สำนักงานวิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

Chapter III

Studies on HIV/AIDS Issues

3.1 What is HIV/AIDS?

AIDS is a fatal illness caused by a retrovirus known as human immunodeficiency virus (HIV) which breaks down the body's immune system, leaving the victim vulnerable to a host of life-threatening opportunistic infections, neurological disorders or unusual cancers. Among the special features of HIV infection is that once infected, it is probable that a person will be infected for life. Strictly speaking, AIDS refers only to the last, fatal stage of HIV infection, which is also known as "full-blown AIDS". At present, there is no cure for AIDS although treatment can relieve distress from opportunistic infections, and no vaccine is available to protect against it. One or two new drugs slow down the rate of progress from HIV infection to serious illness, but they are very expensive and have toxic side effects.

AIDS was first reported in 1981 in Los Angeles, United states of America and subsequently in Western Europe. Retrospective studies indicate that the first case in United states may have occurred as early as 1978. It was later in 1985 that the causal agent, HIV was successfully isolated and the test for this virus was subsequently developed.

After more than a decade of intensive studies of the HIV epidemic, it is known that the means of transmission are few and very specific. They include only three routes of transmission (Acheson, 1989).

- By penetrative sexual intercourse with an HIV infected person, Receptive anal intercourse and inflammatory genital disease increase the risk of transmission.

- By inoculation of infected blood and blood products: In practice, this is principally through the transfusion of contaminated blood and blood components and the sharing of infected equipment amongst drug users. Medical injections using unsterile equipment and other skin piercing practices (e.g. tattooing, acupuncture) are also potential means of transmission.

- By spread from an infected mother to the unborn fetus, to the baby as it is delivered, or during breast feeding: Up to 50% of the babies born to infected mothers may be infected, and carry a poor prognosis.

The virus is not transmitted by social contact, food or water, insect bites, or toilet seats, or by workplace contact except rarely in health care settings. (There is no evidence for HIV spread through close inter-personal contact of a non-sexual nature or by food, water, air or insect vectors.)

According to the report of UNDP (1992) AIDS is one of the most serious threats to human health and life ever faced because:

- The major mode of HIV transmission is sexual, and the urge for physical intimacy is fundamental in all human beings.
- An important means of transmission is from mother to unborn child, in the womb. AIDS therefore presents a major threat to bearing healthy children.
- The period between HIV infection and onset of illness can last several years. A person with no knowledge of being infected can infect others unwittingly.
- There is no cure. Prevention is dependent on following a self-protective behavioral code, and one which protects others.
- Human capacity for denial is so great that the adoption of self-protective behavior tends to become widespread only when deaths from AIDS are close to home, by which time many people have already been infected.

Since HIV/AIDS has become a serious problem nowadays, quite a number of studies including economic studies have been conducted all over the world. In order to calculate and project the cost of HIV/AIDS, it is necessary to know the epidemiology and the natural history of HIV infection, projection of HIV/AIDS cases and different costing methodologies for the treatment and prevention of this disease, which will be described in detail in the following sections.

3.2 Natural History and Epidemiology of HIV/AIDS

Epidemiology is the study of the incidence and spread of a disease, both internationally and within communities. Understanding how AIDS spreads is important in order to predict where it will occur next, and to identify where education and preventive measures would be most

effective. So far, the HIV virus seems to have followed three distinct epidemiological patterns (The Panos Institute, 1989).

Pattern I (homosexual, IDU, others): introduced or began to spread extensively in mid-1970s or early 1980s; found predominantly in homosexual population with limited heterosexual transmission. IDUs account for the second largest proportion of HIV infection. Transmission via contaminated blood products is not a continuing problem, perinatal transmission to newborn babies is found primarily among female IDUs, sex partners of IDUs, and women originally from countries where heterosexual spread is common. Infection is distributed in Western Europe, North America, some areas in South America, Australia and New Zealand.

Pattern II (heterosexual, transfusion, others): introduced or began to spread extensively in early to late 1970s; found predominantly in heterosexual populations. Homosexual transmission is not a major factor. Transfusion of contaminated blood is a major public health problem. Perinatal transmission is a significant problem in areas where 5-15 % of women are seropositive. Infection is distributed in Africa, Caribbean, and some areas of South America.

Pattern III (mixed): introduced in early to mid 1980s with spread among persons with multiple sex partners. Both homosexual and heterosexual transmission has been documented with a current very low prevalence of HIV infection even in persons with multiple sex partners, such as CSWs. In some areas, IDU transmission has been recorded. Transmission from contaminated blood is not a significant problem at present, though some infections have occurred in recipients of imported blood or blood products. Perinatal transmission is currently not a problem. Infection distributed in Asia, the Pacific region (except Australia and New Zealand) , the Middle East, Eastern Europe, some rural areas of South America.

Two serotypes of HIV are recognized, HIV-1 and HIV-2. Worldwide, the predominant virus is HIV-1. Their modes of transmission are similar, and AIDS cases resulting from HIV-1 or HIV-2 infections appear to be clinically indistinguishable. Studies to date indicate that about 60 % of adults infected with HIV-1 will develop AIDS within 12-13 years of infection. Less is known about the natural history of HIV-2 infections; the evidence to date suggests a rate of progression of HIV 2 infection to AIDS is considerably slower than that of HIV-1 infection. No

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major differences have so far been found in the rate of progression with HIV-1 to AIDS among middle-aged adults by geographical area, sex or race. In infants born infected with HIV-1, the progression to AIDS is more rapid than in adults.

Virtually all persons diagnosed as having AIDS die within a few years. Survival after diagnosis has been increasing in industrialized countries from an average of less than 1 year to about 1-2 years at present. However, survival time with in developing countries remains short - an estimated 6 months or less. Longer survival appears to be directly related to routine use of antiviral drugs, the use of prophylactic drugs for some opportunistic infections, and to a better overall quality of health care.

3.2.1 Clinical Stages of HIV/AIDS

HIV infection may be divided into five different stages (DOH, 1992) as:

(a) Acute phase
(b) Asymptomatic stage
(c) Persistent Generalized Lymphadenopathy (PGL)
(d) AIDS - Related Complex (ARC)
(e) (Full Blown) AIDS

(a) **Acute phase**:- It may occur as early as a week after infection. Clinical manifestations are fever, lymphadenopathy, night sweats, skin rashes, headache and cough, resembling signs and symptoms similar that those of infectious mononucleosis. Seroconversion usually develops 6-12 weeks after infection but may take longer.

(b) **Asymptomatic stage**:- There are no clinical signs and symptoms except HIV seropositivity. The patient is apparently healthy in this stage.

(c) **PGL**:- This stage is characterized by enlarged lymph nodes, greater than 1 cm in diameter invading two or three extrainguinal sites and lasting for at least three months, in the absence of any current illness known to cause lymphadenopathy.

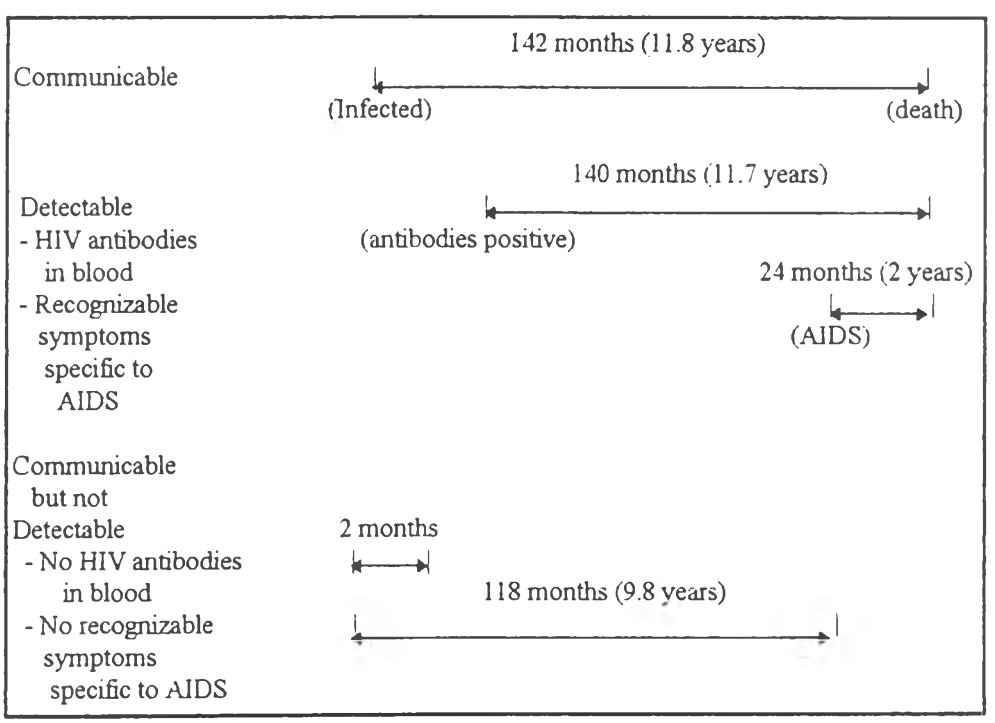
(d) **ARC**:- This stage is characterized by diarrhea, weight loss, malaise, fatigue, and lethargy, anorexia, abdominal discomfort, fever, night sweats, headache, lymphadenopathy, splenomegaly, neurological changes leading to loss of memory and peripheral neuropathy, oral thrush, hairy leukoplakia and herpes zoster.

(e) **AIDS**:- The period between HIV infection and the onset of AIDS symptoms may range from six months to 8 or 10 years or more. AIDS represents the severe end-stage of the clinical spectrum of HIV infection. It is characterized by the presence of opportunistic infections and tumors. AIDS is usually fatal, recovery from it has never been documented.

3.2.2 Natural History of HIV/AIDS

The knowledge of natural history of any infection is very important for the prevention and control of that disease. It is also very true in HIV/AIDS. For example, sero-conversion can only be detected 6 to 12 weeks after an individual has been infected with HIV. That period is called "Window Period". During this period, as HIV anti-bodies cannot be detected, HIV antigen test should be performed in screening tests, especially in blood donors. Absence of any signs and symptoms of ARC/AIDS does not mean that it is not communicable. In fact, once he or she has been infected he or she will be able to infect any other person. Natural history of HIV/AIDS is depicted in Figure 3.1.

Figure: 3.1
Natural History of HIV/AIDS



Source: UCLA Department of Epidemiology, Los Angeles, California, USA

3.3 Forecasting HIV/AIDS Epidemic

Since the early 1980s, when AIDS was first recognized, there has been uncertainty about the future trends and ultimate dimensions of this pandemic. Uncertainty persists because of the difficulties in measuring, with any substantial of degree of precision, the prevalence and more particularly the incidence of AIDS cases and HIV infections in any given population. As a result, many HIV/AIDS models have been developed in an attempt to: (1) understand the dynamics and interrelations of the major determinants of HIV transmissions; and/or (2) develop reliable estimates and projections of HIV/AIDS. Forecasting models have 3 main purposes: (a) to warn decision makers; (b) to check the effectiveness of intervention; and (c) to help health planning.

Many types of HIV/AIDS models have been developed over the past decade. Major components of all models include: (1) the assumptions and input parameters used; (2) the value of range of values used for the input parameters; and (3) mathematical inter-relationships between the parameters used in the model.

Because AIDS is the last stage of HIV infection, which according to studies in developed countries can take 10 years or more to develop in HIV infected adults, the current number of adult AIDS cases reflects the number of HIV infections 10 years ago. For a realistic picture of the pandemic today, one must look not at the number of AIDS cases but at the number of people infected with HIV.

A comprehensive country package for managing HIV sentinel surveillance data and for using such data in forecasting the number of people with AIDS has been developed by Global Program on AIDS (GPA). This package includes three computer programs: Epi-info (data base and data analysis), Epi-map (graphic display of data on maps), Epi-model (short-term AIDS projection) and a country-specific data base which is regularly updated nationally (WHO, 1991). Since 1988, WHO GPA has provided technical support and training for the development of HIV sentinel surveillance in over 100 nations AIDS programs worldwide. Many countries now use WHO methodology to assess HIV seroprevalence among population groups such as pregnant women attending antenatal clinics or men and women attending STD clinics.

The AIDS short-term projection model (Epimodel) developed by WHO is then used to obtain global and regional estimates and forecasts of AIDS cases. In this model, the latest available estimate of point prevalence of HIV infection is extrapolated back to the estimated start of extensive spread of HIV in each region, to derive an annual regional incidence of HIV infection. The model assumes that the HIV epidemic will follow the same pattern of development over the coming 5 years as it had in the past.

3.3.1 Methods of Projecting HIV/AIDS

Since the mid-1980s, numerous HIV/AIDS models have been developed for projecting the future course of the HIV/AIDS epidemics in different areas and populations. Most of these deterministic or simulation models require, to varying degrees, extensive data sets on virtually all of the demographic, biological, and behavioral variables considered to be important in the epidemiology and natural history of HIV infections. The validity of any of these models can be seriously challenged, and at present, there are no criteria to select among these different models (Chin, 1993). There are many methods in these different models and the following methods are some of them. Based on these methods, Epimodel has been developed and used for the projection of HIV/AIDS cases.

(A) According to James Chin's (1993) report for estimation and projection of HIV/AIDS in South-East Asia, there are two methods or approaches for projection of HIV/AIDS cases.

(a) The Delphi Method

This method obtains educated guesses from selected "experts" in a reiterative fashion and then the average and range of the Delphi responses are presented. In 1988, WHO used a "Delphi" survey to project HIV prevalence to the year 2000. In mid-1992, a working group (AIDS in the world - AIW) at Harvard, using similar data and methods as WHO, estimated and projected the numbers of HIV infections which may occur globally by the year 2000. Table 3.1 shows the WHO and AIW projections of cumulative adult HIV infections to the year 2000 for the major regions of the world. The low AIW Delphi projections are very close to the conservative projections of WHO, but the high AIW Delphi projections are 3-4 times higher than both of the WHO projections and the low AIW Delphi projections. For the South-East Asia Region, WHO

and the low AIW Delphi projections are about 10 to 11 million, but the high AIW Delphi projection is about 45 million.

Table 3.1: Cumulative Adult HIV Projections to the Year 2000 (in Million)

Area	WHO	Low AIW Delphi	High AIW Delphi
North America	1.63	1.81	8.15
Sub-Saharan Africa	15.00	20.78	33.61
Western Europe	0.85	1.19	2.33
South-East Asia	10.25	11.28	45.06
Latin America and Canada	2.37	2.14	15.51
Total	30.10	37.20	104.66

Source : Chin, 1993

(b) The Scenario/Modeling Approach

Since the validity of any HIV/AIDS model can be seriously challenged, and the Delphi method can yield markedly different estimates and projections based on the selection of Delphi participants, a scenario/modeling approach was developed to provide conservative estimations and projections based on the available HIV and their observed trends. This approach can be summarized as follows:

(i) The "best" estimates of the patterns, prevalence, and trends of HIV infections in specific population groups are first derived from analysis of the available data.

(ii) Based on these data and observations, different prevalence levels of HIV infection (i.e., scenarios) can be projected to the year 2000 or beyond. An optimistic scenario (i.e. conservative projection) can be initially constructed for modeling purposes.

(iii) Epimodel, a simple, computerized model can be used to estimate and project AIDS cases and deaths based on the constructed HIV scenario.

Using the scenario/modeling approach, the numbers of adult AIDS and the potential numbers of HIV infected infants and AIDS orphans can be calculated.

(B) Recognizing the serious nature of the HIV/AIDS epidemic, Thailand has implemented the most extensive national HIV surveillance in the world. There are two major components in this surveillance , each conducted twice a year: one is the sentinel seroprevalence survey conducted by the Epidemiology Division of the Ministry of Public Health and another is the regular testing of military conscripts undertaken by the Royal Thai Army. These data have been supplemented by studies of sexual behavior which have been conducted nationwide, including the survey of Partner Relations and Risk of HIV infection in Thailand conducted by the Thai Red Cross Society and Chulalongkorn University in 1990, and the Media Effectiveness Survey conducted by Mahidol University in 1993 (National Economic and Social Development Board, NESDB 1994).

This wealth of data makes modeling of the Thai HIV/AIDS epidemic both a realistic possibility and a challenge: a realistic possibility because sufficient data exists on historical changes in HIV infections and behavior upon which to base models, but a challenge because any credible model must reproduce the trends seen in these data. Models for the HIV/AIDS epidemic take two fundamental forms: i.e. curve fitting models, and process models. In a curve fitting model, past levels of HIV and/or AIDS are fit by a function which has worked well in approximating epidemic growth in other settings. An example of curve fitting model is Epimodel. Process models attempt to simulate the processes which transmit HIV infection: sexual intercourse, passage of the virus from mother to child, receipt of infected blood products. or sharing of needles.

Both types of models have advantages and disadvantages. For short term projections of AIDS cases, curve fitting models can be quite accurate. They require less data than process models, e.g. in the simplest application of Epimodel one needs only estimate the current number of HIV infections and determine in what year the number of new infections peaked. However, since they do not only fitting the existing data of a curve, they do not allow one to explore the impacts of changes in the underlying behaviors transmitting HIV, e.g. what happens if condom use increases or STD levels drop. A further limitation of curve fitting models is that they generally calculate only the total number of HIV infections or AIDS cases and deaths, not the age structure of the infections. Process models, on the other hand, require much more data as inputs. For each of the behaviors transmitting HIV, one must supply information about the age distribution and frequency of these behaviors over time. However,

this disadvantage is offset by an increased ability to directly explore the impacts on future levels of HIV of changing one or more of these behaviors.

For the projections of HIV/AIDS in Thailand for 1987-2020, NESDB developed a model which combined the two approaches. The model has three components. The first component is a simple process model to calculate the number of new infections (incidence) occurring in each year. This permits the effects of changing condom use, STD levels, and the size of risk populations to be estimated and incorporated into the projections. The second component is Epimodel. Once the number of new infections in each year is calculated, they are entered into Epimodel which is used to calculate current HIV infections (prevalence), cumulative HIV infections, and cumulative AIDS cases and deaths. The third component calculates the age structure of AIDS deaths from the age distribution of HIV infections based on observed STD data. This component is needed to incorporate the impacts of HIV into population projections.

3.3.2 Forecasting Models

There are many forecasting (predicting) models. In projecting the number of HIV/AIDS, many models could be used. Some of the models were developed in the late 1980s and some in the early 1990s, and some new models are still being processed.

(1) Epimodel

Epimodel is a simple microcomputer program for short term (less than 5 years) projections of AIDS cases. It is an extrapolation model that can be used for predicting AIDS cases and deaths once a given infection level has been determined. The basic methodology of this model was developed during the late 1980s by James Chin, Chief of the Surveillance, Forecasting and Impact Assessment unit of the WHO, (GPA), in collaboration with Stephen K. Lwanga, Statistician, Epidemiological and statistical Methodology Unit of the Division of Epidemiological Surveillance and Health Situation Trend Assessment, WHO. In 1987, it was a simple spreadsheet. In 1988, Eric Brenner wrote an Epimodel program in Dbase. In 1989, Jeff Dean wrote version 1 and he prepared the refined and upgraded version 2 in late 1993 and version 2.1 in early 1995 (Chin, 1995).

A simple scenario/modeling approach for estimation and projection of HIV infections and AIDS cases was developed at the WHO during the late 1980s. This approach or method can be used in individual countries and for selected populations within countries to provide working estimates and short-term projections of HIV-related morbidity and mortality for policy development and public health planning. Epimodel, Type 2, is one of the methods used in the scenario/modeling approach and it can be used to derive annual and cumulative estimates and projections of AIDS cases and deaths based on the general HIV scenarios constructed.

Epimodel can be classified into 3 types that range from the simplest to the most complex.

Type 1 models use reported AIDS case data to make short terms (2-3 years) projections of AIDS cases, and should be used only for populations for which AIDS case reporting is relatively timely, reliable and complete. Such short-term projections have been made by statistical extrapolation and regression techniques.

Type 2 models use data on estimated HIV infections as well as progression rates from infection to AIDS to calculate the number of past AIDS cases and to provide short-term (3-5 years) projections of AIDS cases. It is developed for use in areas where AIDS case reporting is known to be largely incomplete and unreliable. A variation of this approach is the "back calculation" method that uses AIDS case reports with annual progression rates from infection to AIDS to estimate the number of annual HIV infections that have occurred.

Type 3 models are more complex and incorporate biological and behavioral variables that describe the transmission and natural history of HIV infection to simulate the entire disease process. Many mathematically sophisticated Type 3 models have been to develop to project the future course of HIV/AIDS epidemics in different areas and populations. These models include many other models which require extensive data sets on nearly all of the demographic, biologic and behavioral variables considered to be important in the epidemiology and natural history of HIV infection. The major problem with these models, besides their complexity, is that most of the precise, detailed data sets they require to make projections are not available, even in those countries with the best data collecting systems. The greatest value may be to test hypotheses and to help in understanding the dynamic interrelationships

between important biological and behavioral variables rather than for estimation and projection of HIV/AIDS.

Assumptions Used in Epimodel

Epimodel uses epidemiologically derived estimates of the HIV epidemic curve along with progression rates from HIV infection to AIDS.

The basic assumptions used in Epimodel are that:

(1) Annual HIV incidence is distributed along an epidemic curve that approximates a gamma distribution.

(2) Annual progression rates from HIV infection to AIDS, derived from cohort studies of white males, can be applied to other populations.

(3) Within any population group, cumulative HIV infections ultimately follow a sigmoid curve. Such a curve is characteristic of a single source epidemic with person to person transmission.

(4) The distribution of HIV infection over time in any population will be skewed with a long right tail.

(5) Of the numerous curves which could satisfy these assumptions, a simple Gamma function: $t^{(p-1)}e^{-t}/(p-1)!$ to describe the HIV incidence at time 't'. Parameter 'p' defines the steepness of the HIV epidemic curve. A value of p = 5 is used since this Gamma distribution for HIV infections provided the best empirical 'fit' to the reported AIDS cases curves in countries with reliable case reporting systems. Epimodel provides Gamma curves from p = 3, up to p = 20.

(6) For the purpose of Epimodel, extensive spread is defined as when about 1 % or more of selected population sub-groups with high HIV-risk behaviors were infected with HIV.

(7) Thus in the absence of specific data to indicate otherwise, 1980+2 years can be used as the most likely starting point for extensive spread of HIV infections in North America, Sub-Saharan Africa, and Western European countries. For South and South-East Asian countries, extensive spread of HIV infection was not documented until 1988.

(8) The annual default progression rates used in Epimodel up to year 15 were extrapolated from published cohort studies. After 10 years, progression to AIDS in Epimodel is continued at the rate of 4% annually so that about 70% of an initial cohort progress to AIDS within 15 years: the model assumes that the rate will remain stable so that about 90% of infected adults will develop AIDS within 20 years. The default progression rates used in Epimodel assume that the median progression is 10 years. However, the progression rates with medians of 6, 8, and 12 years are also available for use in Epimodel.

Variables Required in Epimodel

The followings are the variables required for Epimodel program:

1. The year widespread HIV spread began;
2. HIV point prevalence;
3. The year HIV prevalence was estimated (the reference year);
4. Annual HIV-infected cohorts;
5. Progression rates from HIV infection to AIDS; and
6. Annual AIDS cases in terms of time, place and person.

From these variables, the point- prevalence or reference year is assumed to be of greatest annual incidence. The effects of stopping or continuing HIV transmission beyond the year of peak incidence can make one scenario and shifting the point-prevalence year (reference year) to earlier or later points on the HIV epidemic or incidence curve can make another scenario.

Advantages of Epimodel

1. Epimodel is a simple model that can provide AIDS control programs with reasonable insight into likely trends and numbers of AIDS cases over the short-term (3 to 5 years). Short-term projections of AIDS cases are not greatly affected by stopping or continuing HIV transmission after a specific year since 80% to 90% of AIDS cases that will be occurring 3 to 5 years after the reference year will be in the persons who were already infected as of the reference year.

2. Projections of AIDS cases for periods longer than 3 to 5 years can be produced by Epimodel by assuming that annual HIV infection beyond the reference year will continue along the gamma curve selected for use in Epimodel.

3. It can, with the additional input of a population denominator, calculate annual incidence and prevalence rates for HIV infection.

4. Other modules of Epimodel include a child module that estimates and projects annual numbers of HIV-infected and uninfected infants born to HIV infected women.

5. Detailed costs such as medical care (hospital, drugs, laboratory etc.) can be estimated and projected.

6. In 1995, a new TB module was added to estimate and project HIV-related TB cases.

Disadvantages (Limitations) of Epimodel

1. Epimodel was not designed to provide projections of HIV infection.

2. The greatest error could occur in estimating HIV point prevalence.

3. Annual progression rates from HIV infection to AIDS are also possible sources of error.

4. Epimodel was not designed to project AIDS cases for periods longer than 3 to 5 years.

5. It offers no additional insights about the epidemiological features to predict consequences of behavioral and social changes.

6. It is difficult to use in countries where extensive spread of HIV has not been noted.

Estimates of AIDS cases (for 1993) and projections of AIDS (for the year 2000), are based on Epimodel for many countries. The following table shows the estimated and projected HIV/AIDS cases in selected countries in Asia and the Pacific by using Epimodel.

Table 3.2 : Cumulative Numbers of HIV Infected Individuals and AIDS Cases in Selected Countries in Asia and the Pacific (in thousands)

Country	HIV (reported)	AIDS (reported)	HIV (estimated)	AIDS (estimated)	HIV (by 2000)	AIDS (by 2000)	Seroprevalence (per 100,000)
Thailand	34.5	2.5	550-700	25	3900-5000	550	1080
Myanmar	5.2	0.05	150-400	6	1900	260	630
India	12.5	0.44	1,000-2,500	23	5000-7000	900	200
Australia	16.8	3.7	20	3	44	14	105
Singapore	0.2	0.06	2	0.1	14	2	70
HongKong	0.4	0.08	2-5	0.2	14-35	4	60
Srilanka	0.1	0.03	4-10	0.2	24-69	6	40
Philippines	0.4	0.09	5-30	0.4	35-210	17	30
Japan	2.7	0.01	5	0.1	n.a.	n.a.	30
Indonesia	0.15	0.04	20-25	0.5	140-170	21	12
Korea, Rep.	0.3	0.01	2-3	0.06	14-21	2	6
China	1.1	0.01	5-11	0.2	35-75	8	3. 1

Source : Bloom's Lecture at Health Economics Forum, Chulalongkorn University , 1994

(2) SIMULAIDS

A separate model, SIMULAIDS, is a software program for microcomputers and is based on a mathematical model utilizing the Monte-Carlo method (User's Manual, SIMULAIDS 1993). The main characteristics of this program are as follows:

(a) It allows to simulate, for a population, the spread of an epidemic due to a HIV and more specifically, to simulate the AIDS.

(b) It provides a method to determine the theoretic efficiency of interventions destined to fight the spread of the epidemic.

(c) It applies to populations where there is both heterosexual and homosexual transmission of the disease.

(d) It can be adapted to different situations by the utilization of more than 250 parameters: such as:

- demographic parameters;
- epidemiological parameters;
- physio-pathological parameters of HIV infection;
- factors affecting HIV transmission;
- sexual parameters;
- non-sexual factors of risk such as blood transfusion;
- utilization of condoms;
- vaccinations etc.;

The results of each simulation can be studied either numerically or graphically (with more than 300 variables).

Advantages of SIMULAIDS

1. It helps in understanding the dynamic interrelationships between epidemiological, behavioral and demographic variables.

2. It can simulate the age, sex and other specific prevalence and incidence of HIV/AIDS and their relationship with other factors such as condom use, blood transfusion, intra-venous drug use, STDs etc.

Disadvantages of SIMULAIDS

1. Most of the precise, detailed data sets required to make projections are not available, even in those countries with the best data collection systems.

2. It may require other studies to get the necessary data but this will take too much time.

3.4 Costing Methodology

3.4.1 Definition of Cost

Cost is defined as the value of resources used to produce something, including a specific health service or a set of services (as in a program) which may be expressed as a monetary or non-monetary value. The accounting cost of goods or services may be defined as the monetary value of actual expenditure for the acquisition of these goods or services. (Creese and Parker, 1994)

Different studies covered different aspects of costs depending on the interest and other reasons. In every day usage cost is expenditure on goods and services. To an accountant costs may be sub-divided into capital and operating costs. Capital costs may be depreciated over a period of years i.e. the value of the capital item shown in a balance sheet decreases each year. In economic terms cost may include expenditure on the activity (accounting costs) together with revenue forgone or opportunity cost (the highest valued opportunity necessarily forsaken). It is evident that the cost of an activity will depend upon the system of costing used (Kaewsonthi et al., 1983).

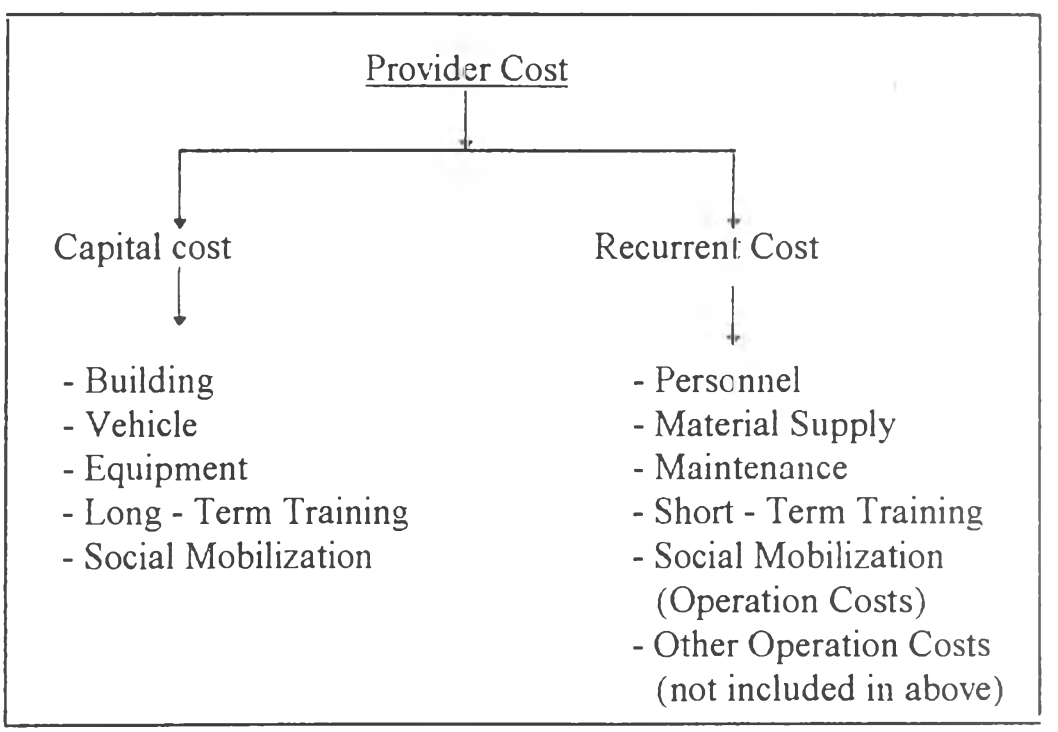
Accounting cost is expenditure, in a particular time period, on inputs i.e. labor, and capital equipment. If the capital equipment can be used for several years the expenditure on the capital equipment at a particular time is shared among the years in which the equipment can be used. Opportunity cost is revenue forgone through using resources for one purpose rather than another. Economic cost is the summation of accounting and opportunity costs.

Costs are often usually thought of in terms of money paid for resources used. Analyses using economic costs do not replace studies done with financial costs, but supplement financial cost analysis with additional information useful for decision makers. The concept of opportunity cost or economic cost has application beyond valuing resources not paid for. It cannot be assumed that the price paid for the resources used in the program always reflects the true value of these resources to society. Costing is never complete or perfect when it is dealed with prices that have been distorted through taxes, subsidies or other factors (Creese and Parker, 1994).

3.4.2 Classification of Cost

The classification of costs by inputs involves a manageable number of categories, and these categories are general enough that they can be applied to any health program (Creese and Parker, 1994). This classification distinguishes two categories of resources (inputs): the distinction between the two categories is based on life expectancy. Those that are used up in the course of a year and usually purchased regularly are recurrent costs and they include such items as personnel salaries, medicine and supplies, gasoline, electricity, drugs, and food. Those that last longer than one year, such as buildings, vehicles, and equipment are capital costs (see Figure 3.2).

Figure: 3.2
Classification of Costs by Inputs



Capital or non-recurrent inputs have special nature. With economic cost, it will usually be concerned with the cost of resources used over a specific period (say, one year) and not just when they were purchased. For recurrent cost, resources purchased and resources used in a given year are likely to be very similar. However, capital items are by their nature bought in one year and used for several more.

For the cost calculation, all the resources that are inputs into the health care process are considered as cost components and the quantities of them are counted in order to make monetary values. Capital goods are defined as inputs that last for more than one year. Although they last for a long time, these types of capital goods suffer continual wear and tear. As a result of this wear and tear, their useful life or working life is finite and it must then be renewed. Working life of the capital goods will vary considerably, depending on type, terrain, use and maintenance. It is therefore necessary to determine the rate at which this wear and tear occurs annually, i.e. the rate of depreciation or amortization, in order to know how much needs to be set aside annually to be able to ensure renewal. It can be ascertained by asking individuals who operate it how long this type of capital good generally lasts before it is beyond repair.

If a particular input is used only for the prevention and treatment of HIV/AIDS patients, then the entire cost of it can be assigned to calculate. However, people, buildings, vehicles, equipment and supplies have multiple uses, only some of them may be used for the prevention and treatment of HIV/AIDS patients. There will be a variety of services that depends on shared inputs, such as the staff members who provide various types of care and services to various types of patients. The following is the main quality of resource which determines the cost (Table 3.3).

Table 3.3 : Allocating Shared Inputs

Input	**Dimension Determining Cost**
Vehicles	Distance traveled/Time used
Equipment	Time used
Building Space	Time used/Space used
Personnel	Time worked
Supplies	Weight/Volume
Vehicle Operation and maintenance	Distance traveled/Time used
Building Operation and Maintenance	Time used/Space used
Other Inputs	Miscellaneous

Source : Creese and Parker, 1994

3.4.3 Hospital Costing Methodology (1)

There are many methods for cost analysis in health care program. Some appropriate methods are mentioned in this chapter.

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In a lecture on hospital costing methodology at Health Systems Research Institute, MOPH on November 8, 1995, Tangcharoensathien identified several steps:

(a) The system and functional analysis of the hospital such as the number of departments, number of staff in each department, the relationship between departments are identified.

(b) Identification and classification of cost centers are done. Three categories of cost centers can be classified according to the organization of the hospital:

- Non Revenue Producing Cost Center (NRPCC);
such as administration, medical records, catering, central store etc.:
- Revenue Producing Cost Center (RPCC);
such as medication, laboratory services, X-ray and other investigation services and surgical procedures etc.:
- Patient services (PS);
such as Out-patient (OP) services and In-patient (IP) services:

(c) Determination of cost such as Labor Cost (LC), Material Cost (MC) and Capital Depreciation Cost (CC) are done.

(d) Setting up of the allocation (apportionment) of cost from NRPCC and RPCC to PS is the next step. In this step, criteria for allocation of the cost have to be set.

(e) After cost allocation criteria are set, cost allocation technique has to be chosen. There are 4 techniques, namely :

- direct allocation
- step down allocation
- double distribution allocation and
- simultaneous equation allocation (See the illustrations in Appendix 2).

The major advantage of direct allocation method is that it is simple, easily understandable and easy to calculate. The major disadvantage is that it does not allow the allocation among the departments of NRPCC and RPCC and between the departments of NRPCC and RPCC.

The advantage of step down allocation method is that it allows only partial allocation among the departments of NRPCC and RPCC. But it still fails to allow full inter-departmental allocations.

The results from the double distribution method are more accurate than the previous two methods. This is because it allows full inter-departmental allocations among the supporting cost centers like NRPCC and RPCC.

Simultaneous equation method uses the same data as step down and double distribution methods, but it solves a set of simultaneous linear equations to give the allocations. It gives the same answer as double distribution method but involves less work (Drummond et al., 1987).

(f) Full cost of PS can be calculated as follows:

Full cost = Total direct cost of PS + Indirect cost from NRPCC and RPCC

Full cost is a measurement, as expressed in monetary units, of all resources used for a given cost objective. At the risk of oversimplifying, the full cost of a given objective can be defined as the sum of the direct costs of providing the service and a "fair or equitable" share of all indirect expenses (Broyles, 1982).

(g) Unit cost can be calculated as follows:

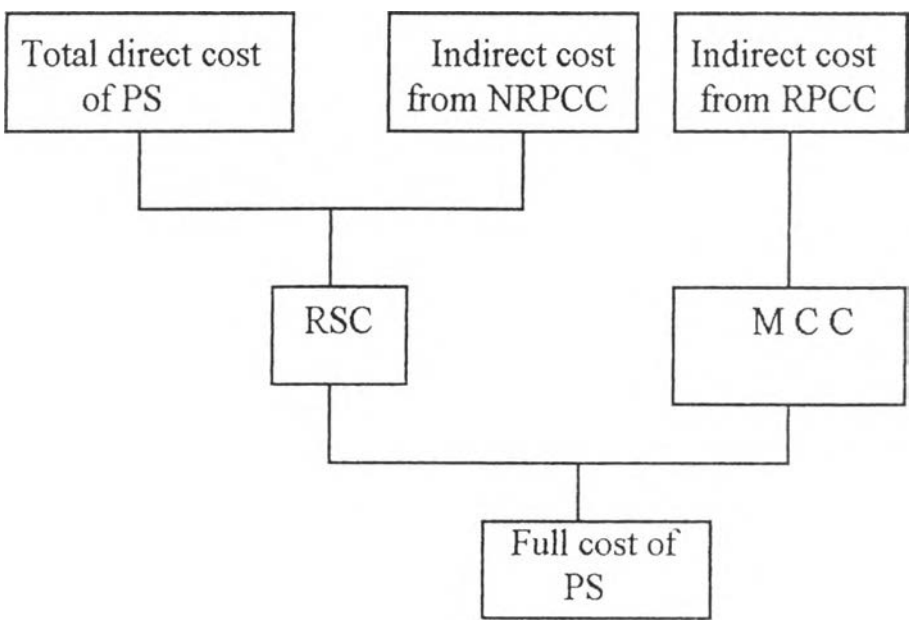
Unit cost = Full cost of PS ÷ Output (Out-patient visits, In-patient cases and In-patient days)

The above-mentioned unit cost is unit cost for any patient attending hospital services either out-patient department (OPD) or in-patient (IPD). The unit of measurement can be cost per OP/IP case or cost per OPD visit or cost per admission or cost per in-patient day. Unit of measurement will depend on the quantity of output to be measured. It can be applied in every hospital costing methodology.

(h) Similar full cost and unit cost calculation in hospital costing is shown in Appendix 3.

(i) Figure 3.3 also describes the calculation of full cost in hospital costing.

Figure: 3.3
Calculation of Full Cost in Hospital Costing Methodology



Source: (Ngamsiriudom and Satiensakpong, 1994)

3.4.4 Hospital Costing Methodology (2) (WHO, 1988)

(i) Cost calculation for the HIV/AIDS in-patients

(A) Hospital recurrent costs (except for drugs): shared by all patients = Salaries/ Allowances ÷ Materials (General - patient supplies, lab. reagents, etc.) + Administration and maintenance + Transport

(B) Hospital recurrent costs of resources only used for in-patients (e.g., food)

(C) Hospital building & furniture costs = (Construction cost of building ÷ Annualization factor or Depreciation factor)+(Cost of furniture ÷ Annualization factor)

(D) % of staff time with HIV/AIDS in-patients

(E) Average length of stay in days of HIV/AIDS in-patients (from the sample of patients)

(F) Total number of in-patients = (Total number of hospital beds × Average daily occupancy rate × 365) or (Average length of stay × Number of in-patients) days in the year

(G) Average cost of drugs and supplies per HIV/AIDS in-patient

(H) Total cost per HIV/AIDS in-patient = [{(A+C)×D}+B)] × (E÷F) + G

(ii) Cost calculation for the HIV/AIDS out-patients

(I) Number of out-patient per annum

(J) % of staff time with HIV/AIDS out-patients

(K) Average cost of drugs and supplies per HIV/AIDS out-patients

(L) Total cost per HIV/AIDS out-patient = [(A+C) × J ÷ I] + K

This model is actually meant for the PHC workers to calculate the hospital care cost for diarrhea diseases. Instead of diarrhea, HIV/AIDS is inserted in the equations. It is easy and rapid to calculate. But it should be modified if it has to be used (e.g. % of staff time from D should be multiplied to Salaries/Allowance from A instead of A+C etc.).

3.4.5 Hospital Costing Methodology (3) (Kaewsonthi et al., 1983)

In this methodology, there are 5 stages to calculate the costs of out-patient and in-patient services. The cost of drugs is excluded from the general analysis of the cost of hospital treatment. This is because the cost of drugs for HIV/AIDS patients is high in relation to other drugs administered to many other patients. The cost of drugs for these patients is added to the general cost of treatment at a later stage.

Stage 1: Apportioning budget expenditure to cost of administration, cost of out-patient services and cost of in-patient services.

1.1 Cost of administration

$$CA = CA_D + CA_N + CA_O + CA_R + CA_S + CA_U + CA_{WS}$$

$$CA_D = TA_D \left[\sum_{i=1}^{n} DP_I \right]$$

$$CA_N = TA_N \left[\sum_{i=1}^{n} PN_i \right]$$

$$CA_O = TA_O \left[\sum_{i=1}^{n} PO_i \right]$$

$$CA_R = R_1 + R_2 + TA_S [R_3] + R_4 + TA_S [R_5]$$

$$CA_S = S_3 + S_4$$

$$CA_{WS} = TA_D [W_{SD}] + TA_N [W_{SN}] + TA_O [W_{SO}]$$

Meaning of variables

CA = Cost of administration
CA_D = Cost of doctors' time for administration
CA_N = Cost of nurses' time for administration
CA_O = Cost of other staff's time for administration
CA_R = Cost of remuneration for administration
CA_S = Cost of supplies and materials for administration
CA_U = Cost of public utilities for administration
CA_{WS} = Cost of social welfare of staff from administration
TA_D = Percentage of time medical doctors spent on administration
TA_N = Percentage of time nurses and assistant nurses spent on administration
TA_O = Percentage of time other staff spent on administration
TA_S = Percentage of time spent for administration
R_1 = Remuneration fees
R_2 = Remuneration freight
R_3 = Transporting and traveling allowance
R_4 = Maintenance and fixed assets
R_5 = Other remuneration
S_3 = Vehicle supplies
S_4 = Maintenance and fixed assets of supplies and materials

PD, PN, PO = Salaries of doctors, nurses and assistant nurses and other staff

W_{SD}, W_{SN}, W_{SO} = Social welfare for medical doctors, nurses, assistant nurses and other staff

1.2 Cost of out-patient services

$$CO = CO_D + CO_N + CO_O + CO_L + CO_R + CO_S + CO_U + CO_{WS}$$

$$CO_D = TO_D \left[\sum_{i=1}^{n} PD_i \right]$$

$$CO_N = TO_N \left[\sum_{i=1}^{n} PD_i \right]$$

$$CO_O = TO_O \left[\sum_{i=1}^{n} PD_i \right]$$

$$CO_L = {}_pOPV \left[P_4 \right]$$

$$CO_R = TO_S \left[R_3 \right] + TO_S \left[R_5 \right]$$

$$CO_S = OPE \left[S_1 \right] + D_O \left[S_2 \right] + {}_pOPV \left[S_5 \right] + {}_pOPV \left[S_7 \right]$$

$$CO_U = OPE \left[U_1 \right]$$

$$CO_{WS} = TO_D \left[W_{SD} \right] + TO_N \left[W_{SN} \right] + TO_O \left[W_{SO} \right]$$

Meaning of variables

CO = Total cost of out-patient services
CO_D = Cost of doctors' time for out-patient services
CO_N = Cost of nurses' time for out-patient services
CO_O = Cost of other staff's time for out-patient services
CO_L = Cost of allowance for out-patient services
CO_R = Cost of remuneration for out-patient services
CO_S = Cost of supplies and materials for out-patient services
CO_U = Cost of public utilities for out-patient services
CO_{WS} = Cost of social welfare of staff from out-patient department
D_O = Proportion of drugs prescribed for out-patients
${}_pOPV$ = Percentage of out-patient visits to in-patient days
OPE = Out-patient in-patient equivalent ratio
P_4 = Personnel allowance
TO_S = Total number of man-hours of all staff spent on out-patient
S_1 = Office supplies
S_2 = Drugs
S_5 = Laboratory supplies
S_7 = Other supplies and materials

U = Public utilities

TO_D , TO_N , TO_O = Total number of man-hours of doctors, nurses and assistant nurses and other staff spent on out-patient services

1.3 Cost of in-patient services

$$CI = CI_D + CI_N + CI_O + CI_L + CI_R + CI_S + CI_U + CI_{WP}$$

$$CI_D = TI_D \left[\sum_{i=1}^{n} PD_i \right]$$

$$CI_N = TI_N \left[\sum_{i=1}^{n} PD_i \right]$$

$$CI_O = TI_O \left[\sum_{i=1}^{n} PD_i \right]$$

$$CI_L = {}_pIPD \left[P_4 \right]$$

$$CI_R = TI_S \left[R_3 \right] + TI_S \left[R_5 \right]$$

$$CI_S = IPE \left[S_1 \right] + D_I \left[S_2 \right] + {}_pIPD \left[S_5 \right] + S_6 + {}_pIPD \left[S_7 \right]$$

$$CI_U = IPE \left[U_1 \right]$$

$$CI_{WS} = TI_D \left[W_{SD} \right] + TI_N \left[W_{SN} \right] + TI_O \left[W_{SO} \right]$$

Meaning of variables

CI = Total cost of in-patient services

CI_D = Cost of doctors' time for in-patient services

CI_N = Cost of nurses' time for in-patient services

CI_O = Cost of other staff's time for in-patient services

CI_L = Cost of allowance for in-patient services

CI_R = Cost of remuneration for in-patient services

CI_S = Cost of supplies and materials for in-patient services

CI_U = Cost of public utilities for in-patient services

CI_{WP} = Low income support for in-patient services

CI_{WS} = Cost of social welfare of staff from in-patient department

${}_pIPD$ = Percentage of in-patient days to out-patient visits

IPE = Out-patient in-patient equivalent ratio

P_4 = Personnel allowance

TI_S = Total number of man-hours of all staff spent on in-patients

TI_D , TI_N , TI_O = Total number of man-hours of doctors, nurses and assistant nurses and other staff spent on in-patient services

Stage 2 : Apportioning cost of out-patient services to out-patient HIV/AIDS cases

COA = (OPVA ÷ OPV) × (CO)
COA = Total cost of HIV/AIDS out-patient services
OPVA = Total number of HIV/AIDS out-patient visits
OPV = Total number of overall out-patient visits

Stage 3 : Apportioning cost of in-patient services to in-patient HIV/AIDS cases

CIA = [NIA × TIA ÷ IPD] × (CI)
CIA = Total cost of HIV/AIDS in-patient services
NIA = Average number of days hospitalized HIV/AIDS in-patients
TIA = Total number of HIV/AIDS in-patients
IPD = Total number of in-patient days

Stage 4 : Apportioning cost of administration to cost of HIV/AIDS out-patients and in-patients

4.1 Apportioning cost of administration to cost of all out-patients and in-patients

CAO = OPE [CA]
CAI = IPE [CA]
CAO = Cost of administration apportioned to all out-patients
CAI = Cost of administration apportioned to all in-patients

4.2 Apportioning cost of administration to cost of HIV/AIDS out-patients and in-patients

CAOA = (OPVA ÷ OPV) × CAO
CAOA = Cost of administration apportioned to HIV/AIDS out-patients
CAIA = (NIA × TIA ÷ IPD) × CAI
CAIA = Cost of administration apportioned to HIV/AIDS in-patients

Stage 5 : Recurrent cost of treatment for HIV/AIDS out-patients and HIV/AIDS in-patients.

5.1 TCOA = COA + CAOA
TCOA = Total cost for out-patients HIV/AIDS cases

5.2 TCIA = CIA + CAIA
TCIA = Total cost for in-patients HIV/AIDS cases

5.3 RCT = TCOA + TCIA
RCT = Recurrent cost for treatment of HIV/AIDS patients

This method is quite similar to step down allocation method. But it is more specific, more accurate and also more complex.

3.5 Cost of HIV/AIDS

The epidemic of HIV/AIDS presents a series of public health and clinical problems which have economic implications. The direct costs of management of this epidemic will vary considerably between one country and another. This will depend on the epidemic pattern and the future number of AIDS cases, the organization and funding of health and social services, and the success of preventive strategies to reduce the future social and financial burden of AIDS. In the case of HIV prevention efforts, however, very limited information is available on the relative costs of the large number of different strategies currently in use.

The cost of treating AIDS is high and places a considerable burden on poorer countries where government expenditure on health is extremely low. Changing patterns of care may alter estimates of cost per case. On the other hand , development of community care may reduce cost by reducing hospital stay, but on the other hand the application of therapies such as AZT (Azidothymidine) may, if they prolong life or are expensive themselves, increase cost.

Whatever the illness, the extent and cost of treatment a patient receives usually depends on the national resources available, except individuals who can afford private treatment. HIV/AIDS is no exception. In many developing countries, treatment for people with HIV is generally restricted to those who are seriously ill, and may extend no further than palliative care. Only rarely are anti-viral drugs available. By contrast, in

the industrialized world a sophisticated combination of drugs can help patients recover from some serious opportunistic infections,

3.5.1 Direct Costs of Treatment for Patients

Studies of direct costs of care have largely focused on the hospital care of AIDS patients. Studies to date have shown wide variations in estimates of cost, partly because of different methodologies but also because of differences in health care organizations.

It was estimated that a lifetime cost was US $ 147,000 per AIDS case in the United States, based on an assumption of 168 hospital in-patient days per case (Hardy et al., quoted in Johnson, 1986, p 151). This figure is now generally regarded as high, reflecting the high estimates of length of stay used in their calculation.

In a study in the USA it was mentioned that a mean life-time cost per case was US $ 27,571 for patients who had received all their care in San Francisco General Hospital and died during 1984 (Scitovsky, Cline and Lee, quoted in Johnson, 1986, p 151). The mean length of stay was only 11.7 days per admission and patients spent on average 34.7 days in hospital over a life-time.

The average lifetime cost of treating a person who has developed AIDS in the United States in 1992 was calculated as US $ 102,000. It is considerably higher than earlier estimates (US $ 85,000 in 1991 and US $ 57,000 in 1988), because many more people are receiving treatment, particularly anti-viral drugs, in the early stages of HIV disease. (The Panos Institute, 1992, p 34)

Spending on AIDS is much lower in developing countries. Figures reported in 1988 cited lifetime direct medical costs as US $ 132 - 1,585 in Zaire and US $ 104 - 631 in Tanzania. These figures represent from 0.2% to 3% of the US costs in the same year. Figures given in 1989 for lifetime costs per patient ranged from US $ 160 in Malawi, US $ 230 - 250 in Uganda and Burundi, and over US $ 1,800 for Brazil. Lifetime costs for Thailand were estimated in 1991 as US $ 923 - 1,522 (The Panos Institute, 1992, p 34).

Johnson (1986) based on cases followed to death in London estimated an average length of stay of 17.2 days per admission and 50 days per life-time. Life-time hospital in-patient and out-patient cost was

estimated at US $ 10,132 based on a general medical ward in a National Health Service Teaching Hospital.

Many studies regarding the direct medical costs per patient per year for AIDS patients were conducted in all continents. According to these studies the costs ranged from a low of US $ 132 in Zaire (Over, quoted in Whiteside and FitzSimons 1992,13) to a high of US $ 135,690 in USA (Broomberg et al., quoted in Whiteside and FitzSimons, 1992, p 12).

Costing studies about in-patient costs have all shown that over 80% of hospital costs relate to room charges. Length of stay is therefore an important determinant of overall hospital cost.

In a study in Thailand (Viravaidya et al., 1991), they used low and high scenario projections to estimate the number of people affected by the end of 2000. They then calculated the direct and indirect costs of AIDS patients and related issues. They estimated total direct costs of AIDS at US $ 909 million using the high scenario and US $ 751 million using the low scenario.

In another study in Thailand (Kongsin et al., 1991), routine service costs (RSC) or labor and operating costs of hospital care for the AIDS Related Complex (ARC) and AIDS patients was found to be US $ 13.65 per in-patient day, with average duration of stay being 12 days. In their study, they also found that medical care costs (MCC) were US $ 169.64 per admission.

In her study for medical care cost of patients with AIDS and symptomatic HIV infections attending Bamrasnaradura Hospital, Bangkok, Thailand during January 1, 1993 to October 31, 1994, Prommool found that the cost per admission was 7,370.19 baht and the cost per out-patient visit was 3,280.29 baht (Prommool, 1995).

3.5.2 Costs for Prevention

1. For promotion of safer sexual behavior, by mass strategies, a case study in Dominican Republic (nationwide) showed cost per capita at US $ 0.06 whereas US $ 0.32 in Gabon (WHO 1993, 7).

2. For promotion of safer sexual behavior and condom use by person - to - person strategies, cost per condom distributed was US $

0.21 and cost per employee contact was US $ 1.89 in workplace education project in Uganda whereas cost per condom distributed was US $ 0.34 and cost per education per year was US $ 5,090 in prostitute peer education project in Cameroon (WHO 1993, 12).

3. Figures for the cost per unit of blood of screening for HIV, assuming different prevalences in Uganda, were calculated. At low levels of HIV seroprevalence in donors, the testing itself constitutes the main cost of HIV safety, whereas at higher levels the costs of replacing infected blood, which has to be destroyed, constitute the major component (Watson and Williams, quoted in WHO, 1993, p 51).

Table 3.4 : Costs of Screening Blood for HIV in Uganda (1990 US $)

HIV sero-prevalence	Cost per unit of blood of screening for HIV	Cost of replacement per unit of blood	Total cost of HIV prevention per unit of blood
5 %	5.70	1.50	7.20
10 %	5.70	3.40	9.10
20 %	5.70	7.60	13.30
30 %	5.70	12.70	18.40

Source : WHO, Global Program on AIDS, GPA/DIR/93.2