

AIM

A Computer Program for Making HIV/AIDS Projections
and Examining the Demographic and Social Impacts of AIDS



Spectrum System of
Policy Models



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December 2007

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I. Introduction

I.A. Description of the Spectrum System

I.A.1. Components

USAID | Health Policy Initiative and its predecessor projects have developed computer models that analyze existing information to determine the future consequences of today's development programs and policies.¹ The Spectrum Policy Modeling System consolidates previous models into an integrated package containing the following components:

- **Demography (DemProj)** – A program to make population projections based on (1) the current population, and (2) fertility, mortality, and migration rates for a country or region.
- **Family Planning (FamPlan)** – A program to project family planning requirements in order to achieve national goals for meeting couple's fertility intentions.
- **Benefit-Cost** – A program for comparing the costs of implementing family planning programs, along with the benefits generated by those programs.
- **AIDS (AIDS Impact Model – AIM)** – A program to project the consequences of the AIDS epidemic including: the number of people infected with HIV, AIDS deaths, the number of people needing treatment, and the number of orphans.
- **Socioeconomic Impacts of High Fertility and Population Growth (RAPID)** – A program to project the social and economic consequences of high fertility and rapid population growth for sectors such as labor force, education, health, urbanization and agriculture.
- **Adolescent Reproductive Health (NewGen)** – A program to examine the effects of policies and programs on the reproductive health of adolescents, including pregnancies, HIV/AIDS, and sexually transmitted infections.

Spectrum consolidates DemProj, FamPlan, Benefit-Cost, AIM, RAPID, and other models into an integrated package.

¹ The terms "model" and "module" are used interchangeably in the Spectrum manuals to refer to the separate computer programs within the system.

- **Prevention of Mother-to-Child Transmission of HIV (PMTCT)**
– A program to examine the costs and benefits of different programs intended to reduce the transmission of HIV from mothers to their newborn children.

I.A.2. Software Description

Spectrum is a Windows-based system of integrated policy models. The integration is based on DemProj, which is used to create the population projections that support many of the calculations in the other components such as FamPlan, Benefit-Cost, AIM, and RAPID.

Each component has a similarly functioning interface that is easy to learn and to use. With little guidance, anyone who has a basic familiarity with Windows software will be able to navigate the models to create population projections and to estimate resource and infrastructure requirements. The accompanying manuals contain both instructions for users, and equations for those who want to know exactly how the underlying calculations are computed.

I.B. Uses of Spectrum Policy Models

Policy models are designed to answer a number of “what if” questions. The “what if” refers to factors that can be changed or influenced by public policy.

Policy models are designed to answer a number of “what if” questions relevant to entities as small as local providers of primary health care services and as large as international development assistance agencies. The “what if” refers to factors that can be changed or influenced by public policy.

Models are commonly computerized when analysts need to see the likely result of two or more forces that might be brought to bear on an outcome, such as a population’s illness level or its degree of urbanization. Whenever at least three variables are involved (such as two forces and one outcome), a computerized model can both reduce the burden of manipulating those variables and present the results in an accessible way.

Some of the policy issues commonly addressed by the Spectrum set of models include:

- The utility of taking actions earlier rather than later. Modeling shows that little in a country stands still while policy decisions are stalled, and that many negative outcomes can accumulate during a period of policy stasis.

A set of policies under consideration may not be acceptable to all stakeholders.

- The evaluation of the costs vs. the benefits of a course of action. Modeling can show the economic efficiency of a set of actions (i.e., whether certain outcomes are achieved more effectively than under a different set of actions), or simply whether the cost of a single set of actions is acceptable for the benefits gained.
- The recognition of interrelatedness. Modeling can show how making a change in one area of population dynamics (such as migration rates) may necessitate changes in a number of other areas (such as marriage rates, timing of childbearing, etc.).
- The need to discard monolithic explanations and policy initiatives. Modeling can demonstrate that simplistic explanations may bear little relationship to how the “real world” operates.
- The utility of “door openers.” A set of policies under consideration may not be acceptable to all stakeholders. Modeling can concentrate on favored goals and objectives and demonstrate how they are assisted by the proposed policies.
- That few things in life operate in a linear fashion. A straight line rarely describes social or physical behavior. Most particularly, population growth, being exponential, is so far from linear that its results are startling. Modeling shows that all social sectors based on the size of population groups are heavily influenced by the exponential nature of growth over time.
- That a population's composition greatly influences its needs and its well being. How a population is composed—in terms of its age and sex distribution—has broad-ranging consequences for social welfare, crime rates, disease transmission, political stability, etc. Modeling demonstrates the degree to which a change in age and sex distribution can affect a range of social indicators.
- The effort required to “swim against the current.” A number of factors can make the success of a particular program harder to achieve; for example, the waning of breastfeeding in a population increases the need for contraceptive coverage. Modeling can illustrate the need for extra effort—even if simply to keep running in place.

I.C. Organization of the Model Manuals

Each manual begins with a discussion of what the model does and why someone would want to use it. The manual also explains the data decisions and assumptions needed before the model can be run, and possible sources for the data. It defines the data inputs and outputs. The manual contains two tutorials, information on the methodology behind the model, a glossary, and a bibliography.

I.D. Information about HPI

USAID | Health Policy Initiative (HPI) is a USAID-funded activity designed to create a supportive environment for family planning and reproductive health programs, through the promotion of a participatory process and population policies that respond to client needs. To achieve its purpose, the project addresses the full range of policies that support the expansion of family planning and other reproductive health services, including:

- national policies as expressed in laws and in official statements and documents;
- operational policies that govern the provision of services;
- policies affecting gender roles and the status of women; and
- policies in related sectors, such as health, education and the environment, that affect populations.

USAID/Health Policy Initiative is implemented by Constella Futures in collaboration with Futures Institute, Centre for Development and Population Activities (CEDPA), White Ribbon Alliance and Conference on Religion for Peace.

More information about the Spectrum System of Policy Models and the POLICY Project are available from:

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Constella Futures
One Thomas Circle, NW Suite 200
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or

USAID | Health Policy Initiative
US Agency for International Development
Center for Population, Health, and Nutrition
1300 Pennsylvania Ave.
Washington, DC 20523
Telephone: (202) 712-5787 or -5839

I.E. What Is AIM?

The AIDS Impact Model, known as AIM, is a computer program for projecting the impact of the AIDS epidemic. It can be used to project the future number of HIV infections, AIDS cases, and AIDS deaths, given an assumption about adult HIV prevalence. It can also project the demographic and social impacts of AIDS. These projections then can be used in graphic policy presentations intended to enhance knowledge of AIDS among policymakers and to build support for effective prevention and care.

The Futures Group, in collaboration with Family Health International, prepared the first version of AIM in 1991 under the AIDS Technical Support (AIDSTECH) and AIDS Control and Prevention (AIDSCAP) projects. The program has been revised a number of times since then in collaboration with the UNAIDS Reference Group on Estimates, Models and Projections.

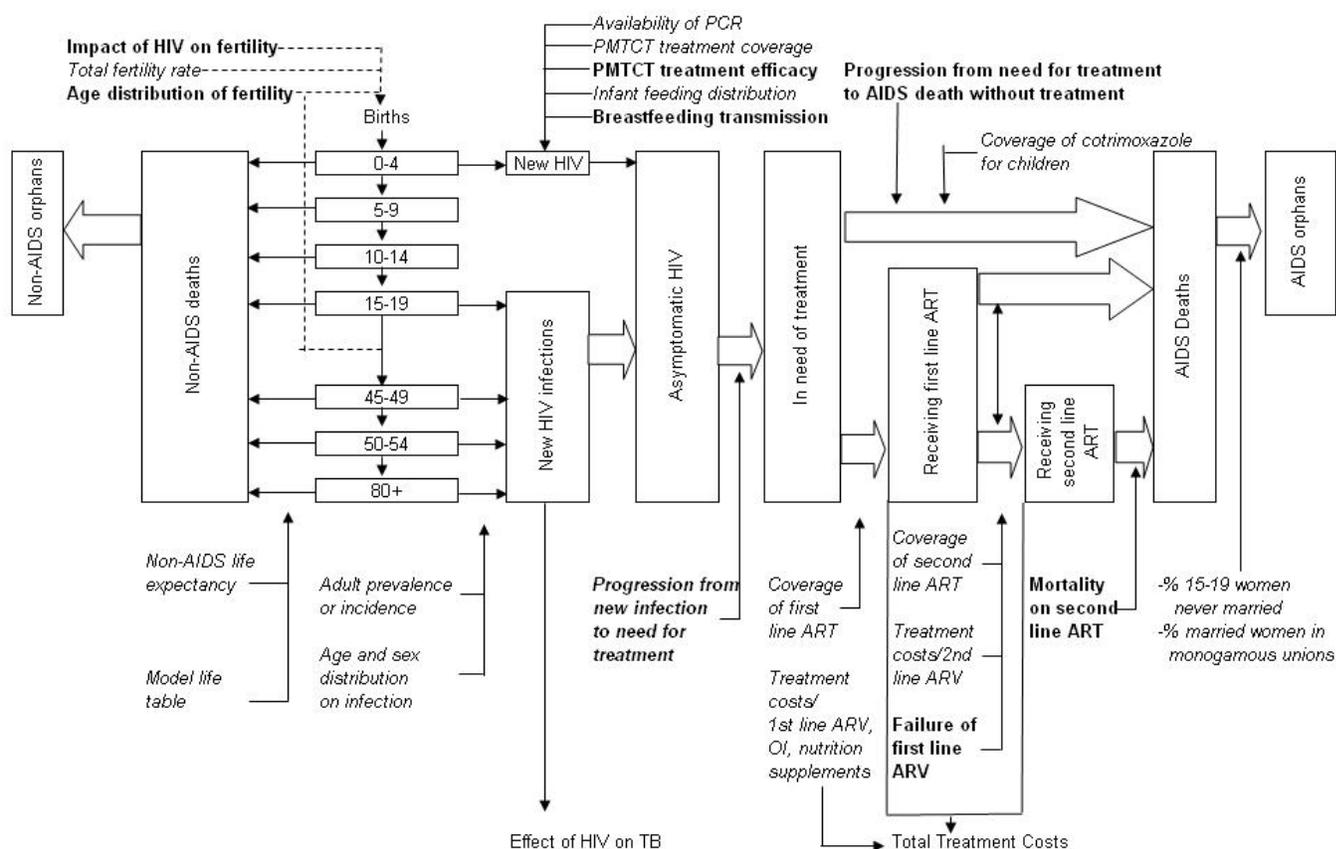
The projection results are usually transferred to presentation software, such as PowerPoint, for presentation to leadership audiences.

AIM requires an assumption about the future course of adult HIV prevalence and treatment coverage. Assumptions about other HIV/AIDS characteristics can also be entered for such variables as the survival period from HIV infection to AIDS death, the age and sex distribution of infections, and the perinatal transmission rate. A demographic projection must be prepared first, before AIM can be used. DemProj, one of the Spectrum system of policy models, is used to make the demographic projection; see the DemProj manual for more information. The demographic projection is modified by AIM through AIDS deaths and the impact of HIV infection on fertility. The *Epidemiology* section of AIM calculates the number of HIV infections, AIDS cases, and AIDS deaths. This information is used in the: *Treatment Costs* section to calculate the costs of treatment for PMTCT, HIV/AIDS, and AIDS associated TB and OI; the *Impacts* section to calculate various indicators of demographic and social impact; and the *Orphans* section to calculate the number of orphans. Please see the following page for a visual diagram of AIM.

AIM's focus is on generating information useful for policy and planning purposes.

AIM (and the entire Spectrum system of models) is designed to produce information useful for policy formulation and dialogue within a framework of computer programs that are easy to use. The focus is on generating information useful for policy and planning purposes rather than on carrying out detailed research into the underlying processes involved. For this reason, the program is designed to be used by program planners and policy analysts. AIM uses data that are readily available and requires little technical expertise beyond what can be acquired through literature review and use of this manual.

Figure 1: AIM diagram



I.F. Why Make HIV/AIDS Projections?

HIV/AIDS projections can illustrate the magnitude of the AIDS epidemic and the demographic, social and economic consequences.

A key aspect of the policy process is recognizing that a problem exists and placing that problem on the policy agenda. HIV/AIDS projections can illustrate the magnitude of the AIDS epidemic and the demographic, social and economic consequences. This illustration also can show policymakers the impacts on other areas of development and the size of the impacts that could be expected without effective action. HIV/AIDS projections are also needed to plan the response. For example, AIM can project the number of people needing anti-retroviral therapy, which can serve as the basis for planning expanded access to treatment. It can be used to estimate the number of orphans in order to develop support programs.

It is often useful to prepare alternative HIV/AIDS projections rather than a single projection, for two reasons. Projections are based on assumptions about the future levels of HIV prevalence and other factors. Because these are uncertain assumptions, it is often wise to consider low, medium and high variants of each of these assumptions so that the range of plausible projections can be determined. When HIV/AIDS projections are used for policy dialogue, it is usually important to show how various assumptions about future rates of HIV prevalence would affect the projections. At a minimum, it is usually useful to prepare one projection that illustrates a likely future course for the epidemic and another that uses the same set of inputs but assumes that there is no AIDS epidemic. In this way, the consequences of the epidemic will be clearly demonstrated.

II. Steps in Making an HIV/AIDS Projection

There are six key steps in making most AIM projections. The amount of time spent on each step may vary, depending on the application, but most projection activities will include at least these six steps.

AIM requires a population projection prepared with DemProj. This projection should be prepared first or at the same time as the AIM projection.

1. **Prepare a demographic projection.** AIM requires a population projection prepared with DemProj. This projection should be prepared first, or at the same time as the AIM projection. The first and last years of the DemProj projection will determine the span of the AIM projection. The HIV/AIDS projections will be more accurate if the projection is started at least a year or two before the start of the AIDS epidemic. Thus, if the first year in which HIV was detected in the population was 1981, the first year of the projection should be set to 1979 or 1980. The projection can start in the middle of the epidemic, but in that case the program needs to back calculate the number and timing of HIV infections that occurred prior to the first year of the projection. This procedure will generally be less accurate than starting the projection before the first year of the epidemic. For a quick start, the EasyProj feature can be used within DemProj to create a population projection based on the estimates and projections of the United National Population Division.
2. **Collect data.** At a minimum, AIM requires an assumption about the trend of adult HIV prevalence. For many other inputs, default values provided by the program can be used, or country-specific figures can be supplied. Country-specific figures on the coverage of antiretroviral therapy, programs to prevent mother-to-child transmission, and cotrimoxazole for children are required to calculate many of the indicators of the impacts of AIDS. Since the projection will only be as good as the data on which it is based, it is worth the effort to collect and prepare appropriate and high-quality data before starting the projection.
3. **Make assumptions.** The full range of AIM indicators requires assumptions about a number of variables such as the future coverage of ART and PMTCT programs.

4. **Enter data.** Once the base year data are collected and decisions are made about projection assumptions, AIM can be used to enter the data and make an HIV/AIDS projection.
5. **Examine projections.** Once the projection is made, it is important to examine it carefully. This examination includes consideration of the various demographic and HIV/AIDS indicators produced as well as the age and sex distribution of the projection. Careful examination of these indicators can act as a check to ensure that the base data and assumptions were understood and were entered correctly into the computer program. This careful examination is also required to ensure that the consequences of the assumptions are fully understood.
6. **Make alternative projections.** Many applications require alternative HIV/AIDS projections. Once the base projection has been made, the program can be used to quickly generate alternative projections as the result of varying one or several of the projection variables.

Once the base projection has been made, the program can be used to quickly generate alternative projections.

III.

Projection Inputs

AIM requires data describing the characteristics of the HIV/AIDS epidemic and the response to it. Some of these inputs require national data while others rely on recommended values based on a review of scientific studies. The inputs that must be country-specific are:

- Demographic projection
- Adult HIV prevalence
- Utilization of PMTCT programs
- Number or percent of adults receiving anti-retroviral therapy (ART)
- Number or percent of children receiving ART and/or cotrimoxazole

Inputs that use recommended values based on international studies include:

- Proportion of those newly infected progressing to need for treatment by time since infection
- Proportion of adults in need of treatment dying from AIDS without treatment by time in need
- Annual mortality among children in need of treatment but not receiving treatment by age
- Annual survival of adults and children on ART
- Probability of transmission of HIV from mother-to-child
- Effect of HIV infection on fertility

At times, the completion of an input [editor] screen for a variable will require both types of inputs. Below, you will find the descriptions for the input of each variable, in the order in which you will encounter them in the program.

III.A. Demographic Projection

As previously noted, AIM requires that a demographic projection first be prepared using DemProj, another model in the Spectrum system. A complete description of the use of DemProj can be found in the DemProj manual, *DemProj, A Computer Program for Making Population Projections*. Model users should keep three key points in mind when preparing a DemProj projection for use with AIM:

Projections should start before the first year of the AIDS epidemic. This may be one or two years before the first reported AIDS case.

1. DemProj contains a feature called EasyProj that automatically provides the necessary demographic data once you have set the first and last years of the projection and selected the country.
2. The first year of the projection should be before the starting year of the HIV/AIDS epidemic. It is possible to start the projection in a year after the beginning of the AIDS epidemic, but this type of projection will be less accurate.
3. The life expectancy assumption entered into DemProj should be the life expectancy in the absence of AIDS. AIM will calculate the number of AIDS deaths and determine a new life expectancy that incorporates the impact of AIDS. It is necessary to use this two-step process because model life tables (for specifying the age distribution of mortality) do not contain patterns of mortality that reflect the excess deaths caused by AIDS.

Adjusting the Population Size to Match Current Estimates

If you use EasyProj for your demographic projection it is possible that the population size may not match the most recent census estimate. The United Nations Population Division bases their estimates and projections on the latest available demographic data for each country. However, a typical application of Spectrum starts the projection in 1970 or 1980 and projects forward to today. Small variations in any of the inputs can affect the population size 25 to 30 years later. Perhaps the most important difference is that the UN Population Division estimates may use a different HIV prevalence trend than the one you are using in Spectrum. In that case, the population projected by Spectrum may not match the UN Population Division estimate or the latest census estimate. Variations in the age distribution of mortality or migration can also cause small difference in the population size today.

If this problem occurs you can get a better match to the census population by adjusting some of the inputs to the demographic projection. Changes to the fertility rate, life expectancy, the model life table chosen and the migration inputs can help to fine tune the projection. Of course, changes to the HIV prevalence curve could also make a difference.

One quick way to get a good match to today's population estimate is to adjust the starting population. One of the demographic inputs is the population by age and sex in the base year. These inputs might need to be adjusted upwards or downwards to modify the current year population projection. This can be done easily by using the "Multiply" button in the editor for the base population to multiply all the inputs by a constant factor. That factor could be the ratio of the actual current year population to the projected population. After making this adjustment the new population projection should match the current estimate better. This approach is only a quick fix. It is always desirable to examine the fertility, mortality and migration assumptions as well as the starting population to reconcile them with national statistics. Most countries have national population projections that can be used as a source of information for the Spectrum projection.

III.B. Adult HIV Prevalence

III.B.1. Historical and Current Year Estimates

Adult HIV prevalence is the percentage of adults aged 15 to 49 who are infected with HIV. Thus, this estimate of prevalence refers to the entire adult population aged 15 to 49, not just a specific risk group.

HIV prevalence data usually come from surveillance conducted among selected population groups. In some countries national household surveys have been used to estimate prevalence for the entire population. There are two major sources of surveillance data:

1. **National AIDS Control Program (NACP).** Generally the National AIDS Control Program will be the best source of HIV surveillance information. In many countries, the NACP operates a sentinel surveillance system that regularly conducts surveys in a number of sites around the country. Other ad hoc surveys may be conducted among special populations.

2. **HIV/AIDS Surveillance Database.** The International Programs Center of the U.S. Bureau of the Census maintains an HIV/AIDS surveillance database that contains information from a large number of surveillance studies. The database contains information from published articles, international AIDS conferences, and other sources. The database is distributed both as hard copy and on computer diskette. For more information about the database or to obtain copies, contact:

Health Studies Branch
International Programs Center
Population Division
U.S. Census Bureau
Washington, DC 20233-8860
E-mail: laura.m.heaton@census.gov

Estimates and projections of HIV prevalence depend on surveillance data and national household surveys.

Surveillance information will generally refer to small populations and various risk groups. Since AIM requires historical estimates of HIV prevalence for all adults over time, it is rarely possible to use surveillance data directly to make this estimate. UNAIDS has developed tools and procedures for making national estimates using available surveillance data. Every two years, UNAIDS works with country counterparts to prepare estimates of national HIV prevalence for most of the countries of the world. These estimates are based on careful consideration of the available surveillance data, by risk group; recent trends in HIV infection; and national population estimates. The latest estimates are available from the UNAIDS website at <http://www.unaids.org>.

III.B.2. Future Projections

An AIM projection requires an estimate of past and future levels of HIV prevalence.

When AIM is used to stimulate policy dialogue, it is often helpful to use a conservative projection of future prevalence.

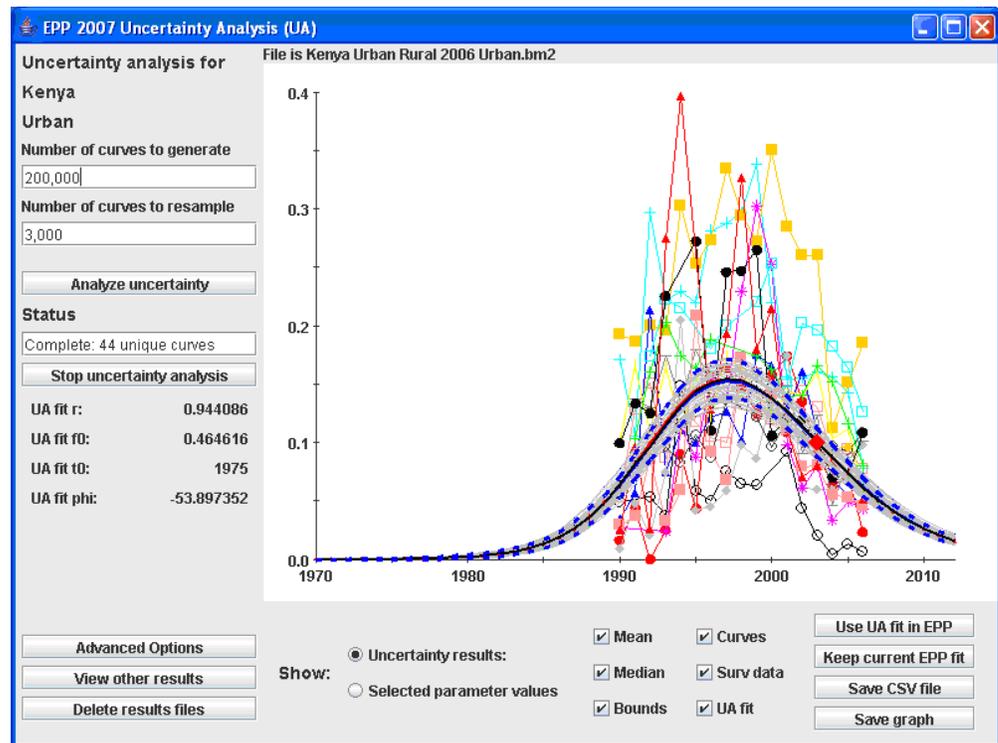
When AIM is used to stimulate policy dialogue, it is often helpful to use a conservative projection of future prevalence. This approach will avoid charges that the presentation is using the worst possible assumptions to make the case for AIDS interventions stronger and will allow the discussion to focus on other, more important issues.

Various approaches and tools outside of the Spectrum system are available to make HIV prevalence projections. The following sections describe several of these approaches. No matter which is used, all the AIM calculations rely on the assumption of future HIV prevalence. Care should be used to develop reasonable assumptions, and the effects of alternative assumptions should be examined.

Estimation and Projection Package - EPP

UNAIDS established a Reference Group on Estimates, Models and Projections to provide advice on methods and assumptions in making national prevalence projections. In 2001 the Reference Group developed a new model, called the UNAIDS Reference Group Model, to fit smooth prevalence curves to available surveillance data. This model has been implemented in a computer program called the Estimation and Projection Package (EPP). EPP replaces EpiModel, which was used previously. EPP can be used to estimate national HIV prevalence. It uses surveillance data to fit an epidemic curve for various geographic areas. These curves are then aggregated to produce a prevalence estimate for the entire country. A sample EPP fit is shown in Figure 2. The output of EPP can be read directly into Spectrum. The EPP Model is available from UNAIDS at www.UNAIDS.org. More information is provided in the manual which is also available on the UNAIDS website. EPP is primarily useful for estimating and projecting national prevalence in countries with generalized epidemics, primarily countries in sub-Saharan Africa plus a few other countries with high prevalence, such as Haiti.

Figure 2. Sample EPP projection



Workbook Approach

For low level and concentrated epidemics a different approach is required. These are countries where HIV infection is concentrated in specific population groups, such as commercial sex workers and their clients, men who have sex with other men and injecting drug use. For these countries, the UNAIDS Reference Group has developed a spreadsheet model (called the Workbook) to estimate an HIV prevalence curve. This model uses estimates of current and past prevalence among groups at higher risk and estimates about the number of people engaging in higher-risk behavior. The Workbook is also available from the UNAIDS website. The prevalence estimate and projection produced with the Workbook can be transferred directly into Spectrum.

In addition to specifying adult HIV prevalence in Spectrum, it is also necessary to specify the start year of the epidemic. The first year of the epidemic is the year in which the first cases of HIV occurred. This date is generally one or two years before the first AIDS cases were reported. If the AIM projection starts after the start year of the epidemic, then AIM uses this information to project in reverse the number of infections (to make an estimate of when past infections were acquired).

The UN estimates of the beginning of the AIDS epidemic, by region, are shown in Table 1.

Table 1. Start of AIDS Epidemic, by Region

Region	Start of Epidemic
Sub-Saharan Africa	Late 1970s - early 1980s
South and Southeast Asia	Late 1980s
Latin America	Late 1970s - early 1980s
North America, Western Europe, Australia, New Zealand	Late 1970s - early 1980s
Caribbean	Late 1970s - early 1980s
Central Europe, Eastern Europe, Central Asia	Early 1990s
East Asia, Pacific	Late 1980s
North Africa, Middle East	Late 1980s

Source: *HIV/AIDS: The Global Epidemic*, UNAIDS and WHO, 1996.

III.C. Progression from Infection to Need for Treatment and from Treatment Need to Death

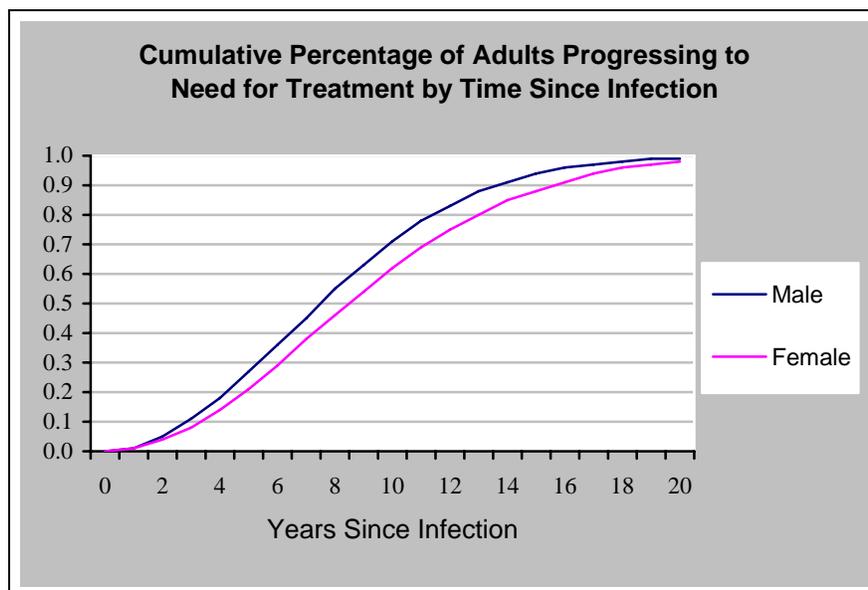
People who become infected with HIV do not need treatment with antiretroviral drugs immediately. There is an asymptomatic period during which the body's immune system controls the HIV infection. After some period of time the rapid replication of the virus overwhelms the immune system and patient is in need of antiretroviral treatment (ART). The time from new infection to need for treatment varies by individual. Cohort studies provide information on the patterns for large numbers of individuals.

Cohort studies are on-going in a number of countries. The Alpha Network (Analyzing Longitudinal Population-based HIV/AIDS data on Africa) in November 2007 reviewed results from 10 cohort studies, seven in sub-Saharan Africa (Masaka, Uganda; Kisesa, Tanzania; Karonga, Malawi; Manicaland, Zimbabwe; Hlabisa, South Africa; Rakai, Uganda; and miners in South Africa), two from Thailand and one from Haiti. (Todd et al, 2007). These studies indicate that the median time from infection to AIDS death in the absence of treatment is about 11 years in most countries and somewhat faster (about 9 years) in Thailand.

Reviews conducted by Zwahlen and Egger (and presented to the UNAIDS Reference Group by Eleanor Gouws, Estimating Time from ART eligibility to death, Prague Decemebr 2007) of information on time from eligibility for ART to AIDS death indicates a median time of about 3 years [2.9 (2-4) years from CD4 count < 200 to AIDS deaths and 2.7 (0.76 – 9.6) from CD4 count <350]. Subtracting this from the median time from

infection to death produces an estimate of the median time from infection to need for treatment of about 8 years. The speed of progression varies by age, with older people progressing more quickly and women tending to become infected at younger ages than men. Therefore, the UNAIDS Reference Group recommends a median time from infection to need for treatment of 7.5 years for men and 8.5 years for women. The recommended patterns in Spectrum use a fitted Weibull distribution to describe the proportion of those infected progressing to need for treatment by years since infection. This pattern is shown in the figure below. A faster progression pattern with median time to need for treatment of 6 years for men and 7 years for women is used in countries with primarily HIV subtype E.

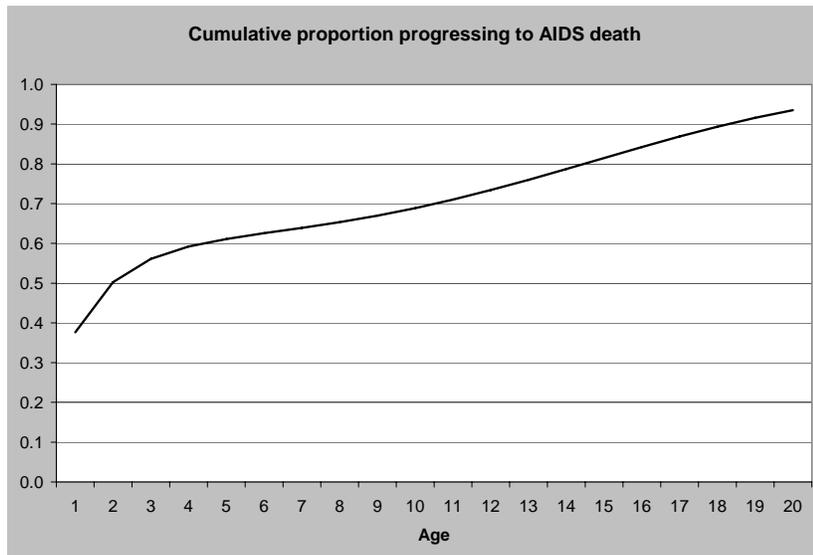
Figure 3: Cumulative percentage of adults progressing to need for treatment by time since infection



For children the progression to need for treatment occurs more rapidly.

Children who are infected perinatally generally progress to AIDS faster than adults. A UNAIDS review of available evidence suggests that the survival is best described by a rapid progression from infection to death for some children and much slower progression for others (Marston, 2005). The default pattern used in AIM is shown below.

Figure 4: Cumulative progression from birth to AIDS death

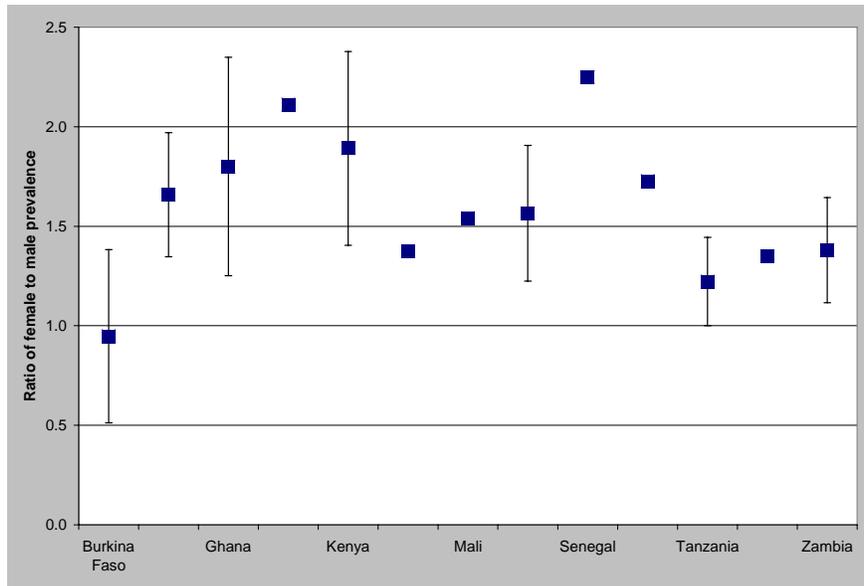


III.D. Age and Sex Distribution of Infections

Adult HIV prevalence trends estimated by EPP or the Workbook refer to the percent of adults aged 15-49 infected with HIV. For use in Spectrum these infections need to be distributed by age and sex. In recent years a number of national surveys have provided information on HIV prevalence by age for women aged 15-49 and men aged 15-59.

Adult HIV prevalence is disaggregated into female and male prevalence by specifying the ratio of female to male prevalence. We assume that the ratio is much less than one at the beginning of the epidemic but increases to greater than one for generalized epidemics about 10 years into the epidemic. The population-based surveys show a wide variation in the sex ratio of prevalence from just below one in Burkina Faso to over two in Guinea and Senegal. These data are shown in Figure 5a along with 95% confidence bounds for those surveys that have reported bounds. For countries with national surveys we use those ratios. For countries without surveys we assume that the ratio will plateau at 1.5.

Figure 5a: Sex ratio of female to male HIV prevalence



These surveys also provide a snapshot for a single year of the age distribution of prevalence. It is unlikely that age patterns remain constant over time due to saturation effects in higher risk age groups, aging of those infected with HIV and likely changes in sexual behavior. We therefore examined the changing pattern of HIV prevalence and incidence by age in a simple model where the risk (or force) of infection depends on age, but does not vary over time. Mortality among those infected with HIV is described by a Weibull distribution (Grassly 2002). The overall level of incidence over time is adjusted to match estimated adult prevalence for the period 1990-2003 and the constant pattern of force of infection by age is adjusted to reproduce the age-specific prevalence pattern in the year of the national survey. The result is a changing pattern of prevalence by age and sex over the course of the epidemic. The model was fit to data from Burkina Faso, Ghana, Kenya, Mali, Tanzania and Zambia.

This model captures the saturation of infection among the higher risk age groups (15-24 year olds), and the aging of those infected, and describes the increases in the mean age of incident and prevalent infections typically observed during the course of a generalized HIV epidemic. Figures 5(b) and 5(c) show these patterns expressed as the ratio of prevalence at any age to prevalence at age 25-29. The patterns refer to the time since the start of the epidemic and, therefore, are adjusted for each country depending on the start year of the epidemic.

Figure 5b: Default pattern of the ratio of prevalence at each age to prevalence at age 25-29 for females in generalized epidemics

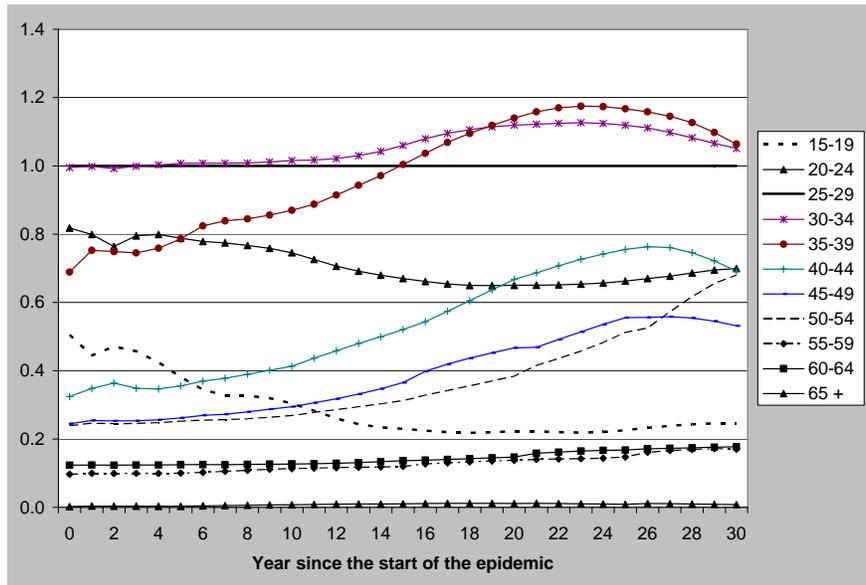
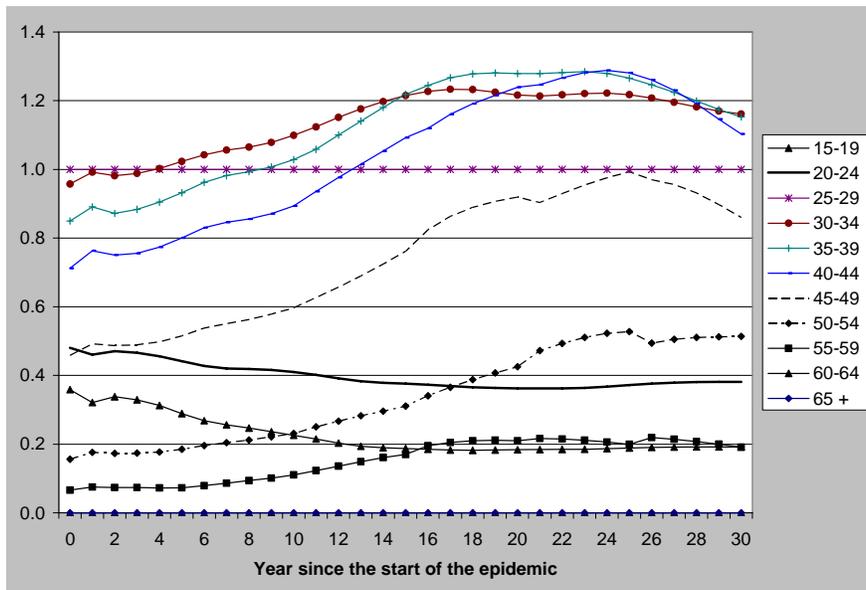


Figure 5c: Default pattern of the ratio of prevalence at each age to prevalence at age 25-29 for males in generalized epidemics



If a country has a national survey the information on prevalence by age and sex from that survey is used to adjust the default patterns to match the actual pattern in the survey year. The adjustment is made by multiplying each curve by the ratio of the actual value in the survey year to the default

value for that year. This has the effect of shifting all curves up or down to match the survey pattern.

For low-level and concentrated epidemics no national prevalence surveys are currently available. Instead we examined data on the distribution by age of populations at higher risk collected as part of behavioral surveillance surveys and provided to the UNAIDS Reference Group by Family Health International (FHI) and Population Services International (PSI). These surveys do not collect information on HIV prevalence but do indicate the age distribution of most at-risk populations. Table 2 shows the countries and population groups for which data were available.

Table 2. Countries with information on the age distribution of high risk populations, by type of risk group

Injecting drug users	Men who have sex with men	Female sex workers	Male clients of female sex workers
Argentina	Argentina	Armenia	Brazil
Armenia	Central America	Cambodia	Haiti
India	Cambodia	Central America	India
Indonesia	East Timor	China	Kosovo
Myanmar	India	East Timor	Nepal
Nepal	Indonesia	India	Philippines
Russia	Nicaragua	Indonesia	Russia
Viet Nam	Russia	Jamaica	Singapore
		Lao PDR	Sri Lanka
		Myanmar	Thailand
		Nepal	
		Nicaragua	
		Philippines	
		Russia	
		Thailand	
		Viet Nam	

Source: Data sets were provided by FHI and PSI from BSS surveys in each country.

When surveys for multiple sites within a country were available we calculated a simple average without weighting to get a single national pattern. These national patterns were averaged across all countries within each population group to estimate the average age distribution of the population within each risk group. These age distributions were weighted by the number of HIV-infected people in each risk group to calculate an average age distribution for the entire HIV+ population. National estimates of the number of infected people by risk group for these countries were aggregated to determine an overall average for countries in Asia and in Latin America and the Caribbean. These percentages were used to weight the age distributions described above. For the general population the age distributions from generalized epidemics were used. We assume that changes in these patterns over time will occur in a similar manner to the generalized epidemics as the HIV-positive populations age. The results are shown in Figure 2(c) and 2(d).

References

N Grassly and the UNAIDS Reference Group on Estimates, Models and Projections. "Improved methods and assumptions for estimation of the HIV/AIDS epidemic and its impact: Recommendations from the UNAIDS Reference Group on Estimates, Models and Projections". *AIDS*, June 2002; 16(9):W1-W14.

III.E. Prevention of Mother-to-Child Transmission of HIV

The mother-to-child transmission rate is the percentage of babies born to HIV-infected mothers who will be infected themselves. Studies have found that this percentage ranges from about 1-2% when women receive triple preventive therapy and use substitute feeding to 35% or more when women receive no preventive drugs and continue breastfeeding for more than 18 months. The recommended values by type of prevention ARV and infant feeding based on reviews of studies of MTCT are shown below in Table 3.

Table 3. Probability of Transmission of HIV from an Infected Mother to her Newborn Child by Type of Prevention Regimen and Type of Infant Feeding

Duration of breastfeeding in the general population	Type of prevention	Mixed breastfeeding	Replacement feeding	Exclusive breastfeeding
< 6 months	None	0.260	0.200	0.230
	Single dose Nevirapine	0.170	0.110	0.140
	Dual prevention ARV	0.100	0.040	0.070
	Triple prevention ARV	0.040	0.020	0.030
7-17 months	None	0.305		
	Single dose Nevirapine	0.215		
	Dual prevention ARV	0.145		
	Triple prevention ARV	0.050		
18+ months	None	0.350		
	Single dose Nevirapine	0.260		
	Dual prevention ARV	0.190		
	Triple prevention ARV	0.060		

References

Replacement BF:

No treatment: 20%: based on UNICEF/UNAIDS/WHO/UNFPA, 2004.

Single dose nevirapine: based on Jackson et al. (11.8% at 6-8 weeks in BF population), 2003 and Moodley et al. (10.7% among replacement feeding population), 2003.

Dual prevention ARV: based on DITRAME Plus Study Group (6.5% at 6 weeks [with some BF transmission]), 2005 and Lallement et al. (1.9-2.8% among replacement feeding population), 2004.

Triple treatment ARV: based on western studies quoted in 2004 UNICEF/UNAIDS/WHO/UNFPA, 2004.

Exclusive BF: in addition to Replacement BF rates:

In addition to Replacement BF rates: 0.5% additional transmission per month (total 3%) based on Iliff et al, 2005 and Rollins, 2006.

Triple treatment ARV: in absence of data, assume 1% additional transmission.

Mixed BF: in addition to Replacement BF rates:

First six months: 1% per month for first 6 months (total 6%) based on Iliff et al., 2005 and Rollins, 2006: approximately double the hazard of Exclusive BF.

Thereafter: 0.75% per month for next 6 months (total 4.5%) and for next 6 months (total 4.5%) based on BHITS meta-analysis, 2004: 8.9% per 100 person-years.

Triple treatment ARV: in absence of data, assume 2% additional transmission for first 6 months, then 1% for next 6 months and again 1% for next 6 months.

III.F. TFR Reduction

A number of studies in sub-Saharan Africa have examined the fertility of HIV-infected women compared to women who are not infected (Lewis et al., 2004). These studies generally show that fertility is lower in HIV-positive women than in HIV-negative women between the ages of 20-45. It is generally higher for HIV-positive women aged 15-19 because they are all sexually active whereas many HIV-negative women in this age group are not sexually active. Based on these the default values in Spectrum assume that fertility for women 15-19 is 50% higher among HIV-positive than HIV-negative women and for women 20-49 fertility is 30% lower for HIV-positive women than HIV-negative women.

III.G. Adult ART

Anti-retroviral (ARV) therapy can extend life and improve the quality of life for many people infected with HIV. ARV therapy has restored health to many people and continues to do so after many years. But ARV therapy does not help everyone. Some people have a good reaction (response) initially, but over time the virus becomes resistant to the drugs and the benefits diminish. Others experience such severe side effects that they cannot continue to take the drugs.

AIM can calculate the effects of ARV therapy based on assumptions over time about the proportion of those in need receiving ARVs. ARV therapy is assumed to delay progression to death as long as it is effective. However, some people will develop resistance to ARVs and others may have to stop treatment because of severe side effects. As a result, only a proportion of those on ARV therapy in one year continue the next year. When a person stops ARV therapy, s/he progresses to AIDS death quickly.

Since people with HIV will survive longer if they are on ARV therapy, introducing ARVs will tend to raise prevalence initially as new infections continue to occur and there are fewer deaths. In most cases the prevalence input from EPP or Workbook will be derived from surveillance data collected when ARVs were not available. Thus, both the prevalence input, and the resulting incidence estimate, for now can be considered to represent the situation without ARV therapy. In this case, if incidence remains the same, introducing ARVs will raise prevalence above the input projection. However, if ARVs are already being supplied to significant portions of the HIV-infected population, portions of the historical surveillance data and, thus, the prevalence projection input will include

the effect of ARVs. In this case, the prevalence estimate should not be changed by ARV therapy.

AIM determines the effect of ARV on prevalence in any future year by calculating the cumulative number of AIDS deaths that have been averted by increasing coverage of ART since the current year. These averted deaths result in an increased prevalence as a result of increased ART coverage.

The recommended effects of ART on mortality are derived from cohort studies commissioned by the UNAIDS Reference Group on Estimates, Models and Projections (Dabis et al. Survival of HIV Infected Adults and Children on Antiretroviral Therapy in Low and Middle Income Countries. Institut de Santé Publique, Epidémiologie et Développement (ISPED), Université Victor Segalen, February 2007). They are as follows :

Survival of adults on ART

- First year : 0.85
- Subsequent years : 0.95

At the moment, little information is available on the survival rates on second line ART. Therefore, the same survival rates are currently used for both first and second line. As more information becomes available in the futures, these assumptions will be adjusted.

III.H. Child Treatment

AIM considers two types of treatment for children: cotrimoxazole prophylaxis and ART. WHO recommends that cotrimoxazole be provided to all children born to HIV+ mothers until their status can be determined. With normal antibody tests a child's HIV status cannot be determined until 18 months of age, because the mother's antibodies are present in the child's blood. Therefore, all children born to HIV+ mothers should receive cotrimoxazole until 18 months. After that, WHO recommends cotrimoxazole should be provided to all children who are HIV+. Therefore the need for cotrimoxazole is defined as all children born to HIV positive mothers up to the age of 18 months and all children over 18 months who are HIV positive. If early diagnosis is available, then only HIV+ children are considered in need of cotrimoxazole. The effect is to enhance survival such that 91% of HIV-positive children receiving cotrimoxazole are assumed to survive to the following year. This is based on an analysis of age-specific AIDS-related mortality rates by Newell, *et al.* using data from a trial in Zambia (Chintu, 2004).

ART can also prolong life for infected children. HIV-positive children who have progressed to moderate-to-severe HIV disease are likely to die within 2-3 years if not treated. The default assumption in AIM is that ART can increase annual survival rates as follows:

Survival of children on ART

- Under one year of age: 0.80
- Over one year of age, first year: 0.90
- Over one year of age: subsequent years: 0.95

This is based on an analysis of age-specific AIDS-related mortality rates by Newell, *et al.* (*Dabis, 2007*)

III.I. Treatment Costs

Treatment costs are a combination of two parts:

1. Costs per patient per year – These are the costs for all of the “tangible” tests and treatments ideally used to improve the health of AIDS patients. They include drug and lab costs for AIDS, OI, and associated TB, in addition to nutritional supplements. These costs are then added to....
2. The total cost for service delivery, or the total cost for the hospital and clinic services needed to give the above tests and treatments, in addition to palliative care and medical counseling. The total cost for service delivery is made up of two parts: service delivery cost (which can be thought of as a unit cost for the hospital/clinic services), and service delivery requirements (which can be thought of as the annual number of days in the hospital and number of outpatient clinic visits).

Thus, the total for treatment costs can be thought of mathematically as:

$$\begin{aligned} & \text{Costs per patient per year} \\ & \quad + \\ & \quad (\text{Service delivery cost} * \text{service delivery requirements}) \end{aligned}$$

III.J. Health Sector Impacts

In addition to projecting the number of infections, AIDS cases, and deaths, AIM can also calculate some of the additional impacts of AIDS. In this section you can display the number of young adults deaths (15-49) and the number of expected

cases of tuberculosis. TB cases are projected on the basis of three inputs.

- **TB incidence with HIV (%):** The proportion of people with HIV infection who develop TB each year. Estimated to be 2.3 to 13.3 percent (Cantwell and Binkin, 1997).
- **TB incidence without HIV (%):** The expected adult incidence (per thousand) of tuberculosis each year in the absence of HIV infection. Estimated to be about 2.4 per thousand in Africa.
- **Percent of the population with latent TB.** This is the percentage of the population that has a latent TB infection. It is usually estimated to be around 50% in sub-Saharan Africa.

III.K. Orphans

AIM will estimate the number of AIDS and non-AIDS orphans caused by adult deaths. An orphan is defined as a child under the age of 18 who has lost at least one parent. These estimates are based on the fertility over time and the age at death of the parent. AIM will estimate maternal orphans (children whose mother has died), paternal orphans (children whose father has died), and dual orphans (children whose father and mother have both died). AIDS orphans are children who have lost at least one parent to AIDS. To estimate double AIDS orphans, AIM needs to estimate the proportion of couples with both parents infected with HIV.

In sub-Saharan Africa, this estimation is based on a regression equation using data from national population surveys. To make the estimate more precise, two additional pieces of information are required: the percentage of women aged 15-19 who have not married, and the percentage of married women who are in monogamous unions (Grassly and Timaeus, 2005). Both of these parameters are available from national population surveys for most countries. Table 3 shows values for these two indicators from various DHS reports.

Outside sub-Saharan Africa, the estimation is also based on a regression equation using data from national population surveys. However, the information needed to refine the precision of the estimate focuses on the percentage married and distribution of AIDS deaths for four risk groups: injection drug users, men who have sex with men, sex workers, and the lower risk general population. This is because outside of sub-

Saharan Africa, high-risk groups have lower rates of marriage and are thus less likely to have children.

Table 4. Percent of Women 15-19 Never Married and Percent of Married Women in Monogamous Unions from Various DHS Reports

Country	Percent 15-19 never married	Percent of married women in monogamous unions
Benin 2001	76.1	54.2
Botswana 1988	93.9	
Burkina Faso 2003	67.7	51.6
Burundi 1987	93.2	88.3
Cameroon 2004	66.8	
CAR 1994/95	57.7	71.5
Chad 2004	54.7	60.7
Comoros 1996	88.5	74.7
Congo, Rep. of 2005	80.1	80.5
Cote d'Ivoire 1998/99	74.6	65.0
Eritrea 2002	69.0	
Ethiopia 2005	73.3	
Gabon 2000	77.6	78.0
Ghana 2003	86.3	76.9
Guinea 2005	62.1	46.9
Kenya 2003	79.7	81.2
Lesotho 2004	82.0	
Liberia 1986	64.0	61.9
Madagascar 2003/2004	67.0	96.6
Malawi 2004	63.7	
Mali 2001	51.4	57.3
Mauritania 2000/01	72.3	88.4
Mozambique 2003	56.7	68.4
Namibia 2000	93.9	69.5
Niger 2006	39.3	64.1
Nigeria 66.7	66.7	63.5
Rwanda 2005	97.1	88.8
Senegal 2005	70.2	60.2
South Africa 1998	95.9	87.5
Sudan 1990	84.1	79.6
Tanzania 2004	72.1	
Togo 1998	80.1	57.2
Uganda 2006	77.6	69.3
Zambia 2001/2002	73.0	83.8
Zimbabwe 2005/2006	76.2	

IV. Projection Outputs

AIM will calculate and display a number of indicators grouped under the headings *Total population, Adults, Children, Regional table, AIDS Impacts, Orphans, and Treatment Costs*. A complete list of indicators available and their definitions is given below.

IV.A. Total Population

- **HIV population:** The total number of people who are alive and infected with HIV.
- **HIV age distribution:** The number of infected people, by age and sex. This information can be displayed as a table or a pyramid chart.
- **Number of HIV+ pregnant women:** The number of pregnant women who are infected with HIV. *Note that not all of these women will give birth since some pregnancies will end in miscarriage. The number of HIV+ women giving birth is included in the section on Children 0-14 under the indicator "Mothers Needing PMTCT".*
- **Number of new HIV infections:** The total number of new HIV infections each year.
- **New infections by age:** The number of new infections by age and sex and incidence by age and sex.
- **AIDS deaths:** The annual number of deaths due to AIDS.
- **Cumulative AIDS deaths:** The cumulative number of AIDS deaths since the beginning of the projection.
- **AIDS deaths by age:** The number of AIDS deaths each year by age and sex.
- **HIV/AIDS summary:** A table with a selection of indicators shown for a selection of years. Input assumptions are also shown on this table.

IV.B. Adults (15-49 years old) and Adults 15+

- **HIV population:** The total number of adults who are alive and infected with HIV.

- **Adult HIV prevalence:** The percentage of adults (population aged 15 to 49) who are infected with HIV.
- **Number of new HIV infections:** The total number of new adult HIV infections each year.
- **Adult HIV incidence:** The percentage of uninfected adults who become infected in each year.
- **Annual AIDS deaths:** The annual number of adult deaths due to AIDS.
- **Total need for ART:** The total number of people needing ARV therapy. This includes those newly needing therapy and those who continue successfully on therapy from the previous year.
- **Total number receiving ART:** The number of people receiving ARV therapy.
- **Number in need of first line therapy:** The total need for first line ART.
- **Number newly needing first line ART:** The number of adults progressing to the stage where they need ARV therapy. This is estimated as those within two years of AIDS death if they do not receive ARV therapy.
- **Number receiving first line therapy:** The number currently receiving first line ART.
- **Number receiving second line therapy:** the number currently receiving second line ART.
- **Unmet need for first line therapy** The number needing ART who are not receiving it.
- **Adults 15-49 summary:** A table showing indicators just for adults 15-49.

IV.C. Children (0-14 years old)

- **HIV population:** The total number of children who are alive and infected with HIV.
- **Number of new HIV infections:** The total number of new child HIV infections each year.
- **Annual AIDS deaths:** The annual number of child deaths due to AIDS.
- **Population 0-14:** The number of children between the ages of 0 and 14 years old.
- **Mothers needing PMTCT:** The number of HIV-positive women giving birth each year and, therefore, in need of prophylaxis to prevent HIV transmission to the baby.

- **Children needing cotrimoxazole:** The number of children in need of cotrimoxazole.
- **Children receiving cotrimoxazole:** The number of children receiving cotrimoxazole.
- **Children needing ART:** The number of children who have progressed to moderate-to-severe disease and, therefore, need ART.
- **Mothers receiving PMTCT:** The number of HIV-positive women giving birth and receiving prophylaxis to prevent transmitting HIV to the baby.
- **Children receiving cotrimoxazole:** The number of children receiving cotrimoxazole.
- **Children receiving ART:** The number of children receiving ART.
- **Child summary:** A table showing indicators just for children under the age of 15.

IV.D. Regional Table

- **Regional summary:** If the prevalence trend is read from a file produced by EPP or the Concentrated Epidemic Spreadsheet and this file includes prevalence by region, then AIM will display key indicators by region for any year between 2000 and 2010. The regions are those included in the EPP or spreadsheet file.

IV.E. AIDS Impacts

- **Young adult (15-49) deaths:** The total number of annual deaths occurring to adults between the ages of 15 and 49, inclusive.
- **TB cases:** The annual number of new tuberculosis cases.
- **Impacts summary:** A table showing the number of TB cases, young adult (15-49) deaths, TB incidence without HIV (per 1000), percent of the population with latent TB, and TB incidence with HIV (%).

IV.F. Orphans

- **Maternal AIDS orphans:** Children under the age of 15 who have lost their mother to AIDS.
- **Paternal AIDS orphans:** Children under the age of 15 who have lost their father to AIDS.

- **Dual AIDS orphans:** Children under the age of 15 who have lost both parents to AIDS.
- **All AIDS orphans:** Children under the age of 15 who have lost one or both parents to AIDS.
- **Maternal non-AIDS orphans:** Children under the age of 15 who have lost their mother due to causes other than AIDS.
- **Paternal non-AIDS orphans:** Children under the age of 15 who have lost their father due to causes other than AIDS.
- **Dual non-AIDS orphans:** Children under the age of 15 who have lost both their parents due to causes other than AIDS.
- **All non-AIDS orphans:** Children under the age of 15 who have lost one or both parents due to causes other than AIDS.
- **Maternal orphans:** Children under the age of 15 who have lost their mothers due to any cause.
- **Paternal orphans:** Children under the age of 15 who have lost their father due to any cause.
- **Dual orphans:** Children under the age of 15 who have lost both their parents due to any cause.
- **Total orphans:** Children under the age of 15 who have lost one or both parents due to any cause.
- **Summary by age:** A table showing orphans by type and single age.
- **Summary table:** A table showing all orphans by type and year.
- **Total new orphans:** The number of children newly orphaned each year.
- **Orphans and vulnerable children:** The number of orphans plus vulnerable children. There are several definitions of vulnerable children in use by different agencies. This indicator defines a vulnerable child as one who will become orphaned in the following year. Other definitions, not used here, include children living with a chronically ill adult and/or those living below the poverty line.

IV.G. Treatment Costs

- **First line ARV:** The cost of first-line ARV drugs for all recipients.
- **Second line ARV:** The cost of second-line ARV drugs for all recipients.

- **TB-ARV:** The combined additional cost of ART for all male and female recipients of ARV drugs with TB.
- **Lab tests:** Total lab costs associated with all ART treatment.
- **OI treatment:** Total OI treatment costs.
- **Cotrimoxazole:** The cost of cotrimoxazole for all recipients.
- **TB prophylaxis:** The cost of TB prophylaxis for all recipients.
- **Nutrition:** The cost of nutritional supplements. The assumption is that the target population is those newly receiving ART and malnourished², and therefore that supplementation is for six months.
- **First line service delivery costs:** Total delivery costs for first line ARV for all recipients.
- **Second line service delivery costs:** Total delivery costs for second line ARV for all recipients.
- **Total treatment costs:** The total cost for drugs, labs, and service delivery for prevention and treatment of HIV/AIDS to all those receiving such care in the country.
- **Summary costs:** A table showing all costs by type and year.

² “Malnourished” is defined as prevalence of undernourishment, and is taken from the World Development Indicators online database, available at: <http://web.worldbank.org>

V. Program Tutorial I: Overview

This tutorial covers the key steps in installing and running Spectrum and AIM. It assumes you have a computer running Windows 95 or higher and that you are familiar with the basic operation of Windows programs and terminology.

V.A. Before You Get Started

You will need to collect data and make certain decisions before running the model. [At a minimum you will need an estimate and projection of adult HIV prevalence]. This may come from EPP or the Projections Workbook or some other source. You should also have information on the current coverage of PMTCT and ART programs. For other data needs Spectrum provides default patterns that you can use if you do not have information, but you should review these default patterns to make sure they are appropriate for your application.

V.B. Installing the Spectrum Program

The Spectrum program is distributed on CD-ROMS or through the Internet at <http://www.PolicyProject.com>. It must be installed on a hard disk before it can be used. Spectrum will operate on any computer running Windows 98 or later version. It requires about 30MB of hard disk space.

To install the Spectrum program, follow the directions below.³

Installing from a CD-ROM. Insert the CD-ROM into your CD-ROM drive. The installation program should start automatically. If it does not, Select "Start" from the task bar, then select "Run" from the pop-up menu. In the dialogue box that appears, click on Browse, and find the file SpecInstall.exe. Then press "Ok."

Installing from the internet. Start your internet browser and go to www.PolicyProject.com. Click on "Software" and then "Spectrum." Next click on "Spectrum download (single

³ To remove the Spectrum program from your hard disk, run the unwise.exe program located in the Spectrum directory.

executable file).” From the dialogue box that appears next, select “Save.” Select a location for the file. Once the file has been downloaded, click on that file and follow the instructions.

V.C. Creating a New Projection

V.C.1. Starting the Spectrum Program

To start Spectrum:

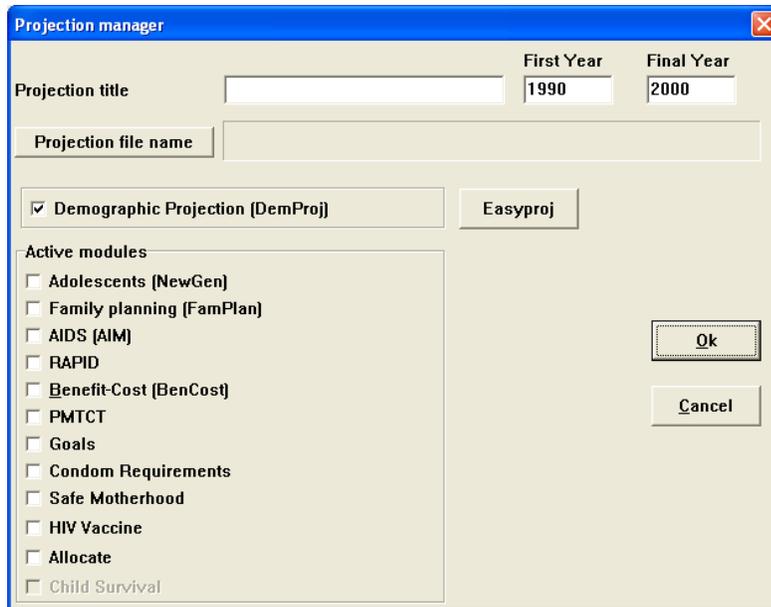
1. Click the “Start” button on the task bar.
2. Select “Programs” from the pop-up menu.
3. Select “Spectrum” from the program menu. Alternatively, you can use Windows Explorer to locate the directory “c:\spectrum” and double click on the file named “spectrum.exe.”
4. If you get an error saying that the gdiplus.dll file is missing you may have to download this file from Microsoft. It is included with Microsoft Office and recent versions of Windows, but may not be on computers with Windows 2000 or 98.

V.C.2. Opening a Demographic Projection with Planned Use for AIM

Before using AIM, you should use DemProj to prepare a demographic projection. DemProj is part of the Spectrum System of Policy Models; for more information, consult its manual. The EasyProj feature allows you to read the demographic inputs from a database prepared by the United Nations Population Division.

AIM in Spectrum requires a demographic projection prepared with DemProj. In a typical AIM application, the demographic projection calculates all the normal demographic processes (births, deaths, migration, aging). AIM influences the demographic projection by adding a number of AIDS deaths and, possibly, specifying a lower fertility rate because of the effects of HIV infection. All the population figures required by AIM (e.g., size of the adult population) are provided by DemProj. Therefore, before using AIM you should prepare a demographic projection using DemProj. For more information on DemProj, consult the DemProj Manual for Spectrum that is a companion to this one, *DemProj: A Computer Program for Making Population Projections*. One easy way to create a demographic projection is to use the EasyProj feature of DemProj. To use this feature, follow these steps:

1. Select “File” and “New projection” from the Spectrum menu.
2. You will see the Projection manager dialogue box. It will look similar to the display shown below:



The following information is displayed.

Once all the information is entered for this dialogue box, click on the “Ok” button. You can always return to this screen and change some of the information by selecting “Edit” from the menu bar and then “Projection” from the pull-down menu.

If you want to change the projection file name, the years, or the demographic projection interval, you will need to do so in DemProj. The options in the Projection manager dialogue box were set when the demographic projection was created with DemProj.

Projection title: This title will be printed at the top of all printed output and will be used to identify the projection if more than one projection is loaded at a time. You can change the title to reflect the projection you are about to prepare.

Projection file name: This is the name that will be used to store all data files associated with this projection. You cannot change the file name here. You can change it if you select “File” and “Save projection as” to save the projection to a new name.

First year: This is the first year of the projection.

Final year: This is the final year of the projection.

Active modules: The check boxes let you select other modules that will be used with the population projection.

3. In the Projection manager dialogue box, fill in the projection title, the first year of the projection and the last year of the projection. It is a good idea to set the first year of the projection to one or two years before the start of the HIV/AIDS epidemic.
4. Check the box next to “AIDS (AIM)” to include the AIM module.
5. Click the “File name” button and enter a file name for this projection. Then click “Save.”

6. Click the “EasyProj” button and select your country from the country list. EasyProj is a special feature that allows you to use data prepared by the United Nations Population Division and published in *World Population Prospects*. If you click on the EasyProj button, the program will prompt you to select a country and ask whether you want to use the UN low, medium, or high projection assumptions. Once you click “Ok,” the program will load the base year population, the total fertility rate, and the male and female life expectancy from the United Nations estimates and projections.
7. Click “OK” to return to the dialogue box and click “OK” once more to complete the set-up process.
8. Select “File” and “Save projection” from the Spectrum menu to save this projection.
9. You can then go to “Edit” and click on “AIM” to begin working in AIM.

V.C.3. Adding the AIM Module to a Previously Prepared Demographic Projection

If a box is shown in gray, you will not be able to change its contents. It means that a projection has been loaded, and the data must remain the same. If you want to create an entirely new projection, you should close the other projections, using “File” and “Close,” and then select “File” and “New.” Users may want to have several projections open in order to examine the effects of changing assumptions.

The first step in adding AIM to a previously prepared demographic projection that did not include AIM as an active module is to open the demographic projection. To do this,

1. Select “File” from the menu bar.
2. From the pull-down menu that appears, select “Open projection.”
3. Select the projection file from the “Open” dialogue box and press “Ok.” All pre-existing projections that can be loaded will be listed here.
4. Once the demographic projection is open, you need to change the configuration to indicate that the AIDS module will be used as well. To do this, select “Edit” from the menu bar and “Projection” from the pull-down menu.
5. You will see the Projection manager dialogue box. Check the box next to “AIDS (AIM)” to include the AIM module.
6. Click “OK” to complete the set-up process.
7. Select “File” and “Save projection” from the Spectrum menu to save this projection.

8. You can then go to "Edit" and click on "AIM" to begin working in AIM.

V.D. Saving the Projection

It is always a good idea to save the projection whenever you make a change to any assumptions. To save the projection without changing the name, choose "File" from the menu bar and "Save projection" from the pull-down menu.

To save the projection with a different name, choose "File" from the menu bar and "Save projection as" from the pull-down menu. You will then have a chance to specify a new file name for the projection. Normally when you save the projection with a new name, you should also change the projection title. This step will avoid confusion if you have both projections loaded at the same time.

V.E. Opening an Existing Projection

If you have already created an AIM projection or are using a projection provided by someone else, you can immediately load that projection.

1. Select "File" from the menu bar.
2. Select "Open projection" from the pull-down menu.
3. Select the file you wish to use and click the "Ok" button to open the projection.

You can open more than one projection at a time. Simply repeat these steps to load a second, third, or even up to ten projections. When you have more than one projection loaded, all projections will be displayed in the graphs and tables. The number of projections you can load at any one time is determined by the amount of available memory in your computer.

When you have more than one projection loaded, you will be asked to choose a projection when performing certain tasks, such as editing assumptions. The program will display a list of the projection names and you may choose the appropriate one from the list.

V.F. Closing a Projection

To close a projection that has already been opened,

1. Choose "File" from the menu bar and
2. "Close projection" from the pull-down menu. If you have more than one projection loaded, you will be asked to select which projection should be closed.

Closing a projection merely removes it from the computer's memory; it does not erase it from the hard disk. You can open that projection again at any time.

VI. Program Tutorial II: Projection Editors

VI.A. Entering the Projection Inputs Using Editors

For readers who feel they need additional review or explanations of the terms found in this section, Chapter III and the glossary of this manual may be useful.

VI.A.1. About the Editors: Editor Screen Format

The editors are similarly formatted screens which allow you to enter and/or edit the inputs on which a projection is based. At the bottom of the editor are special function buttons which will more easily allow you to work within the cells of the editor when entering data. "Duplicate" allows you to copy information from one cell, column, or row to another; "Interpolate" to enter a beginning and ending number and have the computer calculate the numbers for the intervening intervals; "Multiply" to multiply a cell, column or row by a specific number; and "Source" to write notes indicating the source of the data for future reference.

To use the "Duplicate" button,

1. Highlight (select) the range (column, row, or cells to be affected). The first cell in the range should be the value you want to copy.
2. Extend the range to the last year by using the mouse (hold down the left button and drag the range) or the keyboard (hold down the shift key and use the arrow keys).
3. Click on the "Duplicate" key to copy the value at the beginning of the range to all the other cells in the range.

To use the "Interpolate" button,

1. Enter the beginning and ending values in the appropriate cells.
2. Highlight the entire range from beginning to end.
3. Click on the "Interpolate" key to have the values interpolated and entered into each of the empty cells.

To use the “Multiply” button,

The multiply button is found only in the “First year population” editor under Demographic Data in DemProj. It is useful when entering the populations by age for the base year. It can be used to scale the population for each age and sex by the same amount. This can be useful to estimate the base population for a district if you only have the total population.

1. Highlight the range (column, row, or cells to be affected).
2. Enter the multiplier in the dialogue box.
3. Click “Ok” to accept. The entire range will be multiplied by the designated number.

To use the “Source” button,

1. Click on the “Source” button to open a small word processor window.
2. Enter the source of the data and make any special comments about the assumptions.
3. Click on “Close” to return to the editor.

This feature allows you to keep a record of the data sources and assumptions as you make the projections. This source information will be maintained with the data file and printed whenever you print the projection summary. It is **strongly** recommended that you use this feature to avoid later confusion.

To use the “Cancel” and “Ok” buttons,

The “Cancel” or “Ok” button are usually used only when data has been input for all editors in a variable grouping. Therefore, please see page 53 (which follows the directions for the input to all editors in the variable groupings) for more information.

VI.A.2. About the Editors: Organization of the Editor Screens

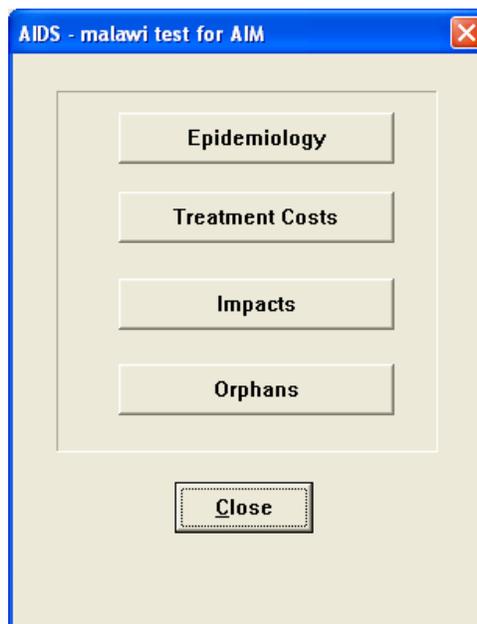
The editor screens are organized by input variable, each of which is labeled on a tab at the top of the editor. The editor for that variable is brought to the foreground when its tab is clicked on, and it becomes active when the actual editor screen is clicked on.

The variable tabs and the editor screens they house are found within four variable groupings listed in the AIDS dialogue box: Epidemiology, Treatment costs, Impact, and Orphans.

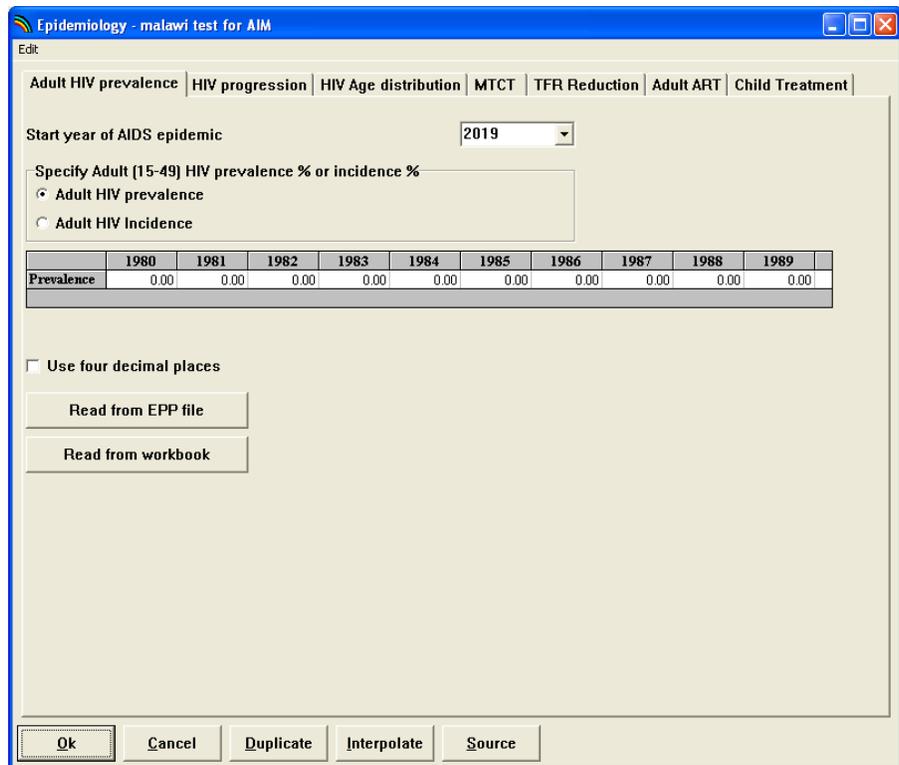
Instructions on how to access and utilize the AIDS dialogue box, the variable groupings, and the editors for each variable follow below.

VI.B. Epidemiology

1. Choose "Edit" from the menu bar.
2. Choose "AIDS (AIM)" from the pull-down menu. This step will display the AIDS dialogue box, as shown below.



3. Choose "Epidemiology" from the "AIDS" dialogue box. This step will display an editor like the one shown below.

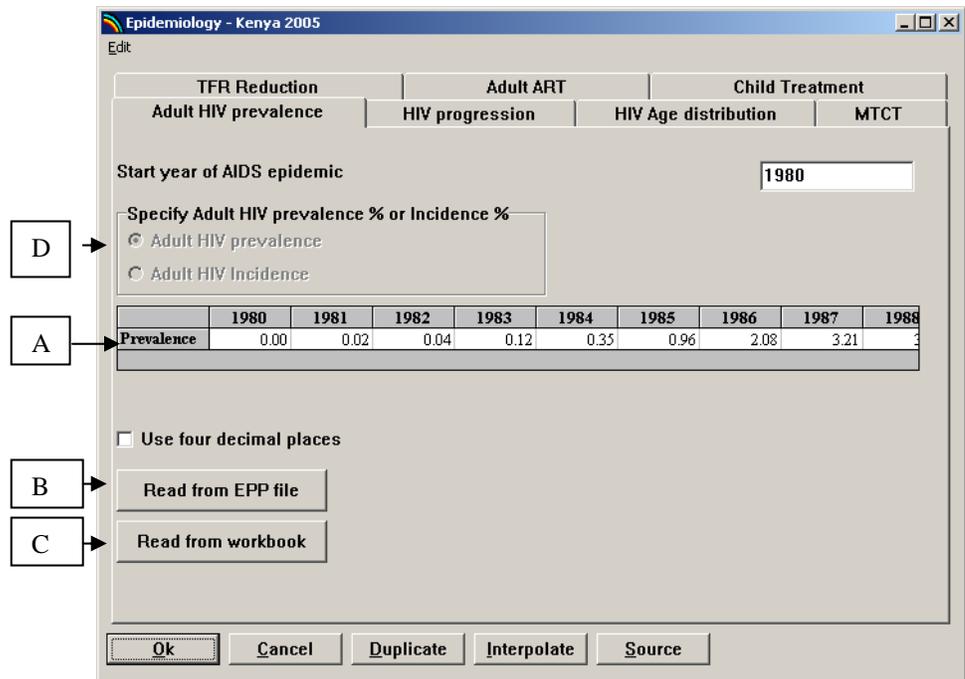


To review, for all inputs required for the projection, there is an editor screen headed by a variable tab near the top of the screen.

1. To enter data for any of these inputs, click on the appropriate variable tab to display the editor for that variable.
2. Then click anywhere inside the editor [screen] to make it active.

VI.B.1. Epidemiology: Adult HIV Prevalence

This tab allows you to enter the adult HIV prevalence or adult HIV incidence. If you are entering prevalence, it can be done in several ways after first clicking the “Adult HIV prevalence” radio button indicated by box “D”:



A. Enter the prevalence manually by typing the values in the editor. You can copy a value to several years by selecting the value and the years to copy to and pressing the “Duplicate” button. You can interpolate between two years by outlining the range, including the first and last year, and pressing the “Interpolate” button.

B. Read the prevalence estimate and projection from EPP. Click the button “Read from EPP file.” This will display a “file open” dialog box. Navigate to the directory where your EPP file is stored (for example C:\Program files\EPP2\epout), select the appropriate file and click “Open” to complete this step. The prevalence projection from this file will be read into Spectrum and displayed in the editor. If you have made regional projections for your country (i.e. urban/rural or by province), then you can also read this information. You must have saved your EPP data as a CSV file first. Click the button “Read from EPP file.” This will display a “file open” dialog box. Navigate to the directory where your EPP is stored, select the appropriate file and click “Open.” This regional projection from this file will be read into Spectrum.

- C. Read the prevalence from the Workbook. Click the button "Read from workbook." This will display a "file open" dialog box. Navigate to the directory where your Workbook file is stored (for example C:\Country files\projection), select the appropriate file and click "Open" to complete this step. The prevalence curve from this file will be read into Spectrum and displayed in the editor.

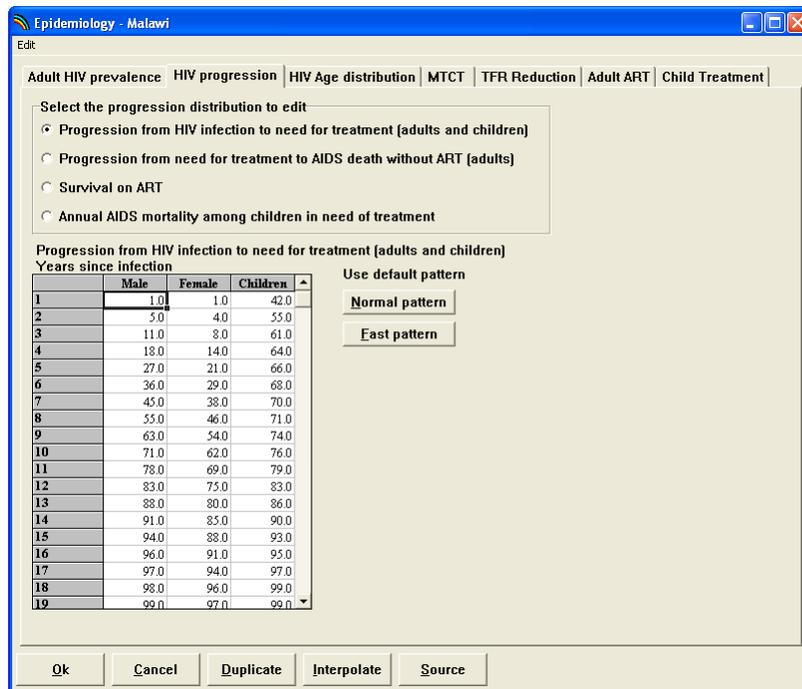
Incidence

To enter incidence data, first click the "Adult HIV incidence" radio button, and then proceed to enter the data manually. You will see that you cannot use the "Read from EPP file" or "Read from workbook" buttons, as those options only contain prevalence data.

If you have manually entered the information in the "Adult HIV prevalence" editor, click the "HIV/AIDS progression" tab to move to the next editor. If you used the "Read from EPP file" or "Read from workbook" options, click the "HIV/AIDS parameters" button and then click the "HIV/AIDS progression" tab to move to the next editor.

VI.B.2. Epidemiology: HIV Progression

AIM requires a distribution of the progression period, described as the cumulative percentage of HIV-infected individuals progressing to need for treatment by the number of years since they acquired the infection. The editor for this data entry is shown below.



You may enter your own data or choose from the default patterns to the right of the editor. These buttons provide several default distributions for both adults and children. Click on the desired option, and the corresponding distribution will be entered into the editor.

When you have entered the information on progression to need for treatment, click on the second radio button to see the pattern of progression from need for treatment to AIDS death.

The third radio button shows the recommended assumptions about the annual survival on ART.

The fourth button shows the recommended pattern for mortality among HIV+ children in need of treatment who do not get treatment.

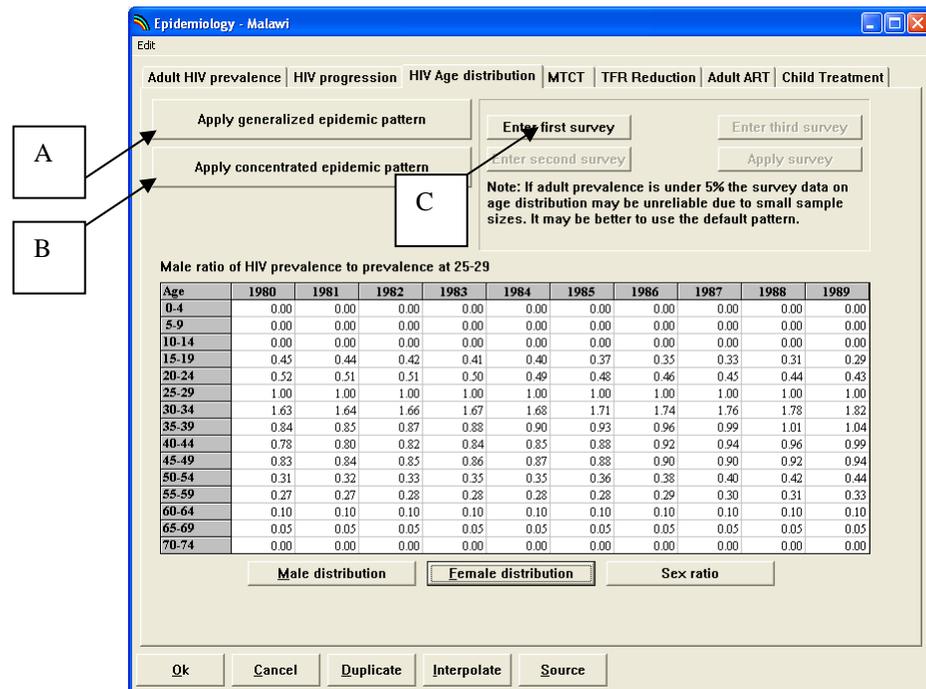
- ❖ **Please note:** Default values are provided for all of these inputs and should normally be used.

When you have entered the information on “HIV progression” editor, click the “HIV Age distribution” tab to move to the next editor.

VI.B.3. Epidemiology: Age Distribution of HIV Prevalence

Select the tab “HIV Age distribution” and the following screen will appear. This editor shows the age distribution of

prevalence for males and females and the ratio of female to male prevalence over time.



Here you have three options to enter the input for HIV prevalence by age and sex:

- A. If your country has a generalized epidemic you should click the button "Apply generalized epidemic pattern." This will insert the default age and sex pattern for generalized epidemics.
- B. If your country has a low level or concentrated epidemic, you should click the button, "Apply concentrated epidemic pattern." This will insert the default age and sex pattern for low level and concentrated epidemics.
- C. If you have had a recent DHS or other general population survey that reported HIV prevalence by age and sex, then you can enter this information by clicking the "Enter DHS data button." Enter the prevalence by age and sex and specify the year of the survey. The program will automatically adjust the pattern in the editors to match the survey data in that year. Data for all other years will be adjusted proportionately. You can enter up to three surveys.

The information that is input can be viewed in one of three tables:

- A. Click the button "Male distribution" to view the male ratio of HIV prevalence % to prevalence % at 25-29.
 - B. Click the button "Female distribution" to view the female ratio of HIV prevalence % to prevalence % at 25-29.
 - C. Click the button "Sex ratio" to view the ratio of female to male prevalence at 15-49.
- ❖ *Please note: If, after completing the data entry for the "HIV Age distribution" editor and exiting the editor you at some point later change the prevalence/incidence data in the "Adult HIV prevalence" editor, you will need to come back to the "HIV Age distribution" editor and re-click on the default epidemic pattern appropriate for your country. This is because when you change the prevalence/incidence data in the "Adult HIV prevalence" editor, the start year of the epidemic will change. Re-clicking on the default epidemic pattern appropriate for your country in the "HIV Age distribution" editor will ensure that the age distribution curves are adjusted appropriately to the revised epidemic start year.*
- ❖ *Please also note: The sex ratio of female to male (15-49) is a default curve for the prevalence. If you originally input incidence into the "Adult HIV Prevalence" editor, there are three ways you can use the sex ratio of female to male prevalence to find the sex ratio for incidence:*
1. *You may assume that the sex ratio of incidence is the same as prevalence. They are not a perfect match, but are usually not too far from each other either.*
 2. *Look at the output (Display) for the sex ratio for prevalence by Male and Female, use it to manually calculate incidence, and then re-enter back into the editor for "Age Distribution of HIV Prevalence" editor under sex ratio.*
 3. *Once in the "Age Distribution of HIV Prevalence" editor, click on the "Apply generalized epidemic pattern" to get the default pattern. Then click "Apply survey" to adjust it for the DHS pattern from the survey you entered. Then you should be able to run the projection and get the correct output.*

When you have entered the information on "HIV Age distribution" editor, click the "MTCT" tab to move to the next editor.

VI.B.4. Epidemiology: MTCT

Select the tab "MTCT" and the following screen will appear:

A

Distribution of HIV+ pregnant women by treatment regimen		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
No treatment		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Single dose nevirapine											
Number		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dual prevention ARV											
Number		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triple prevention ARV											
Number		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total											
Number		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

B

Distribution of HIV+ mothers by infant feeding method		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Mixed feeding		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Number		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Exclusive breastfeeding											
Number		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Replacement feeding											
Number		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total											
Number		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

C

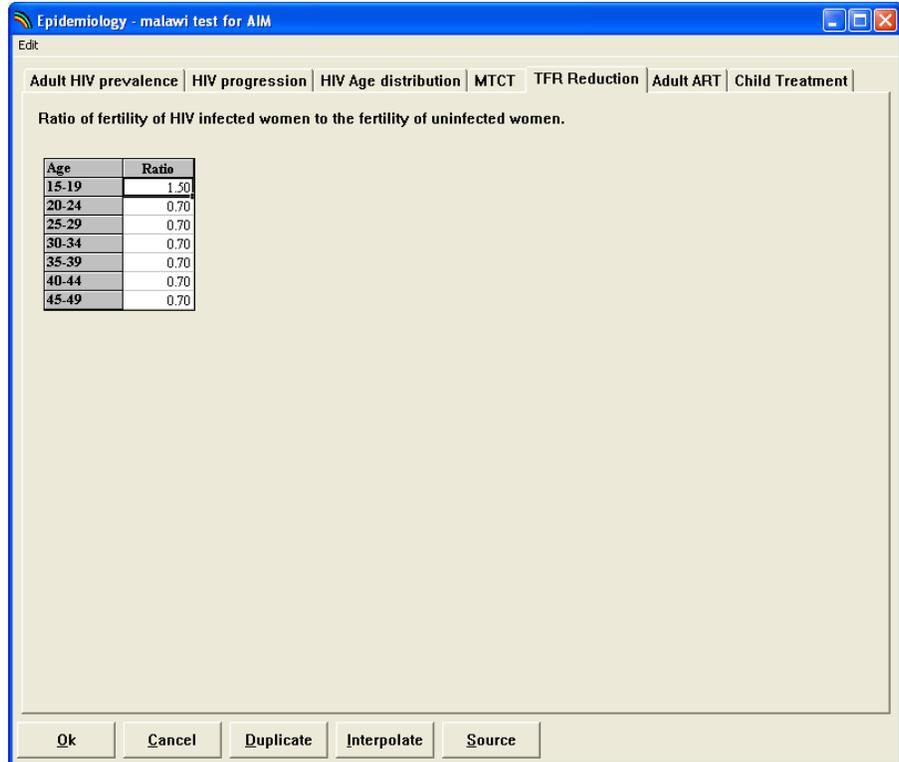
You need to specify the type and scope of the program.

- Enter the number of HIV+ women receiving single dose Nevirapine, dual prevention ARV or triple prevention ART. The top row, No treatment, will automatically update to show those not receiving any treatment. You can also enter the number of women receiving treatment instead of the percent, but you can not mix percents and numbers in the same year
- Enter the number or percentage of HIV+ mothers that practice mixed feeding, exclusive breastfeeding or replacement feeding.
- By clicking on the "Edit" button you can see the transmission probabilities associated with each treatment and infant feeding option. You can also set the average duration of breastfeeding for all women by clicking one of the choices (<=6 months, 7-17 months, or 18+ months).

When you have entered the information in the "MTCT" editor, click the "TFR Reduction" tab to move to the next editor.

VI.B.5. Epidemiology: TFR Reduction

The next editor specifies the ratio of fertility among women who are HIV-positive to those who are HIV-negative. The default values are a 50 percent increase for women 15-19 (due to a higher proportion of HIV-positive women being sexually active) and a 30 percent reduction for all other women. If you know the ratios by age group for your country, you may enter those manually rather than using the default values given.



Age	Ratio
15-19	1.50
20-24	0.70
25-29	0.70
30-34	0.70
35-39	0.70
40-44	0.70
45-49	0.70

When you have decided to use the default values, or you have completed entering in your own values in the "TFR Reduction" editor, click the "Adult ART" tab to move to the next editor.

VI.B.6. Epidemiology: Adult ART

Select the Adult ART tab and you will see a screen that looks like the one below. Here you can describe the scope of antiretroviral treatment.

	1980	1981	1982	1983	1984	1985	1986	1987
Number of adults receiving ART	0	0	0	0	0	0	0	0
Percent of adults in need receiving ART	0	0	0	0	0	0	0	0
Percent of adults failing on first line therapy who receive second line therapy								
Percent	0	0	0	0	0	0	0	0

- A. Number or percent receiving ART. Enter the number of adults or the percentage of those in need that receive ART each year. You can not enter both a number and a percent in the same year. You may enter service statistics (actual #s) on the number receiving ART for past years and use the target (a % coverage) from the national strategic plan or universal access plan for the future.
- B. By default, Spectrum assumes that new ART patients will be distributed by age and sex according to need. If you want a different distribution select the radio button for "Specify the distribution" and click the "Enter Custom Distribution" button to enter the distribution data.
- C. Set a future target. You can enter a future target for ART coverage and interpolate between the current year and the final year just as you would in any other Spectrum editor. But you also have other options in this editor. You can select any of the radio buttons and fill in the required information to project linear trends, achieve a target in the final year or estimate the reduction in unmet need. Once you set the

parameters of your projection method, click the Re-Calc button to see the results. These are default values based on review of current literature.

When you have entered the information in the “Adult ART” editor, click the “Child Treatment” tab to move to the next editor.

VI.B.7. Epidemiology: Child Treatment

Select the “Child treatment” tab and you will see a screen that looks like the one below. Here you can describe the type and scope of child treatment.

Adult HIV prevalence | HIV progression | HIV Age distribution | MTCT | TFR Reduction | Adult ART | Child Treatment

Specify the percentage of children (0-15) receiving treatment
or the number of children receiving treatment
Enter only one number for each year.

	1980	1981	1982	1983	1984	1985	1986	1987	1988
Number receiving cotrimoxazole	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent receiving cotrimoxazole	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Number Receiving ART	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent Receiving ART	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Effectiveness of cotrimoxazole by years on prophylaxis

	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8
Reduction in mortality rate due to cotrimoxazole	0.33	0.33	0.33	0.33	0.17	0.00	0.00	

Is early diagnosis of HIV-infection available?
 Yes
 No

Ok Cancel Duplicate Interpolate Source

- A. **Percent or number of children born to HIV+ mothers receiving cotrimoxazole.** Enter the percentage or number of children needing cotrimoxazole who receive it. Children needing cotrimoxazole are defined as all children aged 0-18 months born to HIV+ mothers and all children aged 18 months to 15 years who are HIV+.
- B. **Percent or number of children in need of ART receiving ART.** Enter the percent or number of HIV+ children with moderate-to-severe HIV disease who are receiving ART.

- C. **Effects of treatment.** This editor shows the recommended values for the reduction in mortality caused by cotimoxazole by the duration of treatment.
- D. **Early diagnosis.** With the typical antibody tests in use in most developing countries, children born to HIV+ mothers cannot be diagnosed as HIV+ until the age of 18 months. Therefore, cotrimoxazole is recommended for all children born to HIV+ mothers until their own status can be determined, and ART is generally not recommended until HIV+ status can be confirmed. Early diagnosis of HIV is possible with PCR tests. If early diagnosis is available then ART can start earlier.

When you have finished entering the necessary data into the editors for all variable tabs,

1. Click the "Ok" button to return to the "AIDS" dialogue box. When you click the "Ok" button, the program will record your changes and return to the "AIDS" dialogue box.
2. Click the "Close" button to complete the editing process.

The "Cancel" button allows you to exit the editor without making any changes to the data. This action will exit the AIDS editors and restore all inputs to their values before you entered the AIDS editors. Any changes you made during the current editing session will be lost.

VI.C. Treatment Costs

To enter the input on impact for the AIDS projection,

1. Choose "Edit" from the menu bar.
2. Choose "AIDS (AIM)" from the pull-down menu.
3. Select "Treatment costs" from the AIDS dialogue box.
4. Click on the variable tab for which you want to enter data into the editor.

VI.C.1. Treatment Cost: Cost per patient per year

Select the "Cost per patient per year" tab and you will see a screen that looks like the one below.

Treatment Costs - malawi test for AIM

Costs per patient per year | Service delivery costs | Service delivery requirements (per patient per year)

	1980	1981	1982	1983	1984	1985	1986
First line ART drugs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Second line ART drugs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional ART drug costs for TB patients (male)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Additional ART drug costs for TB patients (Female)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lab costs for ART treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Drug and lab costs for opportunistic infections	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cotrimoxazole prophylaxis	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TB prophylaxis	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nutrition supplements in first six months	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Buttons: Ok, Cancel, Duplicate, Interpolate, Source

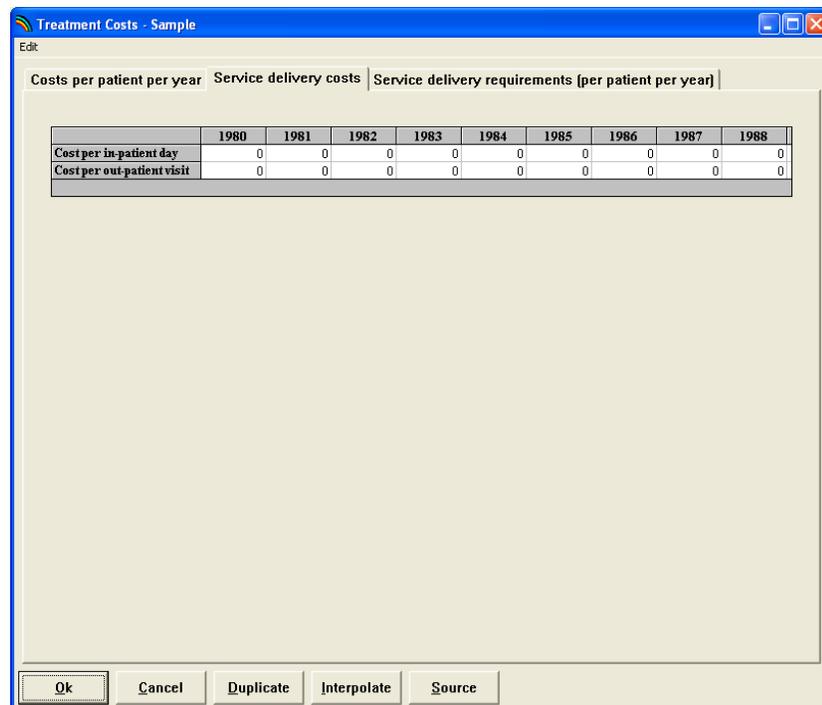
- A. Enter in the cost for the cost of first and second line ART drugs in your country. Further information on drug costs can be found in the WHO, UNAIDS, and UNICEF publication "Towards Universal Access: Scaling up Priority HIV/AIDS Interventions in the Health Sector (April 2007)", available at: http://www.who.int/hiv/mediacentre/universal_access_progress_report_en.pdf
- B. If it is possible in your country to follow the WHO recommendations regarding a change of ART drugs for male (substituting efavirenz for nevirapine) and female (substituting abacovir for nevirapine) TB patients, the costs for those ART drugs will be higher than in non-TB patients. Please see the WHO publication "Antiretroviral therapy for HIV Infection in Resource-Limited Settings: Toward Universal Access (2006 revision)" for more information.
- C. Enter the lab costs for ART treatment. If you do not have data for your country, you may refer to the chart in the following section on service delivery requirements.

- D. Enter the drug and lab costs for opportunistic infections. You may include the drug costs for palliative care with the costs for opportunistic infections.
- E. Enter the cost for cotrimoxazole.
- F. Enter the cost for TB treatment.
- G. Enter the cost of nutrition supplements if given in your country for the treatment of HIV/AIDS. The assumption is that the target population is those newly receiving ART and malnourished, and therefore that supplementation is for six months.

When you have entered the information in the “Costs per patient per year” editor, click the “Service delivery costs” tab to move to the next editor.

VI.C.2. Treatment Cost: Service delivery costs

Select the “Service delivery costs” tab and you will see a screen that looks like the one below:



1. Enter your national data for “cost per in-patient day.” This assumes one bed day at a primary-level hospital.

2. Enter your national data for “cost per out-patient visit.” This assumes one 20-minute outpatient visit at a health centre.

Current data on service delivery costs by country may also be obtained from the WHO-CHOICE database, found online at: <http://www.who.int/choice/en/>

VI.C.3. Treatment Cost: Service delivery requirements (per patient per year)

Select the “Service delivery requirements” tab and you will see a screen that looks like the one below:

	1980	1981	1982	1983	1984	1985	1986	1987	1988
ART: in-patient days	0	0	0	0	0	0	0	0	0
ART: out-patient visit	0	0	0	0	0	0	0	0	0
OI treatment: in-patient days	0	0	0	0	0	0	0	0	0
OI treatment: out-patient days	0	0	0	0	0	0	0	0	0

1. Enter in the average annual number of in-patient days and out-patient visits needed for ART treatment.
2. Enter in the average annual number of in-patient days and out-patient visits needed for treatment for OI.

For reference, you may refer to the following chart which is a compilation of the available studies published on the subject of in-patient days and out-patient visits for ART and OI. You may be able to see your country represented, or choose to look at the averages that were compiled from the compilation of the studies. *Please be aware however, that this chart is not intended as a substitute for country specific

data if you have it available. As you will see, there are few studies, with wide variability between them.

Table 5. Service Delivery Requirements for ART and OI

Country	ARV 1st Line			OI			Source
	#OPV	#IPD	Lab cost (USD)	#OPV	#IPD	Drug/lab cost (USD)	
Cote d'Ivoire			\$51.98			\$131.16	Goldie SJ, Yazdanpanah Y, Losina E, et al., "Cost-Effectiveness of HIV Treatment in Resource-Poor Settings - The Case of Côte d'Ivoire." NEJM 355;11(1141-1153).
Ethiopia	9		\$207.44				G Kombe, D Galaty, R Gadhia, C Decker. The Human and Financial Resource Requirements for Scaling Up HIV/AIDS Services in Ethiopia. PHRPlus, Feb 2005.
Mexico	10	12.17	\$366.00	6.2	9.7	\$48.67	Bautista SA, Dmytraczenko T, Kombe G, Bertozzi SM. "Costing of HIV/AIDS Treatment in Mexico." PHRPlus report, June 2003.
Nigeria	12		\$204.00				PHRPlus. Nigeria: Rapid Assessment of HIV/AIDS Care in the Public and Private Sectors. August 2004.
Rwanda				29.28	68.64	\$39.86	P Vinard, B Nzigiye, S Rugabirwa. Etude sur le cout de la prise en charge des PVVIH. Prejet Int/107 - Initiative ESTHER en collaboration avec la CNLS. Dec 04-Mar 05.
South Africa	5.62	0.45	\$37.00	3.0	4.5		Cleary SM, McIntyre D, Boule AM. "The cost-effectiveness of Antiretroviral Treatment in Khayelitsha, South Africa - a primary data analysis." Cost Eff Resource Alloc 2006, 4:20, available at http://www.resource-allocation.com/content/4/1/20 .
South Africa	8.17	1.56		5.48	9.56		Badri M, Maartens G, Mandalia S, Bekker LG, Penrod JR, et al. (2006) Cost-Effectiveness of Highly Active Antiretroviral Therapy in South Africa. PLoS Med 3(1): e4 doi:10.1371/journal.pmed.0030004.
Thailand	12		\$459.20		19.2		Katajima T, Kobayashi, Y, Chaipah W, Sato H, Chadbunchachai W, Thuennadee R. "Costs of medical services for patients with HIV/AIDS in Khon Kaen, Thailand." AIDS 2003 Nov 7;17(16):2375-81.
Uganda	12		\$74.00	2.77		\$53.63	Chandler R, Decker C, Nziyige B. "Estimating the Cost of Providing Home-based Care for HIV/AIDS in Rwanda." PHRPlus paper June 2004.
Zambia	4		\$177.88			\$42.25	Kombe G, Smith O. "The Costs of Anti-Retroviral Treatment in Zambia." PHRPlus October 2003. Huddart J, Furth R, Lyons JV. "The Zambia Workforce Study: Preparing for Scale-up." April 2004; available at www.qaproject.org .
Median	9.5	1.56	\$190.94	5.475	9.7	\$48.67	

VI.D. Impacts

To enter the input on impact for the AIDS projection,

1. Choose "Edit" from the menu bar.
2. Choose "AIDS (AIM)" from the pull-down menu.
3. Select "Impacts" from the AIDS dialogue box. This step will display an editor like the one shown below.

	1980	1981	1982	1983	1984	1985
TB incidence without HIV (per 1000)	2.40	2.40	2.40	2.40	2.40	2.40
Percent pop with latent TB	50.00	50.00	50.00	50.00	50.00	50.00
TB incidence with HIV (%)	8.00	8.00	8.00	8.00	8.00	8.00

Please note that "Impacts" contains only the variable TB and thus it contains a single editor. Default values can be changed if better information is available

1. Click somewhere inside the editor to make the scroll bar appear.
2. Scroll to the right or left to see all the years and enter the data.

VI.E. Orphans

AIM needs two additional parameters to calculate AIDS orphans. These are the percentage of women 15-19 that have never been married and the percentage of married women 15-49 that are in monogamous unions. These parameters are required to estimate dual AIDS orphans. For many countries they can be obtained from DHS reports. Values for many countries are given in Table 4.

To enter the input on orphans for the AIDS projection,

1. Choose "Edit" from the menu bar.
2. Choose "AIDS (AIM)" from the pull-down menu.
3. Select "Orphans" from the AIDS dialogue box. This step will display an editor like the one shown below.

	Percent
% women 15-19 never married	71.00
% married women in monogamous unions	71.00

Either enter in your own country data, or choose one of the three default patterns:

1. Choose the "Sub-Saharan Africa" default pattern if your country is in sub-Saharan Africa.
2. Choose "Outside Sub-Saharan Africa" if your country is outside sub-Saharan Africa and does not follow the generalized epidemic pattern found there.
3. Choose "Use Sub-Saharan Africa default pattern" if your country is outside sub-Saharan Africa, but does have a generalized epidemic pattern similar to that found in sub-Saharan Africa.

Saving the Input Data

Once you have entered the projection inputs, it is a good idea to save the data onto your hard disk. To do this, select "File" from the menu bar and "Save projection" from the pull-down menu. The data will be saved using the file name you specified earlier.

VII. Program Tutorial III: Display

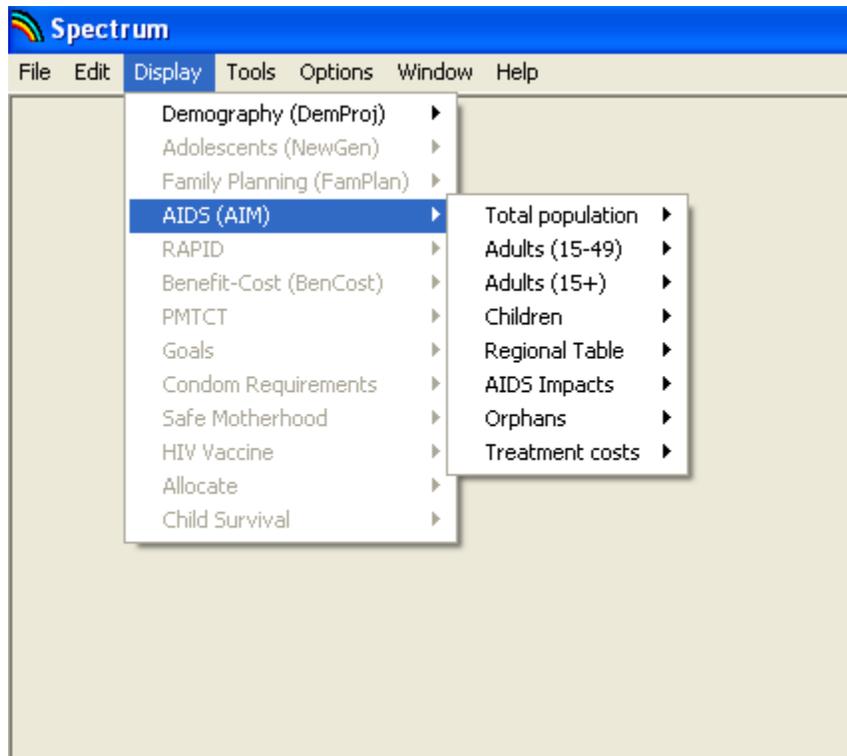
VII.A. Making the Projection

Whenever you enter data for a new projection or edit the variables, Spectrum will note that the data have been changed. The next time you try to display an indicator, it will inform you that the data may have changed and ask if you want to recalculate the projection. Normally, you should answer "Yes" to this question. Spectrum will then make the projection. This step may take only a few seconds or much longer, depending on the length of the projection and the number of modules being used. Once the projection is made, you will not be asked if you want to project the population again, unless you edit the variables.

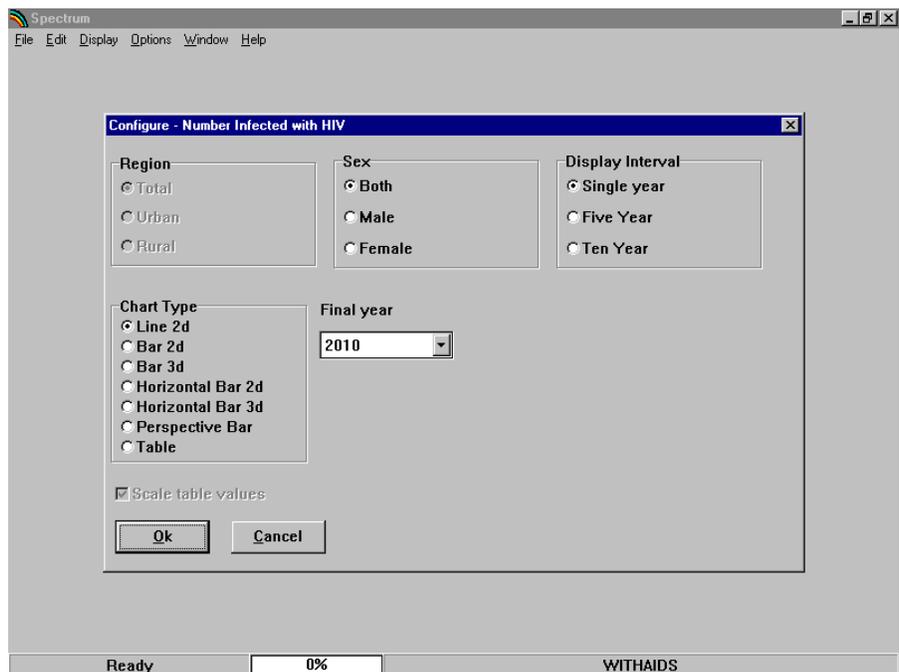
VII.B. Examining the Output

To see the results of the projection, select "Display" from the menu bar. From the pull-down menu select "AIDS." You will then see another menu showing the categories of indicators available:

- Total population
- Adults
- Children
- Regional table
- AIDS Impacts
- Orphans
- Treatment costs

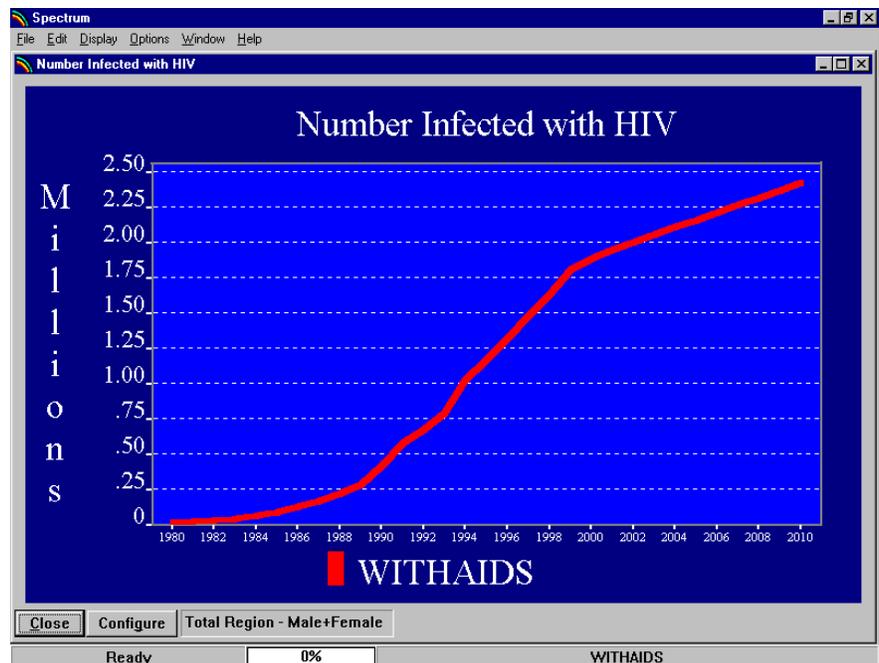


Choose one of these categories and you will see one final menu listing the indicators available in that category. Select one of the indicators. Then you will see the display dialogue box. It will look similar to the one shown below.



The exact choices available will depend on the indicator you have selected. For "Number infected with HIV," sex can be set to "Both," "Male," or "Female." The display will normally be in single years but you can change it to display every five or ten years if desired. The chart type is also set through this dialogue box. Click on the button next to the type of display you want. Normally the display will show all the years in the projection. However, if you want to see only part of the projection, you can change the final year by selecting a new final display year from the "Final year" list box.

Once you are satisfied with the type of display, click the "Ok" button and the display will appear. It will look similar to the display shown below.



All the projections that are currently in use will be displayed on the same graph.

You can change the configuration of the display by clicking the "Configure" button. You can also change the type of display by placing the mouse pointer anywhere inside the chart and clicking with the right mouse button.

To close the display, click on the "Close" button. You do not have to close the display immediately. You can choose to display another indicator and it will appear on top of the first display. The first display will be covered but it will still be there. You can return to any previous display that you have not closed by choosing "Window" from the menu bar and

selecting the name of the display from the pull-down menu. From the "Window" selection you can also choose to tile or cascade all the existing display windows.

VII.B.1. Graphs and Bar Charts

Spectrum will display a variety of graphs and bar charts, including:

- Line charts
- Two- and three-dimensional bar charts (column charts)
- Two- and three-dimensional horizontal bar charts
- Two- and three-dimensional overlap bar charts (bars for multiple projections are shown on top of one another)
- Three-dimensional perspective bar charts.

To print the active chart, select "File" from the menu bar and "Print" from the pull-down menu.

VII.B.2. Tables

Spectrum will also display data in the form of tables. In tables, each projection that is in use will be displayed in a separate column. You can scroll through the table to see all the years by using the PgUp and PgDn keys or by using the mouse.

To print a table, select "File" from the menu bar and "Print" from the pull-down menu.

VII.B.3. Displaying All Age Groups

If you wish to see the number of people with AIDS by age and sex, choose "Display," "AIDS (AIM)," "Epidemiology," and then "AIDS age distribution."

You can display the information as a table, "Summary table," or as a population pyramid showing either numbers of people ("Pyramid (numbers),") or the percent distribution by age and sex ("Pyramid (percent)").

The pyramid display always shows two pyramids. If you are using a single projection, then the pyramids on both the left and the right will be for the base year. You can change the year for the pyramid on the right by clicking one of the buttons at the bottom of the screen to advance the pyramid one year ("Next"), show the previous year ("Previous"), show the first year ("First year"), or show the last year ("Last year").

If you have two projections loaded, then the pyramid on the left will display the first projection and the one on the right will show the second projection. Both pyramids will display the same year.

If you have more than two projections loaded, you will be asked to choose which two pyramids should be shown before the pyramids appear.

VII.B.4. Summary Tables

The final choice in each section is a summary table showing all the indicators and input assumptions. You can scroll through this page to see all the output. If you have more than one projection loaded, the indicators for the second projection will immediately follow the first. To print a table, select "File" from the menu bar and "Print" from the pull-down menu.

VIII. Program Tutorial IV: Tools

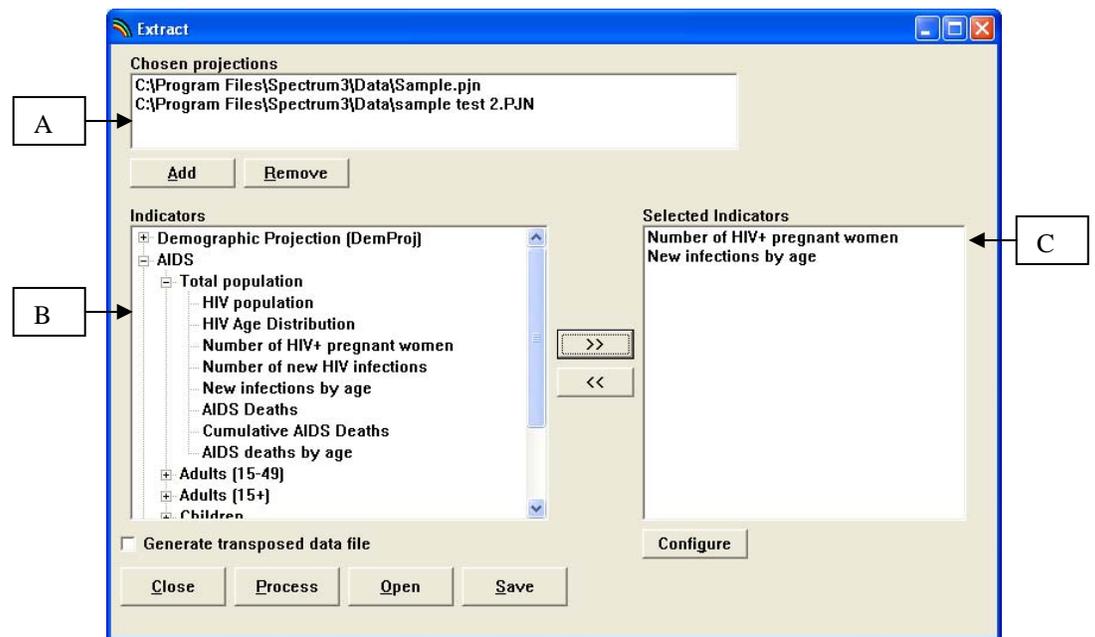
VIII.A. Tools

The tools in AIM allow for further use of the data generated while creating projections.

- The extract feature enables you to extract the projected data from a previous projection (or multiple previous projections) on one or more indicators. The extracted data is then saved to a CSV file, and can be imported into excel for further analysis. An example would be to use the extract feature to extract the data for “Mothers Needing PMTCT” and “Mothers Receiving PMTCT” for both Brazil and Mexico into an excel table all at once.
- The aggregate feature enables you to extract and *combine* projected data from two or more previously saved projections into one new projection that will be weighted appropriately by Spectrum. The data from that new projection can then also be extracted to excel for further analysis if so desired. An example of the use of the aggregate feature would be to aggregate the data across all countries in the East Africa to project for “Total Need for ART (15+)” in the region as a whole.
- The scenario generator feature enables you to vary the targets for PMTCT, Infant Feeding, Adult ART, and Child Treatment in order to project the course of the epidemic following and increase or decrease in the above targets (and thereby effort to achieve them).
- The uncertainty analysis feature will enable you to estimate the uncertainty associated with each variable. This analysis estimates the plausible range of values associated with each Spectrum variable.

VIII.A.1. Extract

After entering Spectrum, go to “Tools” and click on “Extract” from the drop-down menu. (**Note:** You can not use the Extract function if you have a projection file open. If the “Extract” menu appears in grey, select “File” and “Close Projection” to close the projection. Then you should be able to select “Extract”.) An “Extract” window will open, in which the white “choice” boxes will be empty. Below is an example of what the “Extract” window looks like once filled in, flowed by instructions on how to do so:



- A. For the “Chosen Projections” box, click “add” to browse and add a previously saved projection. Highlight a projection from the “Chosen Projections” box and click “remove” to remove it.
- B. Once a projection is added to the “Chosen Projections” box, the indicators for that projection will appear in the “Indicators” box. Click on the “+” to open a category and see the indicators housed within it.
- C. To pull an indicator into the box of “Selected Indicators” that you wish to work with, highlight the indicator in the “Indicators” box and press the “>>” button. To remove an indicator from the “Selected Indicators” box, highlight it and click “<<.” To further refine your selected indicator by sex or region (urban/rural), highlight the indicator in the “Selected Indicators” box and click “Configure.”

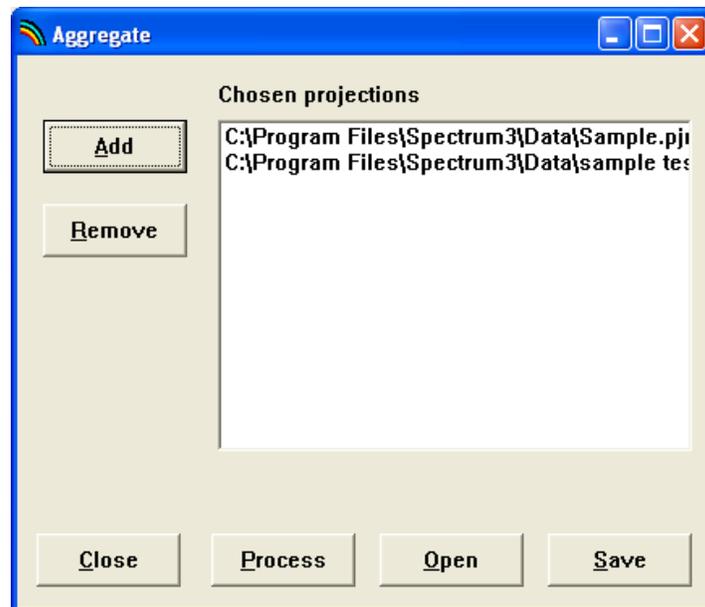
To process the extraction, click the "Process" button. Enter the file name you wish to save the extraction as, and click "Ok." It will then be saved as a CSV file, ready for use in Excel.

If you do not wish to process the extraction immediately, but would like to save the "Extract" window in which you have pulled out the mix of projections and indicators that you would like to use in the future, click the "Save" button. Enter the file name you wish to save the "Extract" window as, and click "Ok." It will then be saved as an .ex file.

If you have a previous "Extract" window saved as an .ex file, you may open it by clicking the "Open" button.

VIII.A.2. Aggregate

After entering Spectrum, go to "Tools" and click on "Aggregate" from the drop-down menu. (**Note:** You can not use the Aggregate function if you have a projection file open. If the "Aggregate" menu appears in grey, select "File" and "Close Projection" to close the projection. Then you should be able to select "Aggregate".) An "Aggregate" window will open, in which the white "choice" boxes will be empty. Below is an example of what the "Aggregate" window looks like once filled in, flowed by instructions on how to do so:



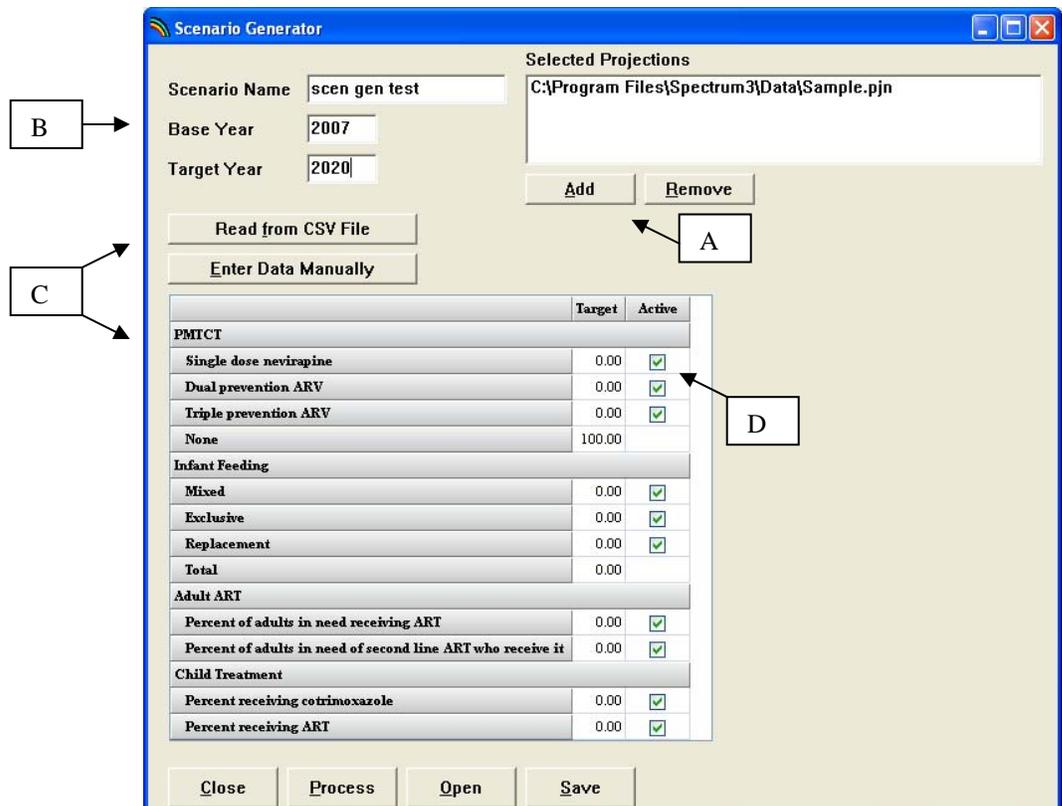
Click "Add" to browse previously saved projections. Click on the file name to highlight it, and then click "Open." To remove a selected projection from the "Chosen Projections," click on it to highlight it, and then click "remove" to remove it.

To process the aggregation, click the “Process” button. Enter the file name you wish to save the aggregation as, and click “Ok.” It will then be saved as a new projection (pjn file).

If you do not wish to process the aggregation immediately, but would like to save the “Aggregate” window in which you have pulled out the projections that you would like to aggregate in the future, click the “Save” button. Enter the file name you wish to save the “Aggregate” window as, and click “Ok.” It will then be saved as an .ex file.

VIII.A.3. Scenario Generator

After entering Spectrum, go to “Tools” and click on “Scenario Generator” from the drop-down menu. A “Scenario Generator” window will open, in which the white “choice” boxes will be empty. Below is an example of what the “Scenario Generator” window looks like once filled in, flowed by instructions on how to do so:



A. For the “Chosen Projections” box, click “add” to browse and add a previously saved projection. Highlight a projection from the “Chosen Projections” box and click “remove” to remove it.

- B. Choose a "Scenario Name". Then choose the "Base Year" and "Target Year" for which you wish to generate a scenario. Often, the base year is the current year.
- C. The target data may then be entered manually, or it can be pulled from a CSV file by clicking on "read from CSV File." Highlight the CSV file you wish to choose in the "Open" window, and click "open." CSV files are usually used rather than manual entry of the targets if a series of targets (matching the categories shown in the "Scenario Generator" editor) were previously prepared in CSV files to speed the process of running a series of scenarios for comparison purposes. However, if a CSV file or files are used, Spectrum can not interpolate between the base Year and Target Year. Therefore, the interpolation for each year must be done in the CSV file before importing into the Scenario Generator for application to the Chosen Projections.
- D. Check the box in the "Active" column if you want the Scenario Generator to use the target that is listed in the "Target" column (either the default zero, or the target that you enter). If the "active" box is left unchecked, a target will not be used for that variable and the scenario will be generated based on any prevention and/or treatment data that was entered to make the projection(s) for which you are generating the scenario.

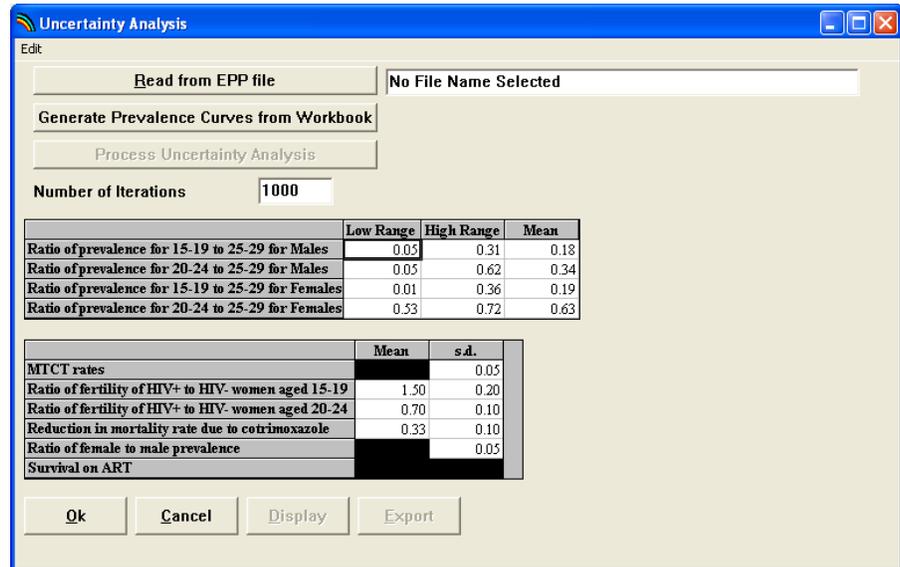
To process the scenario generation, click the "Process" button. Enter the file name you wish to save the scenario generation as, and click "Ok." It will then be saved as a Scenario Generator file (.SG file).

If you do not wish to process the scenario generation immediately, but would like to save the "Scenario Generation" window in which you have pulled out the projections that you would like to generate scenarios for in the future, click the "Save" button. Enter the file name you wish to save the "Scenario Generator" window as, and click "Ok." It will then be saved as an .ex file.

VIII.A.4. Uncertainty Analysis

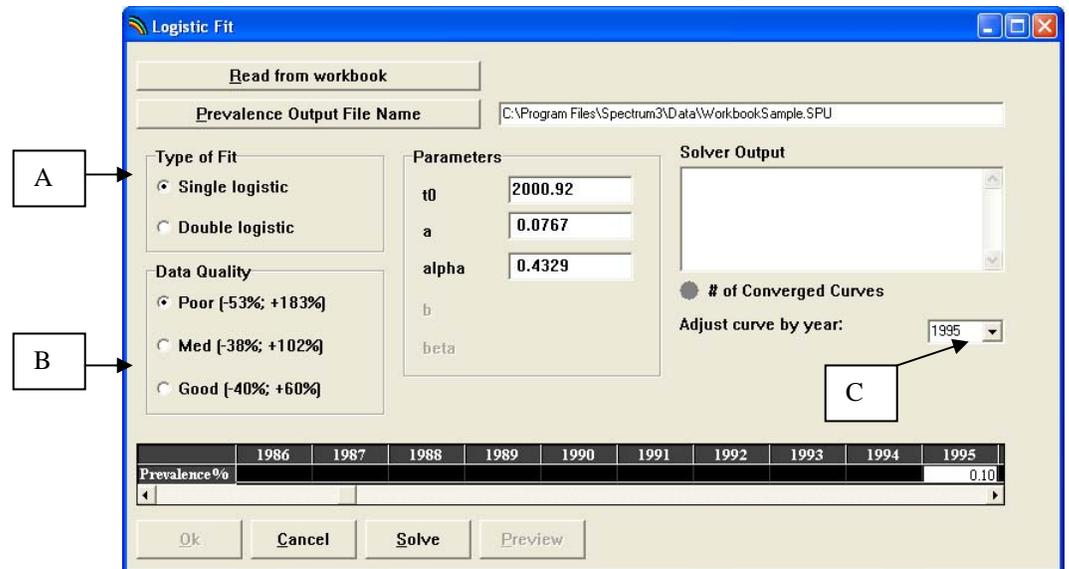
Unlike the three tools described above, you must have a single projection already open in Spectrum for the "Uncertainty analysis" choice to appear. In addition, you can only use the uncertainty analysis feature if you have prepared your prevalence projection using EPP or the Workbook.

Go to “Tools” and click on “Uncertainty Analysis” from the drop-down menu. An “Uncertainty Analysis” window will open, in which the white “choice” boxes will be empty. Below is an example of what the “Uncertainty Analysis” window looks like once filled in, flowed by instructions on how to do so:



There are two major options depending on how your prevalence projection was prepared.

1. **If your prevalence projection was prepared with EPP**, then you should have saved an uncertainty file for Spectrum while in EPP. If you did not do that, you will need to go back to EPP and save the uncertainty file for Spectrum. From the Spectrum uncertainty dialogue box you can click on the first button, “Read from EPP file” and Spectrum will read the uncertainty inputs for prevalence. These will be used as described below to calculate the uncertainty for all the other Spectrum variables.
2. **If your prevalence projection was prepared using the Workbook**, then you should click on the second button, “Generate Prevalence curves from Workbook.” Spectrum will ask for the name of the Workbook file. It will then read that file to get the prevalence points and the initial values used to fit a curve to those points. When you click this button you will get another dialogue box like the following:



Click the “Read from Workbook” button to select the Workbook file. Spectrum will read the Workbook and display the prevalence estimates and the parameter values of the logistics fit in the Workbook. You need to indicate:

- A. Type of fit. If there is substantial evidence that prevalence is declining then you should choose “Double logistic.” Otherwise choose “Single logistic.”
- B. Data quality. Indicate the quality of the surveillance data as “poor,” “medium” or “good.” Information on how to classify surveillance systems is available from Garcia-Calleja JM, Zabiewski E, Gys PD, Stanecki K, Walker N. *A global analysis of trends in the quality of HIV sero-surveillance Sexually Transmitted Infections* 2004; 80 (Suppl 1): i25-i30.
- C. Adjustment year. The final results will be adjusted to match prevalence in the most recent year of surveillance data. Select that year from the drop down list.

Once you have set these parameters, click the “Solve” button. Spectrum will generate 1000 different logistic curve fits for the prevalence data, varying the data before each fit with the ranges indicated next to the quality categories. These ranges represent two standard deviations around the central estimate. Once

the calculations are completed, you will have 1000 prevalence curves that can be used in the next step of the uncertainty analysis.

In the main uncertainty dialogue box, set the number of iterations to be performed. Generally this number should be 1000. Once this is set, click the "Process uncertainty analysis" button. Spectrum will do the requested number of iterations using the different prevalence curves read from EPP or generated with logistic fitting. Each projection will use different input values selected from ranges indicated in the bottom half of the dialogue box.

Once the analysis is complete you can view the results as graphs or tables by clicking "Display."

Once you are done examining the results, click the "Ok" button. Spectrum will save the results to a file before quitting the procedure. If you press "Cancel" instead of "OK" the results will not be saved.

IX. Methodology

IX.A. Epidemiology

The population is disaggregated by age, sex, time, HIV state and duration in that HIV state. The population array is defined as $pop(a,s,t,h,d)$ where:

- a = age (0..80, 80+, total), by single year of age
- s = sex (male, female, both)
- t = time in years (1 = first year of projection)
- h = HIV state (all are exclusive except OnCTX which can be combined with other states)
 - Neg: HIV-
 - Asym: HIV+ and not in need of treatment
 - NeedTx: HIV+ and in need of ART
 - FLART: On first line ART
 - SLART: On second line ART
 - OnCTX: On cotrimoxazole.
 - hAll : all HIV states
- d = duration (number of years in the HIV state), dAll refers to all durations

IX.A.1. Initializing the Population

The base year population by age and sex can be read from a database of the United Nations Population Division estimates and projections or entered directly. The input population for the base year is by sex and five year age group. It is split into single ages using a modified Beers approach as described in the manual for DemProj. In the base year the entire population is assumed to be HIV-negative.

IX.A.2. Progressing the Population to the Next Year

The first step in the projection is to progress the population of the previous year to the current year. These calculations start with the second year of the projection and continue until the final year. Each population group progresses one year in age and one year longer duration in the current state. Each population group is also subjected to non-AIDS mortality according to the input non-AIDS life expectancy and the selected model life table. The non-AIDS mortality rate is applied equally to all HIV states and durations within a specific age and sex group. Migration is calculated as a proportion of the population in each category. Thus we assume that migrants, whether in- or out-migrants, are distributed by HIV state and duration in that state according to the distribution of the resident population. The migration rate (mr) is the average number of migrants during the year divided by the population at the beginning of the period.

For each age, sex, year, HIV state and duration in that state:

$$\text{Pop}(a,s,t,h,d) = \text{pop}(a-1,s,t-1,h,d-1) \times (1 + \text{mr} - \text{dr})$$

$$\text{mr} = [\text{migrants}(a-1,s,t-1) + \text{migrants}(a,s,t)] / 2 / \text{pop}(a-1,s,t-1,hAll,dAll)$$

$$\text{dr} = [\text{pop}(a-1,s,t-1,hAll,dAll) + \text{migration}(a-1,s,t-1)] \times (1 - \text{sr})$$

Where:

- mr = migration rate
- dr = death rate
- sr = survival rate (determined from the non-AIDS life expectancy and the selected model life table)

IX.A.3. Progression From Asymptomatic Infection to Need for Treatment

The population that is infected with HIV but asymptomatic will progress to needing treatment over time. This progression is determined from two processes: the distribution of time from infection to AIDS death without treatment and time before death when a person becomes eligible for treatment.

Progression from infection to death is assumed to be distributed according to a Weibull distribution with a median of 10.5 years for males and 11.5 years for females for most populations. The difference by sex results because the average age at infection is younger for women than for men and young age at infection results in longer survival. Studies from Thailand show a progression about 2.5 years faster. WHO has established criteria for eligibility for anti-retroviral treatment that depend on CD4 count and stage of disease. Work by Marcel Zwahlen and others has estimated that the median time from eligibility to death if treatment is not available is about 3 years. Details of both of these analyses are provided elsewhere (Stover *et al.* forthcoming).

Progression from new infection to need for treatment is modelled as a Weibull distribution with a median time of 8 years (7.5 for men and 8.5 for women). The fraction of the asymptomatic population progressing to 'need for treatment' each year is determined by the amount of time spent in the asymptomatic state and this progression period. The default progression patterns are shown in Table 5.

Table 6. Cumulative Proportion Progressing from Asymptomatic HIV Infection to Need for Treatment by Years since Infection

Years Since Infection	Male Adults	Female Adults
1	1	1
2	5	4
3	11	8
4	18	14
5	27	21
6	36	29
7	45	38
8	55	46
9	63	54
10	71	62
11	78	69

Years Since Infection	Male Adults	Female Adults
12	83	75
13	88	80
14	91	85
15	94	88
16	96	91
17	97	94
18	98	96
19	99	97
20	99	98
21	99	98
22	99	98
23	99	98
24	99	98
25	99	98
26	99	98
27	99	98
28	99	98
29	99	98
30	99	98

$$\text{Fraction Progressing}(s,d) = \text{Pneed}(s,d) - \text{Pneed}(s,d-1)$$

where $\text{Pneed}(s,d)$ is the cumulative proportion of a population that will have progressed from new infection to need for treatment d years after infection.

The indicated proportion of the asymptomatic population is progressed to 'need for treatment'.

For all durations :

$$\text{Pop}(a,s,t,\text{NeedTx},1) = \text{Pop}(a,s,t,\text{Asymptomatic},d) \times \text{Fraction Progressing}(s,d)$$

IX.A.4. Progression From First Line ART to Need for Second Line

Survival on first line ART is modelled as an annual survival probability as shown in Table 6.

Table 7. Annual Survival on ART

Population	Annual Probability of Survival
Adults	
First year on ART	0.85
Subsequent years on ART	0.95

Source: Stover *et al.* Forthcoming.

For each duration, d, of time on first line ART we calculate:

$$\begin{aligned}\text{FractionProgressing}(a,d) &= 1 - \text{Probability of survival}(a,d) \\ \text{Progressors}(a,s,t) &= \text{pop}(a,s,t,\text{OnFLART},d) \times \text{FractionProgressing}(a,d)\end{aligned}$$

The number of people progressing from first line ART to need for second line is subtracted from those on ART and added to those in need of second line ART.

$$\begin{aligned}\text{Pop}(a,s,t,\text{OnFLART},d) &= \text{pop}(a,s,t,\text{OnFLART},d) - \text{Progressors}(a,s,t) \\ \text{Pop}(a,s,t,\text{NeedSLART},1) &= \text{pop}(a,s,t,\text{NeedSLART},1) + \text{Progressors}(a,s,t)\end{aligned}$$

IX.A.5. Progression From Second Line ART to AIDS Death

Survival on second line ART is assumed to be the same as on first line ART. Those not surviving on second line ART are assumed to die from AIDS.

For each duration, d, of time on second line ART we calculate:

$$\begin{aligned}\text{FractionProgressing}(a,d) &= 1 - \text{Probability of survival}(a,d) \\ \text{Progressors}(a,s,t) &= \text{pop}(a,s,t,\text{OnSLART},d) \times \text{FractionProgressing}(a,d)\end{aligned}$$

The number of people progressing from second line ART to AIDS death is subtracted from those on second line ART and added to the number of AIDS deaths.

$$\begin{aligned}\text{Pop}(a,s,t,\text{OnSLART},d) &= \text{pop}(a,s,t,\text{OnSLART},d) - \text{Progressors}(a,s,t) \\ \text{AIDS deaths}(a,s,t) &= \text{AIDS deaths}(a,s,t) + \text{Progressors}(a,s,t)\end{aligned}$$

IX.A.6. Need for ART

The total need for ART is calculated as all those on first or second line ART at the beginning of the year plus those who progress to needing first and second line ART during the year. This represents all those who need ART at some time during the year.

$$\begin{aligned}\text{NeedFLART}(a,s,t) &= \text{pop}(a,s,t,\text{OnFLART},d) + \text{pop}(a,s,t,\text{NeedTx},d) \\ \text{NeedSLART}(a,s,t) &= \text{pop}(a,s,t,\text{OnSLART},d) + \text{pop}(a,s,t,\text{NeedSL},d) \\ \text{NeedART}(a,s,t) &= \text{pop}(a,s,t,\text{OnFLART},d) + \text{pop}(a,s,t,\text{NeedTx},d) + \text{pop}(a,s,t,\text{OnSLART},d) + \\ &\quad \text{pop}(a,s,t,\text{NeedSL},d)\end{aligned}$$

IX.A.7. Number of New Adult Patients on ART

The number of adults starting on first line ART is determined from the total number that should be on first line ART and the number surviving on ART from the previous year. The number that should be on first line ART is either a direct input or is calculated from the specified coverage.

If the input is coverage then the number that should be on first line ART is calculated as the total need for first line across all adult ages and both sexes multiplied by the coverage:

Number on FL ART(t) = $\sum_a \sum_s \text{NeedFLART}(a,s,t) \times \text{coverage of first line ART}(t)$

Similarly, the number that should be on second line ART is either a direct input or is calculated as the total need for second line across all adult ages and both sexes multiplied by the coverage:

Number on SL ART(t) = $\sum_a \sum_s \text{NeedSLART}(a,s,t) \times \text{coverage of second line ART}(t)$

The total number of new adult ART patients is the difference between the number that should be on ART and the number surviving on ART from the previous year.

TotalNewFLART(t) = Number on FLART(t) - $\sum_a \sum_s \sum_d \text{pop}(a,s,t, \text{OnFLART}, d)$

TotalNewSLART(t) = Number on SLART(t) - $\sum_a \sum_s \sum_d \text{pop}(a,s,t, \text{OnSLART}, d)$

The total number of new adult ART patients is distributed by age and sex according to the distribution of those needing but not yet on ART.

NewFLART(a,s,t) = TotalNewFLART(t) $\times \sum_d \text{pop}(a,s,t, \text{NeedTx}, d) / \sum_a \sum_s \sum_d \text{pop}(a,t,s, \text{NeedTx}, d)$

NewSLART(a,s,t) = TotalNewSLART(t) $\times \sum_d \text{pop}(a,s,t, \text{NeedSL}, d) / \sum_a \sum_s \sum_d \text{pop}(a,t,s, \text{NeedSL}, d)$

Those newly on ART are added to the ART population with a duration of 1 to indicate that this is their first year in this state.

Pop(a,s,t,OnFLART,1) = NewFLART(a,s,t)

Pop(a,s,t,OnSLART,1) = NewSLART(a,s,t)

Those newly added to first line ART are subtracted from those needing first line ART. We assume that those added to first line ART are taken equally from those in need of ART by duration. That is, there is an equal chance of starting on ART regardless of whether a person has been in need of ART for one year or ten years.

Pop(a,s,t,NeedTx,d) = $\text{pop}(a,s,t, \text{NeedTx}, d) - \text{NewFLART}(a,s,t) \times \text{pop}(a,s,t, \text{NeedTx}, d) / \sum_d \text{pop}(a,s,t, \text{NeedTx}, d)$

Those in need of second line ART are assumed to die from AIDS in that same year if they do not get on second line ART. So the duration of need for second line ART is always 1.

Pop(a,s,t,NeedSL,1) = $\text{pop}(a,s,t, \text{NeedSL}, 1) - \text{NewSLART}(a,s,t)$

IX.A.8. Progression to AIDS Death

The progression from need for first line treatment to AIDS death if treatment is not obtained is a Weibull distribution with a median time of three years. The distribution is shown in Table 7.

Table 8. Cumulative Proportion of Adults in Need of First Line ART that Have Died from AIDS by Number of Years in Need

Years in Need	Males	Females
1	7.4	7.4
2	26.6	26.6
3	50.1	50.1
4	70.9	70.9
5	85.5	85.5
6	93.8	93.8
7	97.7	97.7
8	99.3	99.3
9	99.8	99.8
10	100.0	100.0

Source: Stover *et al.* Forthcoming.

Fraction Progressing to AIDS death(s,d) = CumProg(s,d) – CumProg(s,d-1)

Those progressing to AIDS death are subtracted from the population in need of first line ART and added to the number of AIDS deaths.

$$\begin{aligned} \text{Progressors}(a,s,t,d) &= \text{pop}(a,s,t,\text{NeedTx},d) \times \text{Fraction Progressing to AIDS death}(s,d) \\ \text{Pop}(a,s,t,\text{NeedTx},d) &= \text{Pop}(a,s,t,\text{NeedTx},d) - \text{progressors}(a,s,t,d) \\ \text{AIDSdeaths}(a,s,t) &= \text{AIDSdeaths}(a,s,t) + \text{progressors}(a,s,t,d) \end{aligned}$$

All of those remaining in need of second line ART (those who did not get on second line when they failed on first line) progress to AIDS death.

$$\text{AIDSdeaths}(a,s,t) = \text{AIDSdeaths}(a,s,t) + \text{pop}(a,s,t,\text{NeedSL},1)$$

IX.A.9. Deaths Averted by ART

Most applications of AIM use a prevalence trend as the input. This trend is usually developed from surveillance data. If the use of ART has only increased substantially in the last few years the impact of future ART use on the number of AIDS deaths may not be fully captured by the prevalence trend. In that case increases in the future coverage of ART should lead to fewer future AIDS deaths than are anticipated by the input prevalence trend and, therefore, prevalence should rise above the trend line. This effect is included in the Spectrum projections by estimating the number of AIDS deaths in any year that result from increases in the coverage of ART over coverage in 2006.

In the Spectrum model the use of ART postpones death according to the effectiveness of ART. Since need for ART is defined as occurring a median of three years before death not all those on ART would be dead if they did not receive it.

To estimate the number of deaths averted by increased ART use we first estimate the proportion of those in need of ART who would die of AIDS this year if they did not start on ART.

$$\text{Proportion}(a,s,t) = \frac{\sum_d [\text{pop}(a,s,t,\text{NeedTx},d) \times \text{Fraction Progressing to AIDS death}(s,d)]}{\sum_d \text{pop}(a,s,t,\text{NeedTx},d)}$$

From this proportion we calculate the number of deaths averted among those who started on ART this year (i.e. those on first line ART with a duration in that state of 1 year).

$$\text{DeathsAverted}(a,s,t) = \text{Proportion}(a,s,t) \times \text{pop}(a,s,t,\text{OnFLART},1)$$

The cumulative proportion of those who would have died if they did not get on ART for increases by about 0.25 in years two, three and four (Table 7). So we assume that the proportion of those on ART for more than one year that would be dead of AIDS without ART increases by 0.25 each year until it reaches 1.0. All of those who have been on ART for more than four years are counted as deaths averted by ART.

$$\begin{aligned} \text{DeathsAverted}(a,s,t) = & \text{DeathsAverted}(a,s,t) + \text{pop}(a,s,t,\text{OnFLART},2) \times (\text{Proportion}(a,s,t) + \\ & 0.25) + \text{pop}(a,s,t,\text{OnFLART},3) \times (\text{Proportion}(a,s,t) + 0.5) + \\ & \text{pop}(a,s,t,\text{OnFLART},4) \times (\min(1, \text{Proportion}(a,s,t) + 0.75)) + \\ & \sum_d \text{pop}(a,s,t,\text{OnFLART},d) + \sum_d \text{pop}(a,s,t,\text{OnSLART},d) \end{aligned}$$

Any deaths averted by ART prior to the last year of surveillance data will have influenced the prevalence curve derived from surveillance data, so those deaths are removed to produce the final estimate of deaths averted by the increase in ART coverage since 2006.

$$\text{DeathsAverted}(a,s,t) = \text{DeathsAverted}(a,s,t) \times \frac{(\text{ARTcoverage}(t) - \text{ARTcoverage}(2006))}{\text{ARTcoverage}(t)}$$

IX.A.10. New Adult HIV Infections

New HIV infections are calculated either from adult prevalence or adult incidence, depending on the inputs used.

Incidence

If the input is incidence then the number of new adult infections is calculated as follows.

Incidence among adult females is determined from the input values for incidence among both sexes and the ratio of female to male incidence.

Total adult incidence is the weighted average of male and female incidence.

$$\text{Incidence}(\text{total},t) = \frac{[\text{Incidence}(\text{female},t) \times \text{pop}(\text{female},t) + \text{Incidence}(\text{male},t) \times \text{pop}(\text{male},t)]}{\text{pop}(\text{total},t)}$$

If we let R be the ratio of female to male incidence and rearrange the equation to estimate female incidence the result becomes :

$$\text{Incidence}(\text{female},t) = \text{Incidence}(\text{total},t) \times [\text{pop}(15-49,\text{male},t) + \text{pop}(15-49,\text{female},t)] / [\text{pop}(15-49,\text{female},t) + \text{pop}(15-49,\text{male},t) / R]$$

Then the number of new adult female infections is the incidence multiplied by the uninfected population. The uninfected population is the total population minus the population in any of the HIV states (asymptomatic, in need of treatment, on first line ART, on second line ART) for all durations in those states).

$$\text{NewHIV}(15-49,\text{female},t) = \text{Incidence}(\text{female},t) \times [\text{pop}(15-49,\text{female},t) - \sum_{h=\text{Asymp to OnSLART}} \sum_d \text{pop}(15-49,\text{female},h,d)]$$

Male incidence is calculated from female incidence and the ratio of female to male incidence.

$$\text{Incidence}(\text{male},t) = \text{incidence}(\text{female},t) / R$$

$$\text{NewHIV}(15-49,\text{male},t) = \text{Incidence}(\text{male},t) \times [\text{pop}(15-49,\text{male},t) - \sum_{h=\text{Asymp to OnSLART}} \sum_d \text{pop}(15-49,\text{male},h,d)]$$

IX.A.11. Prevalence

If prevalence is the input then new infections are calculated as the number of new infections required to achieve the specified prevalence level. The number of HIV-infected adults required is the input prevalence multiplied by the adult population. If AIDS deaths have been averted due to increased use of ART those deaths averted are added to required number of adult infections in order compensate for the effects of increased coverage of ART. The number of deaths averted is also subtracted from the total adult population in order to estimate the adult population that would be alive if ART coverage had not increase.

$$\text{NeededHIV}[\text{both sexes},t] = [\text{pop}(15-49, \text{both sexes}, t) - \text{DeathsAverted}(15-49, \text{both sexes},t)] \times \text{InputPrevalence}(t) + \text{DeathsAverted}(15-49, \text{both sexes},t)$$

The number of infections needed by sex is calculated from the ratio of female to male prevalence, R.

$$\text{NeededHIV}(\text{female},t) = \text{NeededHIV}[\text{both sexes},t] \times R / (1 + R)$$

$$\text{NeededHIV}(\text{male},t) = \text{NeededHIV}[\text{both sexes}, t] - \text{NeededHIV}(\text{female},t)$$

The number of new HIV infections required to attain the input prevalence is the difference between the total number of infections needed and the infected population surviving to the current year. The infected population is the sum of the population in all HIV states (asymptomatic, need treatment, on first line ART, on second line ART) and all durations in those states.

$$\text{NewHIV}(s,t) = \text{NeededHIV}(s,t) - \sum_{h=\text{Asymp to OnSLART}} \sum_d \text{pop}(15-49,s,t,h,d)$$

IX.A.12. New Infections by Age and Sex

The number of new infections is distributed by age and sex according to the input pattern of prevalence by age. This pattern is expressed as the ratio of prevalence at any age to prevalence in the age group 25-29.

First we calculate the weighted sum of the prevalence.

$$\text{Sum}(s,t) = \text{pop}(a,s,t,hAll,dAll) \times \text{PrevRatio}(a,s,t)$$

The prevalence required in the 25 to 29 age group is the share of the HIV population needed in that age group divided by the population aged 25 to 29.

$$\text{Prev25}(s,t) = \frac{[\text{pop}(25-29,s,t) \times \text{PrevRatio}(25-29,s,t) / \text{sum}(s,t)] \times \text{NeededHIV}[s,t]}{\text{pop}(25-29,s,t)}$$

The total number of infections needed in each age group to match the input prevalence is calculated from the share of all infections needed in that age group.

$$\text{NewHIV}(a,s,t) = \text{pop}(a,s,t,hAll, dAll) \times \text{Prev25}(a,s,t) \times R - [\text{pop}(a,s,t,hAll,dAll) - \text{pop}(a,s,t,\text{HIV-},1)]$$

IX.A.13. Births to HIV+ Women

The number of HIV+ births is calculated from total births, the prevalence among pregnant women and the transmission rate.

Births to HIV+ women are calculated in a similar manner to the calculation of all births. The number of HIV+ women in each age group is multiplied by the total fertility rate and by the proportion of life time births that occur in that age group. The key difference is that HIV+ women have somewhat different total fertility than HIV- women. The default assumption is that fertility of HIV+ women over 20 is 70% of that for HIV- women. For women 15 to 19 the default assumption is that their fertility is 50% higher, since those women are known to be sexually active whereas many 15 to 19 years olds are not sexually active.

$$\text{BirthsToHIVWomen}(a,t) = \text{pop}(a,\text{females},t,\text{AllHIV+},dAll) \times [\text{TFR}(t-1) + \text{TFR}(t)] / 2 \times \text{BirthsProp}(a,t) \times \text{BirthRatio}(a)$$

Where

$\text{BirthsProp}(a)$ = proportion of lifetime births occurring at age a

$\text{BirthRatio}(a)$ = ratio of fertility among HIV+ women to HIV- women at age a

Note that births to HIV+ women is different from the number of HIV+ pregnant women. About 15% of pregnancies do not result in a live birth due to miscarriage, spontaneous abortion and still births. The number of HIV+ pregnant women is calculated as the number of births to HIV+ pregnant women divided by (1 - 0.15).

IX.A.14. Need for PMTCT

The need for prophylaxis to prevent mother-to-child transmission is the number of HIV+ women giving birth.

$$\text{NeedForPMTCT}(t) = \text{BirthsToHIVWomen}(t)$$

IX.A.15. Mother-to-Child Transmission Rate

The base rate of HIV transmission from mother to child is determined by the duration of predominant breastfeeding in the population as shown in Table 4 in Chapter III Section E. That rate can be modified by interventions that provide drugs for prophylaxis or safe infant feeding options as shown in Table 4. The mother-to-child transmission rate can also be reduced to just 2% of the pregnant woman is receiving triple ARV therapy to treat her infection. The resulting mother-to-child transmission rate is the weighted average of the proportion in each treatment and infant feeding category and the corresponding transmission rate.

$$\text{MTCTrate}(t) = \text{PMTCT category}(\text{treatment, feeding}) \times \text{transmission rate}(\text{treatment, feeding})$$

Where

MTCTrate = mother to child transmission rate

PMTCT category = the proportion of women by treatment and infant feeding option

Transmission rate = probability of transmission of HIV by treatment and infant feeding option

IX.A.16. HIV+ Births

The number of HIV+ births is equal to the number of births to HIV+ women multiplied by the mother-to-child transmission rate. This is also the HIV+ population aged 0.

$$\begin{aligned} \text{HIV+ births}(t) &= \text{BirthsToHIVWomen}(a,t) \times \text{MTCTrate}(t) \\ \text{Pop}(0,s,t,\text{Asymptomatic},1) &= \text{HIV+ births}(t) \times \text{SexRatioOfBirths}(s) \end{aligned}$$

IX.A.17. Progression of Children from Asymptomatic Infection to Need for Treatment

Children progress from the asymptomatic state at birth to need for treatment in the same manner in which adults progress except that the progression pattern is different as shown in Table 8

Table 9. Cumulative Proportion of Children Progressing to Need for Treatment by Age

Age	Proportion
1	42
2	55
3	61
4	64
5	66
6	68
7	70
8	71
9	74
10	76
11	79
12	83
13	86
14	90
15	93
16	95
17	97
18	99
19	99
20	100

Source: Boerma *et al.* 2006.

$$\text{Fraction Progressing}(s,d) = \text{Pneed}(s,d) - \text{Pneed}(s,d-1)$$

where $\text{Pneed}(s,d)$ is the cumulative proportion of a population that will have progressed from new infection to need for treatment d years after infection.

The indicated proportion of the asymptomatic population is progressed to 'need for treatment'.

For all durations :

$$\text{Pop}(a,s,t,\text{NeedTx},1) = \text{Pop}(a,s,t,\text{Asymptomatic},d) \times \text{Fraction Progressing}(s,d)$$

IX.A.18. Need for ART Among Children

The total need for ART among children is calculated as all those on ART at the beginning of the year plus those who progress to needing ART during the year. This represents all those who need ART at some time during the year.

$$\begin{aligned} \text{NeedFLART}(a,s,t) &= \text{pop}(a,s,t,\text{OnFLART},d) + \text{pop}(a,s,t,\text{NeedTx},d) \\ \text{NeedSLART}(a,s,t) &= \text{pop}(a,s,t,\text{OnSLART},d) + \text{pop}(a,s,t,\text{NeedSL},d) \\ \text{NeedART}(a,s,t) &= \text{pop}(a,s,t,\text{OnFLART},d) + \text{pop}(a,s,t,\text{NeedTx},d) + \text{pop}(a,s,t,\text{OnSLART},d) \\ &\quad + \text{pop}(a,s,t,\text{NeedSL},d) \end{aligned}$$

IX.A.19. Number of New Patients on ART

The number of children starting on first line ART is determined from the total number that should be on first line ART and the number surviving on ART from the previous year. The number that should be on first line ART is either a direct input or is calculated from the specified coverage.

If the input is coverage then the number that should be on first line ART is calculated as the total need for first line across all child ages and both sexes multiplied by the coverage:

$$\text{Number on FL ART}(t) = \sum_a \sum_s \text{NeedFLART}(a,s,t) \times \text{coverage of first line ART}(t)$$

The total number of new child ART patients is the difference between the number that should be on ART and the number surviving on ART from the previous year.

$$\text{TotalNewFLART}(t) = \text{Number on FLART}(t) - \sum_a \sum_s \sum_d \text{pop}(a,s,t,\text{OnFLART},d)$$

The total number of new child ART patients is distributed by age and sex according to the distribution of those needing but not yet on ART.

$$\text{NewFLART}(a,s,t) = \text{TotalNewFLART}(t) \times \sum_d \text{pop}(a,s,t,\text{NeedTx},d) / \sum_a \sum_s \sum_d \text{pop}(a,t,s,\text{NeedTx},d)$$

Those newly on ART are added to the ART population with a duration of 1 to indicate that this is their first year in this state.

$$\text{Pop}(a,s,t,\text{OnFLART},1) = \text{NewFLART}(a,s,t)$$

Those newly added to ART are subtracted from those needing ART. We assume that those added to first line ART are taken equally from those in need of ART by duration. That is, there is an equal chance of starting on ART regardless of whether a person has been in need of ART for one year or ten years.

$$\text{Pop}(a,s,t,\text{NeedTx},d) = \text{pop}(a,s,t,\text{NeedTx},d) - \text{NewFLART}(a,s,t) \times \text{pop}(a,s,t,\text{NeedTx},d) / \sum_d \text{pop}(a,s,t,\text{NeedTx},d)$$

IX.A.20. Need for Cotrimoxazole

Children are assumed to need cotrimoxazole if they are HIV+ and under the age of five. In addition all children born to HIV+ mothers are in need of cotrimoxazole until their own HIV status is confirmed. If testing occurs at 18 months of age then all children born to HIV+ mothers are considered to be in need of cotrimoxazole until that age. If early diagnosis through PCR is available then just those who are confirmed to be HIV+ are in need of cotrimoxazole.

If early detection is available then need is all HIV+ children up to the age of 5.

$$\text{NeedCTX}(s,t) = \sum_{h=\text{asymptomatic to OnFLART}} \sum_d \text{pop}(0-4,s,t,h,d)$$

If early detection is not available then need is all children born to HIV+ mothers until age 18 months and all HIV+ children from 18 months to 5 years old.

$$\text{NeedCTX}(s,t) = \text{BirthsToHIVWomen}(t) \times 1.5 + \text{pop}(1,s,t,\text{allHIV},d\text{All}) / 2 + \sum_{a=2-4} \text{pop}(a,s,t,\text{allHIV},d\text{All})$$

IX.A.21. Children Receiving Cotrimoxazole

The number of children receiving cotrimoxazole may be a direct input or may be calculated from the input coverage.

$$\text{pop}(0-4,\text{Bothsexes},t,\text{OnCTX},d\text{All}) = \text{direct input or NeedCTX}(\text{BothSexes},t) \times \text{CTXcoverage}(t)$$

The number newly receiving cotrimoxazole is the difference between total use and those surviving on cotrimoxazole from the previous year.

$$\text{NewCTX} = \text{pop}(0-4,\text{BothSexes},t,\text{OnCTX},d\text{All}) - \text{pop}(0-4,\text{BothSexes},t-1,\text{OnCTX},d\text{All}) \times (1 - \text{MortalityOnCTX})$$

Children newly receiving cotrimoxazole are distributed by age and sex according to unmet need.

$$\text{pop}(a,s,t,\text{OnCTX},1) = \text{NewCTX} \times \text{NeedCTX}(a,s,t) / \text{NeedCTX}(0-4,\text{BothSexes},t)$$

IX.A.22. Progress Children to AIDS Death

Children who HIV+ and in need of ART but are not receiving either ART or cotrimoxazole progress to AIDS death according to a mortality rate that varies by age, as shown in Table 9.

Table 10. Annual Probability of Mortality among HIV+ Children in Need of Treatment by Age

Age	Mortality
1	0.9
2	0.9
3	0.7
4	0.6
5	0.4
6	0.2
7	0.2
8	0.2
9	0.2
10	0.2

Source: Fassinou *et al* 2004.

$$\text{AIDS deaths}(a,s,t) = \sum_a \text{pop}(a,s,t,\text{NeedTx},d) \times \text{Mortality}(a)$$

$$\text{Pop}(a,s,t,\text{NeedTx},d) = \text{pop}(a,s,t,\text{NeedTx},d) \times [1 - \text{Mortality}(a)]$$

The mortality of HIV+ children in need of treatment is reduced if they are receiving cotrimoxazole. Mortality is reduced by 33% for children during the first four years of cotrimoxazole use and by 17% during the fifth year of use. There is no effect after age 5 years of use.

$$\text{AIDS deaths}(a,s,t) = \sum_d \text{pop}(a,s,t,\text{OnCTX},d) \times \text{Mortality}(a) \times [1 - \text{CTXeffect}(d)]$$

$$\text{Pop}(a,s,t,\text{OnCTX},d) = \text{pop}(a,s,t,\text{OnCTX},d) \times [1 - \text{Mortality}(a) \times [1 - \text{CTXeffect}(d)]]$$

Survival of children on ART is modelled as an annual survival probability as shown in Table 10. We only consider first line ART for children so those failing on first line die from AIDS in the same year.

Table 11. Annual Survival of Children on ART

Population	Annual Probability of Survival
Children	
Under 1 year old	0.80
>1 and first year on ART	0.90
>1 and subsequent years on ART	0.95

Source: Stover *et al.* Forthcoming.

For each duration, d , of time on ART we calculate:

$$\text{FractionProgressing}(a,d) = 1 - \text{Probability of survival}(a,d)$$

$$\text{Progressors}(a,s,t) = \text{pop}(a,s,t,\text{OnFLART},d) \times \text{FractionProgressing}(a,d)$$

The number of children failing on ART is subtracted from those on ART and added AIDS deaths.

$$\text{Pop}(a,s,t,\text{OnFLART},d) = \text{pop}(a,s,t,\text{OnFLART},d) - \text{Progressors}(a,s,t)$$

$$\text{AIDS deaths}(a,s,t) = \text{AIDS deaths}(a,s,t) + \text{Progressors}(a,s,t)$$

For HIV+ children receiving both ART and cotrimoxazole the survival on ART is increased due to the effect of cotrimoxazole. We assume that the coverage of cotrimoxazole is distributed equally among children on ART and not on ART. This may understate the effect for children receiving ART and overstate the effect for children not receiving ART if, in fact, use of ART and cotrimoxazole are strongly correlated.

$$\text{FractionProgressing}(a,d) = 1 - \text{Probability of survival}(a,d) \times [1 - \text{CTXeffect}(a) \times \text{CTXcoverage}(t)]$$

$$\text{Progressors}(a,s,t) = \text{pop}(a,s,t,\text{OnFLART},d) \times \text{FractionProgressing}(a,d)$$

$$\text{Pop}(a,s,t,\text{OnFLART},d) = \text{pop}(a,s,t,\text{OnFLART},d) - \text{Progressors}(a,s,t)$$

$$\text{AIDS deaths}(a,s,t) = \text{AIDS deaths}(a,s,t) + \text{Progressors}(a,s,t)$$

IX.B. Treatment Costs

The costs of HIV treatment are calculated by component and summed to get the total costs. The cost by component is calculated as follows.

First and second line drug costs are the product of the number of people on first or second line ART and the drug costs per patient (an input).

$$\begin{aligned} \text{FL ART drug cost}(t) &= \text{pop}(0-80+, \text{BothSexes}, t, \text{OnFLART}, d\text{All}) \times \text{FL drug costs per patient}(t) \\ \text{SL ART drug cost}(t) &= \text{pop}(0-80+, \text{BothSexes}, t, \text{OnSLART}, d\text{All}) \times \text{SL drug costs per patient}(t) \end{aligned}$$

The additional cost to treat those infected with both HIV and TB is usually confined to the first six months of treatment. The calculation is based on those newly starting on ART, the additional cost of ART for TB patients and the proportion of the population with active TB.

$$\begin{aligned} \text{TB-ART drug cost}(t) &= [\text{pop}(15-80+, \text{Bothsexes}, t, \text{OnFLART}, d\text{All}) - \text{pop}(15-80+, \text{BothSexes}, \\ &\quad t-1, \text{OnFLART}, d\text{All})] \times \\ &\quad \text{TB-ART drug costs}(t) / \text{pop}(15-80+, \text{BothSexes}, t) \end{aligned}$$

$$\begin{aligned} \text{Lab costs}(t) &= [\text{pop}(\text{AllAges}, \text{BothSexes}, t, \text{OnFLART}, d\text{All}) + \\ &\quad \text{pop}(\text{AllAges}, \text{BothSexes}, t, \text{POnFLART}, d\text{All})] \times \\ &\quad \text{Lab costs per patient per year} \end{aligned}$$

Treatment of opportunistic infections (OI) is based on two years of treatment, the year preceeding AIDS death and a year in need of ART before ART starts. For those who do get on ART, OI treatment is assumed to be needed for only one-half year.

$$\begin{aligned} \text{OI costs}(t) &= \text{AIDSdeaths}(t) + \text{pop}(\text{AllAges}, \text{BothSexes}, t, \text{NeedTx}, d\text{All}) \times \\ &\quad (1 - \text{ARTcoverage}) \times \text{OI treatment costs per patient} \end{aligned}$$

The costs of cotrimoxazole and TB prophylaxis for adults are based on those in need of ART and not receiving it.

$$\begin{aligned} \text{CTX costs}(t) &= \text{pop}(\text{AllAges}, \text{BothSexes}, t, \text{NeedTx}) \times \text{CTX costs per patient}(t) \\ \text{TB pro costs}(t) &= \text{pop}(\text{AllAges}, \text{BothSexes}, t, \text{NeedTx}) \times \text{TB pro costs per patient}(t) \end{aligned}$$

The costs of nutrition supplementation are based on the assumption that supplementation is only needed for new ART patients.

$$\text{Nutrition costs}(t) = \text{pop}(\text{AllAges}, \text{BothSexes}, t, \text{OnFLART}, 1) \times \text{Nutrition costs}(t)$$

The costs for service delivery are based on the number of people receiving treatment, the average number of in-patient and out-patient days per patient per year and the cost per in-patient day and out-patient day.

$$\begin{aligned} \text{FLART SerDel cost}(t) &= \text{pop}(\text{AllAges}, \text{BothSexes}, t, \text{OnFLART}, d\text{All}) \times \\ &\quad [\text{In-patient days} \times \text{cost per day} + \text{Out-patient visits} \times \text{cost per visit}] \\ \text{SLART SerDel cost}(t) &= \text{pop}(\text{AllAges}, \text{BothSexes}, t, \text{OnSLART}, d\text{All}) \times \\ &\quad [\text{In-patient days} \times \text{cost per day} + \text{Out-patient visits} \times \text{cost per visit}] \\ \text{OI Tx costs}(t) &= \text{AIDSdeaths}(t) + \text{pop}(\text{AllAges}, \text{BothSexes}, t, \text{NeedTx}, d\text{All}) \times \\ &\quad (1 - \text{ARTcoverage}) \times [\text{In-patient days} \times \text{cost per day} + \text{Out-patient} \\ &\quad \text{visits} \times \text{cost per visit}] \end{aligned}$$

IX.C. Health

IX.C.1. Number of Cases of Non-HIV Tuberculosis

$$Non_HIV\ TB_t = Tbincidence \cdot \sum_{a=15}^{80+} Pop_{at} ,$$

where

Non-HIV TB_t = The annual number of cases of tuberculosis (TB) that are not related to HIV infection, at time *t*

TBincidence = The normal incidence of TB cases in the adult population.

IX.C.2. Number of Cases of HIV-Related Tuberculosis

$$HIV_TB_t = PercTB \cdot HIV_Tbincidence \cdot \sum_{a=15}^{80+} HIV_Pop_{a,s,t} ,$$

where

HIV_TB_t = The annual number of TB cases that are related to HIV infection, at time *t*

PercTB = The percentage of the adult population with latent TB infection

HIV_TBincidence = The proportion of HIV- positive individuals developing TB each year.

IX.D. Orphans

The orphan calculations are based on estimates of the number of surviving children of adults who die from AIDS or other causes. The program calculates the expected number of children that were born to an adult before his or her death, and estimates how many are still alive and their age. The same approach is used for AIDS and non-AIDS orphans and for maternal and paternal orphans. For dual AIDS orphans the program uses a regression equation to estimate the proportion of children who are likely to have both parents die from AIDS given that one parent has died. This equation has been developed using data from Africa and may not be appropriate for other regions of the world. Full details of the methodology used here are provided in Grassly *et al.*, 2003.

X. References

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XI. Glossary of Terms

Most of the definitions were obtained from the United Nations World Wide Web site: <http://www.unaids.org/>

Click on the ribbon to enter the site, then *Human Interest*, then *ABC's of HIV/AIDS*.

Adult. In AIM, an adult is defined as a person aged 15 or older.

AIDS. The abbreviation for the acquired immune deficiency syndrome, a disabling and fatal disease caused by the human immunodeficiency virus (HIV).

Epidemiology. The study of the incidence, distribution, and determinants of an infection, disease, or other health-related event in a population. Epidemiology can be thought of in terms of who, where, when, what, and why. That is, who has the infection/disease, where are they located geographically and in relation to each other, when is the infection/disease occurring, what is the cause, and why did it occur?

HIV. The human immunodeficiency virus is the virus that causes AIDS. Two types of HIV are currently known: HIV-1 and HIV-2. Worldwide, the predominant virus is HIV-1. Both types of virus are transmitted by sexual contact, through blood, and from mother to child, and they appear to cause clinically indistinguishable AIDS. However, HIV-2 is less easily transmitted, and the period between initial infection and illness is longer in the case of HIV-2.

HIV Infection. Infection with the human immunodeficiency virus (HIV). HIV infection is primarily a sexually transmitted infection, passed on through unprotected penetrative sex. The virus can also be transmitted through blood transfusions, through the use of unsterilized injection equipment or cutting instruments, and from an infected woman to her fetus or nursing infant.

HIV Sentinel Surveillance. The systematic collection and testing of blood from selected populations at specific sites—for example, pregnant women attending prenatal clinics—for the purpose of identifying trends in HIV prevalence over time and place.

Incubation Period. The time interval between infection and the onset of AIDS.

Interpolation. Given two numbers that serve as boundary points, it is possible to estimate the values that lie at intervals between the two points. For example, if the HIV prevalence rate for a country or region was actually measured only in 1985 and in 1995, by assuming even increments from year to year, it is possible to interpolate a TFR for each intervening year. Spectrum uses a linear form of interpolation so that the difference between each annual value is the same. Other nonlinear forms of interpolation are also possible but are not used in Spectrum.

Life Expectancy. The average number of years a newborn can expect to live, based on the mortality and conditions of the time.

Model. Computer system designed to demonstrate the probable effect of two or more variables that might be brought to bear on an outcome. Such models can reduce the effort required to manipulate these factors and present the results in an accessible format.

Module. Synonym for “model.”

Orphan. In this manual, an orphan is defined as a child under the age of 15 whose mother has died of AIDS. It is assumed that if the mother has AIDS, the father will have the fatal disease as well.

Perinatal and Perinatal Transmission. Pertaining to or occurring during the periods before, during, or shortly after the time of birth; that is, before delivery from the 28th week of gestation through to the first seven days after delivery. The transmission of HIV from an infected woman to her fetus or newborn child is referred to as perinatal transmission.

Prevalence. The proportion of a defined population with the infection, disease, or other health-related event of interest at a given point or period of time.

Seroprevalence (HIV, STD). The percentage of a population from whom blood has been collected that is found, on the basis of serology, to be positive for HIV or other STD agents at any given time.

Sentinel Surveillance. See HIV Sentinel Surveillance.

XII. Acronyms and Abbreviations

AIDS	acquired immune deficiency syndrome
AIDSCAP	AIDS Control and Prevention Project (USAID-funded)
AIDSTECH	AIDS Technical Support Project (USAID-funded)
AIM	AIDS Impact Model
CDC	U.S. Centers for Disease Control and Prevention
FHI	Family Health International
GDP	gross domestic product
GNP	gross national product
HIV	human immunodeficiency virus
ILO	International Labor Organization
MOH	Ministry of Health
NACP	national AIDS control program
PTR	perinatal transmission rate
STD	sexually transmitted disease
TFR	total fertility rate
TB	tuberculosis
UNAIDS	Joint United Nations Programme on HIV/AIDS
USAID	United States Agency for International Development