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AIM

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

Spectrum System of Policy Models

The publication was produced for review by the United States Agency for International Development. It was prepared by John Stover of Futures Institute. The development of the software and manual is supported by the USAID | Health Policy Initiative, Task Order I implemented by the Futures Group International.

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1. INTRODUCTION

Description of the Spectrum System

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.
- **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.
- **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.
- **Child survival (LiST)** – A program to estimate the effects of scaling up child survival intervention on the rate and number of deaths to children under the age of five.

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, 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.

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

The accompanying manuals contain both instructions for users, and equations for those who want to know exactly how the underlying calculations are computed.

Uses of Spectrum Policy Models

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.
- 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.

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.

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.

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

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Futures Group
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Washington, DC 20005
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Fax: (202) 775-9694
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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

What Is AIM?

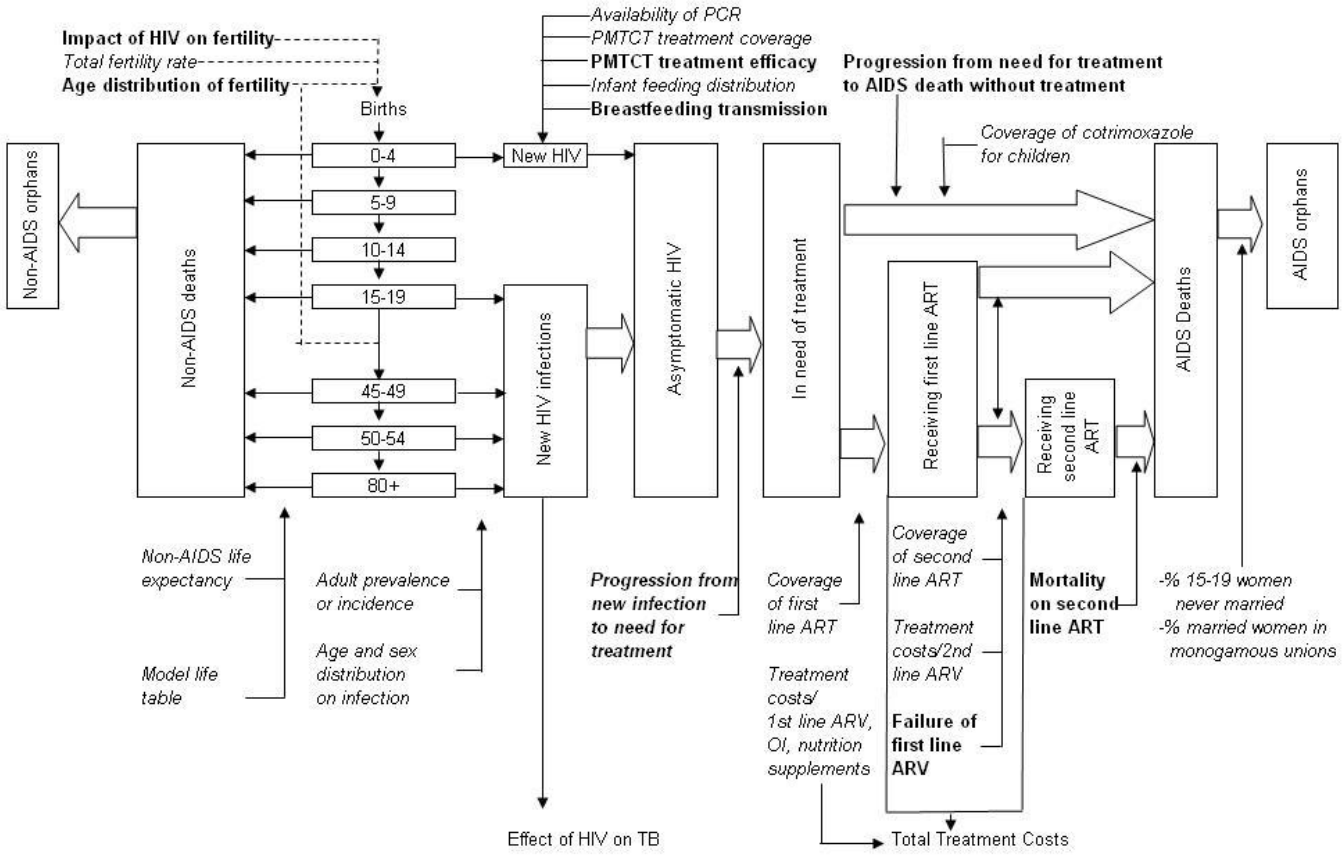
The AIDS Impact Model, known as AIM, is a computer program for projecting the impact of the AIDS epidemic. It can be used to project the future number of HIV infections, AIDS cases, and AIDS deaths, given an assumption about adult HIV prevalence. It can also project the demographic and social impacts 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. It is now maintained and updated by Futures Institute with support from the USAID | Health Policy Initiative.

AIM requires an assumption about the past and future course of adult HIV incidence 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 new 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 (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



Why Make HIV/AIDS Projections?

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.

2. 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.

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.

3. 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 incidence
- 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:

- Age and sex distribution of new infections
- 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.

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:

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.

You so not need to use EasyProj to generate the demographic projection. You can input your own data. However, this should be done with caution. Raw census data on the number of people by age and sex should be adjusted to account for age mis-reporting and undercounts before they can be used in Spectrum. The projection requires past and future trends in the total fertility rate and non-AIDS life expectancy. Information on the non-AIDS life is not likely to be readily available. Thus it is often better to start with EasyProj and then adjust any inputs as necessary than to build your own projection from the start.

Adult HIV Incidence

Historical and Current Year Estimates

Adult HIV incidence is the percentage of susceptible (uninfected) adults aged 15 to 49 or 15+ who are newly infected with HIV in a year.

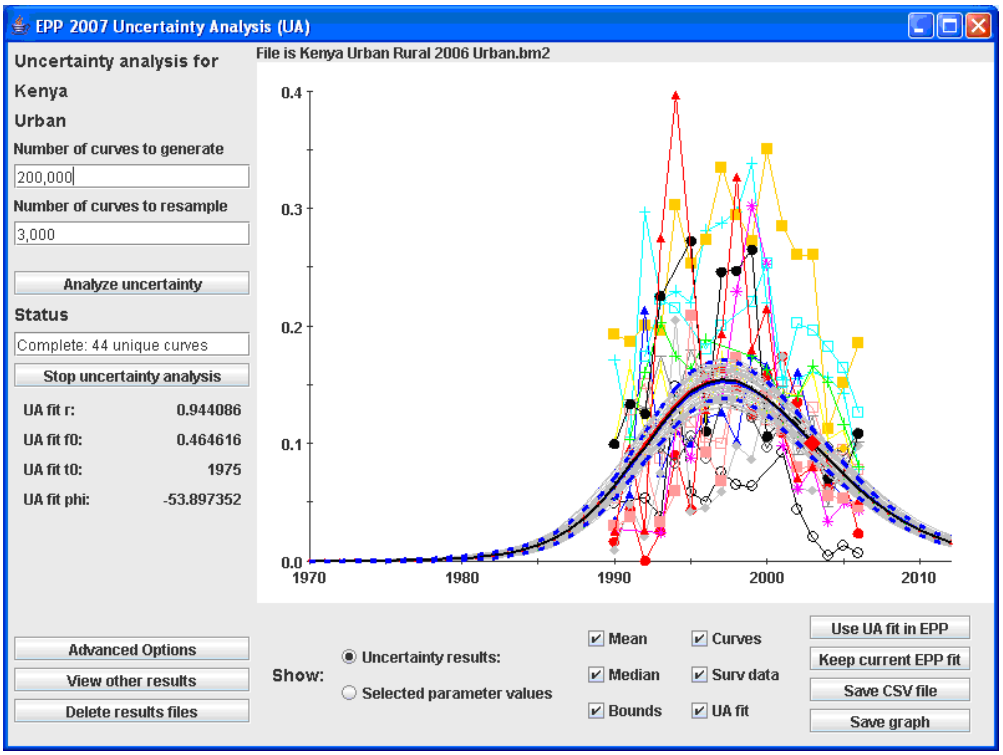
HIV prevalence data are usually available from surveillance conducted among selected population groups and from national household surveys. Data on HIV incidence are usually only available for special cohorts, and are not available at the national level.

To estimate national incidence trends from surveillance and survey data UNAIDS has developed specialized software called EPP (Estimation and Projection Package).

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 and incidence. It uses surveillance data to fit an epidemic curve for various geographic areas. These curves are then aggregated to produce prevalence and incidence 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 countries with low-level or concentrated epidemics that have trend surveillance data for high risk populations. The latest version Spectrum works best with EPP 2009 or later.

Figure 2. Sample EPP projection



Workbook Approach

For low level and concentrated epidemics without surveillance trend data for high risk populations a different approach is required. 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.

Progression from Infection to Need for Treatment and to Death

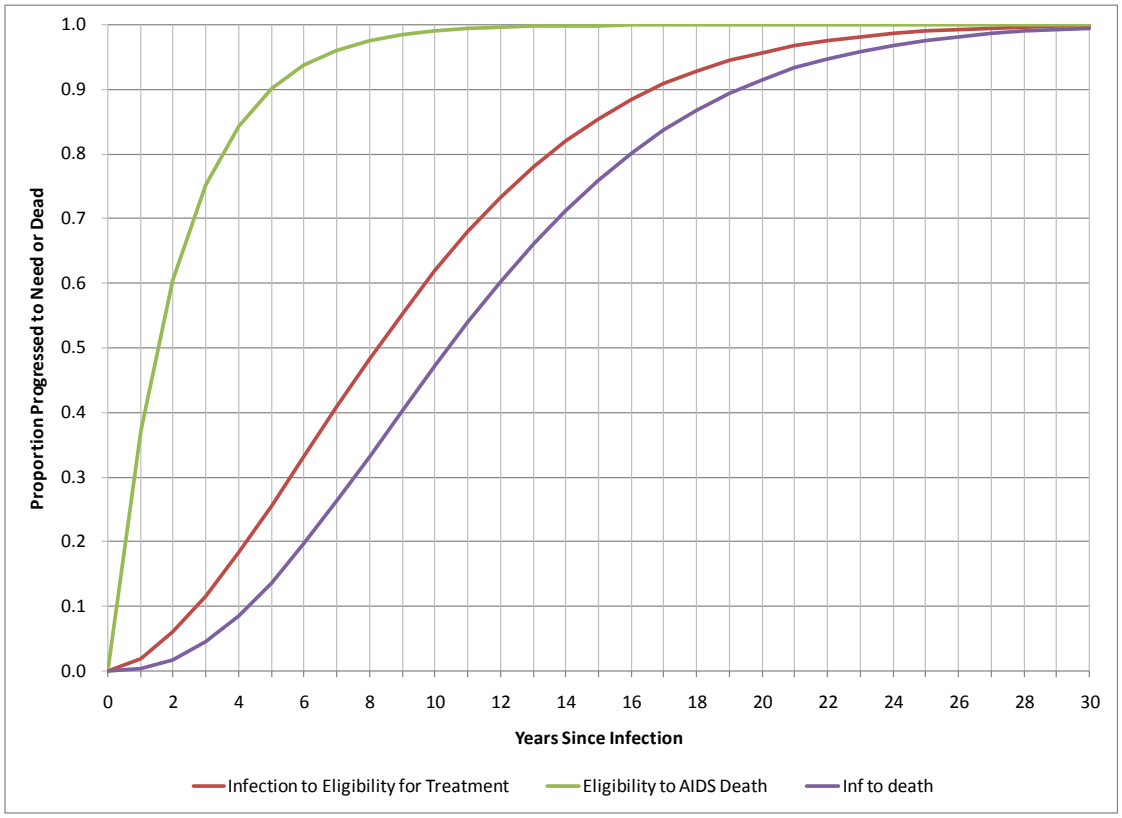
People who become infected with HIV do not need treatment with antiretroviral drugs immediately. There is an asymptomatic period during which the body's immune system controls the HIV infection. After some period of time the rapid replication of the virus overwhelms the immune system and patient is in 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. 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 AIDS death of 10.5 years for men and 11.5 years for women. For the faster progression patterns seen in Thailand the median progression times are assumed to be 8.1 years for men and 8.9 years for women.

Analysis conducted by the e-ART LINC Collaboration (e-ART LINC, 2008) of cohort data indicates that the median time from infection to a CD4 count of 200 is 7.6 (3.4-15.2) years and the median time from CD4 count of 200 to AIDS death without treatment is 2.7 (0.8-8.4) years. If eligibility for treatment is defined as CD4 count under 350 then the median time from infection to eligibility is 3.2 (1.0-9.7) and from eligibility to AIDS death without treatment is 7.6 (3.0-18.3) years.

The progression patterns used in Spectrum were prepared by finding Weibull progression curves for infection to eligibility for treatment and for eligibility to AIDS deaths that match as closely as possible the median progression times described by the e-ART LINC Collaboration and the overall pattern of progression from infection to AIDS death described by the ALPHA network. The resulting pattern for males is shown in Figure 3.

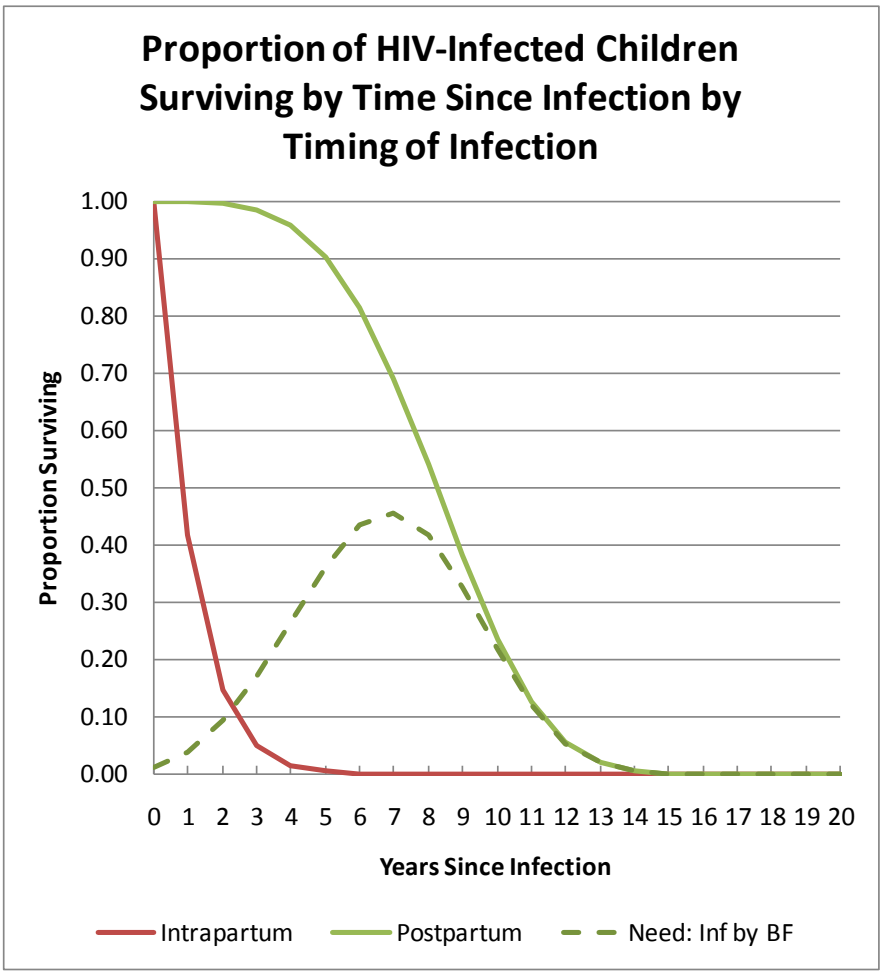
Figure 3: Cumulative percentage of adult males progressing to need for treatment by time since infection



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.

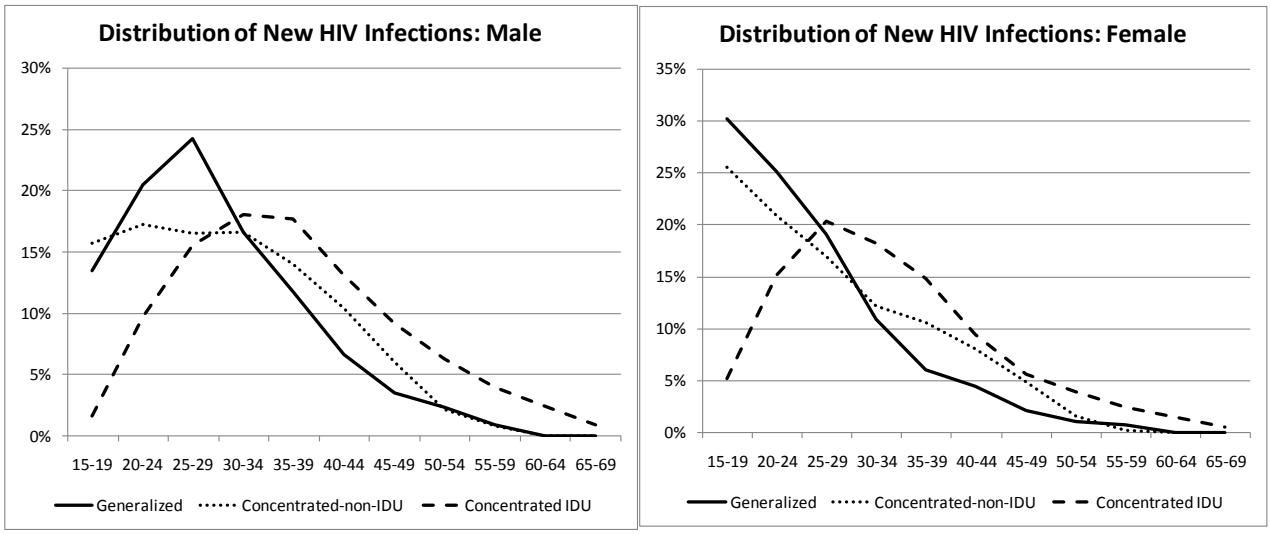
Figure 4: Cumulative progression from birth to AIDS death



Age and Sex Distribution of Infections

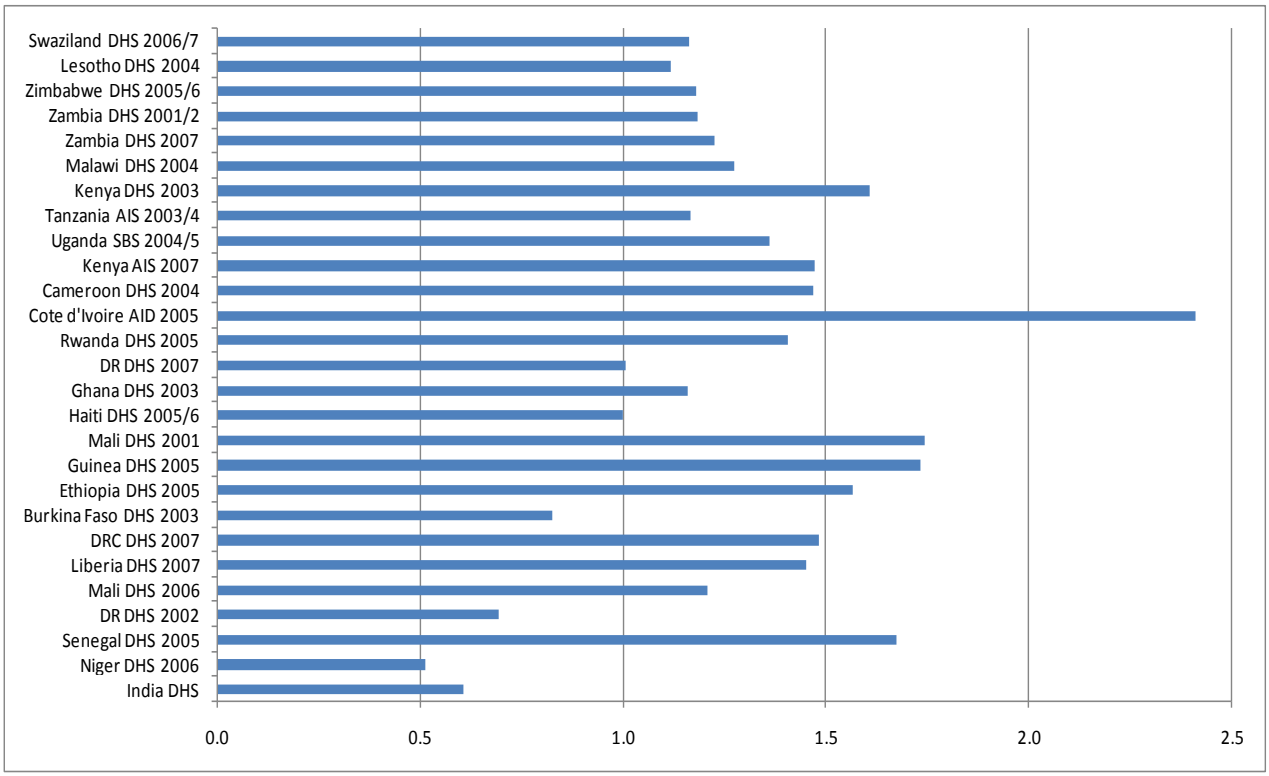
Adult HIV incidence trends estimated by EPP refer to new infections among adults aged 15 and up. For use in Spectrum these infections need to be distributed by age and sex. In recent years a number of national surveys have provided information on HIV prevalence by age for women aged 15-49 and men aged 15-59. Incidence by age can be estimated from two prevalence surveys spaced some years apart (Hallet *et al.* 2008). The same approach can be used to estimate incidence by age from a single survey if prevalence is assumed to be stable over time. We applied this method to data from 32 surveys to estimate incidence by age and sex. We then transformed this information into the distribution of new infections by age. These calculations were done separately for countries with relatively large samples of HIV-infected people (those with HIV prevalence above 4%) and those with lower levels of prevalence. The curves for the 14 surveys from high prevalence countries were averaged to produce standard patterns. The curves for the 17 surveys from lower prevalence countries were smoothed to reduce fluctuations due to small numbers of HIV-infected people and then averaged to produce standard patterns for these countries. For countries with epidemics driven by transmission through needle sharing for drug injection the patterns were developed using data on new case reports provided by WHO (ECDC, 2008).

Figure 5: Distribution of New HIV Infections by Age



Adult HIV incidence is disaggregated into female and male incidence by specifying the ratio of new female infections to new male infections. 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 incidence prevalence from just about 0.5 in Niger to 2.4 in the Cote d'Ivoire. These data are shown in Figure 6. Based on these data we assume a ratio of 1.38 for generalized epidemics, 0.84 in most low-level and concentrated epidemics and 0.42 in IDU-driven epidemics (based on the ECDC data (ECDC, 2008) described above.

Figure 6: Ratio of new infections among adult females to new infections among adult males



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 2.

Table 2. Probability of Transmission of HIV from an Infected Mother to her Newborn Child by Type of Prevention Regimen

Type of Regimen	Mother-to-Child Transmission Rate
None	20%
Single dose Nevirapine	11%
Dual prevention ARV	4%
Triple prevention ARV	2%
Triple treatment ARV	2%

References

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.

Transmission may also occur after birth through breastfeeding. The amount of transmission depends on the type and duration of feeding. A review of studies indicates that transmission rates vary from 0% for replacement feeding to 1.5% per month for mixed breastfeeding (Table 3).

Table 3. Monthly Probability of Transmission of HIV from an Infected Mother to her Newborn Child by Type of Feeding

Type of Infant Feeding	Monthly Probability of HIV Transmission
Replacement Feeding	0%
Mixed breastfeeding, 1-6 months	1.5%
Exclusive breastfeeding, 1-6 months	0.75%
Mixed breastfeeding 6-36 months	0.75%
Mother receiving ART	0.3%

Sources: Iliff 2005, Rollins 2006, BHITS 2004.

Information on the distribution of infant feeding practices may be available from national surveys (such as DHS or MICS) for the general population and from PMTCT program statistics for women accessing the program. The average pattern in Sub-Saharan Africa is shown in Table 4.

Table 4. Percent Distribution of Infant Feeding Practices by HIV Status of Mother and Age of Child

Age of Child and HIV Status of Mother	No Breastfeeding	Exclusive Breastfeeding	Mixed Feeding
Children <6 months			
Mother HIV-positive	0.8	31.3	67.9
Mother HIV-negative	0.9	37.6	61.5
Children 6-11 months			
Mother HIV-positive	6.4	1.4	92.1
Mother HIV-negative	1.8	5.8	92.4
Children 12-23 months			
Mother HIV-positive	23.4	0.7	75.9
Mother HIV-negative	15.9	1.2	82.9

Source: Bradley SE and Mishra V. HIV and Nutrition among Women in Sub-Saharan Africa, DHS Analytical Studies No. 16. Macro International: Calverton, MD. September 2008.

Information on the median duration of breastfeeding is also available from national surveys such as DHS and MICS. Table 5 provides data for a number of countries with recent surveys.

Table 5. Median Duration of Any Breastfeeding in Months

Country	Median Duration (Months)	Country	Median Duration (Months)
Armenia 2005	10	Madagascar 2003/2004	23
Azerbaijan 2006	8	Malawi 2004	24
Bangladesh 1999/2000	31	Mali 2006	21
Benin 2006	22	Mauritania 2000/01	21
Bolivia 2003	21	Mexico 1987	8
Botswana 1988	18	Moldova 2005	12
Brazil 1996	7	Morocco 2003-2004	15
Burkina Faso 2003	26	Mozambique 2003	23
Burundi 1987	24	Namibia 2006/2007	17
Cambodia 2005	22	Nepal 1996	31
Cameroon 2004	18	Nicaragua 2001	18
CAR 1994/95	21	Niger 2006	22
Chad 2004	22	Nigeria 2003	19
Colombia 2005	15	Pakistan 2006/07	21
Comoros 1996	20	Paraguay 1990	11

Country	Median Duration (Months)	Country	Median Duration (Months)
Congo (Brazzaville) 2005	17	Peru 2000	21
Congo Democratic Republic 2007	22	Philippines 2003	15
Cote d'Ivoire 1998/99	21	Rwanda 2005	34
Dominican Republic 2007	7	Senegal 2005	21
Ecuador 1987	13	South Africa 1998	16
Egypt 2005	19	Sri Lanka 1987	20
Eritrea 2002	23	Sudan 1990	19
Ethiopia 2000	28	Swaziland 2006	17
Gabon 2000	12	Tanzania 2004	22
Ghana 2003	23	Thailand 1987	15
Guatemala 1998/99	20	Togo 1998	24
Guinea 2005	24	Trinidad and Tobago 1987	6
Haiti 2005/06	19	Tunisia 1988	15
Honduras 2005	20	Turkey 1998	12
India 2005/2006	31	Turkmenistan 2000	18
Indonesia 2002/2003	23	Uganda 2006	22
Jordan 2002	14	Uzbekistan 1996	17
Kazakhstan 1999	15	Vietnam 2002	18
Kenya 2003	22	Yemen 1997	18
Kyrgyz Republic 1997	17	Zambia 2001/02	22
Lesotho 2004	22	Zimbabwe 2005/06	19
Liberia 2007	20		

Source: Demographic in Health Surveys

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. A recent analysis of data from national surveys calculated this information for 20 countries and found that the average ratio of fertility among HIV+ to HIV- women drops from 0.765 among women 20-24 to just 0.47 among women 45-49 (Chen and Walker 2008). See Table 4 below. For women 15-19 the ratio depends on the proportion that is sexually active.

Table 6. Ratio of Fertility among HIV-Infected Women to HIV-Uninfected Women Based on Analysis of DHS Data from 20 Countries in Sub-Saharan Africa

Age of Woman	Ratio
15-19	2.528 – 0.031 x % sexually active
20-24	0.765
25-29	0.706
30-34	0.647
35-39	0.588
40-44	0.529
45-49	0.470

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 equally. 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. Others may start treatment too late to benefit. 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.

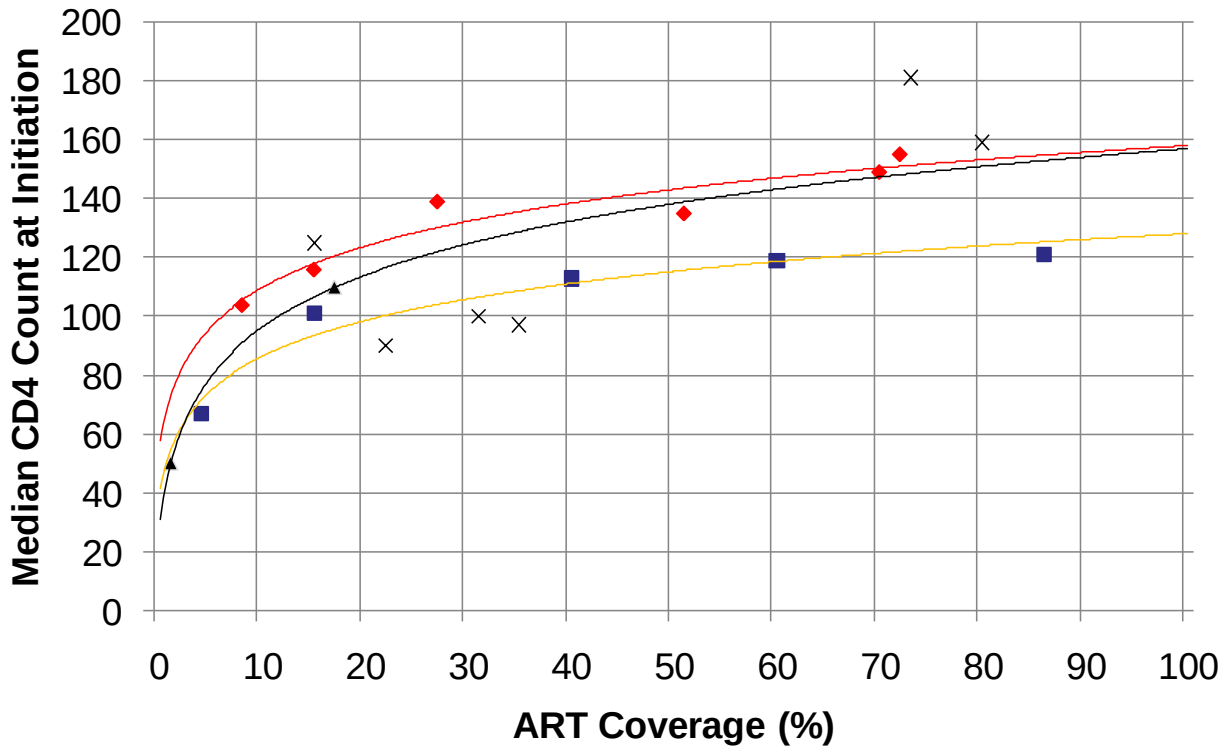
The recommended values for the effects of ART on mortality are derived from cohort studies that track the progress of their patients (Dabis *et al.* 2007), analysis of program statistics (Rosen, 2007), and studies of mortality among those lost to follow-up (Brinkhof *et al*, 2009). The values recommended for use in Spectrum are :

Survival of adults on ART

- First year : 0.86
- Subsequent years : 0.90

First year survival is worse than subsequent year survival because many patients start very late, at CD4 counts well below 200. The median CD4 count in African cohorts reporting data is 87-125 (Egger *et al.* 2007). As national programs improve treatment coverage the median CD4 count at treatment initiation will rise. At 100% coverage the median CD4 count would be above 200 and survival should be equal to the rate for subsequent years. Figure 7 shows the pattern for countries and regions for which data are available.

Figure 7: ART Coverage and Median CD4 Count at ART Initiation



A review of published and unpublished data shows that survival increases as the starting level of CD4 levels increase. The pattern suggests that, if data are available on the proportion starting ART with CD4 counts under 50, then first year survival can be estimated as:

First year survival on ART = % starting under 50 x 0.16 + (1- % starting under 50) x 0.06 + 0.08

At the moment, little information is available on the survival rates on second line ART. Therefore, we use 0.90 annual survival on second line therapy, the same as first line. As more information becomes available in the futures, these assumptions will be adjusted.

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. For children between 18 months and 5 years of age WHO recommends cotrimoxazole should be provided to all children who are HIV+. After age children should be on cotrimoxazole if they have progressed to Stage III or IV. If early diagnosis is available, then only HIV+ children are considered in need of cotrimoxazole.

The effect is to reduce mortality by 33% in each of the first five years of treatment for those children who are not also receiving ART and, for those receiving ART, to reduce mortality by 33% in the first year, 16% in the second year, 8% in the third year, 4% in the fourth year and 2% in the fifth year. (UNAIDS/UNICEF/WHO, 2008).

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. Current guidelines define the need for ART as all children under the age of 1 year with confirmed HIV infection plus all those children over the age of 1 who have progressed to moderate-to-severe disease. Analysis of data from ART-LINC cohorts suggests the following survival rates for children in ART (UNAIDS/UNICEF/WHO, 2008):

- Under one year of age: 0.85
- Over one year of age, first year: 0.85
- Over one year of age: subsequent years: 0.93

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:

Costs per patient per year
+
(Service delivery cost * service delivery requirements)

Table 7 below provides data from recent studies on the number of out-patient visits (#OPV), in-patient days (#IPD), and laboratory and drug costs for ART and treatment of opportunistic infections.

Table 7. 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/AID 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, Boulle 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	

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.

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. These calculations are based on methods developed by Ian Timaeus and Nicolas Grassly (Grassly and Timaeus, 2005; Timaeus, 2008).

Outside sub-Saharan Africa the estimation of orphanhood needs to be adapted for the fact that many of the AIDS deaths will occur to high risk groups, such as men who have sex with men, infecting drug users and sex workers, who may have fertility that is very different from the general population. The number of orphans is adjusted for the lower fertility of these groups. Since information on the fertility of these high risk groups is not readily available the proportion marred may be used as a proxy.

4. PROJECTION OUTPUTS

AIM will calculate and display a number of indicators grouped under the headings *Total population, Adults (15-49), Adults (15+), Children (0-14), Children (under 1), Children (1-4), Regional table, AIDS Impacts, Orphans, and Treatment Costs*. A complete list of indicators available and their definitions is given below.

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.

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.

Children

- **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 bithe and receiving prophylaxis to prevent transmitting HIV to the baby.
- **Children receiving cotrimoxazole:** The number if 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.

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.

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 (%).

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.

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 malnourished[2], 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

5. 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 98 or higher and that you are familiar with the basic operation of Windows programs and terminology.

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.

Installing the Spectrum Program

The Spectrum program is distributed on CD-ROMS or through the Internet at http://www.HealthPolicyInitiative.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.HealthPolicyInitiative.com. Click on "Software" and then "Spectrum." Next click on "Spectrum download (single 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 the follow the instructions.

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

Creating a New Projection

Starting the Spectrum Program

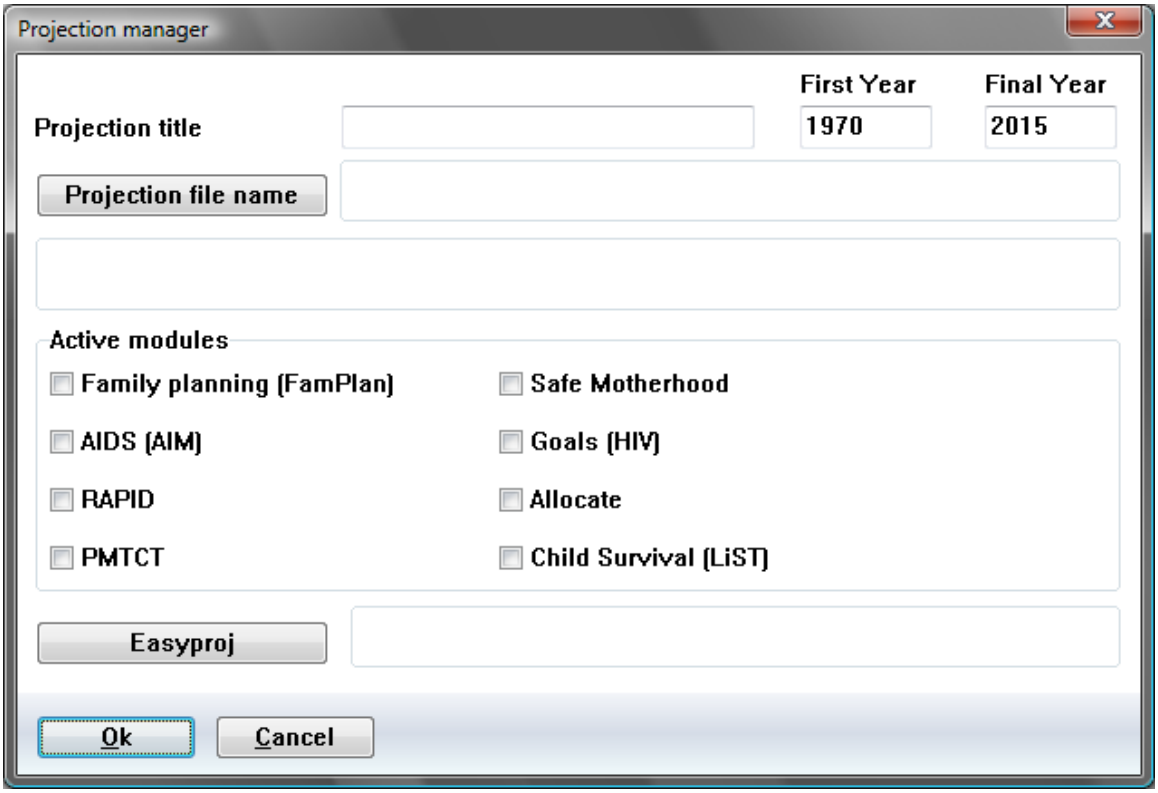
To start Spectrum:

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.

Opening a Demographic Projection with Planned Use for AIM

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.

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.

1. 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.
2. Check the box next to "AIDS (AIM)" to include the AIM module.
3. Click the "File name" button and enter a file name for this projection. Then click "Save."
4. 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.

5. Click "OK" to return to the dialogue box and click "OK" once more to complete the set-up process.
6. Select "File" and "Save projection" from the Spectrum menu to save this projection.
7. You can then go to "Edit" and click on "AIM" to begin working in AIM.

Adding the AIM Module to a Previously Prepared Demographic Projection

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.

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.

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.

To update a projection that was prepared with a previous version of Spectrum to the current version you should follow these steps:

1. Read the new incidence trend from EPP as described below under 'Read the incidence trend from EPP'
2. Designate the type of epidemic for the age and sex patterns of incidence.
3. Update data on PMTCT and treatment programs if necessary.

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.

6. PROGRAM TUTORIAL II: PROJECTION EDITORS

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.

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.

About the Editors: Organization of the Editor Screens

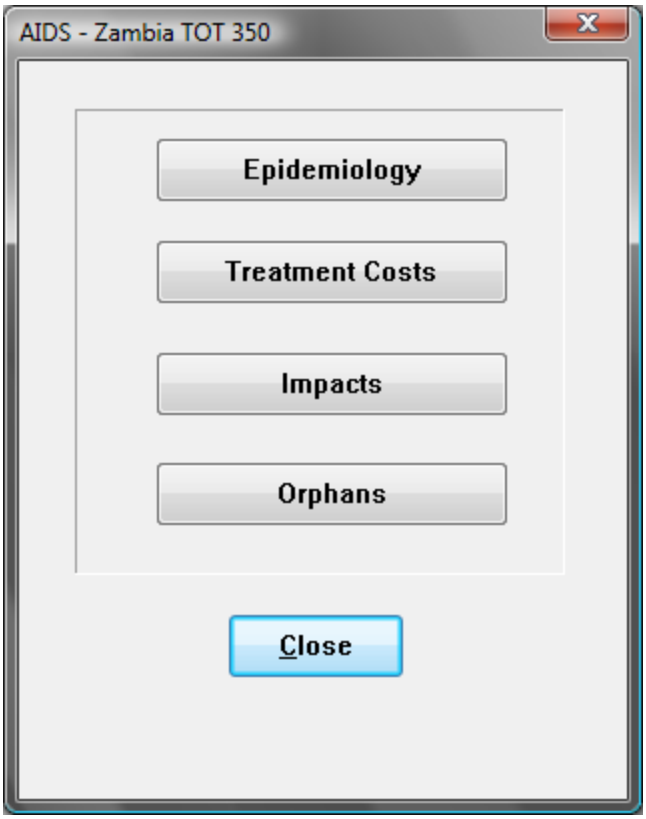
The editor screens are organized by input variable, each of which is labeled on a tab at the top of the editor. The editor for that variable is brought to the foreground when its tab is clicked on, and it becomes active when the actual editor screen is clicked on.

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.

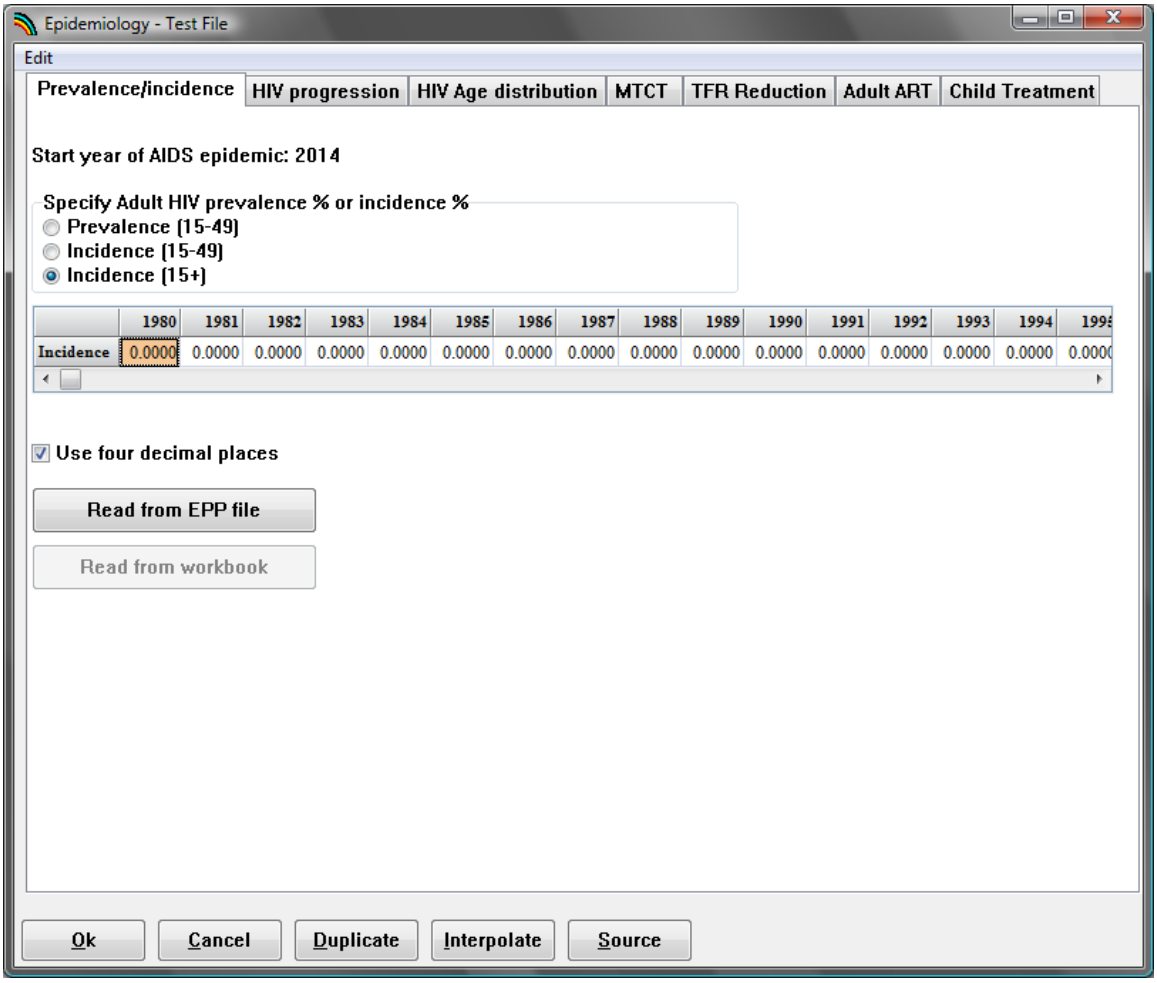
Instructions on how to access and utilize the AIDS dialogue box, the variable groupings, and the editors for each variable follow below.

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.



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.

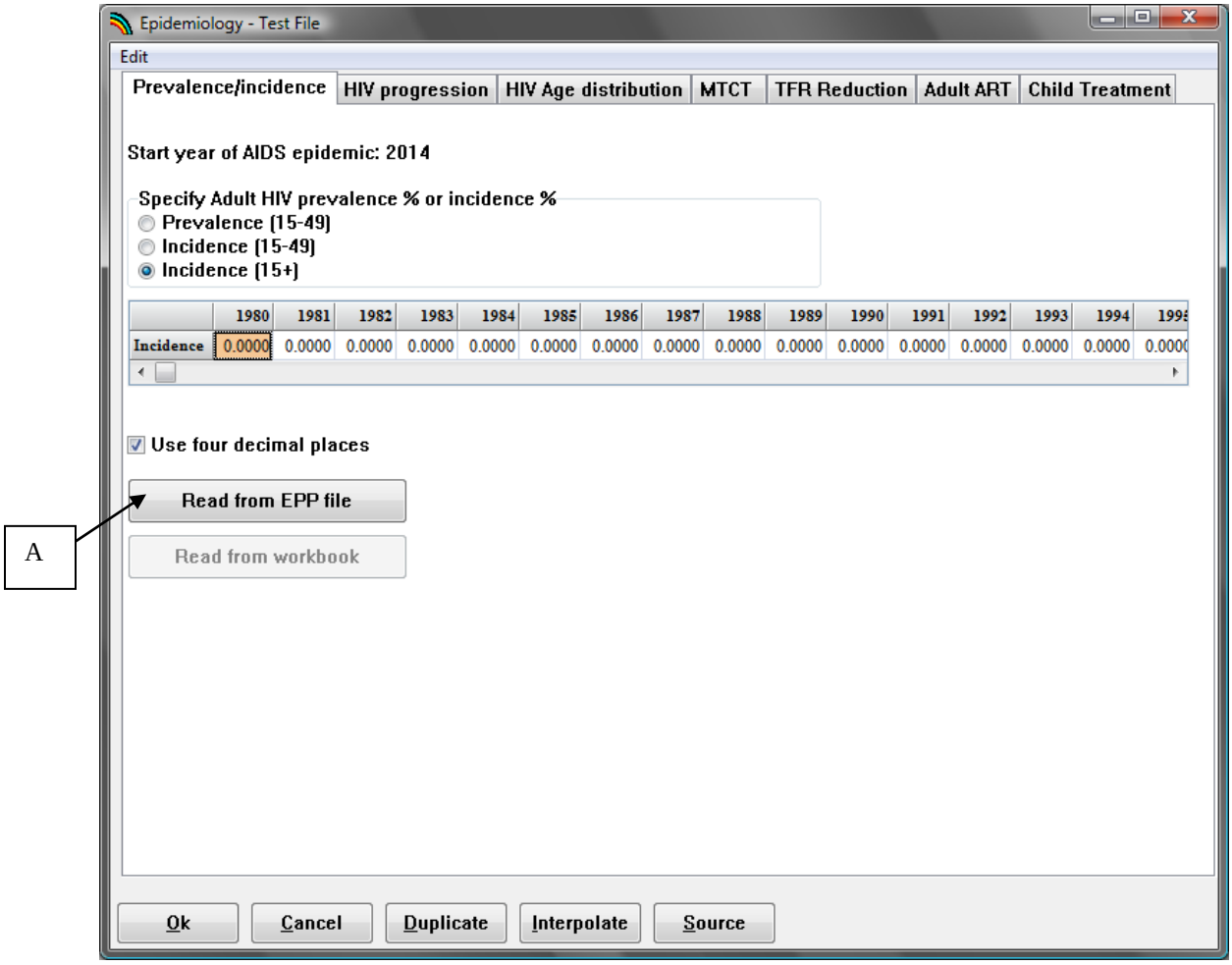
Epidemiology: Adult HIV Incidence

This tab allows you to enter the adult HIV prevalence or adult HIV incidence. In most cases the projection should be based on HIV incidence in order to allow Spectrum to calculate the effects of ART correctly.

Read the incidence trend from EPP

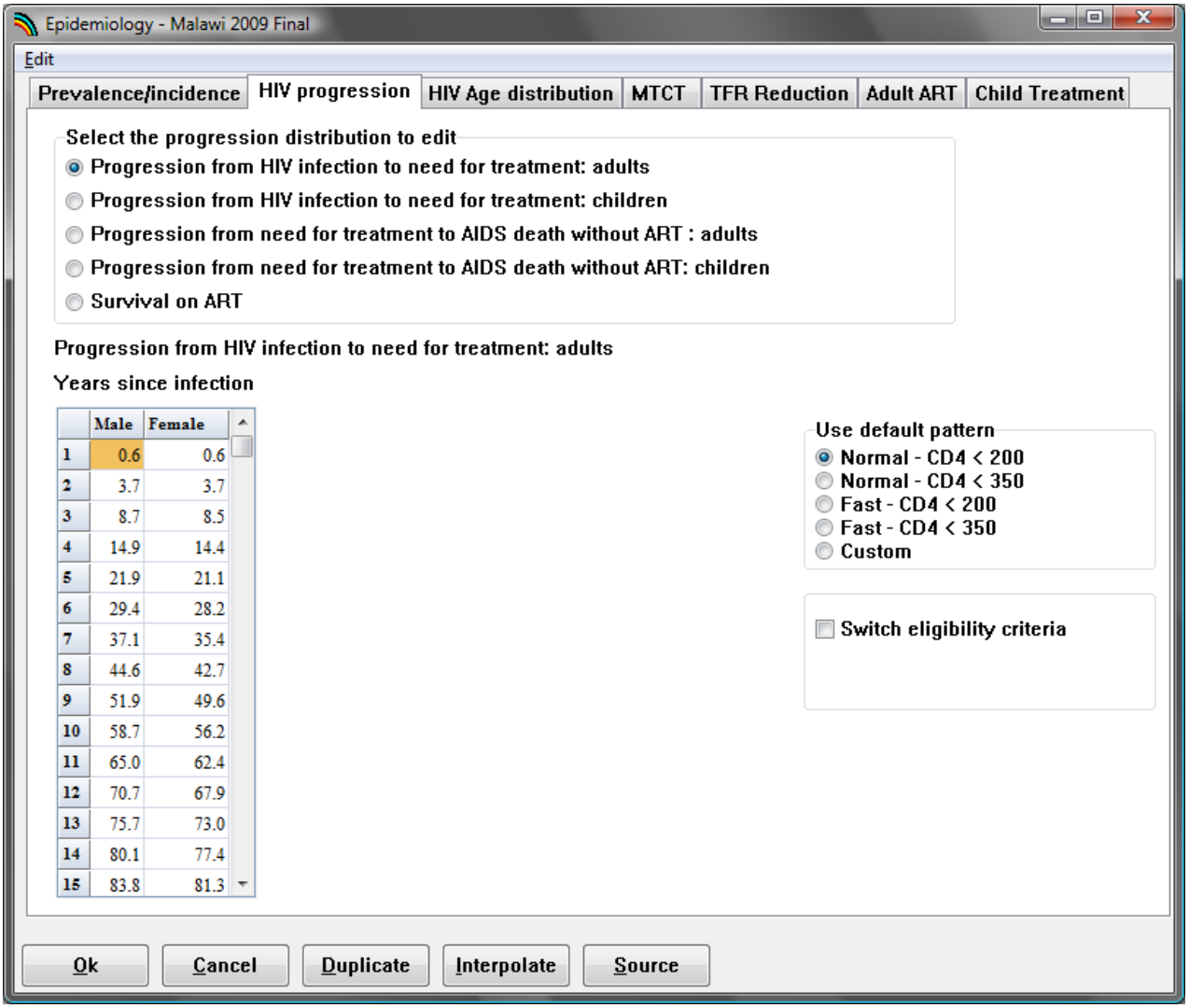
Select “Edit” and “AIDS (AIM)” from the Spectrum menu. Next, click “Epidemiology” from the dialog box. Then you will see the editor for the incidence trend. It will look like the screen shown below.

From this editor you can read the incidence trend that was prepared in EPP. Click the button "Read from EPP file" [A]. This will display a "file open" dialog box. Navigate to the directory where your EPP file is stored (for example C:\Program files\EPP 2009\eppout), select the appropriate file and click "Open" to complete this step. The incidence projection from this file will be read into Spectrum and displayed in the editor.



Review the progression assumptions

Select the 'HIV Progression' tab and the follow screen will appear. This screen shows the assumptions about progression from infection to need for treatment, progression from need for treatment to AIDS death in the absence of treatment and survival on ART.

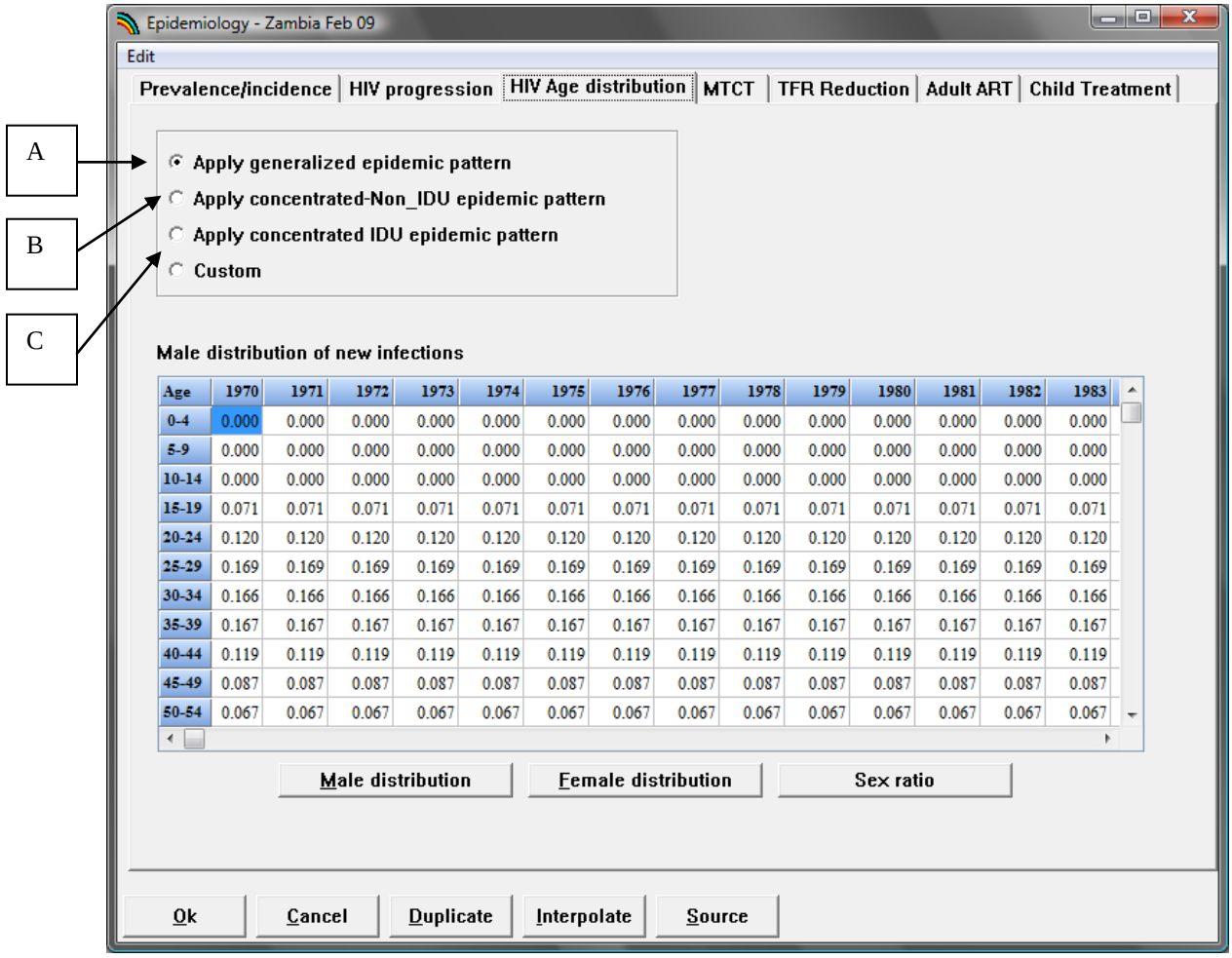


You can view the standard assumptions by clicking on the radio buttons at the top of the screen. For adults you can choose the normal progression patterns or the fast patterns, which apply primarily to Thailand, Cambodia and Myanmar. For children there is only one progression pattern. You can enter your own patterns by choosing 'Custom' but this should only be done for research purposes. You should generally leave the pattern at the default setting: Normal.

You can test the effects of switching criteria for eligibility for treatment from CD4 counts under 200 to under 350 by clicking the 'Switch eligibility criteria' button. Then you will need to select the year in which the switch takes place. The result will be a sharp rise in the number of people in need of treatment after the switch.

Set the pattern of incidence by age and sex

Select the tab "HIV Age distribution" and the following screen will appear. This editor shows the age distribution of new infections for males and females and the ratio of female to male incidence over time.



Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-19	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071
20-24	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120	0.120
25-29	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169
30-34	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166
35-39	0.167	0.167	0.167	0.167	0.167	0.167	0.167	0.167	0.167	0.167	0.167	0.167	0.167	0.167
40-44	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119
45-49	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087
50-54	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067

Here you have four options.

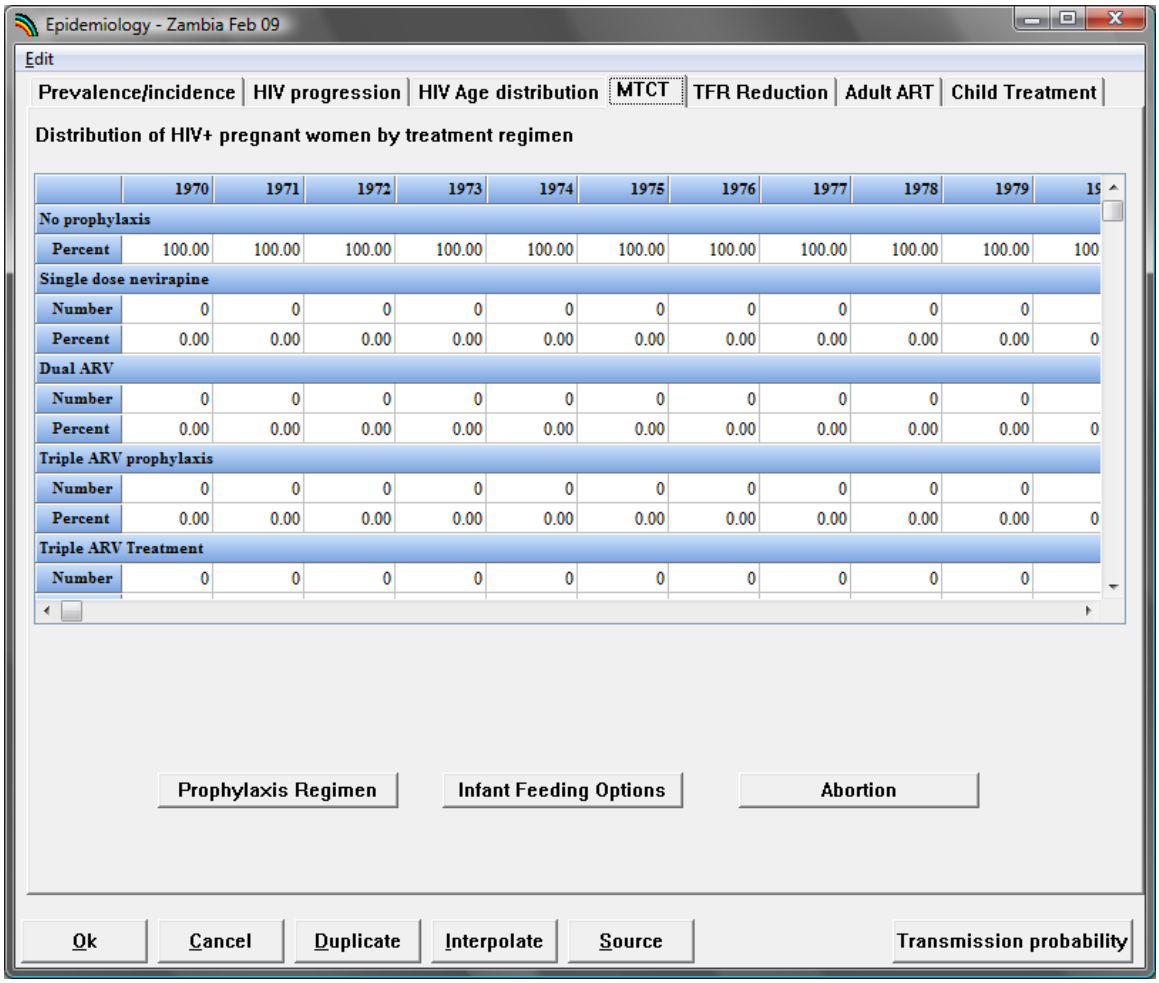
A. If your country has a generalized epidemic you should click the button "Apply generalized epidemic pattern". This will insert the default age and sex pattern for generalized epidemics.

B. If your country has a low level or concentrated epidemic and is not driven by transmission among injecting drug users, you should click the button, "Apply concentrated non-IDU epidemic pattern". This will insert the default age and sex pattern for low level and concentrated epidemics.

C. If your country has a concentrated epidemic and is driven by transmission among injecting drug users, you should click the button, "Apply concentrated IDU epidemic pattern". This will insert the default age and sex pattern for concentrated epidemics driven by IDU transmission.

Describe mother-to-child transmission

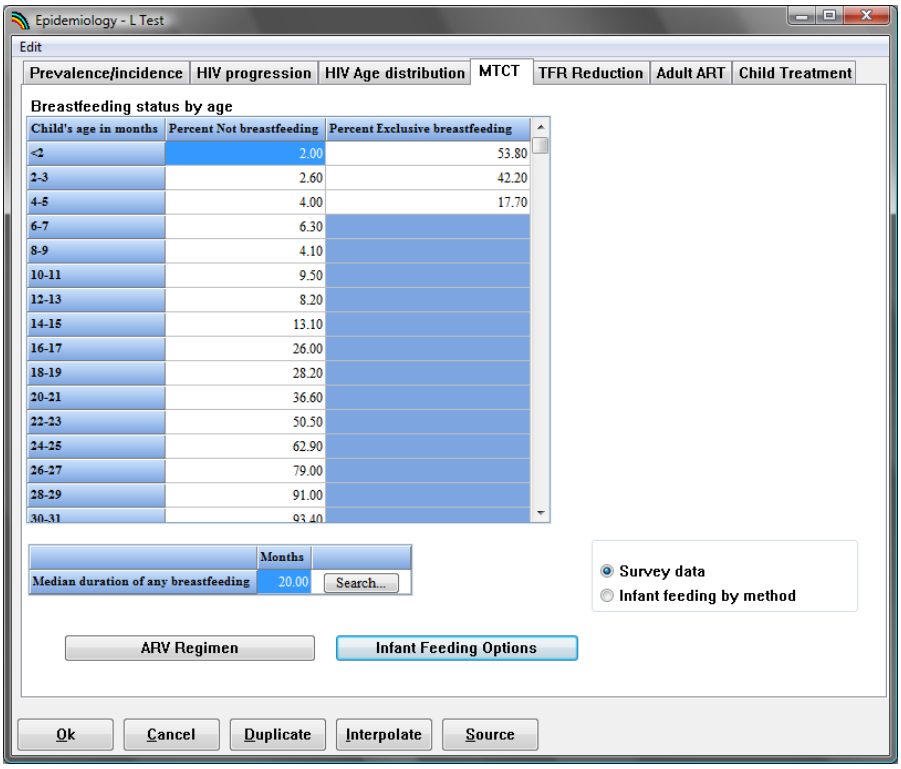
Select the tab "MTCT" and the following screen will appear:



You can use this editor to describe the PMTCT program. When the screen first appears it will show the editor for the prophylaxis regimens. You can switch to the Infant Feeding Option or Abortion screens by clicking on the appropriate button.

A. **Prophylaxis Regimen.** Enter either the percentage of pregnant women receiving each type of treatment (the top row will show the percent not receiving any treatment) or the number of women receiving each type of treatment (the bottom row will show the total number receiving any type of treatment. You can enter percentages in one column and numbers in another but do not mix them in the same column (year).

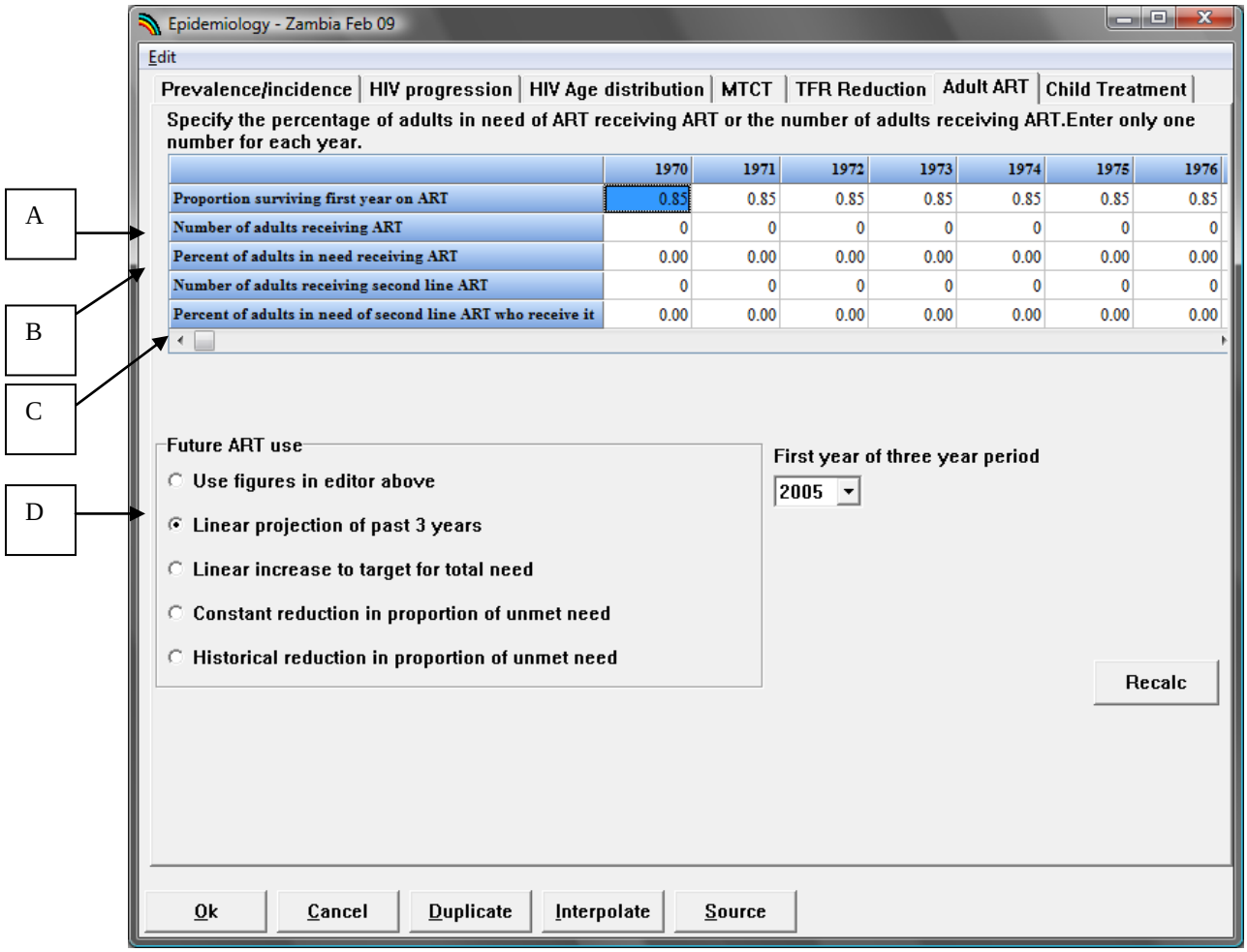
B. **Infant feeding options.** If you click on the Infant Feeding Option button you will see a new screen like the one below. There are two ways to enter information about infant feeding practices. If you have a DHS or other national survey you can enter the proportion of mothers not breastfeeding and the proportion practicing exclusive breastfeeding by the age of the child. This is the editor you will normally see when you enter this screen. If you created your projection using EasyProj these data will already be filled in if there is a DHS for your country. If you do not have this information you can select 'Infant feeding by method' from the radio button at the bottom right of the screens. Then you can enter diretly the number or proportion of mothers by type of feeding. You may enter either the percentage or the number of HIV+ women using each infant feeding option. You can enter percentages in one column and numbers in another but do not mix them in the same column (year). You also need to enter the median duration of breastfeeding (in months). If you press the 'Search' button you will see a list of countries with survey data.



C. **Abortion.** If abortion is a legal option for HIV+ women you can click the 'Abortion' button and enter the number or percentage of HIV+ women terminating pregnancies.

Describe the adult ART program

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.



A. Proportion surviving first year on ART. If you have information on the proportion of ART patients that survive their first year on ART you may enter it here. Survival may increase as coverage rises and the patients get started at higher CD4 counts. Some programs report first year survival but do not take into account the mortality that may occur among those lost to follow-up. If you use program-specific data be sure to include an estimate of mortality among those lost to follow-up.

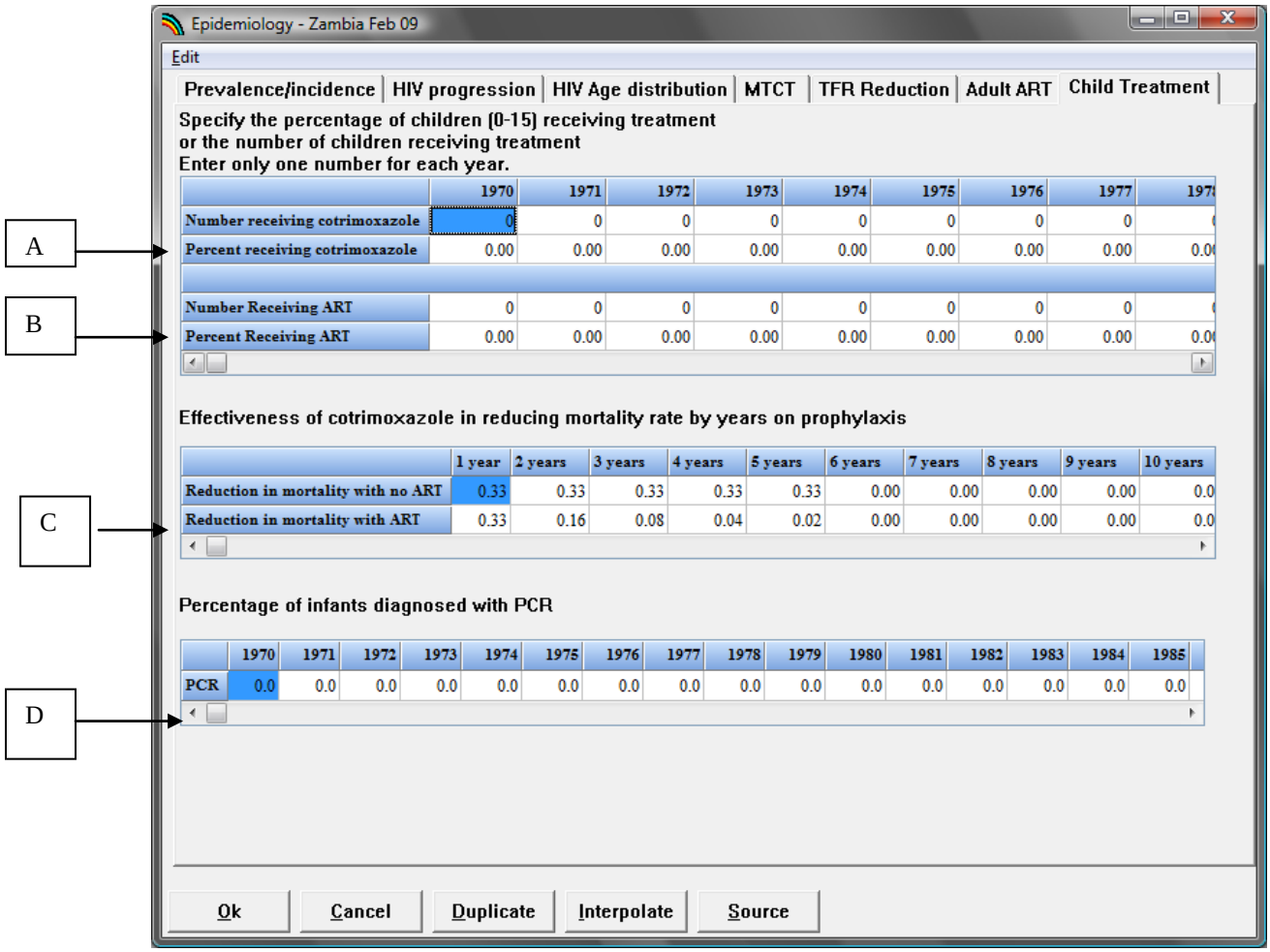
B. Set the program scope for first line therapy. You can describe the scope of the ART program for first line therapy either as the number of people receiving ART or the percent of those who need it.

C. Specify the use of second line therapy. You can describe the scope of the ART program for second line therapy either as the number of people receiving ART or the percent of those who need it.

D. Project future treatment. You can enter estimates of the future coverage of first line ART directly or use one of the methods shown to project future coverage. When you select a particular method using the radio buttons, the screen will change to request the necessary information for the projection.

Describe the child treatment program

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.



A. **Coverage of cotrimoxazole prophylaxis.** Enter the number of children receiving cotrimixazole or the percentage of those children in need that receive it.

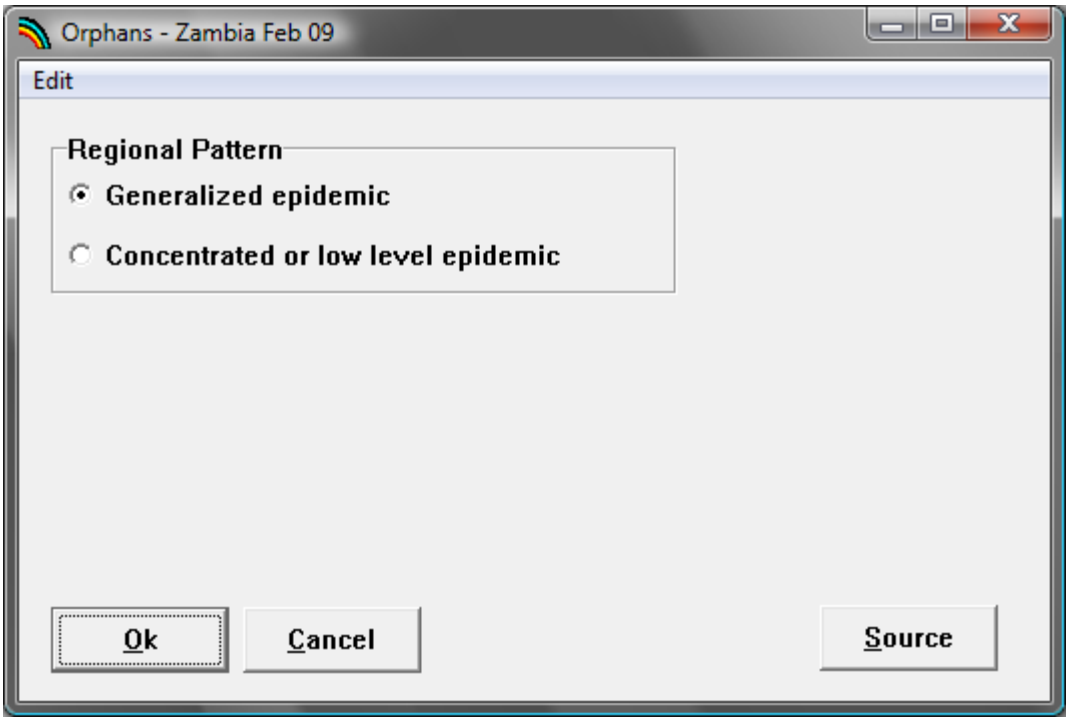
B. **Coverage of ART.** Enter the number of children receiving ART or the percentage of those children in need that receive it. .

C. **Effectiveness of cotrimoxazole.** This is the default assumption about the effect of cotrimoxazole in reducing child mortality from AIDS.

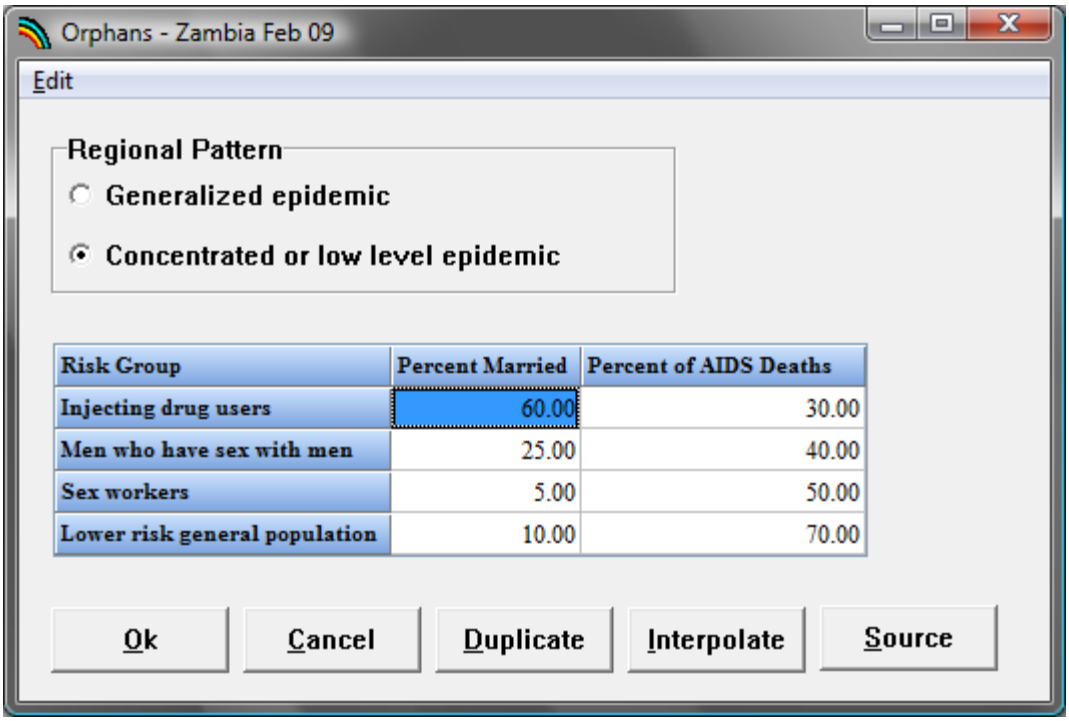
D. **Early diagnosis.** With the typical antibody tests in use in most developing countries children born to HIV+ mothers cannot be diagnosed has HIV+ until the age of 18 months. Therefore cotrimoxazole is recommended for all children born to HIV+ mothers until their own status can be determined and 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. Once you have completed this section click 'Ok' to move to the next step.

Specify approach to estimating orphans

Click on the 'Orphans' button to set the procedure for estimating the number of orphans. Spectrum calculates the number of AIDS and non-AIDS orphans by type: maternal, paternal and double. These calculations are based on data from generalized epidemics in Africa but estimates of the number of AIDS orphans can be made for concentrated epidemics with additional information about the fertility of those who are HIV+.



If you select 'Generalized epidemic' no additional information is needed. If you select 'Concentrated or low level epidemic' then you need to enter information on the percentage married and the percentage of AIDS deaths by risk group as shown below. Once you have completed this, click 'Ok' twice to return to the main menu.


Orphans - Zambia Feb 09
Edit
Regional Pattern
Generalized epidemic
Concentrated or low level epidemic
Risk Group
Percent Married
Percent of AIDS Deaths
Injecting drug users
60.00
30.00
Men who have sex with men
25.00
40.00
Sex workers
5.00
50.00
Lower risk general population
10.00
70.00
Ok
Cancel
Duplicate
Interpolate
Source

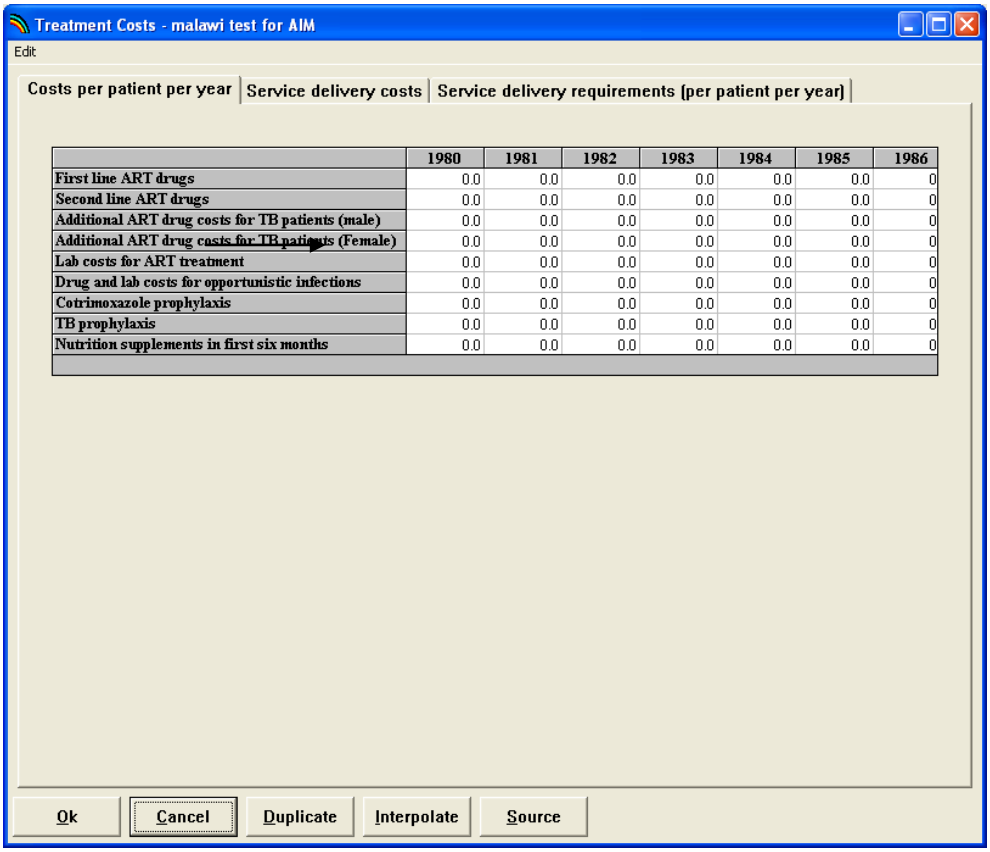
Treatment Costs

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.

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.



	1980	1981	1982	1983	1984	1985	1986
First line ART drugs	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
Additional ART drug costs for TB patients (male)	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
Lab costs for ART treatment	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
Cotrimoxazole prophylaxis	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
Nutrition supplements in first six months	0.0	0.0	0.0	0.0	0.0	0.0	0

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.

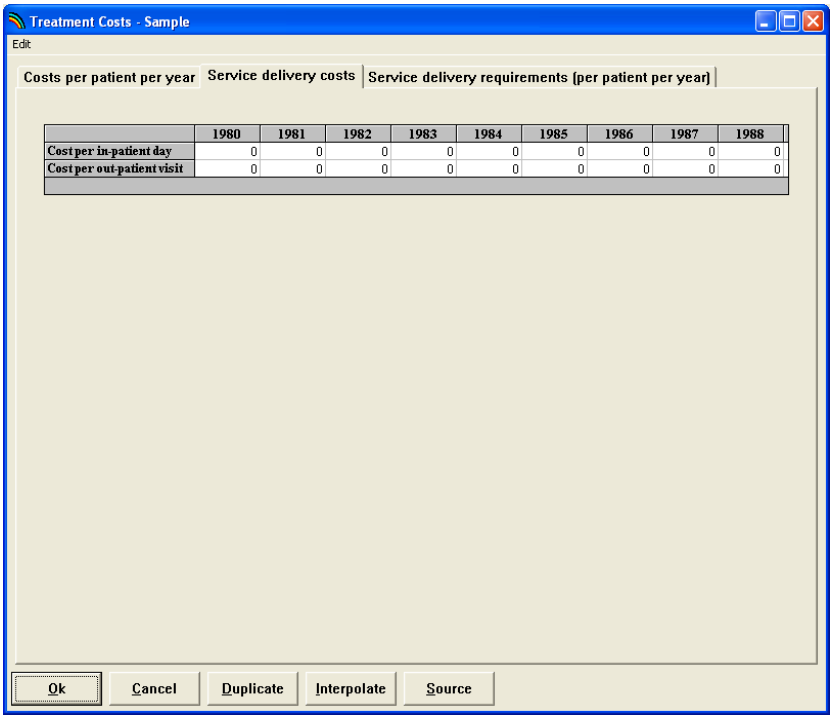
F. Enter the cost for TB treatment.

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.

Treatment Cost: Service delivery costs

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



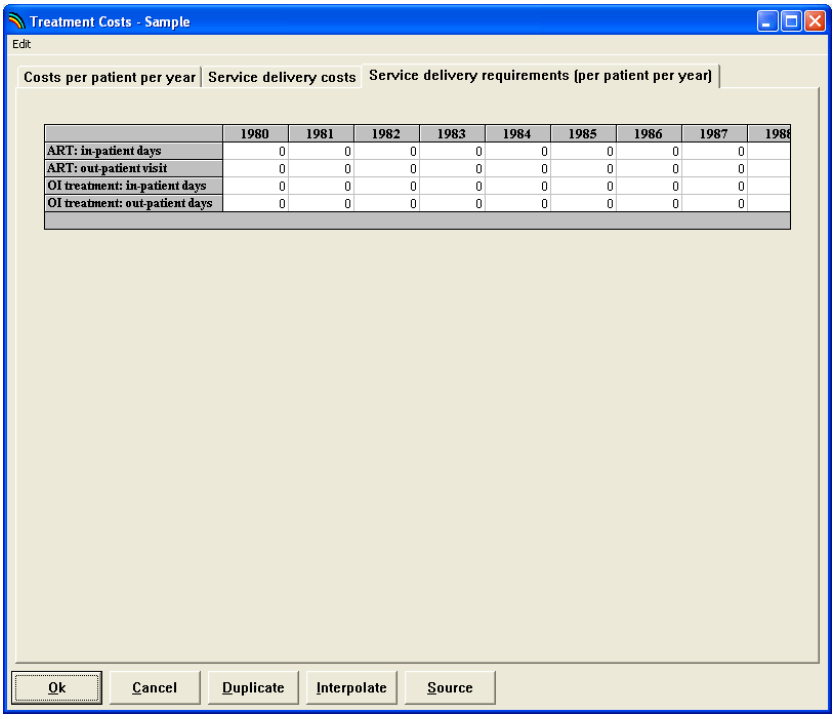
1. Enter your national data for "cost per in-patient day." This assumes one bed day at a primary-level hospital.

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/

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:



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.

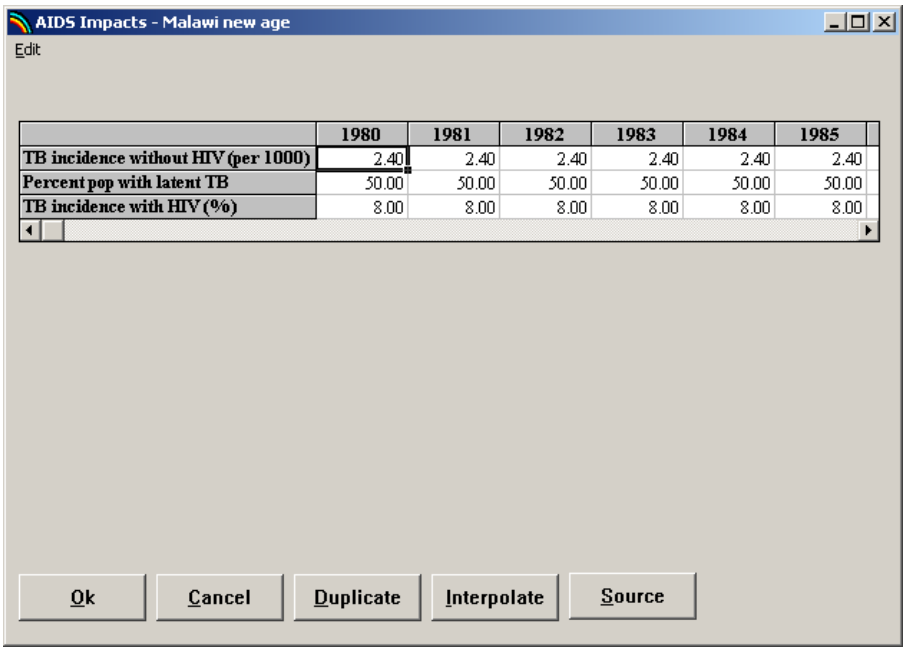
Impacts

To enter the input on impact for the AIDS projection,

3. Choose "Edit" from the menu bar.

4. Choose "AIDS (AIM)" from the pull-down menu.

5. Select "Impacts" from the AIDS dialogue box. This step will display an editor like the one shown below.



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.

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.

7. PROGRAM TUTORIAL III: DISPLAY

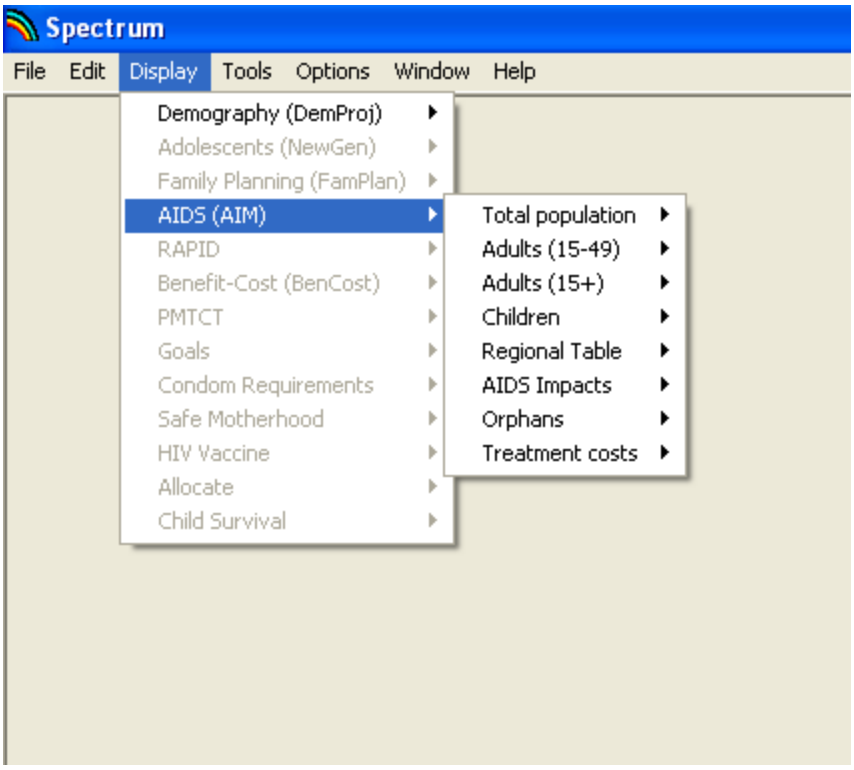
Making the Projection

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.

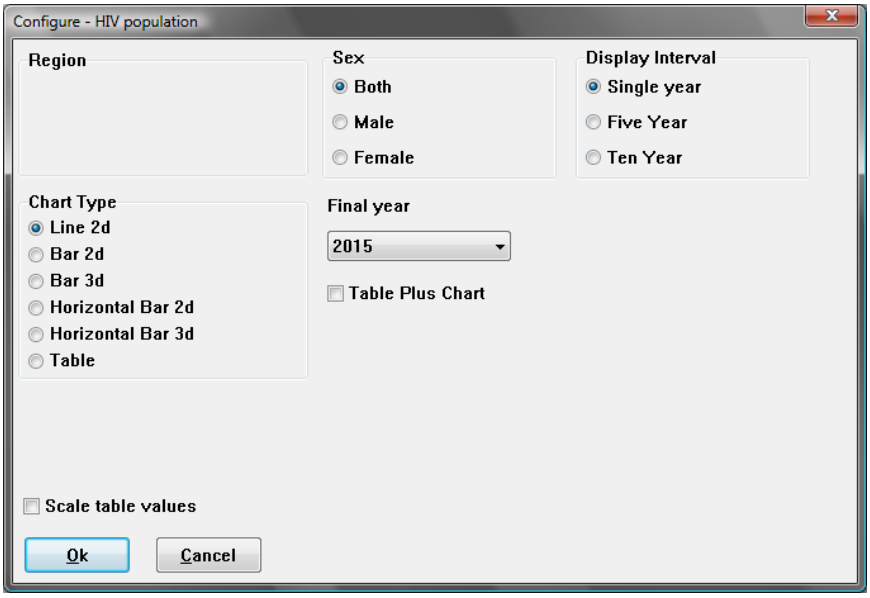
Examining the Output

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



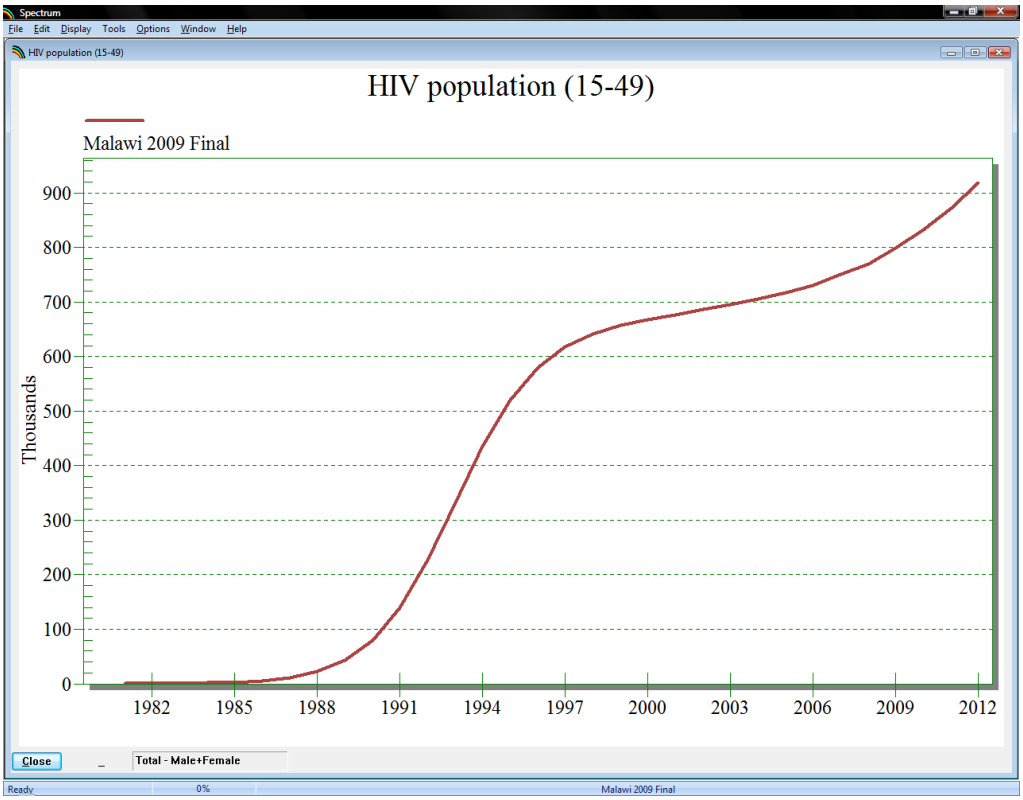
Choose one of these categories and you will see one final menu listing the indicators available in that category. Select one of the indicators. Then you will see the display dialogue box. It will look similar to the one shown below.



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.

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.

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.

You can change the decimal precision on tables by selecting a group of cells and then clicking the right mouse button and selecting 'Increment decimals' or 'Decrement decimals'.

You can copy all the data in a table to Excel or Work by selecting 'Edit' and 'Copy All' and then moving to Excel or Word and pasting the data.

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.

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.

8. PROGRAM TUTORIAL IV: TOOLS

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.

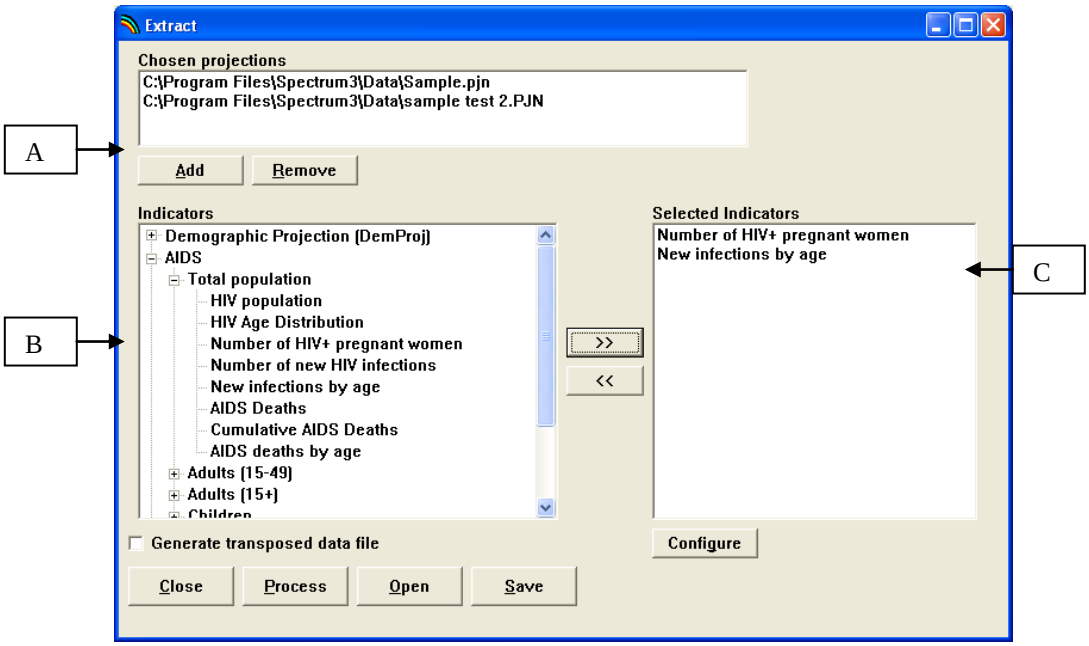
- The aggregate feature enables you to extract and *combine* projected data from two or more previously saved projections into one new projection that will be weighted appropriately by Spectrum. The data from that new projection can then also be extracted to excel for further analysis if so desired. 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.

Extract

After entering Spectrum, go to "Tools" and click on "Extract" from the drop-down menu. (**Note:** You cannot 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.

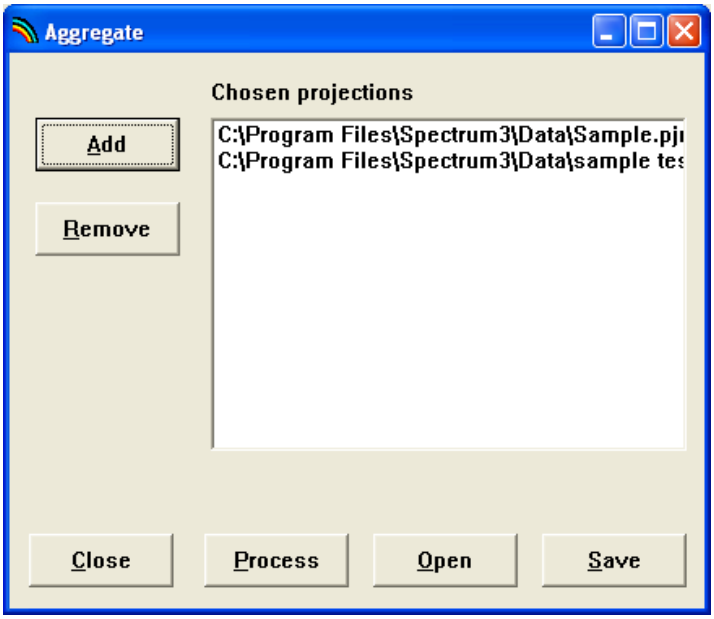
If you do not wish to process the extraction immediately, but would like to save the "Extract" window in which you have pulled out the mix of projections and indicators that you would like to use in the future, click the "Save" button. Enter the file name you wish to save the "Extract" window as, and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

Aggregate

After entering Spectrum, go to "Tools" and click on "Aggregate" from the drop-down menu. (**Note:** You cannot 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:



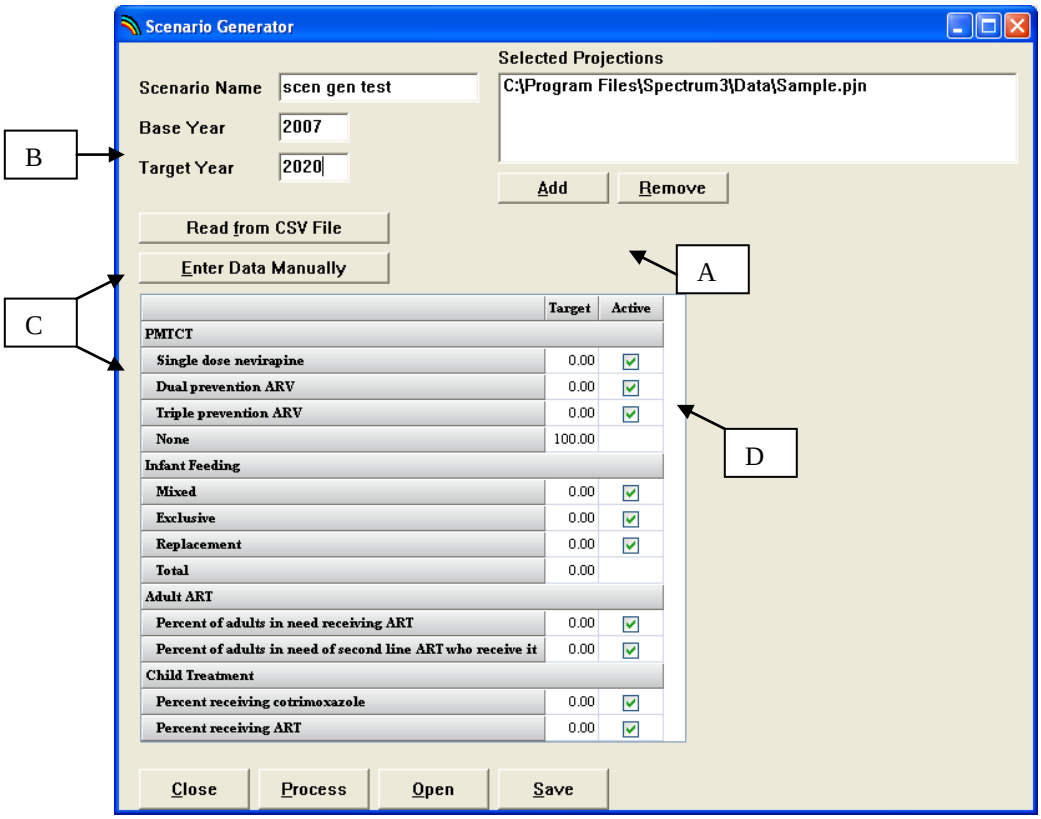
Click "Add" to browse previously saved projections. Click on the file name to highlight it, and then click "Open." To remove a selected projection from the "Chosen Projections," click on it to highlight it, and then click "remove" to remove it.

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.

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.

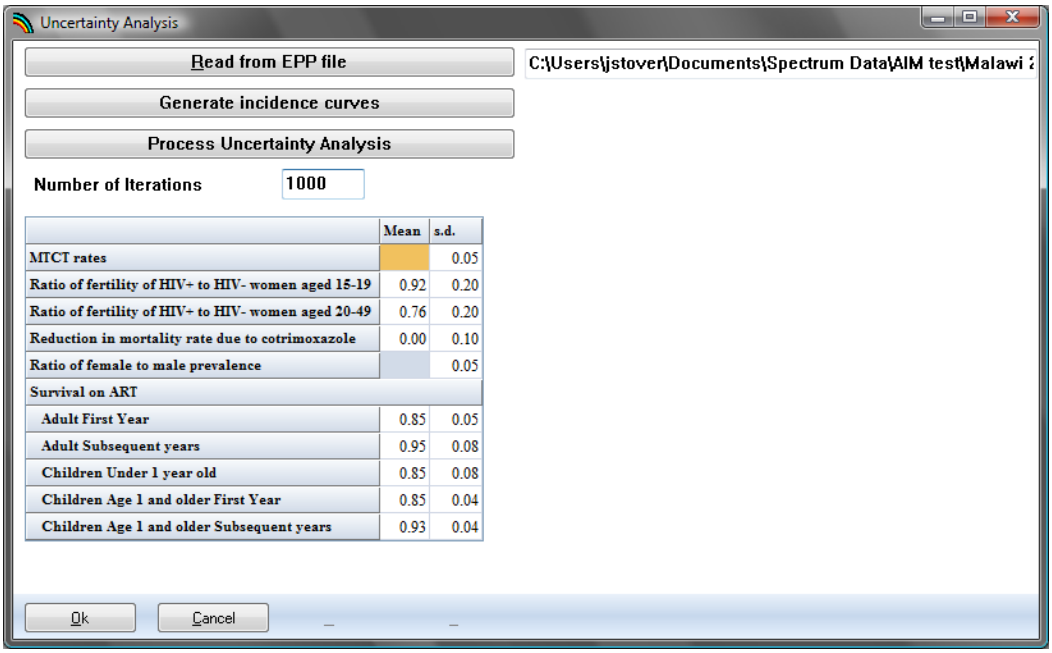
To process the scenario generation, click the "Process" button. Enter the file name you wish to save the scenario generation as, and click "Ok." It will then be saved as a Scenario Generator file (.SG file).

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.

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.

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:

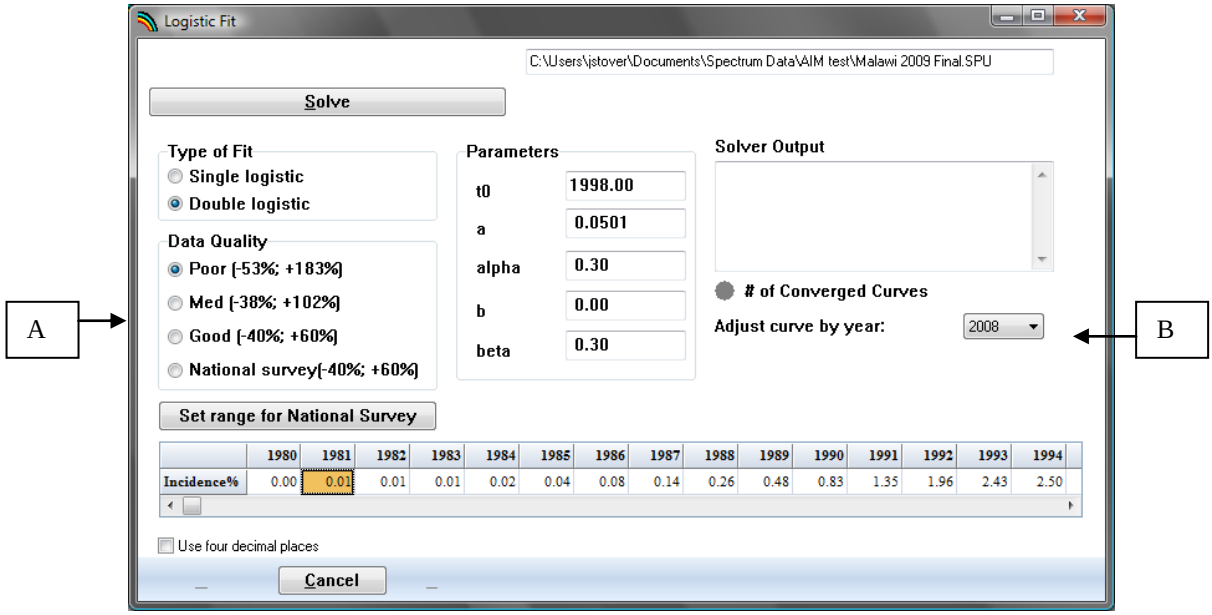


There are two major options depending on how your prevalence projection was prepared.

1. **If your incidence 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 you do not have an uncertainty file from EPP**, then you should click on the second button, "Generate Incidence Curves." Spectrum will use incidence values from the

projection that is open as the input to a curve fitting procedure. It will fit a double logistics curve to the annual incidence estimates.



Spectrum will display the incidence estimates and the initial guesses for the parameter values of the logistics fit. By default Spectrum will use a double logistics curve. You need to indicate:

A. 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 Taransmitted Infections* 2004*;* 80 (Suppl 1): i25-i30.

B. 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 incidence curves that can be used in the next step of the uncertainty analysis. Be sure to save the results before returning to the main uncertainty analysis page.

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.

9. METHODOLOGY

Epidemiology

Structure

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

a = age (0..80, 80+, total)
s = sex (male, female, both)
t = time in years (1 = first year of projection)
h = HIV state
- Neg: HIV-
- Asym: HIV+ and not in need of treatment
- NeedTx: HIV+ and in need of ART
- FLART: On first line ART
- NeedSL: In need of second line ART
- SLART: On second line ART
- BFAsym: HIV+ child infected through breastfeeding and not in need of treatment
- hAll : all HIV states

d = duration (number of years in the HIV state), dAll refers to all durations

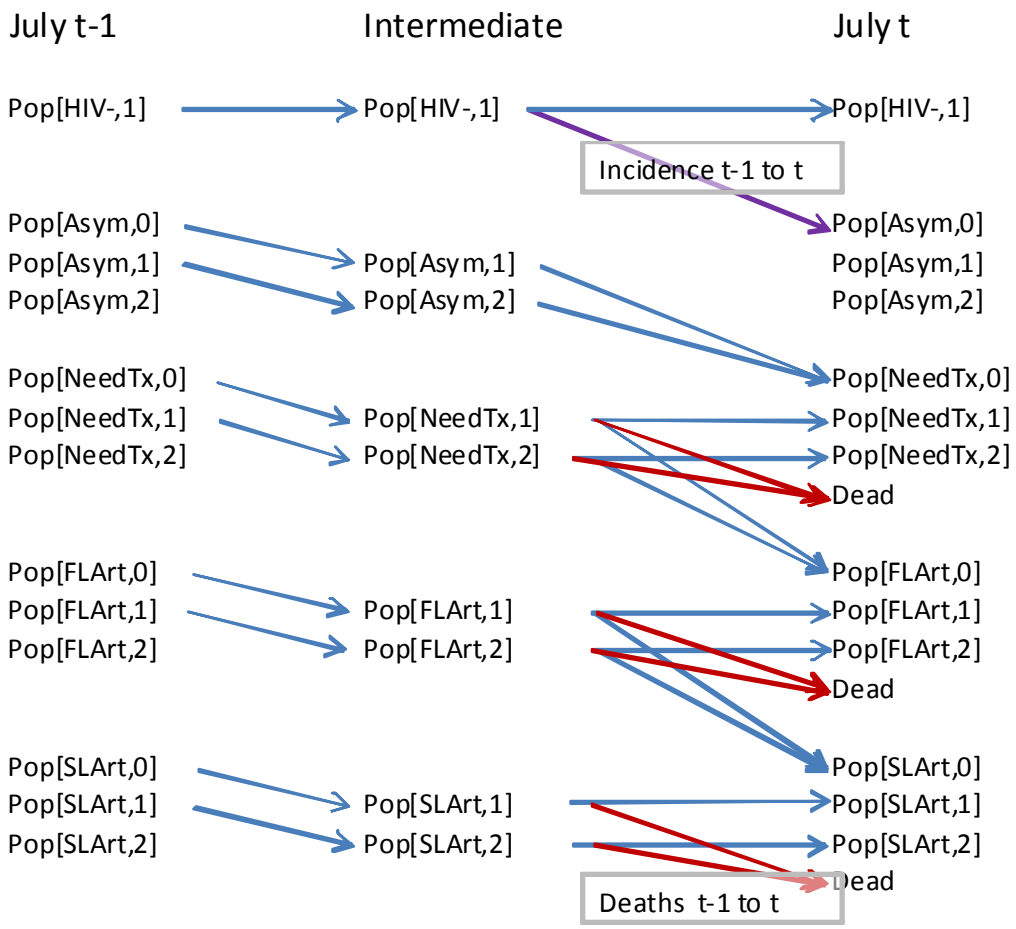
Initializing the population

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.

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.

After these intermediate progressions are done then we calculate the transitions from one state to the next and to death. This sequence is illustrated below.



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

1. Pop(a,s,t,h,d) = pop(a-1,t-1,s,h,d-1) x ([sr(t) + sr(t-1)] / 2 + mr)
2. mr = [migrants(a-1,t-1,s) + migrants(a,t,s)] / 2 / pop(a-1,t-1,s,hAll,dAll)
3. deaths(a,t,s,hAll,dAll) = [pop(a-1,t,s,hAll,dAll) + migrants(a-1,t,s,hAll,dAll)] * (1 – [sr(t)+sr(t-1)]/2)

Where:

mr = migration rate

sr(t) = survival rate during calendar year t (determined from the non-AIDS life expectancy and the selected model life table)

Progression from asymptomatic infection to need for treatment

The population that is infected with HIV but asymptomatic will progress to needing treatment over time. Eligibility for treatment can be defined as either a CD4 count under 200 or a CD4 count under 350. Within any cohort of people some people will progress more rapidly than others. The progression patterns used in Spectrum describe the proportion of people that progress by the number of years since infection. Once a person progresses to need for treatment they will subsequently progress to AIDS death is they do not get treatment. The patterns of progression over time used in Spectrum are described in Chapter 3.

The final set of Weibull parameters is:

Pattern	Sex	Infection to Eligibility		Eligibility to AIDS Death	
		r – shape	μ - scale	r – shape	μ - scale
African Pattern					
CD4 count < 200	Male	10.20	1.71	2.16	1.00
	Female	10.65	1.67	2.82	1.00
CD4 count < 350	Male	4.22	1.09	8.00	1.58
	Female	4.65	1.13	8.79	1.54
Thai Pattern					
CD4 count < 200	Male	7.25	1.67	2.20	1.00
	Female	8.25	1.68	2.20	1.00
CD4 count < 350	Male	2.67	1.19	6.84	1.65
	Female	2.51	1.00	7.84	1.66

For adults the progression from the asymptomatic stage to need for treatment is calculated from the appropriate progression pattern by sex (s), age (a) and time in the asymptomatic stage (d). The fraction progressing d years from infection is calculated as the cumulative proportion progressing by duration d minus the cumulative proportion progressing by duration d-1 divided by the proportion that has not progressed by duration d-1.

4. FractionProgressing(d) = [InfectionToNeed(d+0.5) – InfectionToNeed(d-0.5)]
   / [100 – InfectionToNeed(d-0.5)]

5. Progressors(a,t,s,d) = FractionProgressing(d) x pop(a,t,s,Asym,d)

6. Pop(a,t,s,NeedTx,1) = $\sum_d$ Progressors(a,t,s,d)

7. Pop(a,t,s,Asym,d) = Pop(a,t,s,Asym,d) – Progressors(a,t,s,d)

Progression from first line ART to need for second line

Survival on first line ART is modelled as an annual survival probability.

Those failing on first line do not immediately die, they are placed into a category of needing second line.

8. If d = 1 then FractionProgressing = FirstYearSurvivalOnART else FractionProgressing = 0.95
9. Progressors(a,s,t) = pop(a,t,s,OnFLART,d) x FractionProgressing(a,d)

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.

10. Pop(a,t,s,OnFLART,d) = pop(a,s,t,OnFLART,d) – Progressors(a,s,t)
11. Pop(a,t,s,NeedSLART,1) = pop(a,s,t,NeedSLART,1) + Progressors(a,s,t)

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:

12. FractionProgressing(a,d) = 1 – Probability of survival(a,d)
13. Progressors(a,s,t) = pop(a,t,s,OnSLART,d) x FractionProgressing(a,d)

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.

14. Pop(a,t,s,OnSLART,d) = pop(a,t,s,OnSLART,d) – Progressors(a,s,t)
15. AIDS deaths(a,s,t) = AIDS deaths(a,s,t) + Progressors(a,s,t)

Need for ART

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

16. NeedFLART(a,s,t) = pop(a,s,t,OnFLART,d) + pop(a,s,t,NeedTx,d)
17. NeedSLART(a,s,t) = pop(a,s,t,OnSLART,d) + pop(a,s,t,NeedSL,d)
18. NeedART(a,s,t) = pop(a,s,t,OnFLART,d) + pop(a,s,t,NeedTx,d) + pop(a,s,t,OnSLART,d) + pop(a,s,t,NeedSL,d)

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. Since the input coverage refers to December 31 of the current year we use the average of the input for the previous year (t-1) and the current year (t) to determine the number that should be on ART as of July 1 of year t.

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:

19. Number on FL ART(t) = $\sum_a \sum_s$ NeedFLART(a,s,t) x [coverage of first line ART(t-1) + coverage of first line ART(t)] / 2

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:

20. Number on SL ART(t) = $\sum_a \sum_s$ NeedSLART(a,s,t) x [coverage of second line ART(t-1) + coverage of second line ART(t)] / 2

The total number of new adult ART patients is the difference between the number on ART in the current year and the number surviving on ART from the previous year.

21. TotalNewFLART(t) = Number on FLART(t) - $\sum_a \sum_s \sum_d$pop(a,s,t,OnFLART,d)
22. TotalNewSLART(t) = Number on SLART(t) - $\sum_a \sum_s \sum_d$pop(a,s,t,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.

23. NewFLART(a,s,t) = TotalNewFLART(t) x $\sum_d$ pop(a,s,t,NeedTx,d) / $\sum_a \sum_s \sum_d$ pop(a,t,s,NeedTx,d)
24. NewSLART(a,s,t) = TotalNewSLART(t) x $\sum_d$ pop(a,s,t,NeedSL,d) / $\sum_a \sum_s \sum_d$ pop(a,t,s,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.

25. Pop(a,s,t,OnFLART,1) = NewFLART(a,s,t)
26. 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.

27. Pop(a,s,t,NeedTx,d) = pop(a,s,t,NeedTx,d) – NewFLART(a,s,t) x pop(a,s,t,NeedTx,d) / $\sum_d$ pop(a,s,t,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.

28. Pop(a,s,t,NeedSL,1) = pop(a,s,t,NeedSL,1) – NewSLART(a,s,t)

Progression to AIDS death

Those who are in need of ART but not receiving it have some chance of dying from AIDS, as defined by the progression pattern from eligibility for treatment to death.

29. FractionProgressing(d) = [NeedToDeath(d+0.5) – NeedToDeath(d-0.5)] / [100 – NeedToDeath(d-0.5)]

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

30. Progressors(a,s,t,d) = pop(a,t,s,NeedTx,d) x FractionProgressing(d)
31. Pop(a,t,s,NeedTx,d) = Pop(a,t,s,NeedTx,d) – progressors(a,s,t,d)
32. AIDSdeaths(a,s,t) = AIDSdeaths(a,s,t) + progressors(a,s,t,d)

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.

33. AIDSdeaths(a,s,t) = AIDSdeaths(a,s,t) + pop(a,s,t,NeedSL,1)

Note that these are AIDS deaths from July t-1 to July t.

New adult HIV infections

New HIV infections are calculated from HIV incidence among adults aged 15 and over provided by EPP. The incidence provided by EPP is defined calculated as:

<u>New Infection from July 1 2006 to 2007</u>
Susceptible population on July 1 2006

Total incidence is the average of male and female incidence weighted by the susceptible (HIV-negative) population.

34. Incidence(total) = [Incidence(male) * pop(15+,t-1,male,Neg,dAll)
+ Incidence(female) * pop(15+,t-1,female,Neg,dAll)] /
[pop(15+,t-1,male,Neg,dAll) + pop(15+,t-1, female,Neg,dAll)]

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

35. Incidence(female,t) = Incidence(total,t) x [pop(15+,t-1,male,Neg,dAll) + pop(15+,t-1,female,Neg,dAll)] / [pop(15+,t-1,female,Neg,dAll) + pop(15+,t-1,male,Neg,dAll) / 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.

36. NewHIV(15+,t,female,t) = Incidence(female,t) x [pop(15+,t-1,female,t,hAll,dAll) $- \sum_{h=Asymp\ to\ OnSLART} \sum_{d} pop(15+,t-1,female,h,d)$]

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

37. Incidence(male,t) = incidence(female,t) / R

38. NewHIV(15-49,male,t) = Incidence(male,t) x [pop(15-49,male,t-1) $- \sum_{h=Asymp\ to\ OnSLART} \sum_{d} pop(15-49,t-1,male,h,d)$]

New infections by age and sex

New infections need to be distributed by age and sex. The pattern of new infections by age is an input to Spectrum as described above. New infections by age are calculated from these patterns.

39. Pop(a,t,s,Asym,1) = NewHIV(15+,t,s,t) x PropNewInfByAge(a,s)

Note that these are new infections from July t-1 to July t. For output we need new infections during the calendar year. So the output of new infections is the average of Pop(a,t,s,Asym,1) and Pop(a,t+1,s,Asym,1).

New infections are subtracted from the uninfected population.

40. Pop(a,t,s,Neg,1) = pop(a,t,s,Neg,1) – pop(a,t,s,Asym,1)

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 fertility of HIV+ women is adjusted for the effects of HIV infection on fertility as described in Chapter 3.

41. BirthsToHIVWomen(a,t) = [pop(a,females,t,AllHIV+,dAll) + pop(a,females,t-1,AllHIV+,dAll)] / 2 x TFR(t) x BirthsRatio(a,t) / [BirthsRatio(a,t) * FemalePrevalence(a) + (1 – FemalePrevalence(a))] x BirthProp(a,t)

Where
BirthsProp(a) = proportion of lifetime births occurring at age a
BirthRatio(a) = ratio of fertility among HIV+ women to HIV- women at age a

Note that the number of 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 (Nybo Anderson 2000). The number of HIV+ pregnant women is calculated as the number of births to HIV+ pregnant women divided by (1 – 0.15).

Abortion

In some countries some women who know that they are HIV-infected may elect an abortion to avoid the chance of transmitting the infection to their newborn child. The number of births to HIV+ mothers is reduced by the number or proportion of pregnancies terminated by abortion. The input may be the number of abortions to HIV+ women or the proportion.

42. BirthsToHIVWomen(t) = BirthsToHIVWomen(t) – Abortions(t) OR BirthsToHIVWomen(t) = BirthsToHIVWomen(t) x (1 – ProportionAborted(t))

Need for PMTCT

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

43. NeedForPMTCT(t) = BirthsToHIVWomen(t)

Mother-to-child transmission rate

The transmission of HIV from mother to child is divided into two components: transmission during gestation and delivery and postnatal transmission through breastfeeding. The perinatal transmission rate depends on the type of prophylaxis if any.

The perinatal mother-to-child transmission rate is the weighted average of the proportion in each prophylaxis group and the corresponding probability of transmission.

44. $PTR(t) = \sum_c$ Prophylaxis(c,t) x transmission rate(c)

Where

PTR = perinatal transmission rate
Prophylaxis(c) = the proportion of women by prophylaxis category
Transmission rate = probability of transmission of HIV by prophylaxis category

HIV+ births

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

45. HIV+ births(t) = BirthsToHIVWomen(a,t) x PTR(t)
46. Pop(0,t,s,Asymptomatic,1) = HIV+ births(t) x SexRatioOfBirths(s)

Transmission through breastfeeding

HIV transmission from mother to child also may occur through breastfeeding. The number of children infected through breastfeeding is calculated as the product of the number of children born to HIV+ mothers who were not infected perinatally, the proportion of children exposed to transmission through breastfeeding, the monthly probability of transmission through breastfeeding and the median duration of breastfeeding.

The distribution of women by type of feeding is an input. The distribution of women may be different for those exposed to the PMTCT program and those not exposed to it. We assume that the inputs for year t refer to women exposed to the program in that year and that the distribution for women not exposed to the program is equal to the input distribution in the year before the PMTCT program started (indicated by the last year in which no women

received ARV prophylaxis). The overall distribution is a weighted average of the distributions for women exposed to the program and those not exposed.

Calculations are performed separately for the period 0-5 months, 6-11 months, 12-23 months and 24-35 months. Exclusive breastfeeding is confined to the first six months. Thus the distribution of children by type of feeding in the first six months is adjusted to recognize that all exclusive breastfeeding takes place during this period. It is also adjusted for women who are on ART to treat their own infection, since they have lower transmission rates than women who are exclusively breastfeeding or practicing mixed feeding.

47. Feeding%(Exclusive, 0-5 months) = Feeding%(Exclusive) * (1 – Prophylaxis(TripleTreatmentART) * MedianDurationBF / 6
48. Feeding%(Mixed, 0-5 months) = Feeding%(Mixed) / (Feeding%(Mixed) + Feeding%(Replacement) x (1- Feeding%(Exclusive, 0-5 months – Prophylaxis(TripleTreatmentART))
49. Feeding%(Replacement, 0-5 months) = Feeding%(Replacement) / (Feeding%(Mixed) + Feeding%(Replacement) x (1- Feeding%(Exclusive, 0-5 months - Prophylaxis(TripleTreatmentART))

The monthly probability of transmission during the first six months is a weighted average of the proportion using each feeding method and the corresponding monthly transmission probability.

50. BFTR = Prophylaxis(TripleTreatmentART) * TransmissionRate(TripleTreatmentART) + Feeding%(Exclusive, 0-5 months) * TransmissionRate(Exclusive) + Feeding%(Mixed, 0-5 months) * TransmissionRate(Mixed)

New infections transmitted through breastfeeding in the first six months are the cumulative infections transmitted by month.

51. ProportionInfectedFromBF(m) = $\sum_{m=0,5}$ BFTR * (1 – ProportionInfectedFromBF(m-1)

The calculations are similar for months 6 to 11 except that the proportion of mothers practicing exclusive breastfeeding is set to 0 and mixed and replacement feeding are adjusted accordingly. The monthly probability is cumulated up to the median duration of breastfeeding. The total number of new infections in the first year of life is calculated by multiplying the number of children born to HIV+ mothers who were not infected at birth by the cumulative probability of breastfeeding transmission for months 0-11.

52. NewInfectionsFromBFYear1(t) = [BirthsToHIVwomen(t) – HIV+ births(t)] * $BFTR_{0-11}$

Infected infants will be the sum of those infected perinatally and those infected through breastfeeding in the first year of life. The number who survive to be age 0 and infected is the product of the new infections and the non-AIDS survival rate.

53. Pop(0,t,s,Asym,1) = [NewInfectionFromBYYear1(t) + HIV+ Births(s,t)] x S(0,s,t)

New infections can also occur through breastfeeding to children aged 1 or 2. The percentage of children aged 1 exposed to the risk of breastfeeding transmission is the product of proportion of mothers that are HIV+, and the proportion of children not infected as infants.

54. Exposed(1,t) = BirthsToHIVwomen(t) / AllBirths(t) * [1 – PTR(t)] * [1 – [1 – PropReplacementFeeding(t)] * 0.0075 * Infant BF exposure

If the median duration of breastfeeding is 18 months or more then children will be exposed for an entire year. If it is less than 18 months then some children will be exposed for less than one year.

55. ProportionInfectedFromBF(m) = $\sum_{m=12,\min(23,MDBF)} BFTR_{12\text{-}23}$ * (1 – ProportionInfectedFromBF(m-1)

Where:

MDBR is the Median Duration of Breastfeeding in months.

New infections for children infected at age 2 are calculated in a similar manner.

Progression of children from asymptomatic infection to need for treatment

For children there are two different patterns of disease progression depending on whether they were infected at birth or through breastfeeding.
According to the new WHO guidelines all HIV+ children under the age of one are in need of treatment. This includes both children infected perinatally (Asym) and through breastfeeding (BFAsym).

56. Pop(0,t,s,NeedTx,1) = pop(0,t,s,Asym,1) + pop(0,t,s,BFAsym,1)
57. Pop(0,t,s,Asym,1) = 0
58. Pop(0,t,s,BFAsym,1) = 0

After the age of one need for treatment is defined as those HIV+ children who have progressed to moderate-to-severe disease. Thus, children who were in need of treatment when under the age of but did not start on treatment will no longer be in need of treatment unless they have progressed to moderate-to-severe disease. The same equations apply to children infected perinatally (Asym) and through breastfeeding (BFAsym) but the proportion progressing is different. Once children have progressed to need for treatment there is no distinction between those infected perinatally and those infected through breastfeeding.

59. Pop(1,t,s,Asym,2) = pop(1,t,s,NeedTx,2) * [1 – ChildInfToNeed(1,Perinatal)] * (1 – PropNewInfFromBF(t-1))
60. Pop(1,t,s,BFAsym,2) = pop(1,t,s,NeedTx,2) * [1 – ChildInfToNeed(1,BF)] * PropNewInfFromBF(t-1)
61. Pop(1,t,s,NeedTx,2) = pop(1,t,s,NeedTx,2) * [ChildInfToNeed(1,Perinatal) * (1-PropNewInfFromBF(t-1)) + ChildInfToNeed(1,BF) * PropNewInfFromBF(t-1)]

Where

PropNewInfFromBF(t) = the proportion of new infections at age 0 from breastfeeding at year t
ChildInfToNeed(1,x) = Proportion of children progressing to moderate to severe disease after one year where x indicates perinatal infection or breastfeeding infection

Children over the age of one progress from asymptomatic infection to need for treatment according to the appropriate progression pattern. All children infected perinatally will progress before age 15. Children infected through breastfeeding follow their own progression schedule even after the age of 15.

62. FractionProgressing = [ChildInfToNeed(d,Perinatal) – ChildInfToNeed(d-1,Perinatal)] / [100 – ChildInfToNeed(d-1,Perinatal)]
63. Progressors = pop(a,t,s,Asym,d) * FractionProgressing
64. Pop(a,t,s,NeedTx,d) = pop(a,t,s,NeedTx,d) + Progressors
65. Pop(a,t,s,Asym,d) = pop(a,t,s,Asym,d) – progressors
66. FractionProgressing = [ChildInfToNeed(d,BF) – ChildInfToNeed(d-1,BF)] / [100 – ChildInfToNeed(d-1,BF)]
67. Progressors = pop(a,t,s,BFAsym,d) * FractionProgressing
68. Pop(a,t,s,NeedTx,d) = pop(a,t,s,NeedTx,d) + Progressors
69. Pop(a,t,s,BFAsym,d) = pop(a,t,s,BFAsym,d) – progressors

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.

70. NeedFLART(a,s,t) = $\sum_d$ [pop(a,s,t,OnFLART,d) + pop(a,s,t,NeedTx,d)]
71. NeedART(a,s,t) = NeedFLART(a,s,t) + NeedSLART(a,s,t)

Not all need is identified. This is particularly true for children under the age of one. For those children all HIV-positives are in need of treatment. But they can only be identified as HIV+ with a PCR test. Therefore we define 'Identified need' as all those children who have progressed to need for treatment plus all HIV+ children under the age of one whose infection can be identified with a PCR test. The availability of PCR is an input to Spectrum.

72. If a = 0 then IdentifiedNeed = PCR(t) else IdentifiedNeed = 1
73. IdentifiedNeedFLART(t) = $\sum_a\sum_d$ pop(a,t,s,NeedTx,d) * IdentifedNeed + pop(a,t,s,OnFLART,d)

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:

74. Number on FL ART(t) = $\sum_a\sum_s$ NeedFLART(a,s,t) x [coverage of first line ART(t-1) + coverage of first line ART(t)] / 2

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.

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

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

76. NewFLART(a,s,t) = TotalNewFLART(t) x $\sum_d$ IdentifiedNeed(a,s,t) / $\sum_a\sum_s$IdentifiedNeed(a,t,s)

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.

77. Pop(a,s,t,OnFLART,1) = 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.

78. Pop(a,s,t,NeedTx,d) = pop(a,s,t,NeedTx,d) – NewFLART(a,s,t) x pop(a,s,t,NeedTx,d) / $\sum_d$ pop(a,s,t,NeedTx,d)

Need for cotrimoxazole

Children are assumed to need cotrimoxazole under the following conditions:

- Less than 18 months of age, born to an HIV+ mother with unknown HIV status because PCR is not available
- HIV+ and under the age of five
- Age 5 and older and in need of treatment

For children less than 18 months of age the need for cotrimoxazole is all children born to HIV+ mothers who were not infected at birth and have not been tested with PCR plus children known to be infected (HIV+ births plus new infections from breastfeeding in the first 18 months times the proportion confirmed with PCR). The totals are inflated to 18 months by multiplying by 1.5:

79. NeedCTX(t) = BirthsToHIVwomen(t) * 1.5 * [1 – PCR(t)] + (HIVbirths(t) * 1.5 + FYBF + SYBF / 2) * PCR[t]

Where:

FYBF is the number of new infections through breastfeeding in the first year of life
SYBF is the number of new infections through breastfeeding in the second year of life

To this total we add children under the aged 18 to 24 months who are HIV+

80. $NeedCTX(t) = NeedCTX(t) + \sum_s \sum_h \sum_d pop(1,t,s,h,d) / 2$

To this total we add children aged 2 to 4 years who are HIV+

81. $NeedCTX(t) = NeedCTX(t) + \sum_s \sum_{a=2-4} \sum_h \sum_d pop(a,t,s,h,d)$

To this total we add children between the ages of 5 and 14 who have progressed to need for treatment.

82. $NeedCTX(t) = NeedCTX(t) + \sum_s \sum_{a=5-14} \sum_d pop(a,t,s,NeedTx,d)$

Children receiving cotrimoxazole

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

Progress children to AIDS death

Children who are HIV+ and in need of ART but are not receiving either ART or cotrimoxazole progress to AIDS death according to the mortality schedule shown above. Children under the age of 1 in need of treatment have a 95% morality rate. AIDS mortality for those not on ART can be reduced with cotrimoxazole.

83. If a = 0 then FractionProgressing = 0.95 else FractionProgressing = [ChildNeedToDeath(d) – ChildNeedToDeath(d-1)] / [100 – ChildNeedToDeath(d-1)]

The mortality of HIV+ children in need of treatment is reduced if they are receiving cotrimoxazole. Mortality is reduced by 33% in the first five years of use. In Spectrum we assume that all use of cotrimoxazole will be within the five year period of effectiveness. Thus mortality is reduced by the effectiveness of cotrimoxazole adjusted for coverage.

84. FractionProgressing = FractionProgressing * [1 – 0.33 * OnCTX (t)/ NeedCTX(t)]

85. Progressors = pop(a,t,s,NeedTx,d) * FractionProgressing
86. AIDSdeaths(a,t) = AIDSdeaths(a,t) + Progressors
87. Pop(a,t,s,NeedTx,d) = pop(a,t,s,NeedTx,d) – progressors

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

For HIV+ children receiving ART survival can also be increased by cotrimoxazole although its effect is less than when used alone. We assume a reduction in mortality of 33% in the first year, 16% in the second year, 8% in the third year and no effect thereafter. We also assume that duration on cotrimoxazole is the same as duration on ART and that the coverage of cotimoxazole 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.

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

88. FractionProgressing(a,d) = 1 – MortalityOnART(a,d) x [1 – CTXeffect(d) x OnCTX(t) / NeedCTX(t)]
89. Progressors(a,s,t) = pop(a,s,t,OnFLART,d) x FractionProgressing(a,d)
90. Pop(a,s,t,OnFLART,d) = pop(a,s,t,OnFLART,d) – Progressors(a,s,t)
91. AIDS deaths(a,s,t) = AIDS deaths(a,s,t) + Progressors(a,s,t)

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).

FL ART drug cost(t) = pop(0-80+,BothSexes,t,OnFLART,dAll) x FL drug costs per patient(t)
SL ART drug cost(t) = pop(0-80+,BothSexes,t,OnSLART,dAll) x SL drug costs per patient(t)

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.

TB-ART drug cost(t) = [pop(15-80+,Bothsexes,t,OnFLART,dAll) – pop(15-80+, BothSexes,t-1,OnFLART,dAll)] x TB-ART drug costs(t) x TBcases(t) / pop(15-80+,BothSexes,t)

Lab costs(t) = [pop(AllAges,BothSexes,t,OnFLART,dAll) + pop(AllAges,BothSexes,t,POnFLART,dAll)] x Lab costs per patient per year

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.

OI costs(t) = AIDSdeaths(t) + pop(AllAges,BothSexes,t,NeedTx,dAll) x

(1 – ARTcoverage) x OI treatment costs per patient

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

CTX costs(t) = pop(AllAges,BothSexes,t,NeedTx) x CTX costs per patient(t)
TB pro costs(t) = pop(AllAges,BothSexes,t,NeedTx) x TB pro costs per patient(t)

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

Nutrition costs(t) = pop(AllAges,BothSexes,t,OnFLART,1) x 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.

FLART SerDel cost(t) = pop(AllAges,BothSexes,t,OnFLART,dAll) x [In-patient days x cost per day + Out-patient visits x cost per visit]
SLART SerDel cost(t) = pop(AllAges,BothSexes,t,OnSLART,dAll) x [In-patient days x cost per day + Out-patient visits x cost per visit]
OI Tx costs(t) = AIDSdeaths(t) + pop(AllAges,BothSexes,t,NeedTx,dAll) x (1 – ARTcoverage) x [In-patient days x cost per day + Out-patient visits x cost per visit]

Health

Number of Cases of Non-HIV Tuberculosis

$$Non\_HIV\ TB_t = Tbincidence \bullet \sum_{a=15}^{80+} Pop_{at} \ ,$$

where

Non-HIV TBt = 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.

Number of Cases of HIV-Related Tuberculosis

$$HIV\_TB_1 = PercTB \bullet HIV\_Tbincidence \bullet \sum_{a=15}^{80+} HIV\_Pop_{a,s,t} \ ,$$

where

HIV_TBt = 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.

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.

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11. 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.

12. 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