

Global Threat HIV/Aids: Burden, Trends And Hope

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ABSTRACT

In this present review work, we seek to provide the basic characteristics of HIV/AIDS, brief statistics of HIV/AIDS epidemic with respect to global level and Indian level and also with the description of controlling efforts against it. We also provided brief methodology of mathematical models of HIV/AIDS as hope for prevention strategies by shaping the disease burden and trends.

Keywords : HIV Transmissions; AIDS Pandemic; Global Threat.

1. INTRODUCTION

In the early 1980s, the first recognized cases of the acquired immune deficiency syndrome (AIDS) occurred among homosexual men in the United States. These men suddenly began to develop rare opportunistic infections and cancers that seemed stubbornly resistant to any treatment. At this time, AIDS did not yet have a name, but it quickly became obvious that all the men were suffering from a common syndrome. By 1983, the etiological agent, the human immunodeficiency (HIV), had been identified. By the mid-1980's, it became clear that the virus had spread largely unnoticed throughout most of the world. Since then the global AIDS epidemic has become one of the greatest threats to human health and development. At the same time, much has been learnt about the science of AIDS, as well as how to prevent and treat the disease.

2. IMMUNOLOGY OF HIV/AIDS

Once HIV has entered in the body, its major target is a class of lymphocytes, or white blood cells, known as $CD4^+T$ cells. Thus, the immune system initiates anti-HIV antibody and cytotoxic T cell production. However, it can take two to ten weeks for an individual exposed to HIV, to produce measurable quantities of

antibody. When the $CD4^+T$ cells count, which is normally around 1000 mm^{-3} , reaches 200 mm^{-3} or below in an HIV-infected patient; then that person is classified as having AIDS. Because of the central role of $CD4^+T$ cells in immune regulation, their depletion has widespread deleterious effects on the functioning of the immune system as a whole and leads to the immunodeficiency that characterizes AIDS. see Fig. no. (1).

Therefore, HIV levels in the bloodstream are typically highest when a person is first infected and again in the late stages of the illness. The progression of HIV infection to AIDS probably depends on how well the body can replace cells destroyed by HIV, Perelson *et al.*, [13].

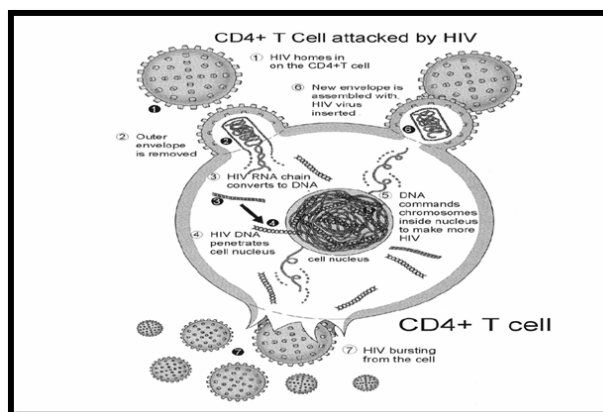


Fig.1. Immunology of HIV infection

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3. TRANSMISSION MODES OF HIV/AIDS

Epidemiological evidence shows that HIV virus is transmitted only through the intimate exchange of body fluids, such as blood, semen, vaginal secretion, and mother's milk, Dane et. al,[2]. Thus, HIV could be passed from an infected mother to her child (i.e., vertical infection) during pregnancy, birth or through infected breast milk. High-risk behaviors include unprotected sexual intercourse and intravenous drug use through sharing needles or syringes, *see Fig. no. (2)*.

Many people in the past have been infected with HIV through transfusions of infected blood or blood-clotting factors, before blood screening began in 1986. Therefore, this is no longer a significant risk in most parts of the world today, as blood donations are routinely tested for HIV.

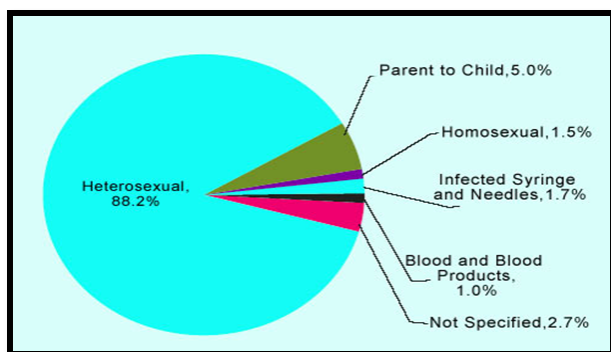


Fig. 2*. Routes of transmission of HIV in India 2011-12.

*Source: Avert statistics- 'Annual Report 2010-2011& NACO Fact Sheet-2012.

4. SPATIAL SPREAD OF HIV/AIDS

HIV is classified as an infectious disease which rapidly spreads amongst communities and changes its distributions in space, time and “social space”, Wallace,[18]. Many factors, including increased mobility, are associated with an increased risk of HIV infection, Welz et al.,[20]. The transmission of HIV is also strongly associated with the spatial distribution of high risk groups. The distribution of AIDS cases not only varies by cities and states, but also by

geographical regions, Lange *et al.*,[8]. The spread of HIV has been attributed to migration from rural to urban areas and its concomitant return migration. Furthermore, the trends in geographic diffusion could be explained by the mobility and travel patterns of high risk populations and their activities while travelling, McCoy et. al.,[9]. Fullilove *et al.*,[4] stated that our ability to predict the future of the HIV/AIDS epidemic will depend on our understanding of the movement of HIV virus from established epicenters to areas where the prevalence of risk behaviors may be high but the prevalence of HIV infection is currently low.

5. CURRENT GLOBAL OVERVIEW OF HIV/AIDS

Globally, 34.0 million [31.4 million–35.9 million] people were living with HIV due to inadequate access to HIV prevention and treatment services at the end of 2011. An estimated 0.8% of adults aged 15-49 years worldwide are living with HIV, although the burden of the epidemic continues to vary considerably between countries and regions, *see Fig. no. (3)*. throughout the duration of the pandemic, 1.7 million [1.5 million–1.9 million] people have already died from AIDS worldwide. Every day, over 7500 more people become infected with HIV, UNAIDS 2013, [16].

On a global level, the HIV pandemic remains the one of the most serious infectious disease challenges facing public health. This concern has been addressed and recognized within international forums and is represented as a primary concern within the Millennium Development Goals. The scope of HIV/AIDS is far-reaching. Although 34.0 million HIV infected individuals is a staggering figure, this number does not account for the additional millions who are also affected by HIV/AIDS. Whether they are AIDS widows, orphans, or relatives caring for the sick and dying, the impacts of are felt well beyond those who are infected. Furthermore, HIV/AIDS is an

international issue that is not concentrated to one region, gender, socio-economic background or profession. People in every region and in every country are affected, UNAIDS 2013, [16].

Africa remains most severely affected with nearly 1 in every 20 adults (4.9%) living with HIV and accounting for 69% of the people living with HIV worldwide. Although the regional prevalence of HIV infection is nearly 25 times higher in sub-Saharan Africa than in Asia where 5.2 million people are living with HIV in South, South-East and East Asia combined. This pandemic concentrated in sub-Saharan Africa with the largest numbers of people living with AIDS and the highest percentages of HIV infections per capita. Here the number of people acquiring HIV infection in 2011 (1.8 million [1.6 million–2.0 million]), UNAIDS 2013, [16], accounted for 71% of the adults and children newly infected in the year 2011, underscoring the importance of continuing and strengthening HIV prevention efforts in the regions.

After sub-Saharan Africa, the region's most heavily affected are the Caribbean, Eastern Europe and Central Asia, where 1.0% of adults were living with HIV in the year 2011, UNAIDS 2013, [16], *While not as high as in sub-Saharan Africa, HIV infections in Asia have increased by more than 100% since 1994, and some argue that Asia will become the next center of the global epidemic in the years to come.* Injecting drug use and the commercial sex industry have played a determining role in the spread of the disease in some places of Asia. But worldwide, Asian countries have been slow to respond to the epidemic. Studies have shown that within Asia, the current allocation of resources for HIV prevention is insufficient and have not targeted at risk groups, which serves as an epidemiological bridge for HIV transmission into the general population. *Roughly 5.2 million Asian adults were living with*

HIV/AIDS in the year 2011 along with 509,000 children. It is expected that if Asian countries fail to respond to the crisis, an estimated 8 million adults and children in the Asia-Pacific will become infected and the annual death toll due to AIDS will increase to 500,000 by the year 2020, UNAIDS 2013, [16].

In recent years, India, Nepal, Bangladesh, Pakistan, Indonesia and China have shown rapid increase of HIV prevalence due to unprotected paid sex, injecting drug use and to a lesser extent unprotected sex between men. These modes of transmission are further exacerbated by a highly mobile population and the challenges presented by natural disasters.

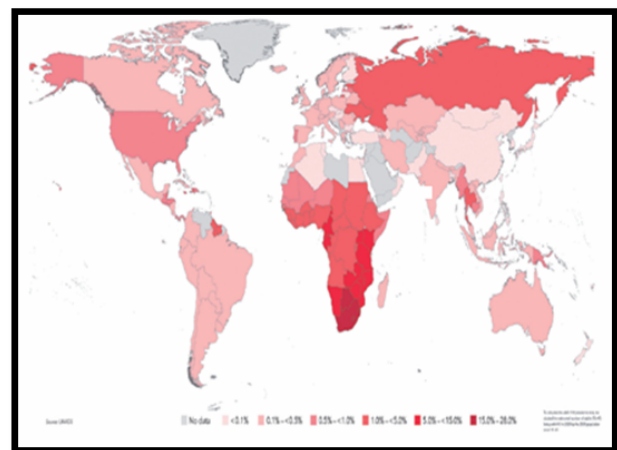


Fig. 3. Global HIV/AIDS prevalence (UNAIDS, 2013).

6. CURRENT INDIAN OVERVIEW OF HIV/AIDS

The first cases of HIV were diagnosed among sex workers in Chennai in 1986. Since then, the country has evolved from “low” to “concentrated” epidemic. Now days India is become a country with a large number of people living with HIV. According to the National Aids Control Organization (NACO), approximately 2.5 million with uncertainty bounds of 1.93 to 3.04 million people infected with HIV in the year 2009. However, given the size of Indian

population, this only represents a national prevalence rate of 0.36% and people living with HIV are estimated at approximately 61% male and 39% female. The percent distribution of HIV infection by age is estimated at 4.4% among children below the age of 15 years, 82.4% among adults aged 15 to 49 years and the remaining 13.2% among people over 50 years of age. As 39% of all HIV infection are estimated to be among women. This amounts to 0.93 million women with HIV in India, NACO 2012, [10].

The four high prevalence states of South India account for 57% of all HIV infections in the country. Whilst Andhra Pradesh accounts for 500,000 cases, Maharashtra accounts for 420,000 cases, Karnataka accounts for 250,000 cases and Tamil Nadu accounts for 150,000 cases. Over 100,000 People Live with HIV (PLHIVs) are estimated in West Bengal, Gujarat, Bihar and Uttar Pradesh and together these states account for 22% of HIV infections in India. The number of PLHIVs in Punjab, Orissa, Rajasthan and Madhya Pradesh range from 50,000 to 100,000 and these states collectively account for 12% of HIV infections and it is also estimated that approximately 9% of HIV infection implicitly presented in rest states of India. Approximately 172,000 people died of AIDS related causes in 2009 in India. At national level, HIV prevalence is highest amongst the Injecting Drug Users (IDU) at 12.22% followed by men who have sex with men (MSM) at 6.82% and Commercial sex workers (CSW) at 5.92%. HIV prevalence amongst IDU, MSM and CSW is 14.92%, 10.31% and 9.48% respectively, NACO 2012, [10]. So it is important to understand that HIV/AIDS is not of any one nation's problem but a global issue that requires global and national solutions. According to UNAIDS, it is imperative for countries to "know their epidemic" in order to develop and implement effective HIV prevention and treatment strategies which are appropriate according to the needs of the region, *see Fig. no. (4)*, UNAIDS 2013, [16].

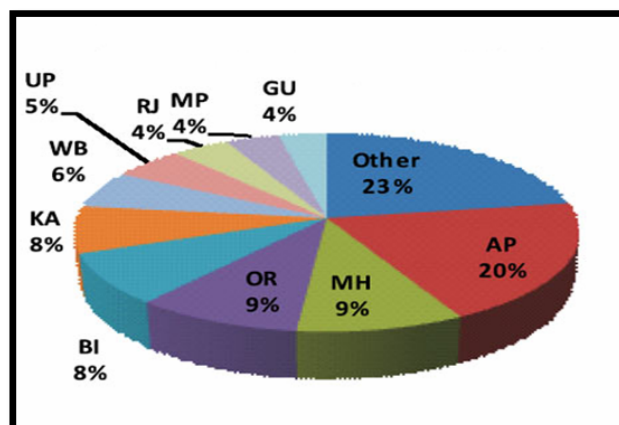


Fig.4*. State wise New HIV infections in India 2009

* Source: Avert statistics- 'Annual Report 2010-2011 & NACO Fact Sheet-2012.

7. CONTROLLING STRATEGIES OF HIV/AIDS

With the advance of this dangerous infection, the world has to involve in a frenetic search for ways to treat or cure or reduce the HIV infection. Over the last 25 years there has been enormous progress in the fight against HIV/AIDS that might suggest that there is hope for the future, Joint UN program on HIV/AIDS 2006, [6].

Further, HIV is a highly mutable virus, so the risk of new multi resistant strains emerging is always present, Joint UN program on HIV/AIDS 2006, [6]. Therefore, efforts to prevent the spread of HIV are still very important. However, there are many issues that make it especially difficult to implement effective prevention programmes that reduce the prevalence of HIV infection in the population. Among these issues, the main difficulties are in reaching a significant portion of the population with programmes for education about the infection and its transmission, the structure/cost of prevention programmes, compliance of the population and the fact that HIV infection is primarily a sexually transmitted infection, thus prevention strategies have to address many delicate issues of sexuality, intimacy and privacy, (UNAIDS 2006, (Joint UN program on HIV/AIDS 2006, [6] and Joint UN program on HIV/AIDS; Facts Sheet 2006, [7]).

It is important to study the trends in the dynamics and patterns of distribution of HIV/AIDS epidemic. To effectively create and implement strategies of prevention it is necessary to focus on the driving forces of the epidemic and the impact of various epidemic parameters on the distribution of the pathogen in the population.

8. TREATMENT AND MEDICATION EFFORTS OF HIV/AIDS

HIV is isolated and recognized as the pathogen responsible for AIDS in the year 1983. A cure or vaccine is not yet available and treatments to combat the opportunistic infections caused by the immune deficiency were very few, (Overview HIV/AIDS 2005{NIAD},[11]).

In 1987, the first treatment emerged. The drug was called *Anti Zidovudine Therapy (AZT)*, a reverse transcriptase inhibitor. By 1992, combinations of drugs were introduced to improve treatment, called *Anti-Retroviral Therapy (ART)*. It has been a great stepping stone to allowing people living with HIV/AIDS to lead normal and healthy lives. This “triple cocktail” (three medications taken at the same time) is composed of chemicals that suppress a person’s viral load to undetectable levels, *see Fig. no. (5-7)*, Orrell *et al.*,[12].



Fig.5. Number of People Receiving Antiretroviral Therapy in Low-in Middle-Income Countries, by WHO Region,2012 (UNAIDS ,2013).

These medications are to be taken every day for the rest of the patient’s life and sometimes have debilitating side effects, including nausea, dizziness, pain, and inability to perform everyday functions, Powers *et al.*,[14]. The issues of drug resistance with ART therapy frequently arise for patients who do not take their medication consistently. Since the virus multiplies in the body so rapidly, thousands of genetic variants are created every minute, and when drugs are taken inconsistently, there is a higher chance of drug resistance developing, Vernazza *et al.*,[17].

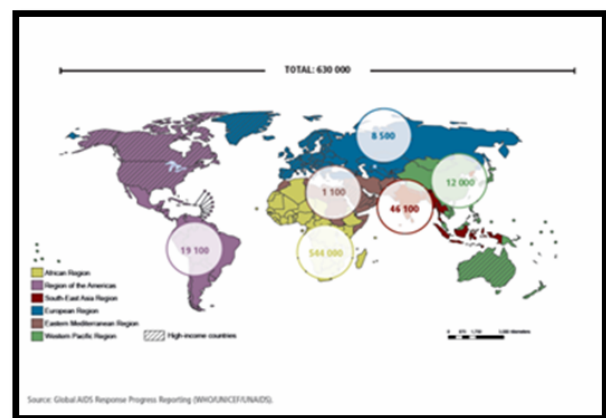


Fig.6. Number of Children (0-14 years old) Receiving Antiretroviral Therapy in Low-in Middle-Income Countries, by WHO Region, 2012 (UNAIDS, 2013).

In 1996, evidence of the efficacy of a new treatment, called *Highly Active Anti Retroviral Therapy (HAART)* was presented for the first time at the 11th International AIDS Conference in Vancouver, (Joint UN program on HIV/AIDS; Facts Sheet 2006, [7]). Since to now days, HAART is used to slow the progression of HIV infection and it postponed death from AIDS of individuals which result an increase in the life expectancy and quality of life of those diagnosed with HIV infection, (Overview HIV/AIDS 2005{NIAD},[11]). HAART is credited as a major factor in significantly reducing annual deaths by AIDS in the world. By the end of 2012, 9.7 million people in low- income and middle-income countries have received access to HAART, UNAIDS: Global Update 2012,[15].

Although, HAART has clear benefits but it also has its shortcomings and risks. HAART can increase only life expectancy and health prospects in HIV infected individuals, this medication does not provide a cure for the infection at any stage. HAART only control viral load and cannot eliminate the virus from the body, (Overview HIV/AIDS 2005{NIAD},[11] and Zhang *et al.*,[21]). This means that HIV can still be transmitted. These therapies have a strict schedule and adherence is difficult, (Joint UN program on HIV/AIDS; Facts Sheet 2006, [7]). So, these existing therapies and other factors influence the need for continued efforts toward treatment/medication to reduce further spread of the HIV infection.

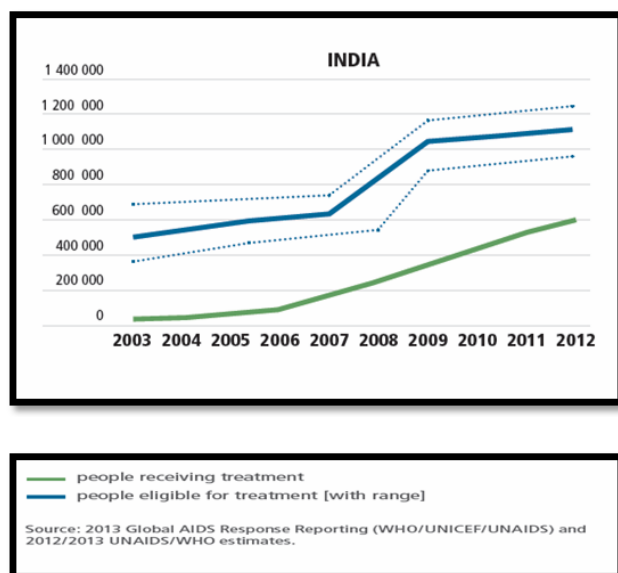


Fig.7. Number of People Eligible for and Receiving Antiretroviral Therapy in India, 2003-2012.

9. MATHEMATICAL MODELS OF HIV/AIDS; A HOPE

HIV transmission models aim to describe the dynamics of the spread of the disease by a system of equations in which the transition rates between defined states are specified quantitatively, De anglis *et al.*,[3]. These models are complex and incorporate biological and behavioural variables, which describe HIV transmission and its natural history to simulate the

infection process. Therefore they could be used to reliably project HIV infection rates and AIDS cases if the model is shown to be valid and the data sets used are accurate, Chin J *et al.*,[1].

This approach to modeling HIV/AIDS uses HIV transmission dynamics models which include the progression to AIDS and often have the population divided into compartments consisting of those who are susceptible, in each of the infection stages or in the AIDS phase. In transmission models, the movement between these compartments by becoming infected, progressing to the next stage or AIDS, migrating or dying is specified by systems of difference or differential equations, Hethcote *et al.*,[5].

The equations used in deterministic models are derived by taking into account the biological and the epidemiological as well as the clinical aspects of the HIV epidemics. By analyzing these equations, one may then study the behaviour and progression of the HIV epidemics as time progresses, Wan-Yunan *et al.*,[19].

Epidemiologists find it more convenient to use deterministic (usually compartment) models in which individuals are categorized into different disease progress stages (sub-groups or compartments). In HIV/AIDS, for instance, individuals are classified into (without complicated thought) three compartments designated as susceptible, infectious and recovered/immunized (SIR) which in the case of HIV is the group of individuals identified as HIV positive or those developing AIDS and also may be defined as the study desire at a given time, Wan-Yunan *et al.*,[19].

Another very important reason for HIV modeling is the value of models for theoretical evaluation and comparisons of detection, prevention, therapy, and control programs. Epidemiologists (planners) and politicians need to understand the effects of different policies decisions on the dynamics of a particular

infection in order to decide which approach is the most ethical, appropriate and economical, Hethcote *et al.*, [5].

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