APN 105: MINIMUM REQUIREMENTS FOR DERIVING AIDS EXTRA MORTALITY RATES

Classification

This Advisory Practice Note (APN) provides guidance for Actuaries deriving AIDS extra mortality rates. APN 105 replaces PGN 105. Where legislation or documentation refers to PGN 105 it should be interpreted as APN 105.

Abstract

APN 105 describes the steps to be followed and the minimum requirements for the models to be used to derive projected HIV prevalence and extra AIDS mortality rates.

Purpose

The purpose of APN 105 is to recommend to actuaries in South Africa an approach for determining projected extra AIDS mortality for assured lives.

Legislation or Authority

Actuarial Society of South Africa AIDS Committee

Application

Actuaries in South Africa determining projected extra AIDS mortality for assured lives

Author

Actuarial Society of South Africa AIDS Committee

Status

Version 1	Effective from 1 January 1995
Version 2	Effective from 1 January 2002
Version 3	Effective from 1 July 2007
Version 4	Effective from 1 July 2012

Table of contents

1. BACKGROUND

1.1 This Advisory Practice Note applies in South Africa and came into effect for financial years commencing on or after 1 January 1995 and was revised with effect from 1 January 2002. The second revision came into effect from 1 July 2007 and this third revision comes into effect from 1 July 2012.

1.2 This Advisory Practice Note APN 105 replaces Professional Guidance Note PGN105. Where legislation or other documentation refers to PGN105 it should be interpreted as APN 105.

1.3 There is sufficient data available to illustrate the existence of a widespread pattern II (heterosexual) HIV and AIDS epidemic in South Africa. The potential effect of this epidemic is more serious and complex than the epidemics in Western Europe or North America.

1.4 SAP104, a mandatory Standard of Actuarial Practice issued by the Actuarial Society of South Africa requires the statutory actuary of a life office to take into account the effect of HIV and Aids when performing the valuation of a long term insurer's liabilities.

1.5 The purpose of APN 105 is to recommend to actuaries in South Africa an approach for determining projected extra AIDS mortality for assured lives. The original APN 105 provided four tables that could be used by actuaries as a basis for deriving projected extra AIDS mortality: light group (LG1), heavy group (HG1), light assured lives (LA1) and heavy assured lives (HA1), where "light" and "heavy" refer to the extent of HIV risk exposure. Extra AIDS mortality and HIV prevalence tables were provided separately for males and females, by calendar year and by age.

1.6 The first revision to APN 105 provided new mortality and prevalence tables (LA2, HA2, LG2, HG2) based on the ASSA2000 AIDS and Demographic model, as well as a sub-population model (spreadsheet application). The sub-population model drew HIV infection (incidence) rates from ASSA2000Lite and applied them to a user-specified sub-population. The sub-population was specified in terms of risk group composition, median term to death for HIV positive lives and a scaling factor that was applied to incidence rates. The actuary was therefore free to use the default LA2/HA2/LG2/HG2 tables as basis for projecting extra AIDS mortality, or to alter the sub-population model parameters to fit more closely the experience or risk profile of the particular group under his or her consideration.

1.7 The key elements of the second revision of APN 105 are as follows:

1.7.1 We describe the steps to be followed and the minimum requirements for the models to be used to derive projected HIV prevalence and extra AIDS mortality rates for assured lives in sections 2 to 4. To comply with this advisory practice note these steps must be followed and the models used must meet at least the minimum requirements when deriving projected HIV prevalence and extra AIDS mortality rates.

1.7.2 We provide a spreadsheet model (the APN 105 model) that meets the minimum requirements and is capable of producing HIV prevalence and AIDS mortality rates. Actuaries are not obliged to use the model.

1.7.3 Actuaries can use the APN 105 model or other models to obtain rates more closely suited to their particular requirements. The APN 105 model contains bases (sets of parameters) for a few default scenarios. The sample bases are: assured lives best rate group (AB1), assured lives worst rate group (AW1), group lives high risk (GH1), group lives low risk (GL1), funeral principal lives (FP1) and population (P1). The actuary may use these sample bases as a point of

departure for refinement for a particularly situation. The actuary must ensure that he or she understands the significance of changing the parameters in the sample basis.

1.7.4 The sample bases produce ultimate HIV prevalence and extra AIDS mortality rates. The model allows the user to enter the last date that the cohort in question returned a negative HIV test result to produce select rates.

1.8 This third revision, APN 105 removes and updates references to PGN102 which was discontinued in May 2009. It also updates the classification of the guidance in the note to Advisory Practice Note.

1.9 There are many aspects of the HIV & AIDS epidemics that are still uncertain, particularly with respect to the impact of interventions, and these recommendations will be revised as new information becomes available.

1.10 Projected extra AIDS morbidity rates have not been calculated, but actuaries should allow for the effect of HIV and AIDS on morbidity rates in actuarial work. Disability resulting from AIDS is expected to occur up to a few years before death, but allowance may be made for the fact that some deaths will occur within the waiting period. Where benefits are paid in instalments, the expected duration until death will be much shorter for disability resulting from AIDS than the average for other causes.

2. RISK GROUPS

2.1 The actuary should analyse any available data in order to assess the exposure of any portfolio of lives to HIV infection. In South Africa, the most important requirement is to determine what proportion of the portfolio is at risk of exposure to the HIV epidemic.

2.2 The "Pattern II" HIV epidemic (mode of transmission largely through heterosexual contact) is predominant in Africa and in South Africa. Although this epidemic is often associated with communities that have poor access to primary health facilities and high levels of other infectious diseases, HIV infection has also been observed in the higher socio-economic classes and is likely to have a significant effect on the experience of life offices.

2.3 In practice, however, the assessment will depend on the data available to the actuary. Other criteria may be product type, specific employee groups, underwriting classes, and so forth.

2.4 HIV prevalence and AIDS mortality rates for assured lives, particularly individual assured lives, tend to be significantly lower than for the population as a whole. Actuaries should take this into account where business is written for high risk, non-employee groups.

2.5 There are significant geographical differences in AIDS mortality rates and actuaries should allow for regional differences where appropriate. Reference should be made to the experience over time of antenatal clinics in the various provinces and the results of the ASSA models calibrated for the different provinces.

3. MODELLING HIV AND AIDS

3.1 These are the minimum requirements that are recommended when modelling HIV prevalence and extra AIDS mortality.

3.2 Unless the actuary is dealing with a national group or other relatively closed population (such as an isolated town), a sub-population modelling methodology should be used.

3.2.1. It is not generally acceptable to simply adapt a population model such as ASSA2008 to produce rates for a subset of the population or to model the impact of interventions on a sub-population.

3.2.2. Incidence rates for the population as a whole should be obtained from a suitable population model such as ASSA2008 (for South African lives) and imported into a sub-population model such as the ASSA Select model or the APN 105 model.

3.3 The level of risk of HIV infection for a particular sub-population may be altered by one or more of the following methods as appropriate:

3.3.1. *Using risk-group specific HIV incidence rates from the population model, and then varying the proportion of the sub-population in each risk group*. The actuary must appreciate that changing the risk group composition alters both the level and shape of the incidence rate trends over time.

3.3.2. *Scaling the incidence rates by some multiple*. This approach alters the level of the rates but not the shape.

The APN 105 model uses both of these two approaches.

3.3.3. Using other incidence rates such as race-based or aggregate incidence rates from the population model, and changing the proportions of different incidence rates used to approximate the target population. This approach similarly impacts the level and shape of incidence rates.

3.4 A multistate approach to modelling disease progression is recommended. Disease stage models should include as a minimum the following states, which are used in the APN 105 model:

- HIV negative
- HIV positive, asymptomatic
- HIV positive, AIDS Related Complex, pre full blown AIDS
- On antiretroviral therapy
- Sick (full blown AIDS and/or failure of antiretroviral therapy)

3.4.1. More complex disease stage models such as those used by ASSA Select are possible and may be used as appropriate or desired, with appropriate parameterisation.

3.4.2. The Weibull distribution is the preferred process for modelling disease stage transitions, and is used in the APN 105 model, the ASSA2000, ASSA2002, ASSA2003 and ASSA2008 models. This is because the Weibull distribution allows for changing decrement rates by duration, whereas the exponential distribution has a constant decrement rate by duration since infection.

3.4.3. ASSA Select does not use this approach, relying instead on an exponential disease process to simplify the modelling endeavour in very complex

workforce projections. This approach is acceptable where computing capacity constraints the complexity of modelling, but this approach should be phased out as computing power increases. The actuary should be aware of the consequences of using exponential versus Weibull modelling, and of the differences in shape and timing of the emergence of deaths and disabilities that will result.

3.5 Modelling should preferably produce separate rates for each age, sex and calendar year.

3.5.1. Age bands may be acceptable in certain situations.

3.5.2. Unisex modelling is not recommended.

3.5.3. AIDS rates vary with calendar year and constant AIDS rates with respect to calendar year can hardly if ever be adequate.

3.6 The actuary should allow where appropriate for the effects of selection.

3.6.1. Select periods for policies with HIV selection (such as initial HIV testing) are very long – often fifteen years or more, and rates may never reach an otherwise "ultimate" level.

3.6.2. The dual effect of selection and calendar year must be borne in mind: testing a group of lives in 1990 and in 2005 will have very different effects. Ideally therefore rates should vary by age, calendar year of selection and policy duration (or attained calendar year).

3.6.3. Simplified approximations may be suitable as long as the actuary understands the limitations and impact of the simplifications.

3.7 Output indicators from the modelling exercise – most commonly aggregate (AIDS and non-AIDS) or AIDS-only mortality rates, or HIV prevalence rates – should be verified against available experience or data. The parameters affecting the levels of HIV risk should be adjusted in light of credible information.

4. THE APN 105 MODEL

The onus is placed on the actuary to ensure that he is competent to use the APN 105 model and has a sound and sufficient understanding of the issues relating to HIV and AIDS modelling. This may require attendance of formal training sessions regarding the model or HIV and AIDS modelling in general offered by ASSA or other actuarial bodies.

This section describes the various sheets in the model and provides a summary at the end.

4.1 Introduction

This is the worksheet that appears on the screen when the user opens the model.

At the top it has a button, labelled 'Compute AIDS Death Rates' that initiates the runs. When invoked, a pop-up screen appears prompting a choice from a number of assumption sets or bases. The assumption sets are fully described in the worksheet titled 'EpidemiologicalAssumptions'.

Once the basis has been selected the model is run and the output appears in the sheets 'AIDSDeathRates' and 'HIVPrevalenceRates'.

There are also two graphs that show the modelled extra AIDS death rates and prevalences for selected ages over time.

4.2 Epidemiological Assumptions

This worksheet contains the epidemiological assumptions required to calibrate the model.
These are generally specified separately for males and females.

Incidence Rate Weightings
The user specifies the proportions of the select population deemed to be in the various risk groups as defined by the ASSA20xx model:

PRO Individuals with sexual activity similar to that of commercial sex workers, and with condom usage and infection with STDs similar to that of the STD group.

STD Individuals whose level of sexual activity is such that their HIV prevalence is similar to someone regularly infected with STDs.

RSK Individuals with a lower level of sexual activity, but who are still at risk from HIV in that they have, on average, one new partner per annum and sometimes engage in unprotected sex.

NOT Individuals who are not at risk of HIV infection.

Note: *Setting the proportions equal to 100% for each of the above risk groups imply that the select population contains the same proportion of each risk group as the ASSA20xx model*. This is different to the previous APN 105 model where the proportions parameters summed in total to 100%, representing a partition of the initial subgroup between the different risk groups.

There is a further parameter that allows for a general scaling factor to be applied to the proportions selected above.

Survival Assumptions
The user specifies the survival parameters within various HIV states. Each state is modelled with a Weibull distribution. The median and shape parameters are required for age 14 and 65 with the model interpolating linearly for the ages in-between.

The following states are currently allowed for:

- Stage 1: HIV positive, asymptomatic.
- Stage 2: HIV positive, AIDS related Complex, pre full blown AIDS.
- Stage 3: On antiretroviral treatment.
- Stage 4: AIDS sick (full blown AIDS and/or failure of antiretroviral treatment).

Allow for ART
The user can enter the time from which ART is made available to the cohort in question and the proportion of those in the AIDS sick state who are assumed to initiate ART each year.

Passing of an HIV test
The user can enter the last date that the cohort in question returned a negative HIV test result.

Raw data to use
The user can enter the sheet containing the number of susceptibles and the number of new sero-converters for the different risk groups over time as produced by an ASSA population model (e.g. ASSA2008)

4.3 Calibration

This worksheet has been included to assist the user in calibrating the model to the desired cohort.
The user must first enter the profile of the cohort in question, which is gender specific and may be weighted either by number or amount.

The most likely points of calibration are prevalence rates or death rates experienced by the cohort. The user can enter any actual observed data on prevalence or AIDS deaths, and the worksheet graphically shows the fit of the current calibration to these.

The worksheet also shows the implied incidence rates for the cohort and the fitted levels of incidence, prevalence and death rates for the cohort contrasted against those for the national population from the ASSA20xx model.

4.4 AidsDeathRates

This worksheet contains the output of the AIDS deaths for the run in question. The results are generated from a macro that makes successive calls to the 'Cohort Workings' spreadsheet.

4.5 HIVPrevalenceRates

This worksheet contains the output of the HIV prevalence rates for the run in question. The results are generated from a macro that makes successive calls to the 'Cohort Workings' spreadsheet.

4.6 Terminations sheets

These worksheets determine the survivor functions and death rates for the specified states. These are based on a Weibull structure, the parameters of which are given in the EpidemiologicalAssumptions worksheet. The median and shape parameters for each state are required for ages 14 and 65 and parameters for intermediate ages are linearly interpolated.

The user would not normally be required to make any changes to these worksheets.

4.7 IncidenceRates

This worksheet derives the incidence rates for the cohort in question based upon the assumptions given in the EpidemiologicalAssumptions worksheet as applied to the output of the ASSA20xx model as copied to the sheet ASSA20xx_RawData.

The user would not normally be required to make any changes to this worksheet.

4.8 ASSA20xx_RawData

The macro under the button 'Compute AIDS Death Rates' copies the number of susceptibles and the number of new sero-converters for the different risk groups over time from the sheet specified under the heading 'Raw data to use' on the sheet EpidemiologicalAssumptions.

The user would not normally be required to make any changes to this worksheet.

4.9 Cohort Workings

This is the crux of the model and the sheet which is successively called in generating the prevalence and death rates given in the 'HIVPrevalenceRates' and 'AIDSDeathRates' worksheets.

For a given starting age and calendar year the worksheet tracks the specified cohort from the start of the epidemic through to calendar year 2020. The relevant incidence rates are accessed and the breakdown of the cohort by different HIV/AIDS stages is determined. The worksheet also produces prevalence rates and AIDS deaths for the cohort over time.

The mathematics underlying these projections assumes that non-AIDS mortality is independent of an individual's HIV status. This has been debated at some length and whilst there is evidence to suggest that this assumption is incorrect, the effect on the underlying results is not significant.

A macro calls successive cohorts and copies the results to the worksheets 'HIVPrevalenceRates' and 'AIDSDeathRates'. For each single age above 18 years at the start of the epidemic (1985), a separate cohort is tracked to calendar year 2020. New cohorts are introduced for new entrants aged 18 commencing in years 1986 through to 2020.

It is hoped that this worksheet will assist users in understanding the results and in an audit capacity should the user choose to amend the modelling process.

4.10 AuditCohortExits

This worksheet is a tool for checking the output and assists the user in understanding the underlying approach to the calculations.

4.11 Summary of sheets

In theory, the user can change virtually any value or formula in the workbook. In practice, there are a limited number of values and formulae that can usefully and sensibly be changed. The third column of the table below indicates which worksheets contain cells with assumptions that can sensibly be changed. The fourth column indicates the worksheets that are changed by the model during projections.

Worksheet name	Worksheet function	Can be changed	Changed by model during projections
Introduction	Set up runs	YES	YES
EpidemiologicalAssumptions	Sets overall assumptions	YES	NO

Worksheet name	Worksheet function	Can be changed	Changed by model during projections
Calibration	Tests results against reality	YES	NO
AidsDeathRates	Results	NO	YES
HIVPrevalenceRates	Results	NO	YES
ASYMP+ARC_terminations	Calculates steps of projections	NO	NO
SICK_terminations	Calculates steps of projections	NO	NO
ART_terminations	Calculates steps of projections	NO	NO
IncidenceRates	Calculates steps of projections	NO	NO
ASSA20xx_RawData	ASSA20xx input	NO	YES
Cohort Workings	Calculates steps of projections	YES	YES
AuditCohortExits	Audit tool	YES	YES

5 SAMPLE BASES

The sheet "EpidemiologicalAssumptions" contains a number of sample bases. The table below lists the basis names and what the output could approximate.

Output – most commonly aggregate (AIDS and non-AIDS) or AIDS-only mortality rates, or HIV prevalence rates – should be verified against available experience or data.

The parameters affecting the levels of HIV risk should be adjusted in light of credible information. Actual experience will depend inter alia on underwriting, region and industry.

Set the "Did the cohort pass an AIDS test in the past" parameter to "Y" and insert the year of passing the test if it applies.

Adjust the distribution of exposed lives on the "Calibration" sheet if necessary before calibration.

Basis	**Approximation for**
Assured lives worst rate group (AW1)	Assured lives in the worst rate group.
Assured lives best rate group (AB1)	Assured lives in the best rate group.
Funeral no medical testing, principal lives, 6 months waiting period (FP1)	Principal lives under funeral type policies with no medical testing and a 6 month waiting period. Dependants under funeral type policies are likely to have worse experience because of anti-selection.
High group lives (GH1)	Group lives with a high AIDS risk
Low group lives (GL1)	Group lives with low AIDS risk.
Population (P1)	Population.

6.1 Structure of HIV stages

The APN 105 model assumes that all lives receiving ART must first pass through the sick state. ASSA2008 assumes that lives either move to stage 4 or stages 5 and 6.

The APN105 model merges some of the ASSA stages into one.

These differences are illustrated in Figure 1.

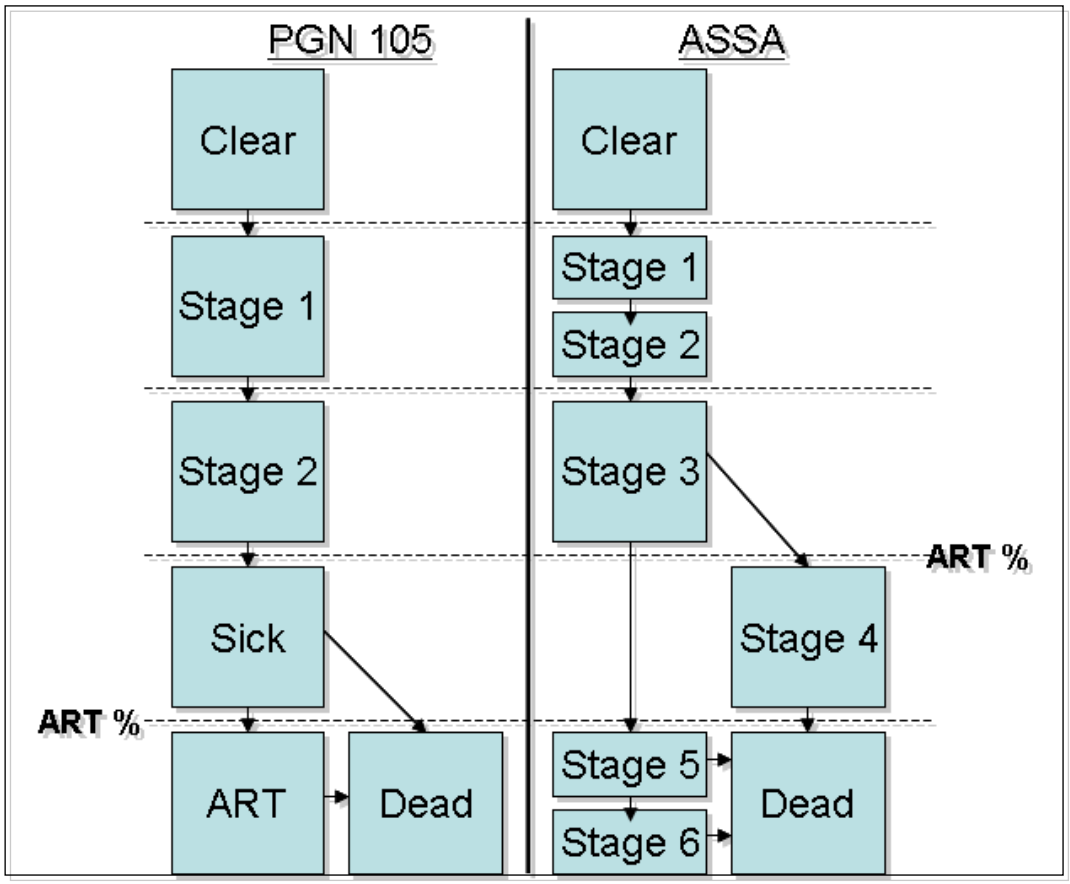

Figure 1: Structure of HIV stages in APN 105 and ASSA2008

6.2 Non-AIDS deaths

The APN 105 model does not allow for Non-AIDS deaths. Rates provided are independent of all Non-AIDS decrements.

6.3 Immigration

The ASSA2008 model allows for immigration, while the APN 105 model does not.

6.4 Structure of transition rates

APN 105 has just two sets and these are for age 14 and 65, while ASSA2008 has three sets of median term rates for ages 19, 29 and 39. In order to compare the calculations in the two models, all five sets of assumptions would have to be set consistently.

6.5 ART phase-in

APN 105 assumes that ART starts in one particular year at a certain percentage. Thereafter, ART is fixed at this percentage. ASSA2008 allows for a phased roll out of antiretrovirals.

6.6 AIDS death rates

ASSA2008 assumes that there are no deaths in the first 6 months from infection, while APN 105 assumes that deaths in the first 6 months follow the Weibull curve.