicable diseases which still demand the utmost attention from the health services. If therefore, the prevalence and incidence of AIDS is overestimated and consequently greater emphasis is put on addressing it, it will be deterimental to both, the basic health services and the control of AIDS itself in the long term.

Taking the above situation into consideration and the epidemiological fact of diversity in evolution of the epidemics in different contexts and groups , it can be concluded that the WHO projection model for short term estimate will not be appropriate in the prevailing situation in India. A sensitive simulation process with respect to all the groups and simulation within the groups taken representatively, is a useful methodology bringing estimates and projections closer to reality and for getting a proper insight into the problem.

Since the health problems afflicting India are many and resources scarce, it is of much importance that India designs programmes of alleviation which are proportionate to the specificities of each health problem being tackled, and which are economical in their use of resources.

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ZONAL BLOOD TESTING CENTRES IN THE COUNTRY

IN VARIOUS STATES/UNION TERRITORIES	
1. Andhra Pradesh	1. Blood Bank, Gandhi Hospital, Hyderabad 2. Blood Bank, M.J. Caqncer Hospital, Hyderabad 3. Blood Bank, Nizam's, IMS Hyderabad 4. Blood Bank, Instt. of Preventive Medicines, Hyderabad 5. Blood Bank, Govt. Headquarters Hospital, Vijayawada 6. Blood Bank, Govt. Headquarters Hospital, Karim Nagar 7. Blood Bank, Govt. Headquarters Hospital, Cuddapeh 8. Blood Bank, Govt. Headquarters Hospital, Kammam 9. Blood Bank, Govt. Headquarters Hospital, Chittor 10. Blood Bank, Medical College, Tirupati 11. Blood Bank, Guntur Medical College, Guntur 12. Blood Bank, General Hospital, Kurnool
2. Arunachal Pradesh	13. Blood Bank, Government Hospital, Itanagar
3. Assam	14. Blood Bank, Guwahati Medical College, Guwahati 15. Blood Bank, Medical College, Dibrugarh 16. Blood Bank, Medical College, Silchar
4. Bihar	17. Blood Bank, Medical College, Gaya 18. Blood Bank, Patna Medical College, Patna 19. Blood Bank, District Hospital, Dhanbad 20. Blood Bank, District Hospital, Jamshedpur 21. Blood Bank, Jamshedpur 22. Blood Bank, Rajendra Medical College, Ranchi 23. Blood Bank, Medical College, Bhagalpur 24. Blood Bank, Shri Krishna Medical College, Muzzafarpur 25. Blood Bank, Medical College, Dharbanga
5. Goa	26. Blood Bank, Medical College, Panaji 27. Blood Bank, Civil Hospital, Panaji
6. Gujarat	28. Blood Bank, Surat Medical College, Surat 29. Blood Bank, Govt. Medical College, Vadodara 30. Blood Bank, B.J. Medical College, Ahmedabad 31. Blood Bank, M.P. Shah Hospital, Jamnagar 32. Blood Bank, District Hospital, Junagarh 33. Blood Bank, Civil Hospital, Amreli
7. Haryana	34. Blood Bank, Medical College, Rohtak 35. Blood Bank, District Hospital, Hissar 36. Blood Bank, General Hospital, Faridabad 37. Blood Bank, General Hospital, Karnal
8. Himachal Pradesh	38. Blood Bank, Indira Gandhi Medical College, Shimla 39. Blood Bank, District Hospital, Dharamsala
9. Jammu & Kashmir	40. Blood Bank, Govt. Hospital, Srinagar 41. Blood Bank, Medical College, Jammu

10. Karnataka	42.	Blood Bank, K.C. General Hospital, Bangalore
	43.	Blood Bank, H.S.I.S. Hospital, Bangalore
	44.	Blood Bank, K.M. Instt. of Oncology, Bangalore
	45.	Blood Bank, K.M.C. Hospital, Hubli
	46.	Blood Bank, Kasturba Medical College, Manipal
	47.	Blood Bank, Medical College, Bellari
	48.	Blood Bank, Kasturba Medical College, Mangalore
	49.	Blood Bank, Medical College, Gulbarga
	50.	Blood bank, Medical College, Belgaum
11. Kerala	51.	Blood Bank, Medical College Hospital, Calicut
	52.	Blood Bank, Govt. Hospital, Ernakulum
	53.	Blood Bank, Medical College, Trivandrum
	54.	Blood Bank, District Hospital, Trichur
	55.	Blood Bank, District Hospital, Cannanore
12. Madhya Pradesh	56.	Blood Bank, Medical College, Bhopal
	57.	Blood Bank, Dist. Hospital, Ujjani
	58.	Blood Bank, Medical College, Gwalior
	59.	Blood Bank, D.H. Sagar
	60.	Blood Bank, Medical College, Indore
	61.	Blood Bank, Rewa Medical College, Rewa
	62.	Blood Bank, District Hospital, Bilaspur
	63.	Blood Bank, Medical College, Jabalpur
	64.	Blood Bank, District Hospital, Chindwara
	65.	Blood bank, Medical College, Raipur
13. Maharashtra	66.	Blood Bank, KEM Hospital, Bombay
	67.	Blood Bank, L.T.M.G. Hospital, Bombay
	68.	Blood Bank, B.Y.L. Nair Hospital, Bombay
	69.	Blood Bank, Haffkine Institute, Bombay
	70.	Blood Bank, Tata Memorial Hospital, Bombay
	71.	Blood Bank, Red Cross, Bombay
	72.	Blood Bank, Cooper Hospital, Bombay
	73.	Blood Bank, Rajawadi Hospital, Bombay
	74.	Blood Bank, J.J. Hospital, Bombay
	75.	Blood Bank, General Hospital, Solapur
	76.	Blood Bank, Govt. Hospital, Ulhasnagar
	77.	Blood Bank, Sasoon Hospital, Pune
	78.	Blood Bank, Govt. Medical College, Miraj
	79.	Blood Bank, Dist. Hospital, Chandrapur
	80.	Blood Bank, General Hospital, Kolhapur
	81.	Blood Bank, Medical College, Nagpur
14. Manipur	82.	Blood Bank, J.N. Hospital, Imphal
15. Meghalaya	83.	Blood Bank, Pasteur Hospital, Shillong
16. Mizoram	84.	Blood Bank, Government Hospital, Aizwal
17. Nagaland	85.	Blood Bank, Dist. Hospital, Dimapur
	86.	Blood Bank, District Hospital, Muckchong
	87.	Blood Bank, Govt. Hospital, Kohima
18. Orissa	88.	Blood Bank, M.K.G.G. Hospital, Burla
	89.	Blood Bank, V.S.S. Medical College, Berhampur
	90.	Blood Bank, S.C.B. Medical College, Cuttack

19	Punjab	91.	Blood Bank, Shri Guru Tegh Bahadur Hospital, Amritsar
		92.	Blood Bank, Rajendra Hospital, Patiala
		93.	Blood Bank, Civil Hospital, Ludhiana
20.	Rajasthan	94.	Blood Bank, S.M.S. Medical College, Jaipur
		95.	Blood Bank, Medical College, Ajmer
		96.	Blood Bank, Medical College, Bikaner
		97.	Blood Bank, S.N. Medical College, Jodhpur
		98.	Blood Bank, General Medical College, Udaipur
		99.	Blood Bank, Medical College, Kota
21.	Sikkim	100.	Blood Bank, S.T.N.M. Hospital, Gangtok
22.	Tamil Nadu	101.	Blood Bank, Madras Medical College, Madras
		102.	Blood Bank, Stanley Medical College, Madras
		103.	Blood Bank, Kilpak Medical College, Madras
		104.	Blood Bank, Govt. Royapettah Hospital, Madras
		105.	Blood Bank, Apollo Hospital, Madras
		106.	Blood Bank, Madurai Medical College, Madras
		107.	Blood Bank, S.G. Hospital, Madras
		108.	Blood Bank Central, Egmore, Madras
		109.	Blood Bank, Govt. Hospital, Coimbatore
		110.	Blood Bank, Govt. Hospital, Salem
		111.	Blood Bank, Govt. Hospital, Tiruchirapally
		112.	Blood Bank, Medical College, Tirunelveli
23.	Tripura	113.	Blood Bank, G.B. Hospital, Agartala
24.	Uttar Pradesh	114.	Blood Bank, District Hospital, Gorakhpur
		115.	Blood Bank, G.S.V. Medical College, Kanpur
		116.	Blood Bank, District Hospital, Allahabad
		117.	Blood Bank, K.L. Sharma Hospital, Meerut
		118.	Blood Bank, K.G. Medical College, Lucknow
		119	Blood Bank, S.G.P.G.I., Lucknow
		120.	Blood Bank, Medical College, Agra
		121.	Blood Bank, District Hospital, Dehra Dun
		122.	Blood Bank, District Hospital, Nainital
		123.	Blood Bank, District Hospital, Shahjahnpur
		124.	Blood Bank, M.L.B. Medical College, Jhansi
25.	West Bengal	125.	Central Blood Bank, Calcutta
		126.	Blood Bank, C.N.M.C.H. Calcutta
		127.	Blood Bank, N.R.S.M.C.H., Calcutta
		128	Blood Bank, R.G K.A.R.M.C.H., Calcutta
		129.	Blood Bank, S.S.K.M., Calcutta
		130.	Blood Bank, District Hospital, West Dinajpur
		131.	Blood Bank, North Bengal Medical College, Darjeeling
		132.	Blood Bank, District Hospital, Jalpaiguri
		133.	Blood Bank, State Hospital, Burdwan
26.	A & N Islands	134.	Blood Bank, G.B. Pant Hospital, Port Blair
27.	Chandigarh	-	
28.	Dadra & Nagar HAveli	-	
29.	Daman & Diu	-	
30.	Delhi	135.	Blood Bank, G.T.B. Hospital, Shahdara, Delhi
		136.	Blood Bank, Hindu Rao Hospital, New Delhi
		137.	Blood Bank, LNJP/MAMC Hospital, New Delhi
31.	Lakshadweep	-	
32.	Pondicherry	-	

UNDER INDIAN COUNCIL OF MEDICAL RESEARCH	
	138. Blood Bank, RMRC, Bhubneshwar 139. Blood Bank, Institute of Pathology, New Delhi
UNDER DIRECTOR GENERAL OF ARMED FORCES MEDICAL SERVICES	
	140. Blood Bank, Command Hospital, Bangalore 141. Blood Bank, Command Pathology Lab, Eastern Command, Calcutta 142. Blood Bank, Armed Forces Command Hospital, Delhi Cantt. 143. Blood Bank, Command Pathology Lab, Central Command, Lucknow 144. Blood Bank, Armed Forces Medical College, Pune 145. Blood Bank, Command Hospital, Northern Command, Udhampur
IN CENTRAL INSTITUTIONS	
	146. Blood Bank, Lady Hardinge Medical College, New Delhi 147. Blood Bank, Blood Transfusion Services, Safdarjung Hospital, New Delhi 148. Blood Bank, Jipmer, Pondicherry 149. Blood Bank, RML Hospital, Delhi
IN AUTONOMOUS INSTITUTIONS(Other than ICMR)	
	150. Blood Bank, Medical College, Banaras Hindu University, Varanasi 151. Blood Bank, AIIMS, New Delhi 152. Blood Bank, Indian Red Cross Society, New Delhi 153. Blood Bank, PGI, Chandigarh
IN PRIVATE INSTITUTIONS	
	154. Blood Bank, Christian Medical College, Vellore

List of surveillance centres where HIV testing facilities are available

IN VARIOUS STATES/UNION TERRITORIES	
1. Andhra Pradesh	1. Department of Microbiology, Osmania College, Hyderabad 2. Department of Microbiology, SV Medical College, Tirupati 3. Department of Microbiology, Andhra Medical College, Vishakapatnam 4. Instt. of Preventive Medicine, Hyderabad
2. Arunachal Pradesh	5. District Hospital, Itanagar
3. Assam	6. Department of Microbiology, Guwahati Medical College, Guwahati
4. Bihar	-
5. Goa	7. Department of Microbiology, Goa Medical College, Panaji
6. Gujarat	8. Department of Microbiology, BJ Medical College, Ahmedabad
7. Haryana	9. Department of Microbiology, Medical College, Rohtak
8. Himachal Pradesh	10. Department of Microbiology, Indira Gandhi Medical College, Shimla
9. Jammu & Kashmir	11. Department of Immunopathology, Sher-e-Kashmir Institute of Medical Sciences, Srinagar 12. Department of Microbiology, Government Medical College, Jammu
10. Karnataka	13. Department of Microbiology, Bangalore Medical College, Bangalore 14. Department of Microbiology, Kasturba Medical College, Manipal
11. Kerala	15. Department of Microbiology, Medical College, Trivandrum
12. Madhya Pradesh	16. Department of Pathology, Gandhi Medical College, Bhopal 17. Choitram Hospital and Research Centre, Indore
13. Maharashtra	18. Department of Microbiology, Seth G.S. Medical College, Bombay 19. Department of Microbiology, JJ Hospital, Bombay 20. Sion Hospital, Bombay 21. B.Y.N. Nair Hospital, Bombay 22. Rajawadi Hospital, Ghatkopar, Bombay 23. B.J. Medical College, Pune 24. Department of Microbiology, Govt. Medical College, Nagpur 25. Civil Hospital, Kolhapur 26. District Hospital, Chandrapur 27. Government Medical College, Miraj
14. Manipur	28. J.N. Hospital, Imphal
15. Meghalaya	29. Civil Hospital, Shillong
16. Mizoram	30. Civil Hospital, Aizwal
17. Nagaland	31. Naga Hospital, Kohima 32. District Hospital, Dimapur
18. Orissa	33. Department of Microbiology, S.C.B Medical College, Cuttack
19. Punjab	34. Government Medical College, Amritsar
20. Rajasthan	35. Department of Microbiology, S.M.S. Medical College, Jaipur
21. Sikkim	36. S T N M Hospital, Gangtok
22. Tamil Nadu	37. Department of Microbiology, Instt. of Child Health and Hospital for Children, Madras 38. Department of Microbiology, Madurai Medical College, Madurai
23. Tripura	39. District Hospital, Agartala
24. Uttar Pradesh	40. Department of Microbiology, K.G. Medical College, Lucknow
25. West Bengal	-
26. A & N Islands	41. G.B. Hospital, Port Blair
27. Chandigarh	-

28.	Dadra & Nagar Haveli		
29.	Daman & Diu		
30.	Delhi	42.	Department of Microbiology, University College of Medical Sciences, Shahdara, Delhi
		43.	Deptt. of Microbiology, Maulana Azad Medical College, New Delhi
31.	Lakshdweep	44.	Govt. Hospital, Kavaratti
32.	Pondicherry	45.	Government General Hospital, Pondicherry
UNDER INDIAN COUNCIL OF MEDICAL RESEARCH			
		46.	Central JALMA Instt. for Leprosy, Agra
		47.	Regional Medical Research Centre, Bhubneshwar
		48.	Regional Medical Research, Centre for Tribal Health, Jabalpur
		49.	Tuberculosis Research Centre, Madras
		50.	Rajendra Memorial Research, Institute, Patna
UNDER DIRECTOR GENERAL OF ARMED FORCES MEDICAL SERVICES			
		51.	Indian Naval Ship Hospital, Ashwani, Bombay
		52.	Indian Naval Ship Hospital, Cochin
		53.	Armed Forces Command Hospital, Delhi Cantt
		54.	Department of Microbiology, Armed Forces Medical College, Pune
		55.	Indian Naval Ship Hospital, Kalyani, Vishakapatnam
IN CENTRAL INSTITUTIONS			
		56.	All India Institute of Hygiene & Public Health, Calcutta
		57.	Department of Microbiology, JIPMER, Pondicherry
IN AUTONOMOUS INSTITUTIONS			
		58.	Department of Microbiology, Instt of Medical Sciences, Varanasi
		59.	Jawahar Lal Nehru Medical College, Aligarh
		60.	Department of Immunopathology, P.G.I., Chandigarh
		61.	National Institute of Mental & Neurosurgery
IN PRIVATE INSTITUTIONS			
		62.	Kamla Nehru Memorial Hospital, Allahabad

List of HIV reference centres

1. National Institute of Communicable Disease
   Delhi

2. All India Institute of Medical Sciences
   New Delhi

3. Indian Institute of Immunohematology
   Bombay

4. National Institute of Cholera and Enteric Diseases
   Calcutta

5. School of Tropical Medicines
   Calcutta

6. Madras Medical College
   Madras

7. National AIDS Research Institute (NARI)
   Pune

8. Regional Medical College
   Imphal

9. Christian Medical College
   Vellore

The reference centres should be entrusted with the responsibility of carrying out confirmatory test. They should also be made responsible for diagnosis, quality control of HIV kits. guidelines for HIV testing, training in HIV testing and any other activity which may be necessary for standardization of HIV testing.

Additional Financial Support for the
National AIDS Control Programme 1992-96.

Source/Agency	Amount (US$)		Remarks
ODA(UK)	a)	35,000	1991-92 support to North-Eastern States
	b)	2,500,000	Proposed support to Programme activities in the State of West Bengal, 1993-95 Truckers and IEC/STD proposal
NORAD (Norway)	a)	28,000	Support to NGO AIDS Cell
	b)	110,000	Support to the AIIH&PH Intervention Project, Calcutta,1992-93
	c)	300,000	Support to NACO/CMAI training activities 1993-94
USAID (USA)		10,000,000	Support to Tamil Nadu State for IEC and condom promotion project (APAC).
Ford Foundation		110,000	Support to MCGB Intervention Project through condom promotion with PSI. 1991-92
International Development Association (World Bank)		85,000,000	Support to National AIDS Control Programme, 1992-97
UNDP		18,000	Support to Railway Corporation workplace education programme
UNDCP		15,000	Support to pilot intervention project for HIV/AIDS prevention with street children

WHO Regular and Extrabudgetary resources in support of the Government of India National AIDS Control Programme 1990-96

Period/Details	WHO Regular Country Budget Resources	WHO/Global Programme on AIDS Extrabudgetary Trust Fund Resources		Total (US$)
		Multi-bilateral	Global undesignated	
1990-91				
- MOH&FW (DGHS)	525,850		515,000	1,040,850
- Maharashtra State			445,424	445,424
- Manipur State			62,856	62,856
Total	525,850		1,023,280	1,549,130
1991-92				
- MOH&FW (DGHS/NACO)		245,985 (SIDA) 1,860,000 (USAID)		2,105,985
- Tamil Nadu State		247,021 (SIDA)	39,883	286,904
- West Bengal State		367,412 (SIDA)		367,412
- Delhi Union Territory		93,407 (SIDA)	48,961	142,368
Total		2,813,825	88,844	2,902,669
1992-93				
- MOH&FW (NACO)	306,200		2,417,603	2,723,803
HIV/STD Intervention project		542,495 (SIDA)		542,495
Total	306,200	542,495	2,417,603	3,266,298
1994-95				
- MOH&FW (NACO)	323,900		1,546,850	1,870,750
- MOH&FW (NACO Technical assistance)			600,000	600,000
- HIV/STD Intervention project		542,495 (SIDA)		542,495
- Tamil Nadu State		82,809 (SIDA)		82,809
- West Bengal State		142,671 (SIDA)		142,671
	323,900	767,975	2,146,850	3,238,725
C TOTAL	1,155,950	3,356,320	3,529,727	8,041,997